Lead Agency: National Aeronautics and Space Administration (NASA)

Cooperating Agencies: U.S. Department of the Interior, Minerals Management Service (MMS)
U.S. Army Corps of Engineers (USACE)

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Date: February 2010

Abstract: NASA has prepared a Draft Programmatic Environmental Impact Statement (PEIS) for the Shoreline Restoration and Infrastructure Protection Program (SRIPP) at Wallops Flight Facility in accordance with the National Environmental Policy Act, as amended, to assist in the decision making process for the SRIPP. The MMS and USACE are Cooperating Agencies for this PEIS. The purpose of the SRIPP is to reduce the potential for damage to, or loss of, existing NASA, U.S. Navy, and Mid-Atlantic Regional Spaceport assets on Wallops Island from wave impacts associated with storm events. The potential effects to physical, biological, and socioeconomic environments were studied to determine how the Proposed Action Alternatives and the No Action Alternative could affect these resources. The Proposed Action would have both adverse and beneficial impacts to environmental resources. Adverse impacts would be mitigated to the greatest extent practicable to minimize the effects on resources.
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EXECUTIVE SUMMARY

The National Aeronautics and Space Administration (NASA) has prepared this Programmatic Environmental Impact Statement (PEIS) to evaluate the potential environmental impacts from the proposed Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP). The SRIPP encompasses a 50-year planning horizon and is intended to reduce storm-induced physical damage to Federal and State infrastructure on Wallops Island.

This PEIS has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S. Code 4321-4347), the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] 1500-1508), NASA’s regulations for implementing NEPA (14 CFR Subpart 1216.3), and the NASA Procedural Requirements (NPR) for Implementing NEPA and Executive Order (EO) 12114 (NPR 8580.1).

The U.S. Department of the Interior Minerals Management Service (MMS) and the U.S. Army Corps of Engineers (USACE), Norfolk District, have served as Cooperating Agencies in preparing this PEIS, because they possess regulatory authority and specialized expertise pertaining to the Proposed Action. This PEIS is being developed to fulfill all three Federal agencies’ obligations under NEPA. NASA, as the WFF property owner and project proponent, is the Lead Agency and responsible for ensuring overall compliance with applicable environmental statutes, including NEPA.

PURPOSE AND NEED FOR THE ACTION

The purpose of the Proposed Action is to reduce the potential for damage to, or loss of, NASA, U.S. Navy, and Mid-Atlantic Regional Spaceport (MARS) assets on Wallops Island from wave impacts associated with storm events. The Proposed Action is needed to ensure the continued ability of NASA, the U.S. Navy, and MARS to serve the Nation’s rapidly growing civil, defense, academic, and commercial aerospace requirements. The SRIPP would help reduce the risk to infrastructure on Wallops Island from storm-induced damages by restoring the beach profile in front of the present shoreline.

Wallops Island has experienced shoreline changes throughout the six decades that NASA has occupied the site. The existing seawall is being undermined because there is little or no protective sand beach remaining and storm waves break directly on the rocks. Currently, the south end of the island is unprotected except for a low revetment around the MARS launch pad and temporary geotextile tubes that extend from the southern end of the existing seawall south to camera stand Z-100.

The potential risks to infrastructure from wave impacts are two-fold: first is the interruption of NASA, U.S. Navy, and MARS missions supported from Wallops Island facilities due to temporary loss of facility functions; and second is the potential for complete loss of these unique facilities. If no protective measures are taken, then the assets on Wallops Island will be increasingly at risk from even moderate storm events. Additionally, WFF and MARS are located within the only research range in the United States that is wholly controlled by NASA, and as a result, WFF is the only research range in the world that is solely under NASA control and focused on NASA’s schedule, budget, and mission objectives. Under Title II of the Omnibus Appropriations Act of 2009 (Public Law 111-8), the U.S. Congress stated that “WFF is an
important national asset that can be better utilized by focusing on emerging technologies that meet national needs and NASA priorities.”

**ALTERNATIVES EVALUATED IN DETAIL**

The combination of options that would provide the maximum level of storm damage reduction while remaining within the limits of available funding were chosen to be evaluated in detail as the three Proposed Action Alternatives discussed below.

**Alternative One (Preferred Alternative)**

The Preferred Alternative would involve an initial construction phase with follow-on renourishment cycles. The initial phase would include two distinct elements:

1. Extending Wallops Island’s existing rock seawall a maximum of 1,400 meters (m) (4,600 feet [ft]) south of its southernmost point.

2. Placing sand dredged from Unnamed Shoal A, located offshore in Federal waters, on the Wallops Island shoreline. An estimated 2,446,000 cubic meters (m$^3$) (3,199,000 cubic yards [yd$^3$]) of fill would be placed along the shoreline starting at camera stand Z-100, which is located approximately 4,600 m (1,500 ft) north of the Wallops Island-Assawoman Island property boundary and extending north for 6.0 kilometers (3.7 miles).

Each renourishment fill volume is anticipated to be approximately 616,000 m$^3$ (806,000 yd$^3$). The renourishment cycles would include placing sand on the Wallops Island shoreline taken from either of three sources: the beach on the north end of Wallops Island, or from one of two sand shoals (Unnamed Shoal A or Unnamed Shoal B) located offshore in Federal waters. The renourishment cycle is anticipated to occur every 5 years, with a total of 9 renourishment cycles over the 50-year life of the SRIPP. The topography and bathymetry of the beach would be monitored on a regular basis to determine sand movement patterns and plan when renourishment is needed. The initial fill plus the total fill volume over nine renourishment events would result in approximately 7,992,000 m$^3$ (10,453,000 yd$^3$) of sand being placed on the shoreline.

**Alternative Two**

Under Alternative Two, the seawall extension would be the same as described under Alternative One. In addition, a groin would be constructed at the south end of the Wallops Island shoreline and would involve the placement of rocks in a linear structure perpendicular to the shoreline at approximately 445 m (1,460 ft) north of the Wallops Island-Assawoman Island border. The structure would be approximately 130 m (430 ft) long and 15 m (50 ft) wide. Approximately two-thirds of the groin (80 m [265 ft]) would be installed on the beach once the fill has been placed, and the remaining one-third, approximately 50 m (165 ft), would extend beyond the beach into the ocean. It would take approximately 1 month to build.

Construction of the groin would result in more sand being retained along the Wallops Island beach, so less fill would be required for both the initial nourishment and renourishment volumes compared to Alternative One. The initial fill volume would be 2,229,000 m$^3$ (2,916,000 yd$^3$) and each renourishment fill volume would be 552,000 m$^3$ (722,000 yd$^3$). The initial fill plus the total fill volume over nine renourishment events would result in approximately 7,198,000 m$^3$ (9,414,000 yd$^3$) of sand being placed on the shoreline.
Executive Summary

Beach fill would be placed along the same length of the shoreline as described under Alternative One, but because less initial nourishment and renourishment fill would be required, the beach profile would not extend as far into the ocean. Renourishment borrow sites would be the same as described under Alternative One.

**Alternative Three**

Under Alternative Three, the seawall extension would be the same as described under Alternative One. In addition, a single nearshore breakwater would be constructed at the south end of the Wallops Island shoreline and would involve the placement of rocks in a linear structure parallel to the shoreline. The breakwater structure would be constructed approximately 230 m (750 ft) offshore. The breakwater would be approximately 90 m (300 ft) long and 35 m (110 ft) wide, and would take approximately 1 month to build. Construction would take place in the water using a barge and heavy lifting equipment.

Construction of the breakwater would result in more sand being retained along the Wallops Island beach, so less fill would be required for both the initial nourishment and renourishment volumes compared to Alternative One. The initial fill volume would be 2,170,000 m$^3$ (2,839,000 yd$^3$) and each renourishment fill volume would be 537,000 m$^3$ (703,000 yd$^3$). The initial fill plus the total fill volume over nine renourishment events would result in approximately 7,008,000 m$^3$ (9,166,000 yd$^3$) of sand being placed on the shoreline.

Beach fill would be placed along the same length of the shoreline as described under Alternative One, but because less initial nourishment and renourishment fill would be required, the beach profile would not extend as far into the ocean.

**No Action Alternative**

Under the No Action Alternative for this PEIS, the SRIPP would not be conducted on Wallops Island, but maintenance and emergency repairs to existing structures would continue. Maintenance activities include repairs to the existing seawall and to the geotextile tubes. Emergency actions may include hauling in additional rock to add to the existing seawall, hauling and placing sand on the beach or behind existing shoreline protection, installing sheet piling in or near the high tide level, or emergency geotextile tube installation. Under this alternative, the seawall can be expected to continue to deteriorate and would be increasingly vulnerable to massive failure during large storm events as waves break directly on the structure and also undercut the leading edge of the seawall.

Over $1 billion in NASA, U.S. Navy, and MARS equipment, buildings, and infrastructure would continue to be at increasing risk from storm damage. Maintenance and emergency repairs to structures and the seawall would continue to be required. Shoreline retreat would continue. Operations at facilities may be disrupted during severe storm events from flooding and waves overtopping the seawall. The danger to the MARS launch complex and Uninhabited Aerial Systems airstrip on the southern portion of the island would increase due to the rapidly retreating shoreline in that area.

**SUMMARY OF ENVIRONMENTAL IMPACTS**

A comparison of the potential impacts shown by resource for each alternative is provided in Table ES-1.
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# Executive Summary

## Table ES-1: Summary of Impacts from Proposed Action Alternatives

<table>
<thead>
<tr>
<th>Resource</th>
<th>Alternative One</th>
<th>Alternative Two</th>
<th>Alternative Three</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geology and Sediment</strong></td>
<td>Placement of beach fill (initial and renourishment) would create and maintain a</td>
<td>Placement of beach fill (initial and renourishment) would create and maintain a</td>
<td>Placement of beach fill (initial and renourishment) would create and maintain a</td>
<td>Adverse impacts on land use, geology and sediments from continued loss of the shoreline. Negligible adverse impacts on sediments would be caused during emergency operations over the 50-year lifetime of the SRIPP.</td>
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<td></td>
<td>beach berm approximately 21 meters (70 feet) wide on Wallops Island. The addition of sediment to the longshore transport system would result in accretion at the southern end of Wallops Island and northern end of Assawoman Island. Over the lifetime of the SRIPP, the seawall extension and beach fill would have long-term direct beneficial impacts on geology and the Wallops Island shoreline by mitigating the current rate of shoreline retreat. Continued beach nourishment would add to this benefit by providing ongoing mitigation of shoreline retreat. North Wallops Island sand removal would result in minor adverse impacts on sediments and would lower topography within the excavated areas.</td>
<td>beach berm approximately 21 meters (70 feet) wide on Wallops Island. The addition of sediment to the longshore transport system would result in accretion at the southern end of Wallops Island and northern end of Assawoman Island; therefore, long-term direct beneficial impacts on land use, geology and sediment would occur due to creation of a beach. North Wallops Island sand removal would result in minor adverse impacts on sediments and topography.</td>
<td>Construction of a groin would help to retain sand on the Wallops Island shoreline so that erosion and sediment transport from Wallops Island would be reduced and the beach created by the SRIPP would stay in place longer than under Alternative One. North Wallops Island sand removal would result in minor adverse impacts on sediments and would lower topography within the excavated areas.</td>
<td></td>
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<tr>
<td>Placement of beach fill (initial and renourishment) would create and maintain a beach berm approximately 21 meters (70 feet) wide on Wallops Island. The addition of sediment to the longshore transport system would result in accretion at the southern end of Wallops Island and northern end of Assawoman Island; therefore, long-term direct beneficial impacts on land use, geology and sediment would occur due to creation of a beach. North Wallops Island sand removal would result in minor adverse impacts on sediments and topography.</td>
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<td>North Wallops Island sand removal would result in minor adverse impacts on sediments and would lower topography within the excavated areas.</td>
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<tr>
<td><strong>Offshore Shoals/Bathymetry</strong></td>
<td>Dredging would remove a total of approximately 3,057,500 m$^3$ (3,998,750 yd$^3$) of sand from Unnamed Shoal A for the initial beach fill. Each of the nine anticipated renourishment cycles would require 770,000 m$^3$ (1,007,500 yd$^3$) or a total of approximately 9,990,000 m$^3$ (13,066,250 yd$^3$) over the lifetime of the SRIPP. The renourishment material may be dredged from Unnamed Shoal A, Unnamed Shoal B, and/or the northern end of Wallops Island. The newly created beach profile would extend</td>
<td>Dredging would remove a total of approximately 2,786,250 m$^3$ (3,645,000 yd$^3$) of sand from Unnamed Shoal A for the initial beach fill. Each of the nine anticipated renourishment cycles would require 690,000 m$^3$ (915,500 yd$^3$) or a total of approximately 8,997,500 m$^3$ (11,767,500 yd$^3$) over the lifetime of the SRIPP. The renourishment material may be dredged from Unnamed Shoal A, Unnamed Shoal B, and/or the northern end of Wallops Island. The newly created beach profile would extend</td>
<td>Dredging would remove a total of approximately 2,712,500 m$^3$ (3,548,750 yd$^3$) of sand from Unnamed Shoal A for the initial beach fill. Each of the nine anticipated renourishment cycles would require 671,250 m$^3$ (878,750 yd$^3$) or a total of approximately 8,760,000 m$^3$ (11,457,500 yd$^3$) over the lifetime of the SRIPP. The renourishment material may be dredged from Unnamed Shoal A, Unnamed Shoal B, and/or the northern end of Wallops Island. The newly created beach profile would extend</td>
<td>No impacts.</td>
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<td>Placement of beach fill (initial and renourishment) would create and maintain a beach berm approximately 21 meters (70 feet) wide on Wallops Island. The addition of sediment to the longshore transport system would result in accretion at the southern end of Wallops Island and northern end of Assawoman Island; therefore, long-term direct beneficial impacts on land use, geology and sediment would occur due to creation of a beach. North Wallops Island sand removal would result in minor adverse impacts on sediments and topography.</td>
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<td>North Wallops Island sand removal would result in minor adverse impacts on sediments and would lower topography within the excavated areas.</td>
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<td><strong>Shoreline Change</strong></td>
<td>extend underwater for a maximum of 52 meters (170 feet), resulting in a new bathymetric profile within the subaqueous lands immediately east of Wallops Island.</td>
<td>extend underwater for a maximum of 52 meters (170 feet), resulting in a new bathymetric profile within the subaqueous lands immediately east of Wallops Island.</td>
<td>underwater for a maximum of 52 meters (170 feet), resulting in a new bathymetric profile within the subaqueous lands immediately east of Wallops Island.</td>
<td>The shoreline along the southern portion of Wallops Island would continue to erode at a rate of approximately 3 m (10 ft) per year. The shoreline along the seawall would be held at its current location until erosional forces and undermining of the seawall would cause it to fail. The current seawall shows 13 areas of concern where the seawall has shown a vertical drop of at least 2 m (6 ft). Sediment would continue to accrete along the northern end of Wallops Island.</td>
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<tr>
<td></td>
<td>Placement of beach fill (initial and renourishment) would create a beach berm approximately 21 m (70 ft) wide on Wallops Island, resulting in long-term beneficial direct impacts. The addition of sediment to the longshore transport system would offset some ongoing erosion that is occurring at the northern end of Assawoman Island. Dredging of the offshore shoals would result in minimal change to local wave conditions and no impact to the Assateague Island shoreline. Sediment would continue to accrete along the northern end of Wallops Island.</td>
<td>Placement of beach fill (initial and renourishment) would create a beach berm approximately 21 m (70 ft) wide on Wallops Island, resulting in long-term beneficial direct impacts. The addition of sediment to the longshore transport system would offset some ongoing erosion that is occurring at the northern end of Assawoman Island.</td>
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<tr>
<td></td>
<td>There would be an accumulation of sediment on the updrift side of the groin, and it is possible that groin would function as a “shadow,” causing an increase in erosion downdrift of the area within the groin shadow. Renourishing the beach would reduce the potential for downdrift erosion by providing continual sand on the Wallops Island shoreline, some of which would be available to the longshore sediment transport system. Dredging of the offshore shoals would result in minimal change to local wave conditions and no impact to the Assateague Island shoreline. Sediment would continue to accrete along the northern end of Wallops Island.</td>
<td></td>
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</tr>
<tr>
<td><strong>Water Resources</strong></td>
<td>Elevated turbidity in marine waters at the offshore shoals from dredging and in the nearshore environment from sand placement.</td>
<td>Elevated turbidity in marine waters at the offshore shoals from dredging and in the nearshore environment from sand placement.</td>
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<td>Air Quality</td>
<td>Emissions from construction and dredging activities are not anticipated to cause long-term adverse impacts on air quality or climate change.</td>
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<td>Noise</td>
<td>Temporary, localized impacts during construction, dredging and fill, but no adverse impacts. Temporary, localized impacts on marine mammals associated with increased noise from vessel activities (dredging).</td>
<td>Temporary, localized impacts during construction, dredging and fill, but no adverse impacts. Temporary, localized impacts on marine mammals associated with increased noise from vessel activities (dredging).</td>
<td>Temporary, localized impacts during construction, dredging and fill, but no adverse impacts. Temporary, localized impacts on marine mammals associated with increased noise from vessel activities (dredging).</td>
<td>Temporary, localized impacts during construction and/or maintenance activities.</td>
</tr>
<tr>
<td>Hazardous Materials</td>
<td>Beneficial impact by restoring the shoreline and increasing the distance between breaking waves and hazardous materials critical storage areas and accumulation points.</td>
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<td>Beneficial impact by restoring the shoreline and increasing the distance between breaking waves and hazardous materials critical storage areas and accumulation points.</td>
<td>Potential adverse impacts from shoreline retreat and distance of hazardous materials critical storage areas and accumulation points from breaking waves.</td>
</tr>
<tr>
<td>Munitions and Explosives of Concern (MEC)</td>
<td>MEC are not anticipated to be encountered in the area of seawall construction or beach fill. Shoreline erosion would increase to the south of the seawall extension in the first one to two years of the SRIPP; MEC may migrate to the ocean if further beach erosion occurs in this area. The beach fill (starting in year two) would reduce the potential of MEC migration into the ocean. There is a potential that MEC would be encountered during excavation of the north Wallops Island borrow site. NASA would implement an MEC Avoidance Plan, conduct surveys, and remove MEC as necessary.</td>
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<td>NASA would continue to follow the WFF MEC Avoidance Plan, conduct surveys, and remove MEC as necessary.</td>
</tr>
<tr>
<td>Biological Resources - Benthic Resources</td>
<td>Direct adverse impacts on bottom communities within dredging area. Benthic communities and habitat would be removed during dredging. Assuming the entire proposed borrow area of Shoal A would be</td>
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<td>dredged (uniform dredge depth of approximately 0.6 m [2 ft]) for the initial beach fill, approximately 518 hectares (ha) (1,280 acres [ac]) of benthic habitat would be removed. During each of nine renourishment cycles, approximately 140 ha (347 ac) of benthic habitat on Shoal A or Shoal B would be adversely impacted with a uniform dredging depth of approximately 0.6 m (2 ft). Placement of the initial fill would bury existing intertidal benthic community along an approximate 4,300 m (14,000 ft) length of the seawall. The mean tidal range is approximately 1.1 m (3.6 ft); therefore approximately 0.5 ha (1.2 ac) of hard-bottom, intertidal habitat would be permanently buried. In addition, approximately 91 ha (225 ac) of subtidal benthic community along the existing seawall would be buried during the initial fill placement. A new beach would be formed in front the seawall and a beach benthic community would become established.</td>
<td>dredged (uniform dredge depth of approximately 0.6 m [2 ft]) for the initial beach fill, approximately 518 ha (1,280 ac) of benthic habitat would be removed. During each of nine renourishment cycles, approximately 116 ha (287 ac) of benthic habitat on Shoal A or Shoal B would be adversely impacted with a uniform dredging depth of approximately 0.6 m (2 ft). Placement of the initial fill would bury existing intertidal benthic community along an approximate 4,300 m (14,000 ft) length of the seawall. The mean tidal range is approximately 1.1 m (3.6 ft); therefore approximately 0.5 hectare (1.2 ac) of hard-bottom, intertidal habitat would be permanently buried. Approximately 91 ha (225 ac) of subtidal benthic community along the existing seawall would also be buried during the initial fill placement. A new beach would be formed in front the seawall and a beach benthic community would become established.</td>
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<td>No impacts.</td>
</tr>
</tbody>
</table>

### Biological Resources - Fisheries

Direct site-specific adverse effects on EFH within: (1) the dredged area due to removal of benthic habitat and changes in shoal bathymetry and (2) the fill placement area due to burial of existing benthic habitat. However, the impacts would not be significant within a regional context. There would also be minor direct impacts to fisheries outside the dredging and fill.

Direct site-specific adverse effects on EFH within: (1) the dredged area due to removal of benthic habitat and changes in shoal bathymetry and (2) the fill placement area due to burial of existing benthic habitat. However, the impacts would not be significant within a regional context. There would also be minor direct impacts to fisheries outside the dredging and fill.

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<td><strong>Executive Summary</strong></td>
<td>footprints due to turbidity as a result of the dredging and fill placement operations. The groin would provide hard bottom habitat within the nearshore area. The introduction of hard substrate would provide diverse habitat and prey to the nearshore fish assemblage.</td>
<td>footprints due to turbidity as a result of the dredging and fill placement operations. The breakwater would provide hard bottom habitat within the nearshore area. The introduction of hard substrate would function similar to an artificial reef and provide diverse habitat and prey to the nearshore fish assemblage.</td>
<td>the dredging and fill placement operations. No impacts.</td>
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</tr>
<tr>
<td><strong>Biological Resources – Marine Mammals</strong></td>
<td>Potential temporary, localized adverse impacts associated with (1) physical disturbance to habitats during dredging and fill, (2) vessel strike, and (3) increased noise from vessel activities (dredging).</td>
<td>Potential temporary, localized adverse impacts associated with (1) physical disturbance to habitats during dredging and fill, (2) vessel strike, and (3) increased noise from vessel activities (dredging).</td>
<td>Potential temporary, localized adverse impacts associated with (1) physical disturbance to habitats during dredging and fill, (2) vessel strike, and (3) increased noise from vessel activities (dredging).</td>
<td>No impacts.</td>
</tr>
<tr>
<td><strong>Biological Resources - Threatened &amp; Endangered Species</strong></td>
<td>May affect, not likely to adversely affect vegetation, whales, sea turtles (except for loggerhead), and the Red Knot. May affect, likely to adversely affect loggerhead sea turtle, Piping Plover. No adverse affect to other bird species.</td>
<td>May affect, not likely to adversely affect vegetation, whales, sea turtles (except for loggerhead), and the Red Knot. May affect, likely to adversely affect loggerhead sea turtle, Piping Plover. No adverse affect to other bird species.</td>
<td>May affect, not likely to adversely affect vegetation, whales, sea turtles (except for loggerhead), and the Red Knot. May affect, likely to adversely affect loggerhead sea turtle, Piping Plover. No adverse affect to other bird species.</td>
<td>No impacts.</td>
</tr>
<tr>
<td><strong>Socio-economics</strong></td>
<td>Beneficial impacts from reducing damages to infrastructure, reducing losses of work days and jobs, and from temporary construction-related job creation. Temporary minor adverse effects on surf clams and fisheries at dredge site from smothering and elevated turbidity, temporary impacts on commercial and recreational fishing resources during the placement of beach fill material on Wallops Island due to elevated turbidity levels in the nearshore environment and disruption of the benthos, which would cause fish to avoid the disturbed areas. No long-term adverse impacts on commercial and recreational fisheries.</td>
<td>Beneficial impacts from reducing damages to infrastructure, reducing losses of work days and jobs, and from temporary construction-related job creation. Temporary minor adverse effects on surf clams and fisheries at dredge site from smothering and elevated turbidity, temporary impacts on commercial and recreational fishing resources during the placement of beach fill material on Wallops Island due to elevated turbidity levels in the nearshore environment and disruption of the benthos, which would cause fish to avoid the disturbed areas. No long-term adverse impacts on commercial and recreational fisheries.</td>
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<td>Potential adverse impacts from interruption in WFF activities or loss of infrastructure.</td>
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<th>Alternative Two</th>
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<tr>
<td>Cultural Resources</td>
<td>No archaeological (below ground or underwater) resources or above-ground historic properties are present within the project area; therefore no archeological resources or above-ground historic properties would be impacted.</td>
<td>No archaeological (below ground or underwater) resources or above-ground historic properties are present within the project area; therefore no archeological resources or above-ground historic properties would be impacted.</td>
<td>No archaeological (below ground or underwater) resources or above-ground historic properties are present within the project area; therefore no archeological resources or above-ground historic properties would be impacted.</td>
<td>No archaeological (below-ground) or above-ground historic properties affected.</td>
</tr>
<tr>
<td>Transportation</td>
<td>Temporary increase in upland and maritime traffic, no adverse impacts.</td>
<td>Temporary increase in upland and maritime traffic, no adverse impacts.</td>
<td>Temporary increase in upland and maritime traffic, no adverse impacts.</td>
<td>Increase in upland traffic for emergency/repair measures.</td>
</tr>
<tr>
<td>Cumulative Impacts</td>
<td>Potential adverse impacts on the geomorphic integrity of the offshore sand shoal environment and threatened or endangered species. Beneficial impacts on socio-economics.</td>
<td>Potential adverse impacts on the geomorphic integrity of the offshore sand shoal environment and threatened or endangered species. Beneficial impacts on socio-economics.</td>
<td>Potential adverse impacts on the geomorphic integrity of the offshore sand shoal environment and threatened or endangered species. Beneficial impacts on socio-economics.</td>
<td>Potential adverse impacts on socio-economics from interruption of WFF activities or loss of infrastructure.</td>
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<td>Assateague Island National Seashore</td>
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<td>CFR</td>
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<td>Chincoteague National Wildlife Refuge</td>
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<tr>
<td>CO</td>
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<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
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<td>CO₂e</td>
<td>Carbon Dioxide Equivalent</td>
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<td>Digital Positioning System</td>
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<td>Discarded Military Munitions</td>
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<td>PEIS</td>
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<td>ELV</td>
<td>Expendable Launch Vehicle</td>
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<td>Executive Order</td>
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<td>EOD</td>
<td>Explosive Ordnance Disposal</td>
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<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
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### Acronyms and Abbreviations

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<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>ERD</td>
<td>Environmental Resources Document</td>
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<td>ESA</td>
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<td>FAA</td>
<td>Federal Aviation Administration</td>
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<td>FIRM</td>
<td>Flood Insurance Rate Map</td>
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<td>FMP</td>
<td>Fisheries Management Plan</td>
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<tr>
<td>FONSI</td>
<td>Finding of No Significant Impact</td>
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<td>GB</td>
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<td>GHG</td>
<td>Greenhouse Gas</td>
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<td>GOM</td>
<td>Gulf of Maine</td>
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<td>GSFC</td>
<td>Goddard Space Flight Center</td>
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<td>GWP</td>
<td>Global Warming Potential</td>
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<td>HAP</td>
<td>Hazardous Air Pollutant</td>
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<td>ICP</td>
<td>Integrated Contingency Plan</td>
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<td>JPA</td>
<td>Joint Permit Application</td>
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<td>LHA</td>
<td>Launch Hazard Area</td>
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<td>LiDAR</td>
<td>Light Acquisition, Detection, and Ranging</td>
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<td>MAB</td>
<td>Mid-Atlantic Bight</td>
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<td>MARS</td>
<td>Mid-Atlantic Regional Spaceport</td>
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<td>MACT</td>
<td>Maximum Achievable Control Technology</td>
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<td>MBTA</td>
<td>Migratory Bird Treaty Act</td>
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<td>MEC</td>
<td>Munitions and Explosives of Concern</td>
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<td>Mean Low Water</td>
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<td>MMS</td>
<td>Minerals Management Service</td>
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<td>Material Safety Data Sheet</td>
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<td>NAAQS</td>
<td>National Ambient Air Quality Standards</td>
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<td>NACA</td>
<td>National Advisory Committee for Aeronautics</td>
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<td>NAOTS</td>
<td>Naval Aviation Ordnance Test Station</td>
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<td>NARWC</td>
<td>North Atlantic Right Whale Consortium</td>
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<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<td>NEPA</td>
<td>National Environmental Policy Act</td>
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<td>NESHAP</td>
<td>National Emission Standards for Hazardous Air Pollutants</td>
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<td>NHPA</td>
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<td>NMFS</td>
<td>National Marine Fisheries Service</td>
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<td>N2O</td>
<td>Nitrous Oxide</td>
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<tr>
<td>NO2</td>
<td>Nitrogen Dioxide</td>
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<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>NOx</td>
<td>Nitrogen Oxides</td>
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<tr>
<td>NPR</td>
<td>NASA Procedural Requirements</td>
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<td>NPS</td>
<td>National Park Service</td>
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<td>NRHP</td>
<td>National Register of Historic Places</td>
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<td>NSR</td>
<td>New Source Review</td>
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<td>NSPS</td>
<td>New Source Performance Standards</td>
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<td>NTL</td>
<td>Notice to Lessee</td>
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<td>O₃</td>
<td>Ozone</td>
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<tr>
<td>OB/OD</td>
<td>Open Burn/Open Demolition</td>
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<tr>
<td>OCS</td>
<td>Outer Continental Shelf</td>
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<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
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<td>Pb</td>
<td>Lead</td>
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<tr>
<td>PLDA</td>
<td>Pre-Launch Danger Area</td>
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<tr>
<td>PM₁₀</td>
<td>Particulate Matter Less Than or Equal to 10 microns</td>
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<tr>
<td>PM₂.₅</td>
<td>Particulate Matter Less Than or Equal to 2.5 microns</td>
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<tr>
<td>POV</td>
<td>Personally-Owned Vehicle</td>
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<tr>
<td>ppm</td>
<td>Parts per Million</td>
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<tr>
<td>ppt</td>
<td>Parts per Thousand</td>
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<tr>
<td>PSD</td>
<td>Prevention of Significant Deterioration</td>
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<tr>
<td>PTE</td>
<td>Potential to Emit</td>
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<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
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<td>RMMO</td>
<td>Range and Mission Management Office</td>
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<td>RNA</td>
<td>Regulated Navigation Area</td>
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<td>SAV</td>
<td>Submerged Aquatic Vegetation</td>
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<td>SCS</td>
<td>Soil Conservation Service</td>
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<td>SCSC</td>
<td>Surface Combat Systems Center</td>
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<tr>
<td>SO₂</td>
<td>Sulfur Dioxide</td>
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<tr>
<td>SOLAS</td>
<td>The International Convention for Safety of Life at Sea</td>
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<td>SRIPP</td>
<td>Shoreline Restoration and Infrastructure Protection Program</td>
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<tr>
<td>SWPPP</td>
<td>Storm Water Pollution Prevention Plan</td>
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<tr>
<td>TSS</td>
<td>Traffic Separation Scheme</td>
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<tr>
<td>UAS</td>
<td>Uninhabited Aerial Systems</td>
</tr>
<tr>
<td>µg/m³</td>
<td>Micrograms per Cubic Meter</td>
</tr>
<tr>
<td>URS</td>
<td>URS Group, Inc.</td>
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<tr>
<td>USACE</td>
<td>U.S. Army Corps of Engineers</td>
</tr>
<tr>
<td>USCG</td>
<td>U.S. Coast Guard</td>
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<tr>
<td>USDA</td>
<td>U.S. Department of Agriculture</td>
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<tr>
<td>USFWS</td>
<td>U.S. Fish and Wildlife Service</td>
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<tr>
<td>UST</td>
<td>Underground Storage Tank</td>
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<tr>
<td>Acronym</td>
<td>Abbreviation</td>
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<tr>
<td>UXO</td>
<td>Unexploded Ordnance</td>
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<td>VAC</td>
<td>Virginia Administrative Code</td>
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<td>VACAPES</td>
<td>Virginia Capes Operating Area</td>
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<td>VCP</td>
<td>Virginia Coastal Resources Management Program</td>
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<td>VDEQ</td>
<td>Virginia Department of Environmental Quality</td>
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<td>VDGIF</td>
<td>Virginia Department of Game and Inland Fisheries</td>
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<td>VDHR</td>
<td>Virginia Department of Historic Resources</td>
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<tr>
<td>VEC</td>
<td>Virginia Employment Commission</td>
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<td>VIMS</td>
<td>Virginia Institute of Marine Science</td>
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<tr>
<td>VMRC</td>
<td>Virginia Marine Resources Commission</td>
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<tr>
<td>VOC</td>
<td>Volatile Organic Compound</td>
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<tr>
<td>VPDES</td>
<td>Virginia Pollutant Discharge Elimination System</td>
</tr>
<tr>
<td>WFF</td>
<td>Wallops Flight Facility</td>
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</tbody>
</table>
Common Metric/British System Equivalents

**Linear**

1 centimeter (cm) = 0.3937 inch (in)  
1 inch = 2.54 cm

1 centimeter = 0.0328 foot (ft)  
1 foot = 30.48 cm

1 meter (m) = 3.2808 feet  
1 ft = 0.3048 m

1 meter = 0.0006 mile (mi)  
1 mi = 1609.3440 m

1 kilometer (km) = 0.6214 mile  
1 mi = 1.6093 km

1 kilometer = 0.53996 nautical mile (nmi)  
1 nmi = 1.8520 km

1 mi = 0.87 nmi  
1 nmi = 1.15 mi

**Area**

1 square centimeter (cm²) = 0.1550 square inch (in²)  
1 in² = 6.4516 cm²

1 square meter (m²) = 10.7639 square feet (ft²)  
1 ft² = 0.09290 m²

1 square kilometer (km²) = 0.3861 square mile (mi²)  
1 mi² = 2.5900 km²

1 hectare (ha) = 2.4710 acres (ac)  
1 ac = 0.4047 ha

1 hectare (ha) = 10,000 square meters (m²)  
1 ft² = 0.000022957 ac

**Volume**

1 cubic centimeter (cm³) = 0.0610 cubic inch (in³)  
1 in³ = 16.3871 cm³

1 cubic meter (m³) = 35.3147 cubic feet (ft³)  
1 ft³ = 0.0283 m³

1 cubic meter (m³) = 1.308 cubic yards (yd³)  
1 yd³ = 0.76455 m³

1 liter (l) = 1.0567 quarts (qt)  
1 qt = 0.9463264 l

1 liter = 0.2642 gallon (gal)  
1 gal = 3.7845 l

1 kiloliter (kl) = 264.2 gal  
1 gal = 0.0038 kl

**Mass**

1 gram (g) = 0.0353 ounce (oz)  
1 oz = 28.3495 g

1 kilogram (kg) = 2.2046 pounds (lb)  
1 lb = 0.4536 kg

1 metric tonne (mt) = 1.1023 tons  
1 ton = 0.9072 mt
CHAPTER ONE: MISSION, PURPOSE AND NEED, BACKGROUND INFORMATION

1.1 INTRODUCTION

This Programmatic Environmental Impact Statement (PEIS) has been prepared to evaluate the potential environmental impacts from the proposed Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP). The SRIPP encompasses a 50-year planning horizon and is intended to reduce storm-induced physical damage to Federal and State infrastructure on Wallops Island.

In May 2007, the National Aeronautics and Space Administration (NASA) released for public comment a Draft Programmatic Environmental Assessment (EA) for Goddard Space Flight Center’s (GSFC’s) WFF SRIPP. Since that time, NASA’s Proposed Action has changed (the proposed borrow sites moved from State to Federal waters, and extension of the seawall was added along with more details on placement of sand-retention structures), and as a result, NASA has prepared this PEIS for the Proposed Action currently under consideration.

This PEIS has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S. Code [U.S.C.] 4321–4347), the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] 1500–1508), NASA’s regulations for implementing NEPA (14 CFR Subpart 1216.3), and the NASA Procedural Requirements (NPR) for Implementing NEPA and Executive Order (EO) 12114 (NPR 8580.1).

The U.S. Department of the Interior’s Minerals Management Service (MMS) and the U.S. Army Corps of Engineers (USACE) have served as Cooperating Agencies in preparing this PEIS because they both possess regulatory authority and specialized expertise pertaining to the Proposed Action. This PEIS is being developed to fulfill all three Federal agencies’ obligations under NEPA. NASA, as the WFF property owner and project proponent, is the Lead Agency and responsible for ensuring overall compliance with applicable environmental statutes, including NEPA.

NASA will require authorizations from both the USACE and the MMS for the SRIPP. Under Section 404 of the Clean Water Act, the USACE has jurisdiction over the disposal of dredged and fill material in Waters of the U.S. In addition, under Section 10 of the Rivers and Harbors of Act of 1899, the USACE has jurisdiction over the placement of structures and work, such as dredging, conducted in navigable waters of the U.S. The USACE Norfolk District would also design the SRIPP and serve in a construction management capacity during project implementation, including hiring construction contractors. The MMS has jurisdiction over mineral resources on the Federal Outer Continental Shelf (OCS). Public Law 103-426, enacted October 31, 1994, gave MMS the 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 in whole or part or authorized by the Federal government. A Memorandum of Agreement (MOA) pursuant to section 8(k)(D) of the OCS Lands Act, 43 U.S.C. § 1337(k)(2) would be negotiated between MMS and NASA to allow NASA to dredge sand from the OCS.

This PEIS will be reviewed for adequacy at any time that major changes to the Proposed Action are under consideration or substantial changes to the environmental conditions in the project area occur. As such, the document may be supplemented in the future to assess new proposals or to
address changes in existing conditions, impacts, and mitigation measures. Additionally, as this PEIS considers the effects of the SRIPP over a 50-year timeframe, some project details (e.g., renourishment frequencies, volumes, and sources) are only generally known at the current time. Tiered NEPA documents will be prepared in the future for implementation of certain aspects of the SRIPP once project details become more refined.

1.2 BACKGROUND

1.2.1 Wallops Flight Facility Mission

During its early history, the mission of the GSFC’s WFF was primarily to serve as a test site for aerospace technology experiments. Over the last several decades, the WFF mission has evolved toward a focus of supporting scientific research through carrier systems (i.e., airplanes, balloons, rockets, and uninhabited aerial systems) and mission services. WFF is a NASA facility under the management of GSFC. NASA is the land owner with multiple tenants, including the U.S. Navy, U.S. Coast Guard (USCG), Mid-Atlantic Regional Spaceport (MARS), and the National Oceanic and Atmospheric Administration (NOAA). Each tenant partially relies on NASA for institutional and programmatic services, but also has its own missions. WFF is a fully capable launch range for rockets and scientific balloons, and includes a research airport. In addition, Wallops personnel provide mobile range capabilities, range instrumentation engineering, range safety, flight hardware engineering, and mission operations support to a variety of civil, defense, and academic customers.

1.2.2 Site Location

WFF is located in the northeastern portion of Accomack County, VA, on the Delmarva Peninsula, and is comprised of the Main Base, Wallops Mainland, and Wallops Island (Figure 1). Wallops Island is bounded by the Chincoteague Inlet to the north, the Assawoman Inlet to the south (which is presently filled in), the Atlantic Ocean to the east, and the estuaries to the west.

1.2.3 Facilities, Tenants, and On-Site Organizations at Wallops Island

The facilities on Wallops Island are shown on Figure 2 and described below.

1.2.3.1 Tenants and On-Site Organizations

NASA has several tenants and customers that use WFF facilities, ranges, and airspace. Two of these tenants, the U.S. Navy and MARS, have facilities on Wallops Island that are at risk from storm damages and would be protected by the Proposed Action. The activities of these tenants are described below.

Wallops Flight Facility Range and Mission Management Office

WFF’s Range and Mission Management Office (RMMO) serves as the principal source of project management support for WFF’s Test Range and mobile campaigns, conducting operations from sites around the world. The RMMO aims to “Take Science to New Heights” with its fixed and mobile launch ranges and orbital and suborbital carriers (NASA, 2010a). RMMO coordinates WFF’s Environmental to Payload integration support functions and provides operational leadership for Range-specific functions such as radar, optical tracking, weather forecasting, and control center operations.
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Mission, Purpose and Need, Background Information

U.S. Navy Surface Combat Systems Center

The U.S. Navy Surface Combat Systems Center (SCSC) is WFF’s largest partner. The SCSC’s mission is to “provide live integrated warfare systems in a maritime environment for fleet operations, testing, evaluation, training, research and development,” and its vision is to be “the premier maritime proving ground for fielding and sustainment of joint, combined, and coalition capabilities in support of national interests.” There are no alternative land-based sites for performing many of the mission roles assigned to SCSC. SCSC provides a maritime test environment, operational team, and combat systems of high fidelity to conduct realistic test events in support of Lifetime Support Engineering activities and the upgrade of tactical computer programs. SCSC provides key services for performing systems Developmental and Operational Tests and for Research & Development of potential system upgrades in all areas of Detection, Control, and Engagement. The SCSC Wallops Island location provides the best value to the U.S. Navy for testing and support of deployed surface combat systems, advanced systems under development, and warfare systems integration (such as systems planned for deployment aboard U.S. Navy ship programs.

Wallop Island is home to the unique replica of an AEGIS cruiser and its destroyer combat systems, as well as the experimental radar deck of the DDG 1000 class destroyer. These systems are used to train naval officers and enlisted personnel in the operation and maintenance of sophisticated equipment used by the fleet onboard their AEGIS cruisers and destroyers. The systems are also used to test concepts and solve operational problems.

Other technical missions include Lifetime Support Engineering, In-Service Engineering, Systems Level operations, and maintenance training. The SCSC supports the AEGIS Training Unit by providing equipment on which replacement crew training is held. The U.S. Navy Ship Self Defense System Facility on Wallops Island conducts research, development, testing, and evaluation elements of shipboard systems, integration, and demonstrations of new shipboard systems. WFF also provides missile launch support for the U.S. Navy. Drone vehicles are used for target tracking and are engaged by both the AEGIS facility and operational naval forces.

Mid-Atlantic Regional Spaceport

The Virginia Commercial Space Flight Authority is responsible for the development and operation of MARS, a Federal Aviation Administration (FAA)-licensed commercial spaceport on Wallops Island. MARS currently provides launch support services and facilities to NASA, the U.S. Department of Defense’s Defense Advanced Research Projects Agency, the U.S. Air Force, and commercial and academic users. MARS is a full-service spaceport, offering two FAA licensed launch pads as well as access to three suborbital rail launchers, vehicle/payload storage, processing and launch facilities, a Federal launch range and experienced space technicians and engineers.

MARS’ mission is to develop and operate a multi-user spaceport at WFF that provides low-cost, safe, reliable, “schedule friendly” space access for commercial, government, and academic users (MARS, 2008). MARS operates the orbital Launch Complex 0, which includes launch pads 0-A and 0-B, and provides facilities and services for commercial launches of payloads into space.

NASA and MARS are currently constructing new facilities on Wallops Island to support launching of orbital rockets from Pad 0-A that will carry payloads to the International Space
Station. These facilities include: a Liquid Fueling Facility, launch ramp, and rocket mount at Pad 0-A; a Horizontal Integration Facility that will support the pre-flight processing, horizontal integration, and preparation of launch vehicles and payloads; a Payload Fueling Facility; a Payload Processing Facility; and transportation infrastructure improvements.

1.2.3.2 Location of Facilities

Multiple constraints to siting at WFF limit the development of new facilities and infrastructure. These constraints include current land use (potential for conflict with known or reasonably foreseeable mission-related uses), interference with communications and radar, established hazard arcs surrounding some buildings, and sensitive resources such as wetlands and cultural resources.

Of approximately 50 NASA buildings on Wallops Island, two can be considered administrative in nature; these buildings house a small number of employees, all of whom are associated with the day-to-day upkeep and coordination of Wallops Island’s launch support assets. The U.S. Navy’s facilities on Wallops Island, although not directly associated with launch operations, were originally sited immediately on the ocean as they must routinely interact with ships at sea and train sailors in a real-time maritime environment.

The primary function of most buildings on Wallops Island is to enable operations leading up to, during, and following the execution of a flight. The launch pad is the core of the launch range infrastructure and is characteristically the most difficult to site because it is the location at which the most hazardous operations take place. Launch support structures are generally built as close to the launch pad as possible, because 1) the systems they house (e.g., high speed cameras, noise level monitors, etc.) must be close to the pad to effectively collect data and 2) to provide the shortest travel distance once the launch vehicle and spacecraft are ready to be transported to the pad for final pre-launch preparations.

The facilities on Wallops Island are grouped geographically and are described below.

North Wallops Island: Solid-propellant rocket motors, which are both a fire and explosive hazard, are stored on the north end of Wallops Island so in the event that a mishap occurs; it would have minimal impact on the public or the employees on Wallops Island. Spacecraft fueling and processing facilities, which are the primary locations for the handling of toxic and flammable propellants, are proposed for this remote area for the same reason.

Central Wallops Island: Central Wallops Island contains the U.S. Navy’s ship training facilities, storage and assembly buildings, and the launch blockhouses. This mid-island area typically contains the least hazardous of operations, and is the most densely populated by employees supporting the U.S. Navy’s Surface Combat Systems Center.

South Wallops Island: The south end of Wallops Island contains WFF’s launch pads, additional hazardous materials storage areas, and the facility’s Uninhabited Aerial Systems (UAS) runway. Currently, there are three sounding rocket pads operated by NASA and two orbital pads operated by MARS. These pads are located on south Wallops Island to minimize potential impacts to Chincoteague, Accomack County’s most populated town and home to its busiest commercial fishing route (Chincoteague Inlet and Channel).
1.2.4 Shoreline Erosion at Wallops Island

Wallops Island was subject to the effects of shoreline retreat well before NASA’s presence was established on the island in the 1940s. Between 1857 and 1994, the southern part of Wallops Island retreated approximately 400 m (1,300 ft). The ocean has encroached substantially toward launch pads, infrastructure, and test and training facilities belonging to NASA, the U.S. Navy, and MARS (see Figure 3). Photo 1 below shows the extent of shoreline retreat from 1991 to 2005. Assawoman Island to the south has been impacted even more, with a shoreline retreat rate between 4.9 and 5.2 m (16 and 17 ft) per year.

**Photo 1: 1991 Aerial Photo of Wallops Island Showing 2005 Extent of Shoreline Erosion.**

Since the 1960s, NASA has made several attempts to keep sand on the Wallops Island beach and prevent shoreline retreat. Various measures such as wooden groins, construction of a stone seawall, temporary geotextile tubes (long cylinders of durable textile material that are filled with sand – see Figure 4), and others have been installed along the shoreline to slow the transportation of sand off the beach and help protect onshore assets from wave action.

Despite these efforts, the ocean has continued to encroach substantially toward the valuable infrastructure on Wallops Island. The history of Wallops Island shoreline erosion is described in more detail in Section 3.1.3 of this PEIS.
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1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

1.3.1 Purpose

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.

1.3.2 Need

The Proposed Action is needed to ensure the continued ability of NASA, the U.S. Navy, and MARS to serve the Nation’s rapidly growing civil, defense, academic, and commercial aerospace requirements. The SRIPP would help reduce the risk to infrastructure on Wallops Island from storm-induced damages by restoring the beach profile in front of the present shoreline.

Wallops Island has experienced shoreline changes throughout the six decades that NASA has occupied the site. The existing seawall is being undermined because there is little or no protective sand beach remaining and storm waves break directly on the rocks. Currently, the south end of the island is unprotected except for a low revetment around the MARS launch pad and temporary geotextile tubes that extend from the southern end of the existing seawall south to camera stand Z-100 (shown in Photo 1).

The potential risks to infrastructure from wave impacts are two-fold: first is the interruption of NASA, U.S. Navy, and MARS missions supported from Wallops Island facilities due to temporary loss of facility functions; and second is the potential for complete loss of these unique facilities. If no protective measures are taken, the assets on Wallops Island will be increasingly at risk from even moderate storm events. Additionally, WFF and MARS are located within the only research range in the United States that is wholly controlled by NASA, and as a result, WFF is the only research range in the world that is solely under NASA control and focused on NASA’s schedule, budget, and mission objectives. Under Title II of the Omnibus Appropriations Act of 2009 (Public Law 111-8), the U.S. Congress stated that “WFF is an important national asset that can be better utilized by focusing on emerging technologies that meet national needs and NASA priorities.”

Currently, assets on Wallops Island are valued at over $1 billion. The NASA facilities at greatest risk are the UAS Runway and the Launch Control Center (building W-20), both located within 30 m (100 ft) of the shoreline, and all three sounding rocket launch pads, which are approximately 75 m (250 ft) from the shoreline (Figure 3). U.S. Navy assets at greatest risk include the AEGIS and Ship Self Defense System Facilities, also shown on Figure 3. MARS Launch Pads 0-A and 0-B are located within 75 m (250 ft) of the shoreline, and are also at a high level of risk (Figure 3).

1.4 SCOPE OF THIS PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Both CEQ and NASA NEPA regulations encourage the preparation of NEPA documents for broad actions, such as agency programs and sets of related or similar actions. Broad actions can often be grouped by geographic location; relevant similarities; and state of technical development. These NEPA documents are referred to as “Programmatic,” and are often broad in
scope, and may be followed by more site- or action-specific documents as appropriate. This approach, referred to as “tiering,” can be compared to a funnel, with the broader, Programmatic NEPA document at the top, with the more focused documents below it.

As this is a programmatic NEPA document encompassing a 50-year planning horizon, future tiered documents may be prepared for specific actions (for example, shoreline renourishment cycles) related to the SRIPP. Additionally, due to the extreme variability and unpredictability of the open ocean environment, and through its monitoring efforts, NASA may identify additional measures that may needed to reduced storm damage to its facilities on Wallops Island. As such, NASA would supplement this PEIS in the future to consider the effects of the proposals prior to their implementation.
CHAPTER TWO: DESCRIPTION AND COMPARISON OF ALTERNATIVES

This section presents the range of alternatives that were initially considered to meet the purpose and need of the project.

Several studies have been conducted at Wallops Island to evaluate the effectiveness of previous shoreline protection efforts, to model sediment transport conditions, to conduct site assessments of existing conditions, and to recommend methods for shoreline restoration. The studies include:

- 1986 Wallops Island Shore Protection Study (Moffatt & Nichol)
- 1987 Shore Protection Alternatives (Moffatt & Nichol)
- 1989 Study of Wallops Island Seawall Repair Alternatives Phase B (Moffatt & Nichol)
- 1992 Wallops Island Shoreline Evolution Modeling Study (Moffatt & Nichol)
- 1998 Wallops Island Seawall Study (Moffatt & Nichol)
- 1999 USACE Engineering Research and Development Center and USACE, Norfolk District investigation
- 2006 Beach Erosion Mitigation and Sediment Management Alternatives at Wallops Island, VA (USACE)
- 2007–2009 USACE, Norfolk District, evaluation of potential SRIPP alternatives
- 2010 Beach Restoration Design Report for Wallops Island, Virginia (USACE Research and Development Center and USACE Norfolk District; Appendix A)

The 2006 report evaluated four levels of shore protection scenarios: 1) no project, 2) no new project but continue minor maintenance to existing seawall, 3) project with restricted initial construction budget (primarily beach fill), and 4) optimum project (sand retention structures combined with beach fill).

Based on the recommendations in the 2006 report, the USACE further evaluated existing conditions at Wallops Island and provided a range of alternatives considered technically and economically feasible. This range of initial alternatives was screened to determine which would be carried forward. The alternatives that passed the initial screening—extension of the seawall, beach fill only, or beach fill combined with sand retention structures (groin or breakwater)—were then evaluated by USACE in more detail. A variety of detailed options for implementing beach fill and sand-retention structures were then combined, resulting in 54 different potential alternatives, all of which included extension of the seawall. From these 54 alternatives, NASA and the USACE conducted a secondary screening analysis that resulted in the final three Proposed Action Alternatives evaluated in this PEIS.

2.1 OVERVIEW OF PROPOSED ACTION

NASA’s 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 and nor’easters. The goal of the Proposed Action is to move the zone of breaking waves well away from vulnerable infrastructure. This plan is not intended to protect against inundation and other impacts during major hurricanes and exceptional nor’easters, when
water levels can rise several meters. The SRIPP is also not intended to protect infrastructure from flooding, which occurs both from the estuaries west of Wallops Island and from waves overtopping the existing beach and seawall. Since it began its operations on Wallops Island in the mid-1940s, NASA and its tenants have implemented flood damage reduction measures such as elevating critical structures above Federal Emergency Management Agency (FEMA) flood levels (3.6 m [11 ft] above mean sea level [amsl]) and not storing equipment or materials on the first floors that are not elevated or otherwise protected. Under all of the alternatives considered in this PEIS, NASA would continue to implement such mitigation measures as necessary to provide storm damage reduction from flooding.

The MMS and the USACE, as cooperating Federal agencies, are undertaking a “connected action” (40 CFR 1508.25) that is related, but unique from NASA’s proposed action, the construction of the project. The MMS’s proposed action is the issuance of a negotiated agreement. The purpose of that action is to authorize use of OCS sand resources in beach nourishment and coastal restoration projects undertaken by Federal, State or local government agencies, and/or in other federally authorized construction projects. The USACE’s proposed action is the issuance of permits under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbor Act for dredging and the placement of fill in waters of the U.S.

2.1.1 Project Planning Horizon

A project’s design life is most commonly selected on the basis of project costs and cost effectiveness. The Handbook of Coastal Engineering (Herbich, 2000), which was utilized by the USACE in the design methodology of the SRIPP, established the 50-year project design life. The 50-year project life cycle is employed by the USACE when designing projects that protect infrastructure against wave-induced damages. The life cycle analysis requires that projects be analyzed in terms of cost of repair, periodic replacements, and rehabilitation (Herbich, 2000). Large coastal engineering projects are often designed on an optimized approach in which a balance is obtained between initial construction costs and the maintenance costs associated with storm-induced damages.

2.2 DESCRIPTION OF RANGE OF ALTERNATIVES CONSIDERED

The Proposed Action is to implement a 50-year program to allow NASA and its partners to continue to safely utilize Wallops Island and complete their missions with a reduced threat of storm-related loss of facilities. NASA considered a range of alternatives to meet the purpose and need; each of the alternatives listed below is discussed in this section.

- Relocating At-Risk Infrastructure
- Seawall Extension Only
- Sand Dunes With Various Cores
- Beach Fill Only
- Beach Fill and Seawall Extension
- Beach Fill, Seawall Extension, and Sand Retention Structures
- No Action
2.2.1 Relocating At-Risk Infrastructure

This alternative would involve moving critical infrastructure on Wallops Island (including launch pads) further inland to a nearby location less susceptible to storm damage. This alternative included an evaluation of the existing conditions including an inventory and assessment of the functions of Wallops Island facilities, safety considerations, interrelationship among Wallops Island and Wallops Mainland and Main Base facilities, and multiple mission support with the existing facilities layout. Then NASA evaluated the same things based on a hypothetical move of Wallops Island’s orbital launch pads to Wallops Mainland, approximately 3.5 kilometers (km) (2.2 miles [mi]) west of their current location. The analysis is described below.

2.2.1.1 Existing Conditions

Reason for Location of Facilities at Wallops Island

WFF’s geographic location has been a critical factor in its continued ability to safely and successfully conduct science, technology, and educational flight projects aboard rockets, balloons, and uninhabited aerial systems (UAS), using the Atlantic Ocean for operations on almost a daily basis. WFF’s location immediately on the Atlantic Ocean, its controlled airspace above it, and its direct access to the Department of Defense-managed Virginia Capes Operating Area provide a unique ability for WFF to perform all aspects of its mission (e.g., testing unproven flight vehicles, handling explosive and toxic materials, etc.) that could not be done elsewhere.

As Wallops Island is the WFF landmass farthest away from the general public, it is also the safest part of WFF for hazardous operations. NASA’s primary concern is limiting the risk of harm to private property, its employees, and the general public resulting from hazardous operations. Regarding public safety, one concept prevails: the farther the hazardous activity is from the general public, the smaller the risk of harm. NASA’s safety policy is that such activities must be conducted as far away from the public as possible.

Safety Considerations

When a rocket is being prepared for launch, it possesses certain hazards based upon the types and quantities of explosive charges and propellants onboard. To ensure employee and public safety, an off-limits area is established as a radius around the pad. Only specially trained, mission-essential personnel are allowed within this off-limits area once established. This area is commonly referred to as the Pre-Launch Danger Area (PLDA), and can range from several hundred feet for small weather rockets to more than 380 meters (m) (1,250 feet [ft]) for larger orbital rockets. A PLDA can be in effect as long as the hazard exists on the launch pad, but is typically established for several weeks preceding the launch.

Several hours prior to launch, a Launch Hazard Area (LHA) is established. The purpose of the LHA is to protect the general public from direct harm from the launch (i.e., debris from a rocket flying off course). These areas are sized based on the types and quantities of propellant onboard, rocket reliability, flight trajectory, and types of debris expected if the flight were terminated. The LHAs are considerably larger than PLDAs (Figure 5). LHAs can range in size from 380 m (1,250 ft) for small sounding rockets up to more than 3,050 m (10,000 ft) for larger orbital
Description and Comparison of Alternatives

rockets. LHAs must be clear of people prior to launch; this is part of the go/no-go criteria during a launch countdown. The LHA typically requires evacuation several hours prior to launch until liftoff. Recent orbital launches have had several postponements when conditions do not permit a launch at the originally scheduled time. Postponed launches would require hazard area clearance at the next launch window until either the launch is completed or completely rescheduled.

In addition, other safety considerations include acoustical energy transferred through the atmosphere as result of a rocket explosion (called distance focused overpressure), which can result in injuries inflicted by shattered windows.

Figure 5 shows the current conditions and safety buffers including the PLDA, referred to as the “Pre-Launch Evacuation” on the figure. Under current conditions, assuming an LHA of 3,050 m (10,000 ft), two addresses would require evacuation prior to launching a large orbital rocket, such as Orbital Sciences Corporation’s Minotaur V. Approximately 75 hectares (186 acres) of private lands are within the LHA, and 2,710 hectare (6,700 acre) of uninhabited wetland buffer remains between Wallops Island and mainland residences.

Interrelationship Among Facilities

In addition to safety considerations, facilities on Wallops Island have been sited to properly interface with facilities on WFF’s Mainland and Main Base landmasses, and to support the necessary steps in preparing and launching a rocket. For example, Wallops Mainland infrastructure consists primarily of radar and telemetry systems that are sited specifically to be able to track and process information from rockets launched from Wallops Island. Main Base assets that support Wallops Island operations include the range control center and additional radar and telemetry systems. The location of Wallops Island infrastructure is directly linked to the placement of these range support assets; movement of Wallops Island infrastructure would result in the need to move these facilities as well.

Multiple Mission Support

The geographic locations of the facilities on Wallops Island allow them to support multiple launch operations at once. For example, hazardous storage facilities are located such that their location does not preclude fueling or processing and assembly. Fueling facilities are located such that operations on Wallops Island may continue while a fueling operation is taking place. Rocket launch pads are sited far enough apart to allow simultaneous pre-launch work to occur on multiple pads. To meet the required safety offsets, these facilities must appropriately distant from one another. To meet both safety and mission needs, the assets on Wallops Island must remain in their same general configuration. When evaluating suitable launch sites to the west of Wallops Island, NASA considered these needs as firm requirements for continued ability to successfully carry out its mission.
Toxics Dispersion Hazards

NASA recently conducted a toxic dispersion hazards analysis for its Launch Range Expansion EA (NASA, 2009a)—this analysis is applicable to a facility relocation assessment because it can portray the potential effects of moving a current Wallops Island-based fueling facility to a different location. The WFF Range Safety Office predicted hazard areas ranging from 0.38 km (0.24 mi) to 1.47 km (0.91 mi) for a small release of toxics and up to 2.1 km (1.3 mi) to 5.1 km (3.2 mi) for a large release of toxics. Assuming a small release occurred within existing spacecraft fueling facilities on the north end Wallops Island, no addresses would be affected. Under worst-case existing conditions, a large release could affect up to 67 addresses.

2.2.1.2 Hypothetical Facility Relocation

Figure 6 shows a hypothetical scenario with the launch pads and support facilities moved to Wallops Mainland. To maintain the same general size and layout of the current facilities, 166 addresses would be displaced. Of these addresses, 26 would be within a hazardous storage and operational buffer. Eighty-seven addresses would be within a 3,050 m (10,000 ft) LHA and would require evacuation as part of go/no go criteria for a Minotaur V-type launch. 1,815 hectares (4,480 acres) of private land would also be within the LHA, and 645 addresses would be within an area of equivalent size as the current unpopulated natural wetland buffer between Wallops Island and Mainland.

If the same small release of toxics described above under existing conditions occurred at a hypothetical fueling facility on Wallops Mainland, 24 addresses could be affected. Additionally, a large release at the hypothetical location could result in up to 770 addresses potentially requiring evacuation or shelter if it occurred on Wallops Mainland.

2.2.2 Seawall Extension Only

Under this alternative, the seawall extension would be constructed on the beach parallel to the shoreline in the approximate location of the geotextile tubes shown on Figure 3. The new seawall would be constructed landward of the shoreline and would extend up to 1,400 m (4,600 ft) south of the existing seawall. The southern end of the 1,400 m (4,600 ft) extension would be at camera stand Z-100 (see Figure 4 for location of Z-100). The seawall extension would be constructed in this location because the infrastructure on this part of Wallops Island is relatively close to the shoreline and there are no long-term storm damage reduction measures currently in place.

The seawall extension would consist of the placement of 4.5- to 6.4-metric-tonne (mt) (5- to 7-ton) rocks and would be constructed on a 1 to 1.5 slope. It would be placed in the beach, and the top of the seawall would be approximately 5 m (14 ft) above the normal high-tide water level after completion, depending on the extent of existing shoreline retreat at that time. The seawall would be designed to survive a 100-year storm event.

2.2.3 Sand Dunes with Various Cores

Under this alternative, NASA would create vegetated sand dunes with one of the following cores: rock core, semi-rigid geotextiles filled with rock or sand, or geotextile tubes filled with sand. The core would help stabilize and strengthen the dunes during larger than normal storm events. The sand dunes would be constructed parallel to the shoreline in the area of the existing seawall, and would utilize the existing seawall as a core material. Additionally, the sand dunes
with various cores would be constructed on the beach parallel to the shoreline in the approximate location of geotextile tubes in Figure 3. The constructed dunes would extend 1,400 m (4,600 ft) from the southern end of the existing seawall.

2.2.4 Beach Fill Only

Beach fill (also referred to as beach nourishment) would involve removing sand from either upland, nearshore, or offshore borrow sites and placing the material onto the beach. Beaches serve as a natural function of the floodplain, allowing flood tides to spread over a large area to provide water storage and reduce wind and wave velocity impact to areas beyond the beach. Currently, there is no beach in front of the existing seawall along 4.6 km (2.9 mi) of the Wallops Island shoreline. Creating a beach would provide a shallow water surface for storm waves to break upon, thus reducing wave energy at the seawall (USACE, 2010a)

Initial nourishment would occur, followed by periodic renourishment of sand as erosion occurs. The timing of the renourishment cycles would vary depending of the frequency and magnitude of storm events. The beach fill would be designed to withstand a 30-year storm event. During storm events, a portion of the new beach would provide a surface to dissipate wave energy as well as add sediment to the nearshore system. This design allows the existing beach and shoreline to remain relatively protected in larger storm events while the new beach fill is sacrificed. The beach fill would start approximately 460 m (1,500 ft) north of the Wallops Island-Assawoman Island property boundary (near camera stand Z-100 shown on Figure 4) and extend north for 6.0 km (3.7 mi).

2.2.5 Beach Fill and Seawall Extension

This alternative would be a combination of the beach fill and seawall extension alternatives described above. This alternative would provide a multi-tiered defense against storm damage. The beach fill would provide the majority of protection against smaller, more common storms. The rock seawall would provide wave damage reduction against the largest storms expected over the lifetime of the project. The seawall would reduce potential wave heights; however, flooding would still result in minor damages to infrastructure from both water overtopping the seawall and from the marsh/wetland areas on west side of Wallops Island

2.2.6 Beach Fill, Seawall Extension and Sand Retention Structures

This alternative would be a combination of the beach fill and seawall extension alternative described above, with the addition of sand retention structures. Beach fill could be combined with one or more sand retention structures. The USACE 2006 report concluded that the optimal “engineering solution that would mitigate the ongoing erosion and loss of sand from Wallops Island and protect against the disruption to operations and potential damage to infrastructure caused by ordinary storms and northeasters” is implementation of beach fill along with sand retention structures. The 2006 report stated, “The purpose of the sand-retention structures is to provide additional reduction of damages from storm waves and reduce the volumes of sand needed for maintenance renourishing compared to placing fill alone” (USACE, 2006). Sand retention structure options are described below.
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Groins

Groins are structures built from the shoreline out into the ocean and perpendicular to the beach. A groin functions by slowing the littoral currents to a point where suspended sediment drops out of the water column and accumulates on the updrift side of the structure (Figure 7). Groin structures would be semi-permanent in nature and could be removed if necessary.

The installation of groins can temporarily interrupt longshore transport patterns, and may lead to some shoreline erosion on the downdrift beach. The extent of the erosion depends on the geometry of the groin field and the local longshore transport rates. Eventually, the groin field will saturate with sand and the previous transport rates will be recovered and the downdrift beach will stop eroding. Renourishing the beach in conjunction with a groin or groin field can reduce the potential for downdrift erosion.

Source: USACE, 2006

Figure 7: Example Groin Placement and Effect on the Shoreline
Description and Comparison of Alternatives

**Breakwaters**

Breakwaters are typically constructed parallel to the shoreline and placed a short distance offshore. Breakwaters can either stand alone or be constructed in a series. Nearshore breakwaters reduce the amount of wave energy reaching a protected area. The reduction in wave energy would produce sediment deposition and a shoreline bulge, known as a salient, in the sheltered area behind each breakwater (Figure 8). A reduced amount of longshore sediment transport would occur along the coast behind these breakwaters (Basco, 2006). The breakwaters would be permanent structures because future removal would be impractical and cost prohibitive.

![Image of Breakwater](image)

Source: USACE, 2006

**Figure 8: Example Breakwater Placement and Effect on the Shoreline**

**Beach Prisms/Beach Beams**

This option involves placing pre-cast concrete triangular beach prisms or triangular open-lattice beach berms along the Wallops Island shoreline. In 1988, NASA and the U.S. Navy installed two proprietary structures designed to serve as sills to retain sand on the shore. These were the “Beach Prism,” a precast concrete triangular prism, and the “Beach Beam,” a concrete triangular-shape open lattice, shown in Photos 2 and 3, respectively.
Description and Comparison of Alternatives

Photo 2: Experimental “Beach Prism” sand retention units moved out of alignment during an April 1988 storm on Wallops Island.

Photo 3: “Beach Beam” units partially sunken into seabed during an April 1988 storm on Wallops Island.
2.2.7 No Action

CEQ regulations require that an agency “include the alternative of no action” as one of the alternatives it considers (40 CFR 1502.14[d]). The No Action Alternative serves as a baseline against which the impacts of the Proposed Action are compared. Under the No Action Alternative for this PEIS, the SRIPP would not be conducted on Wallops Island, but maintenance and emergency repairs to existing structures would continue. Maintenance activities include repairs to the existing seawall and geotextile tubes. Emergency actions may include hauling in additional rock to add to the existing seawall, hauling and placing sand on the beach or behind existing shoreline protection, installing sheet piling in or near the high tide level, or emergency geotextile tube installation. Under this alternative, the seawall can be expected to continue to deteriorate and will be increasingly vulnerable to massive failure during large storm events as waves break directly on the structure and also undercut the leading edge of the seawall.

Over $1 billion in NASA, U.S. Navy, and MARS equipment, buildings, and infrastructure would continue to be at increasing risk from storm damage. Maintenance and emergency repairs to structures and the seawall would continue to be required. Shoreline retreat would continue. Operations at facilities may be disrupted during severe storm events from waves overtopping the seawall and flooding. The danger to the MARS launch complex and UAS airstrip on the southern portion of the island would increase due to the rapidly retreating shoreline in that area.

2.3 INITIAL SCREENING OF THE ALTERNATIVES

2.3.1 Screening Criteria

Below are the five criteria used to screen the initial alternatives carried forward as reasonable and feasible:

Disruption to WFF Operations

This factor evaluates the potential disruption to operations at WFF due to implementation of the alternative. Disruption to WFF operations is categorized as follows:

- Low – little to no interruptions in daily activities and/or missions at Wallops Island facilities
- Moderate – minor disruptions during emergency repairs or construction; may cause brief (hours to days) delays or interruptions in daily activities and/or missions at Wallops Island facilities
- High – would cause severe (several days to weeks or longer) interruptions in daily activities and/or missions at Wallops Island facilities; may cause unacceptable delays in missions
**Description and Comparison of Alternatives**

### Storm Damage Reduction

The level of storm damage reduction is a measure of the protection to critical infrastructure provided by the alternative from storm-generated waves. Categories for level of storm damage reduction are identified as:

- Low – provides protection from 10-year storm event or smaller
- Moderate – provides protection between 10-year and 50-year storm event
- High – provides protection above the 50-year storm event

Note that the beach-fill-only alternatives are designed to provide storm damage reduction up to a 30-year storm event, and the beach fill with the seawall is designed to provide storm damage reduction up to a 100-year storm event.

### Initial Cost

The level of storm damage reduction drove the alternative designs and their respective costs; the higher the level of storm damage reduction, typically the greater the cost. Costs of the initial construction of the alternatives developed by the USACE can be categorized as follows:

- Low – less than $30 million
- Moderate – between $30 million and $40 million
- High – greater than $40 million

### Maintenance Costs

This criterion involves the cost driven by the annual maintenance requirements of each alternative. Maintenance could include frequent renourishment of sand or replacement of rock for the sand retention structures or seawall as needed to retain an adequate level of storm damage reduction.

- Low – less than $500,000
- Moderate – between $500,000 and $1,000,000
- High – greater than $1,000,000

### Impact on Adjacent Barrier Islands

This criterion includes an evaluation of the effect of the alternative on longshore sediment transport as well as impacts on the overall sand supply made available to the system.

- Negative – would reduce sand available to longshore sediment transport system
- Neutral – would not alter current longshore sediment transport rates
- Positive – would increase sand available to longshore sediment transport system

### 2.3.2 Screening Results

Table 1 below shows the results of the screening analysis for the alternatives carried forward.
Table 1: Initial Screening Analysis of the Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Disruption to WFF Operations</th>
<th>Initial Cost</th>
<th>Annual Maintenance Costs</th>
<th>Level of Storm Damage Reduction</th>
<th>Impact on Adjacent Barrier Islands</th>
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<td>Negative</td>
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<td>Moderate to High</td>
<td>Positive</td>
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<tr>
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<td>Positive</td>
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<tr>
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<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
</tbody>
</table>

2.3.3 Alternatives Eliminated After Initial Screening

Based on the results of the screening analysis, the following alternatives were dismissed from further consideration. The following discussion explains why each alternative was dismissed.

2.3.3.1 Relocating At-Risk Infrastructure

Figure 6 shows the residences that would be affected if the Wallops Island launch range and the spacecraft fueling facility were moved to Wallops Mainland. While this alternative would reduce the risk to critical infrastructure from storm events, the public would be exposed to greater safety risks, which is absolutely unacceptable to NASA and its partners. In addition, relocating Wallops Island facilities would severely restrict NASA’s ability to conduct its mission.

The LHA typically requires evacuation several hours prior to launch until liftoff. Recent orbital launches have had several attempts where conditions do not permit a launch at that time; rescheduled launches would require hazard area clearance at the next launch window until either the launch is completed or rescheduled again. Requiring large numbers of the people to evacuate their homes for an unpredictable amount of time is not only impractical and unacceptably disruptive to WFF neighbors, it would severely restrict WFF’s continued ability to conduct its low cost, fast turnaround operations. Therefore relocation of launch pads to a western location on Wallops Mainland was dismissed as not feasible.

Based upon the potential impacts to both WFF and the general public under the hypothetical scenarios of moving Wallops Island facilities inland, Wallops Main Base was dismissed as a possible launch site as it would likely require evacuation of all of the Town of Chincoteague, would completely shut down the Route 175 causeway to Chincoteague Island, and would likely require a complete evacuation of the WFF Main Base, which currently serves in a variety of launch support roles during an active launch countdown. Moving Wallops Island facilities to
Wallop's Main Base could result in potential impacts that would substantially alter WFF’s ability to conduct its pre-launch operations and would place the general public at an unacceptable level of risk. For these reasons, use of Wallops Main Base as a launch site was dismissed as not feasible.

NASA also examined the possibility of mainland property acquisition from private landowners. As discussed above, all lands west of Wallops Island would face the same issues as moving to Wallops Mainland—creating unacceptable public safety risks and/or severely constraining mission operations. Therefore, privately owned lands west of Wallops Island were dismissed from further consideration.

To determine if suitable easterly sites are available along the Eastern Shores of Maryland and Virginia, NASA investigated the potential for upland sites with the same approximate longitude of Wallops Island within the region. All properties at least as distant from populated areas on the Eastern Shore of Maryland and Virginia include Virginia’s 11 other barrier islands, all of which are publicly or privately owned for conservation purposes, and would require substantial infrastructure development while still being susceptible to the same storm damage risks that Wallops Island has faced throughout its history.

For the reasons stated above, NASA determined that alternatives to move at-risk infrastructure are not feasible and these alternatives are not evaluated further in this PEIS.

### 2.3.3.2 Seawall Extension Only

The existing seawall is being undermined by wave action and has partially fallen into the ocean; this erosion process of the sediment underneath the seawall will continue if sand is not placed in front of the seawall. Because the Seawall Extension Only alternative does not include beach fill, it would not provide adequate storm damage reduction to the shoreline on Wallops Island. Therefore, this alternative was dismissed from further consideration.

### 2.3.3.3 Sand Dunes with Various Cores Only

The construction of sand dunes with various cores without beach fill would not involve adding sand to the beach and thus would not provide adequate storm damage reduction. Construction of sand dunes without beach in front of them would expose the dunes to wave action and they would be undermined by erosion processes, as evidenced by the existing seawall. Because the Sand Dunes with Various Cores Only alternative does not include beach fill, it would not provide adequate storm damage reduction on Wallops Island. Therefore, this alternative does not meet the purpose and need of the SRIPP to protect critical infrastructure on Wallops Island and was dismissed from further consideration.

### 2.3.3.4 Types of Sand Retention Structures

The use of beach prisms or beach beams as a type of sand retention structure was dismissed from further consideration because, although these structures would provide some damage reduction during normal storm events, they both tend to be knocked over and sink during larger than normal storm events. After the installation of beach beams and beach prisms at WFF in 1988, the shore was monitored by Moffatt & Nichol, Inc., who concluded, “The Beach Beams and Beach Prisms have been only marginally successful. Therefore, their continued use to protect critically needed facilities at Wallops Island is not advised” (Moffatt & Nichol, 1989). Because this
alternative is likely to fail during severe storm events, conditions under this alternative would be no different from the existing conditions on the island and critical infrastructure would remain at risk; therefore, this alternative does not meet the purpose and need of the project and was dismissed from further consideration.

2.3.3.5 Beach Fill Only

This alternative would provide additional damage reduction to the shoreline in front of the existing seawall, reducing the potential for damages to the critical infrastructure on Wallops Island. However, the absence of a seawall extension to the south would leave other valuable infrastructure at risk from 100-year storm events. Therefore, beach fill only, without extension of the seawall did not pass the initial screening and was dismissed from further consideration.

2.4 SECONDARY SCREENING OF ALTERNATIVES

The alternatives that passed the initial screening—extension of the seawall combined with beach fill or extension of the seawall combined with beach fill and sand retention structure (either groin or breakwater)—were evaluated by USACE in more detail. A variety of detailed options for implementing beach fill and sand retention structures were combined, resulting in 54 different potential alternatives. At this point, the USACE determined that all alternatives should include extension of the seawall to provide an adequate level of storm damage reduction to WFF.

2.4.1 Detailed Options within Alternatives Carried Forward

A variety of detailed options for implementing beach fill, the groin, and the breakwater were evaluated to determine which combination would provide the maximum level of storm damage reduction within available funding. The detailed options shown in Table 2 were combined in a variety of ways, resulting in 54 different alternative options. Then, a planning-level cost estimate was prepared for each of the 54 combinations.

<table>
<thead>
<tr>
<th>Component</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of berm1 on beach</td>
<td>9 m (30 ft), 21 m (70 ft), 30 m (100 ft)</td>
</tr>
<tr>
<td>Length of beach fill</td>
<td>Reduced (3.0 km [1.9 mi]) or Long (6.0 km [3.7 mi])</td>
</tr>
<tr>
<td>Location of Breakwater</td>
<td>No Breakwater or South end of Wallops Island</td>
</tr>
<tr>
<td>Location of Groin</td>
<td>No Groin, North End of Wallops Island, South End of Wallops Island, or Both North and South End of Wallops Island</td>
</tr>
<tr>
<td>Renourishment Frequency</td>
<td>3-year cycle, 5-year cycle, 7-year cycle</td>
</tr>
<tr>
<td>Seawall Extension</td>
<td>Common to all Alternative Combinations</td>
</tr>
</tbody>
</table>

1Berm refers to the portion of the beach fill that is the minimum amount needed to provide defense from storm damage

2.4.2 Secondary Screening Results

After secondary screening was conducted, the following components were eliminated from further analysis because they did not provide an acceptable level of storm damage reduction:
9-m (30-ft) beach berm (total width of the aboveground beach fill), northern end sand retention structure, and reduced beach fill. Additionally, after secondary screening was conducted the following components were eliminated from further analysis because of costs: 30-m (100-ft) beach berm, multiple sand retention structures, and the 3-year and 7-year renourishment cycles. The seawall extension remained a component of each alternative.

Figure 9 below shows the results of the secondary screening analysis for the 54 combinations of alternatives. This screening analysis resulted in the final three alternatives carried forward in this PEIS.
Description and Comparison of Alternatives

Figure 9: Secondary Alternative Screening Process Flow
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2.4.3 Navigation Projects

Chincoteague Inlet

Chincoteague Inlet was considered as a possible sediment source because it is periodically dredged by the USACE Norfolk District under the Federal Navigation Project and is immediately to the north of Wallops Island. The sediment in the inlet contains a significant proportion of fine-grained material (silts and clays) and is not the ideal grain size suited for beach fill (USACE, 2006). Because fine-grained material is more vulnerable to storm waves and thus suspension and transport, sediment dredged from Chincoteague Inlet would require a higher overfill ratio to accommodate the higher rate of loss of the fine-grained material compared to sand.

The USACE Norfolk District has been dredging Chincoteague Inlet since the mid-1990s, placing the material in the offshore disposal site that is approximately 1,220 m (4,000 ft) offshore of Wallops Island (Figure 11). The disposal site covers an area approximately 305 m (1,000 ft) by 915 m (3,000 ft). The volume of sediment dredged from Chincoteague Inlet varies annually—in March 2006, 53,520 m$^3$ (70,000 yd$^3$) was removed; in July 2007, 25,360 m$^3$ (33,170 yd$^3$) was removed; in March 2008, 48,810 m$^3$ (63,841 yd$^3$) was removed, and in December 2008, 29,830 m$^3$ (39,018 yd$^3$) was removed.

![Figure 11: Offshore Disposal Site for Chincoteague Inlet Dredged Material](image)

In 2002, the USACE partnered with NASA to place dredged material from the inlet channel along the Wallops Island shoreline to observe the behavior of the material once placed along the shoreline and determine if this placement scenario could be a viable long-term solution. Comparison of the after-placement survey and the monitoring survey generally showed that the material had moved away from the seawall face and joined nearshore bars and generally diffused throughout the area. The cost per yard for the dredging and sand placement operations was
$22.60—this is a very high cost compared to typical dredging and sediment disposal costs for Chincoteague Inlet which ranged from approximately $5 to $9 for the USACE projects between 1995 and 2006 (USACE, 2010a). Because the mobilization and demobilization costs to dredge the relatively small amounts of sediment (compared to the amounts required for the SRIPP) and place them on the beach result in a high cost of the dredged material per yard, the process has not been repeated during more recent inlet dredging events and this area was removed from consideration as a borrow site.

In addition to an inadequate grain size, the nearshore environment off of the northern portion of Wallops Island, immediately south of and including Chincoteague Inlet contains known historic World War II target ranges from the shoreline up to 8 km (5 mi) offshore. These historic ranges contain munitions and explosives of concern (MEC) that are buried in the sea bottom. Magnetometer surveys could be used to delineate the extent of the MEC and allow dredging in the area to occur but this would result in additional costs to the dredge program and the safety risks associated with these areas would be high. Because of the hazard potential, the areas with potential for MEC were removed from consideration for beach nourishment borrow sites.

Virginia Inside Passage

The Virginia Inside Passage, a waterway along the coast of Virginia between the mainland and the barrier islands, was considered as a possible sediment source because it is periodically dredged by the USACE and is adjacent to the west side of Wallops Island. The sediment in the Virginia Inside Passage contains a significant proportion of fine-grained material (silts and clays) and is not suitable for beach fill (Stamper, USACE, personal comm.). In addition, in order to obtain volumes required for SRIPP fill, the Virginia Inside Passage channels would have to be dredged deeper than the current dredge depths of 2.5 m (8 ft). The USACE noted that dredging these channels any deeper is a problem due to their proximity to the marsh islands and nearby oyster grounds. The deeper the channel is dredged, the farther out the side slopes would extend into marsh areas, causing slumping of the marsh into the dredge cut (Stamper, USACE, personal comm.). Therefore, this area was removed from consideration as a potential borrow site.

2.4.4 Offshore Borrow Sites

Because the nearshore seafloor east of Wallops Island contains sediment that is finer than would be ideally suited for beach fill, the USACE conducted additional sampling to identify potential borrow sites further offshore.

2.4.4.1 May 2007 USACE Sampling

In May 2007, the USACE conducted sediment sampling offshore of Wallops Island to identify any areas that might contain suitable beach quality materials (Figure 12). The sampling initially concentrated on areas directly offshore and the attached fingers shoals that are located southeast of Wallops Island. The samples taken immediately offshore of Wallops Island were found to be marginally unsuitable to unsuitable for beach fill (USACE, 2010a). There was substantial scatter in the median grain size of these sediments, but most had a median grain size of less than 0.20 mm. This May 2007 survey also investigated Porpoise Banks, located southeast of Wallops Island. Six borings performed in this area indicated that this area lacked suitable borrow material.
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From the May 2007 sampling, the USACE identified three potential shoals within the geographical range where transportation costs to Wallops Island would not be prohibitive that contained adequate volume and suitable grain size: Blackfish Bank Shoal, Unnamed Shoal A, and Unnamed Shoal B (Figure 12).

### 2.4.4.2 December 2007 USACE Sampling

In December 2007, the USACE concentrated additional vibracore sampling on the three potential shoals to be used as SRIPP borrow sites. Analysis of the samples indicated that Blackfish Bank Shoal contains approximately 19 million m$^3$ (25 million yd$^3$) of beach quality material, Unnamed Shoal A contains at least 30 million m$^3$ (40 million yd$^3$), and Unnamed Shoal B contains at least 34 million m$^3$ (45 million yd$^3$) of suitable material. These volumes are substantially in excess of the estimated 7.6 million m$^3$ (10 million yd$^3$) of fill material needed over the lifetime of the project.

A grain size analysis was conducted on the sediments in the samples. The samples were typically divided into three sections (upper, mid, and lower), with mean grain size calculated for each layer as well as the composite of all three layers. Table 3 below lists the grain sizes of Blackfish Bank Shoal and Unnamed Shoals A in millimeters from the December 2007 vibracore samples. Because dredging could extend to a depth of approximately 1.8 m (6 ft), the results of vibracore sample analysis to approximately 1.8 m (6 ft) are provided. The data indicated that the Blackfish Bank composite mean sediment diameter is 0.35 mm; the range of mean grain size values for the top two layers (which are shown in Table 3) is from 0.14 mm to 0.31 mm.

The sediment on Unnamed Shoals A and B is generally well-sorted, medium sand with a median composite grain size of 0.29 mm (USACE, 2010a). It is anticipated that the dredging would occur within the top two sample layers, the depth of which varies between the samples and is shown in Table 3. The mean grain size in the top layer of Unnamed Shoal A is calculated to be 0.42 mm, while the top layer of Unnamed Shoal B has a mean grain size of 0.34 mm. The range of mean grain sizes within the top two layers of Unnamed Shoal A is between 0.24 mm and 0.78 mm and on Unnamed Shoal B is between 0.17 mm and 0.47 mm. The sampling indicated that the top layer of sand is generally coarser than lower layers, though there were samples where the top layer was finer than the bottom layer.

<table>
<thead>
<tr>
<th>Vibracore Sample Number</th>
<th>Sample Depth m (ft)</th>
<th>Mean Grain Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blackfish Bank</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WIVC-59</td>
<td>0-1 (0-3.2)</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>1-1.4 (32.4-6)</td>
<td>0.20</td>
</tr>
<tr>
<td>WIVC-60</td>
<td>0-0.2 (0-0.8)</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>0.2-1.4 (0.8-4.5)</td>
<td>0.14</td>
</tr>
<tr>
<td>WIVC-61</td>
<td>0-1.5 (0-5)</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>1.5-2.9 (5-9.5)</td>
<td>0.22</td>
</tr>
</tbody>
</table>
### Description and Comparison of Alternatives

<table>
<thead>
<tr>
<th>Vibracore Sample Number</th>
<th>Sample Depth m (ft)</th>
<th>Mean Grain Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIVC-62</td>
<td>0-0.7 (0-2.3)</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>0.7-3 (2.3-10)</td>
<td>0.17</td>
</tr>
<tr>
<td>WIVC-63</td>
<td>0-1.5 (0-5)</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>1.5-2.2 (5-7.3)</td>
<td>0.19</td>
</tr>
<tr>
<td>WIVC-64</td>
<td>0-1.8 (0-6)</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>1.8-3.5 (6-11.6)</td>
<td>0.18</td>
</tr>
<tr>
<td>Unnamed Shoal A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07-WIVC-30</td>
<td>0-1.2 (0-4.1)</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>1.2-2.9 (4.1-9.5)</td>
<td>0.49</td>
</tr>
<tr>
<td>WIVC-54</td>
<td>0-1.5 (0-5)</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>1.5-3.5 (5-11.4)</td>
<td>0.78</td>
</tr>
<tr>
<td>WIVC-55</td>
<td>0-1.7 (0-5.6)</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>1.7-2.7 (5.6-9)</td>
<td>0.45</td>
</tr>
<tr>
<td>07-WIVC-29</td>
<td>0-1.1 (0-3.7)</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>1.1-2.2 (3.7-7.2)</td>
<td>0.38</td>
</tr>
<tr>
<td>WIVC-58</td>
<td>0-1.2 (0-4)</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>1.2-2.4 (4-8)</td>
<td>0.28</td>
</tr>
<tr>
<td>WIVC-56</td>
<td>0-1.9 (0-6.1)</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>1.9-3 (6.1-10)</td>
<td>0.25</td>
</tr>
<tr>
<td>WIVC-57</td>
<td>0-1.2 (0-4)</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>1.2-2.4 (4-8)</td>
<td>0.24</td>
</tr>
<tr>
<td>WIVC-65</td>
<td>0-0.6 (0-2)</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>0.6-1.5 (2-5)</td>
<td>0.34</td>
</tr>
<tr>
<td>WIVC-66</td>
<td>0-0.5 (0-1.8)</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>0.5-2.6 (1.8-5)</td>
<td>0.24</td>
</tr>
<tr>
<td>Unnamed Shoal B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WIVC-67</td>
<td>0-1.5 (0-5)</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>1.5-3 (5-10)</td>
<td>0.47</td>
</tr>
<tr>
<td>WIVC-68</td>
<td>0-1.5 (0-5)</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>1.5-2.8 (5-9.3)</td>
<td>0.43</td>
</tr>
<tr>
<td>WIVC-69</td>
<td>0-1.5 (0-5)</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>1.5-3 (5-10)</td>
<td>0.27</td>
</tr>
<tr>
<td>WIVC-70</td>
<td>0-1.5 (0-5)</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>1.5-2.8 (5-9.2)</td>
<td>0.29</td>
</tr>
</tbody>
</table>
Description and Comparison of Alternatives

<table>
<thead>
<tr>
<th>Vibracore Sample Number¹</th>
<th>Sample Depth m (ft)</th>
<th>Mean Grain Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIVC-71</td>
<td>0-0.4 (0-1.3)</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>0.4-1.5 (1.3-5)</td>
<td>0.17</td>
</tr>
<tr>
<td>WIVC-72</td>
<td>0-0.8 (0-2.6)</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>0.8-1.5 (2.6-5)</td>
<td>0.25</td>
</tr>
</tbody>
</table>

¹See Figure 12 for map of vibracore sampling locations
Source: Alpine Ocean Seismic Survey, Inc., 2008

2.4.4.3 Blackfish Bank Shoal

Blackfish Bank Shoal is located approximately 8 km (5 mi) east of Assateague Island and approximately 11 km (7 mi) northeast of the Wallops Island shoreline. The USACE determined that Blackfish Bank Shoal would provide suitable grain size and adequate quantities of sediment for the SRIPP.

This shoal is a popular commercial and recreational fishing location, partly due to an artificial reef on the southern portion of the shoal that was developed through the efforts of the Town of Chincoteague and the Chincoteague Island Charterboat Association. The artificial reef, which is regulated by the Virginia Marine Resources Commission (VMRC) Artificial Reef Program and constructed primarily of subway cars, covers approximately 1.75 square kilometer (km²) (0.7 square miles [mi²]) and provides habitat for fish and invertebrates.

In the spring of 2009, NASA conducted a survey of commercial and recreational fishermen to determine the level of use of Blackfish Bank Shoal, Unnamed Shoal A, and the Wallops Island shoreline. At the time of the survey, Unnamed Shoal B had not been selected as a potential borrow site therefore was not include in the survey. The survey was designed to assess commercial and recreational fishermen’s perceptions of potential impacts on the fishing industry from dredging activities that may occur at either shoal. The majority of respondents were concerned that project activities would destroy the artificial reef at Blackfish Bank, thereby removing important fishing grounds.

Comments received during the PEIS scoping period in May 2009 also indicated public concern regarding the potential dredging of Blackfish Bank Shoal and the resulting changes to the wave energy on Assateague Island. Some comments focused on the removal of the crest of the Blackfish Bank Shoal that could result in increased wave energy on Assateague Island and increased beach erosion. Other comments stated that Blackfish Bank should be left intact to minimize the potential impacts of dredging on Assateague Island National Seashore marine life.

To determine the potential effects of dredging Blackfish Bank Shoal, Unnamed Shoal A, and Unnamed Shoal B on Assateague Island’s shoreline, the USACE used a model based on site-specific wave characteristics and longshore sediment transport methodology. The USACE modeling methodology and results for dredging Unnamed Shoals A and B are explained in more detail in Section 4.2.2.1 of this PEIS and in Appendix A. Results of the USACE modeling showed that changes in longshore sediment transport as a result of dredging Blackfish Bank Shoal could be distinguished from naturally occurring sediment transport, and therefore the dredging may result in shoreline changes to the Assateague Island shoreline that would be
attributable to the SRIPP. The model results showed a few locations along the Assateague shoreline that could exhibit shoreline changes in response to dredging Blackfish Bank Shoal; however, the primary area that would be impacted would be the Tom’s Cove Isthmus area because it is naturally vulnerable to shoreline change. Because of the potentially adverse impacts on the Assateague Island shoreline and the public perception of negative impacts on commercial and recreational fishing communities, Blackfish Bank Shoal was removed from consideration as a borrow site option.

2.4.4.4 **Unnamed Shoal A**

The southwest end of Unnamed Shoal A is located approximately 11 km (7 mi) east of Assateague Island and approximately 18 km (11 mi) northeast of Wallops Island. The total predicted volume of Unnamed Shoal A is approximately 31 million m$^3$ (40 million yd$^3$). This shoal covers an area of approximately 700 hectares (1,800 acres). This option is carried forward for detailed analysis because sediment analyses and a review of bathymetric data conducted by the USACE indicate that this borrow site would provide adequate volumes and appropriately sized sediment for nourishment of the beach throughout the SRIPP’s 50-year design life. The USACE modeling methodology and results for dredging Unnamed Shoal A are explained in more detail in Section 4.2.2.1 of this PEIS and in Appendix A.

2.4.4.5 **Unnamed Shoal B**

Unnamed Shoal B is located approximately 16 km (10 mi) east of Assateague Island. The southwest end of Unnamed Shoal B is located approximately 19 km (12 mi) east of Assateague Island and approximately 21 km (13 mi) northeast of Wallops Island. The total predicted volume of Unnamed Shoal B is approximately 57 million m$^3$ (70 million yd$^3$). This shoal covers an area of approximately 1,600 hectares (3,900 acres). This option is carried forward for detailed analysis because sediment sampling analyses and a review of bathymetric data conducted by the USACE indicate that this borrow site would provide adequate volumes and appropriately sized sediment for nourishment of the beach throughout the SRIPP’s 50-year design life. The USACE modeling methodology and results for dredging Unnamed Shoal B are explained in more detail in Section 4.2.2.1 of this PEIS and in Appendix A.

2.4.5 **Upland Sand Sources**

2.4.5.1 **North Wallops Island Beach Borrow Site – Renourishment Only**

One option for renourishment is to remove sand from a portion of the existing beach on the northern end of Wallops Island (Figure 13). In addition to the existing sand on the beach, sediment that is expected to accumulate at the north end of Wallops Island after the initial beach fill would extend the existing beach seaward. This future accumulation area could also be used as fill material for renourishment.

The exact limits of the borrow area are intentionally undefined at this time as they will undoubtedly vary between SRIPP initial and renourishment events in response to: the volumes and patterns of accretion, the varying suitability of the sediment, Chincoteague Inlet dynamics, changes in vegetative cover, and biological factors. However, approximate limits of the potential...
borrow site area, shown on Figure 13, were identified based on a vegetation mapping survey conducted in October 2009 (see Section 3.2.1.1 Vegetation for more detail on the survey).

On October 6, 2009, the USACE performed sediment sampling of the beach at the northern end of Wallops Island (USACE, 2009b). Sixteen samples were collected to a depth of 1.8 m (6 ft). Grain size analysis was conducted on the surface layer of all samples, and then at either a depth of 0.6 m (2 ft) or 1.2 m (4 ft) for alternating numbered samples (see Table 4). Figure 13 shows the sample locations. The sediments generally consisted of tan to gray, poorly graded fine to medium sand with trace shell fragments and silt (USACE, 2009b). The median grain sizes of all samples were between 0.18 and 0.27 mm.

Table 4: Grain Size in Samples Collected from North Wallops Island

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Depth¹ m (ft)</th>
<th>Median Grain Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB-01</td>
<td>0</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>0.6 (2)</td>
<td>0.21</td>
</tr>
<tr>
<td>NB-02</td>
<td>0</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>1.2 (4)</td>
<td>0.21</td>
</tr>
<tr>
<td>NB-03</td>
<td>0</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>0.6 (2)</td>
<td>0.20</td>
</tr>
<tr>
<td>NB-04</td>
<td>0</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>1.2 (4)</td>
<td>0.19</td>
</tr>
<tr>
<td>NB-05</td>
<td>0</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>0.6 (2)</td>
<td>0.19</td>
</tr>
<tr>
<td>NB-06</td>
<td>0</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>1.2 (4)</td>
<td>0.19</td>
</tr>
<tr>
<td>NB-07</td>
<td>0</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>0.6 (2)</td>
<td>0.19</td>
</tr>
<tr>
<td>NB-08</td>
<td>0</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>1.2 (4)</td>
<td>0.20</td>
</tr>
<tr>
<td>NB-09</td>
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<td>0.18</td>
</tr>
<tr>
<td></td>
<td>0.6 (2)</td>
<td>0.19</td>
</tr>
<tr>
<td>NB-10</td>
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<td>0.19</td>
</tr>
<tr>
<td></td>
<td>1.2 (4)</td>
<td>0.22</td>
</tr>
<tr>
<td>NB-11</td>
<td>0</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>0.6 (2)</td>
<td>0.19</td>
</tr>
<tr>
<td>NB-12</td>
<td>0</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>1.2 (4)</td>
<td>0.22</td>
</tr>
<tr>
<td>NB-13</td>
<td>0</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>0.6 (2)</td>
<td>0.19</td>
</tr>
</tbody>
</table>
### Description and Comparison of Alternatives

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Depth(^1) m (ft)</th>
<th>Median Grain Size (mm)</th>
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</thead>
<tbody>
<tr>
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<td>0.27</td>
</tr>
<tr>
<td></td>
<td>1.2 (4)</td>
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</tr>
<tr>
<td>NB-15</td>
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<td>0.19</td>
</tr>
<tr>
<td></td>
<td>0.6 (2)</td>
<td>0.20</td>
</tr>
<tr>
<td>NB-16</td>
<td>0</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>1.2 (4)</td>
<td>0.23</td>
</tr>
</tbody>
</table>

---

#### Grain size analysis was done at the surface and 0.6 m [2 ft]) for odd numbered samples, and at the surface and 1.2 m [4 ft]) for even numbered samples; the data presented in this table represent the complete data set.

**Source:** USACE, 2009b

USACE modeling has shown that on average, approximately 30,600 m\(^3\) (40,000 yd\(^3\)) of sediment per year arrives at the northern end of Wallops Island by longshore transport from further south along the Wallops Island shoreline. Once the beach fill is placed, that volume is expected to increase to 76,500 to 115,000 m\(^3\) (100,000 to 150,000 yd\(^3\)) per year under all three of the alternatives (USACE, 2010a). A portion of the renourishment volume under each alternative could come from this beach source. Although not an optimal grain size for use as beach fill material, the northern end of Wallops Island would offer potential renourishment material without the mobilization and operational costs associated with offshore dredging.

Based on current vegetation and wildlife habitat constraints, the total potential area for sand removal is approximately 60 hectares (150 acres) (Figure 13). Excavation depth is expected to be limited to about 1 m (3.5 ft) below the ground surface due to tidal fluctuations and the high permeability of the soil (USACE, 2009b). Based on target depth of sediment removal, the area to be excavated would vary. For example, excavating to a depth of 1 m (3.5 ft) would require a 57-acre area to provide a renourishment volume of 230,000 m\(^3\) (300,000 yd\(^3\)).

#### 2.4.6 Summary of Preferred Borrow Sites

Several borrow sites were dismissed because they did not meet the criteria listed below for a useable source of sand. Based on the evaluation described above, the following three borrow sites are considered potential sand sources for the beach fill under the Proposed Action Alternatives: Unnamed Shoal A, Unnamed Shoal B, and the north Wallops Island beach (renourishment only). The minimum, maximum, and mean grain sizes for each of these three potential borrow sites are shown in Table 5. The data in Table 5 is based on the vibracore sampling by the USACE in 2007 (Alpine Ocean Seismic Survey, 2008) and subsurface sampling of the beach on the northern end of Wallops Island in October 2009 (USACE, 2009b) described above.

Unnamed Shoal A only would be used to obtain initial fill volumes under all three alternatives. For renourishment fill volumes, up to one-half of the fill volume could be excavated from the north Wallops Island borrow site, and the remaining half, or the entire renourishment volume, would be dredged from either Unnamed Shoal A or Unnamed Shoal B.
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### Table 5: Summary of Borrow Site Options Carried Forward for Analysis

<table>
<thead>
<tr>
<th>Borrow Site Option</th>
<th>Source</th>
<th>Minimum Grain Size (mm)</th>
<th>Maximum Grain Size (mm)</th>
<th>Mean Composite Grain Size (mm)</th>
<th>Approximate Travel Distance(^1) from Pump-Out Station (km [mi])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Shoal A</td>
<td>Offshore</td>
<td>0.24</td>
<td>0.78</td>
<td>0.42</td>
<td>22 (14)</td>
</tr>
<tr>
<td>Unnamed Shoal B</td>
<td>Offshore</td>
<td>0.27</td>
<td>0.43</td>
<td>0.34</td>
<td>31 (19)</td>
</tr>
<tr>
<td>North Wallops Island</td>
<td>Upland (beach)</td>
<td>0.11</td>
<td>0.30</td>
<td>0.20</td>
<td>0.8 (0.5)</td>
</tr>
</tbody>
</table>

\(^1\)One-way distance the barge would travel from the shoal to the pump-out station (not a straight line from the shoal to Wallops Island)

Sources: Alpine Ocean Seismic Survey, 2008 and USACE, 2009b

### 2.5 PROPOSED ACTION ALTERNATIVES

The combinations of options that would provide the maximum level of storm damage reduction while remaining within the limits of available funding were evaluated in detail as the three Proposed Action Alternatives discussed below. Each of these three alternatives would require a permit from the USACE under the Clean Water Act, as well as a negotiated lease with MMS for use of OCS sand resources for the beach fill material.

#### 2.5.1 Alternative One (Preferred Alternative): Full Beach Fill, Seawall Extension

The Preferred Alternative would involve an initial construction phase with follow-on renourishment cycles. The initial construction phase would include two distinct elements (Figure 14):

1. Extending Wallops Island’s existing rock seawall a maximum of 1,400 m (4,600 ft) south of its southernmost point.
2. Placing sand dredged from Unnamed Shoal A, located offshore in Federal waters, on the Wallops Island shoreline (refer to Section 2.6.4 for fill volumes).

**Seawall Extension**

The seawall extension would be constructed on the beach parallel to the shoreline in the approximate location of existing geotextile tubes (Figure 14). The new seawall would be constructed landward of the shoreline and would extend up to 1,400 m (4,600 ft) south of the existing seawall. The southern end of the 1,400-m (4,600-ft) extension would be at camera stand Z-100, which is located approximately 460 m (1,500 feet) north of the Wallops Island-Assawoman Island property boundary. The seawall extension would be implemented in the first year of the SRIPP and prior to the beach nourishment.

The seawall would consist of 4.5- to 6.4-mt (5- to 7-ton) rocks and would be placed on the beach (some rock slightly below the beach surface, the majority of the rock sitting on top of the beach surface). The top of the seawall would be approximately 5 m (14 ft) above the normal high tide water level, depending on the extent of existing shoreline retreat.
**Beach Fill**

The beach fill would start approximately 460 m (1,500 ft) north of the Wallops Island-Assawoman Island property boundary (near camera stand Z-100 shown on Figure 14) and extend north for 6.0 km (3.7 mi, Figure 14). The new beach would provide a surface to dissipate wave energy and contribute additional sediment to the nearshore system.

The beach fill is made up of two primary components: the anticipated minimum amount (minimum target fill) needed to provide defense from storm damage, plus an additional sacrificial amount (the advanced fill) that is expected to be removed by longshore transport between renourishment events. As the net overall transport is to the north, there would be a larger volume of advanced fill material placed at the southern end of the project, with little or no advanced fill placed at the northern end of the project area. This approach strives to ensure that the minimum amount of fill remaining at the project site, just before renourishment, would still provide adequate storm damage reduction (USACE, 2002; Gravens, et al., 2006). The volumes needed for the minimum target fill were based upon SBEACH (Storm-Induced BEAch CHange) modeling, and the amount of advanced fill was determined by GENESIS modeling, both conducted by the USACE (Appendix A). The mean composite grain size of Unnamed Shoals A and B, 0.29 mm, was used as a conservative estimate of shoal grain size in the USACE’s modeling of the required beach fill volumes.

Figure 15 shows a conceptual representation of the components of the initial and renourishment fill profiles. The initial fill includes a seawall deficit volume, a berm volume, a dune volume, an overfill volume, and an advanced nourishment volume (Figure 15). The renourishment fill includes the advanced fill volume and a sea-level rise volume.

The initial fill would be placed so that there would be a 1.8-m-high (6-ft-high) berm extending a minimum of 21 m (70 ft) seaward of the existing seawall. The remainder of the fill would slope underwater for an additional distance seaward; the amount of that distance would vary along the length of the beach fill, but would extend for a maximum of about 52 m (170 ft), so that the total distance of the fill profile from the seawall would be up to approximately 73 m (240 ft). The beach fill profile would also include a 4.3-m-high (14-ft-high) dune at the seawall (shown in yellow on Figure 15). The front sloping face of the dune would rest against the seawall.

In the initial nourishment, NASA would place an estimated 2,446,000 m$^3$ (3,199,000 yd$^3$) of fill (minimum and advanced target fill combined) along the shoreline. The placement of sand on the shoreline for the initial beach fill would occur within the first 3 years of the SRIPP (USACE, 2010a). In Year 2, placement activities would be initiated to restore the underwater area in front of the seawall to its equilibrium condition (USACE, 2010a). The remainder of the initial fill volume would be placed in Year 3 (USACE, 2010a).

Sand for the initial nourishment would be dredged from Unnamed Shoal A and placed onto the beach, as described in Section 2.6.5. For renourishment fill volumes, it is anticipated that a portion of the fill volume could be excavated from the north Wallops Island borrow site, and the remaining portion could be dredged from either Unnamed Shoal A or Unnamed Shoal B.
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Subsequent beach renourishment cycles would vary throughout the life of the Proposed Action. Storm frequency and severity would dictate the magnitude and rate of recurrence of beach renourishment. The exact locations and magnitude of renourishment cycles may fluctuate because of the dynamic nature of the ocean environment; therefore, additional NEPA documentation for future renourishment actions may be required, and would be prepared as appropriate.

For the purpose of this PEIS, the renourishment cycle is anticipated to involve approximately 616,000 m$^3$ (806,000 yd$^3$) of sand every 5 years. The initial fill plus the total fill volume over nine renourishment events would result in approximately 7,992,000 m$^3$ (10,453,000 yd$^3$) of sand being placed on the shoreline. The topography and bathymetry of the beach would be monitored on a regular basis to determine sand movement patterns and plan when renourishment is needed.

The absence of sand retention structures would result in a larger amount of sand being available for erosion and longshore transport. Over the 50-year project life, the exact frequency of beach nourishment would be determined by the amount of fill placed each time, and by the number and severity of storm events.

### 2.5.2 Alternative Two: Full Beach Fill, Groin, Seawall Extension

Under Alternative Two, the seawall extension would be the same as described under Alternative One. Construction of a groin (described below) would result in more sand being retained along the Wallops Island beach, so less fill would be required for both the initial nourishment and renourishment volumes compared to Alternative One. The initial fill volume would be an estimated 2,229,000 m$^3$ (2,916,000 yd$^3$), and each renourishment fill volume would be approximately 552,000 m$^3$ (722,000 yd$^3$). The initial fill plus the total fill volume over nine renourishment events would result in approximately 7,198,000 m$^3$ (9,414,000 yd$^3$) of sand being placed on the shoreline.

Beach fill would be placed along the same length of the shoreline as described under Alternative One, but because less initial nourishment and renourishment fill would be required, the beach profile would not extend as far into the ocean (Figure 16). As with the beach fill under Alternative One, the initial beach fill under Alternative Two would extend 21 m (70 ft) seaward from the present shoreline in a 1.8-m-high (6-ft-high) berm, and then would slope underwater for an additional distance seaward (Figure 15). The beach fill profile would also include a 4.3-m-high (14-ft-high) dune at the seawall (shown in yellow on Figure 15). The front sloping face of the dune would rest against the seawall.

In addition, a groin would be constructed at the south end of the Wallops Island shoreline (Figure 16). Groin construction would occur in the third year of the SRIPP, after seawall construction in Year 1 and the first phase of beach fill in Year 2. Construction would involve the placement of rocks in a linear structure perpendicular to the shoreline at approximately 445 m (1,460 ft) north of the Wallops Island-Assawoman Island border (Figure 16). The rocks would be similar in size to those used for the seawall.

The groin would be constructed of 4.5- to 6.4-mt (5- to 7-tons) of rocks placed perpendicular to the shore. The structure would be approximately 130 m (430 ft) long and 15 m (50 ft) wide, and would take approximately 1 month to build. Approximately two-thirds of the groin (80 m [265 ft]) would be installed on the beach once the fill has been placed, and the remaining one-third, approximately 50 m (165 ft), would extend beyond the beach into the ocean.
2.5.3 Alternative Three: Full Beach Fill, Breakwater, Seawall Extension

Under Alternative Three, the seawall extension would be the same as described under Alternative One. Construction of the breakwater (described below) would result in more sand being retained along the Wallops Island beach, so less fill would be required for both the initial nourishment and renourishment volumes compared to Alternative One. The initial fill volume would be 2,170,000 m$^3$ (2,839,000 yd$^3$), and each renourishment fill volume would be 537,000 m$^3$ (703,000 yd$^3$). The initial fill plus the total fill volume over nine renourishment events would result in approximately 7,008,000 m$^3$ (9,166,000 yd$^3$) of sand being placed on the shoreline.

Beach fill would be placed along the same length of the shoreline as described under Alternative One, but because less initial nourishment and renourishment fill would be required, the beach profile would not extend as far into the ocean (Figure 16). Slightly less fill would be required than under Alternative Two. As with the beach fill under Alternative One, the initial beach fill under Alternative Three would extend 21 m (70 ft) seaward from the present shoreline in a 1.8-m-high (6-ft-high) berm, and then would slope underwater for an additional distance seaward (Figure 15). The beach fill profile would also include a 4.3-m-high (14-ft-high) dune at the seawall (shown in yellow on Figure 15). The front sloping face of the dune would rest against the seawall.

In addition, a nearshore breakwater structure would be constructed at the south end of the Wallops Island shoreline in the third year of the SRIPP, after seawall construction in Year 1 and the first phase of beach fill in Year 2 (Figure 16). A single breakwater would be constructed approximately 230 m (750 ft) offshore in order to avoid tombolo formation. A tombolo forms as sand deposited in the sheltered area behind the breakwater connects the breakwater to the beach. A tombolo would block longshore sediment transport and cause erosion on the downdrift side of the feature. Eventually, sand transport may resume along the seaward face of the breakwater, but the water may be too deep for large amounts of transport to occur.

The breakwater would be constructed of 4.5 to 6.4 m (5 to 7 tons) of rocks placed parallel to the shore. It would be approximately 90-m (300-ft) long and 35-m (110-ft) wide (Figure 16), and would take approximately 1 month to build. Construction would take place in the water using a barge and heavy lifting equipment.
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2.5.4 Summary of Dredge and Fill Volumes for Each of the Alternatives

Table 6 below shows the estimated volumes of sand that would be placed on the Wallops Island beach during the project lifecycle for each alternative considered.

<table>
<thead>
<tr>
<th>Volume Type</th>
<th>Alternative One (m³, yd³)</th>
<th>Alternative Two (m³, yd³)</th>
<th>Alternative Three (m³, yd³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Fill</td>
<td>2,446,000 (3,199,000)</td>
<td>2,229,000 (2,916,000)</td>
<td>2,170,000 (2,839,000)</td>
</tr>
<tr>
<td>Renourishment</td>
<td>616,000 (806,000)</td>
<td>552,000 (722,000)</td>
<td>537,000 (703,000)</td>
</tr>
<tr>
<td>Number of Renourishment Events</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Project Lifetime</td>
<td>7,992,000 (10,453,000)</td>
<td>7,198,000 (9,414,000)</td>
<td>7,008,000 (9,166,000)</td>
</tr>
</tbody>
</table>

Source: USACE, 2010a

Because of overflow from the hopper dredge at the offshore borrow sites during dredging, pump-out, and placement, a larger volume of material would need to be dredged to meet the targeted fill volume. Based on information from other shoreline restoration projects, sediment losses during dredging and placement operations may be up to 25 percent (Wikel, personal comm.). Using a conservative 25 percent loss factor for the SRIPP, estimated dredge volumes for the offshore borrow sites in order to meet the targeted fill volumes are shown in Table 7.

The maximum dredging depth for sand from Great Gull Bank (located approximately 8 km [5 mi] east of northern Assateague Island) for the Short-Term Restoration of Assateague project was restricted to 1.8 m (6 ft) by the USACE and MMS (USACE, 2008). Assuming an approximate 1.8-m (6-ft) dredging depth for the SRIPP, the amount of shoal area required to obtain the necessary beach fill material for Alternative One would be approximately 5.2 km² (2 mi²), or 520 hectares (1,280 acres). Because this area would be the largest dredge or borrow area on each of the proposed shoals, it was established as the study area for resources such as benthic (bottom) habitats and submerged cultural resources.

<table>
<thead>
<tr>
<th>Dredge Event</th>
<th>Alternative One (m³, yd³)</th>
<th>Alternative Two (m³, yd³)</th>
<th>Alternative Three (m³, yd³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Fill</td>
<td>3,057,500 (3,998,750)</td>
<td>2,786,250 (3,645,000)</td>
<td>2,712,500 (3,548,750)</td>
</tr>
<tr>
<td>Renourishment</td>
<td>770,000 (1,007,500)</td>
<td>690,000 (915,000)</td>
<td>671,250 (878,750)</td>
</tr>
<tr>
<td>Project Lifetime</td>
<td>9,990,000 (13,066,250)</td>
<td>8,997,500 (11,767,500)</td>
<td>8,760,000 (11,457,500)</td>
</tr>
</tbody>
</table>

2.5.5 Dredging and Sand Placement Operation

2.5.5.1 Offshore Dredging

Trailer suction hopper dredges are the most likely dredges to be used for the SRIPP. These dredges are self-propelled, seagoing vessels and are equipped with propulsion machinery, a sediment container (i.e., hopper), dredge pumps, and other specialized equipment required to perform the essential function of excavating sediments from the sea floor. Hopper dredges have enough horsepower for required free-running speed and dredging against strong currents, and have excellent maneuverability.
The hopper dredge fills its hoppers by employing large pumps to create suction in pipes that are lowered into the water to remove sediment from the shoal bottom (the process very closely resembles that of a typical vacuum cleaner, Photo 4). The hopper dredges likely to be used typically remove material from the bottom of the sea floor in layers up to 0.3 m (1 ft) in depth (Williams, personal comm.).

Centrifugal pumps within the hull, sometimes mounted on the drag arm, create a region of low pressure or centrifugal force around the drag heads. This low pressure forces water and sediment up the drag arm and into the hopper. The closer the drag head is to the sediment, the more efficient the dredging.

Once the dredge hopper is filled, the dredge would transport the material to a pump-out buoy or station that would be placed at a water depth of approximately 9 m (30 ft), which would be approximately 3 km (2 mi) offshore of the placement area. The pathway from Unnamed Shoals A and B to the pump-out buoy is not a straight line, but a dogleg shape with a turning point, for the purpose of avoiding Chincoteague Shoal and Blackfish Bank. The distance from the turning point to the pump-out buoy is approximately 5 km (8 mi). The one-way distance from Unnamed Shoal A to the theoretical pump-out buoy is approximately 22 km (14 mi), and the corresponding transit distance from Unnamed Shoal B to the theoretical pump-out buoy is approximately 31 km (19 mi). Booster pumps may be needed to aid the offloading of sand from the pump-out buoy to the shoreline.

Based on previous offshore dredging operations along the east coast, it is assumed that dredgers with a hopper capacity of approximately 3,000 m$^3$ (4,000 yd$^3$) would be used; however, because this volume is a slurry and not all sand, the actual volume of sand that each dredge would transport during each trip would be approximately 2,300 m$^3$ (3,000 yd$^3$). The dredges would operate for 12- to 24-hour stretches.

**Photo 4: Schematic of a self-propelled trailer suction hopper dredge**

Source: MMS 2004-076

### 2.5.5.2 Sand Placement from Offshore Dredging

Once the dredge arrives at the pump-out buoy, it would connect to the discharge pipeline on the buoy. The dredge would then mix the dredged sand with water to form a slurry, and pump the slurry from its discharge manifold through a submerged or floating pipeline. Discharge at the beach would occur at a fixed point in tandem with contouring of the deposited sand by
buckdozers. Booster pumps may be needed to aid in offloading the sand from the pump-out buoy to the shoreline.

2.5.5.3 North Wallops Island Borrow Site

A pan excavator would likely be used to remove sand from the north Wallops Island borrow site (Photo 5). Because it runs on several rubber tires with a low tire pressure, it can work in areas of the beach where typical equipment may be bogged down in unstable sand. The pan excavator would stockpile the sand, which would be loaded onto dump trucks that would transport the fill material up and down the beach. Bulldozers would then be used to spread the fill material once it is placed on the beach. All heavy equipment would access the beach from existing roads and established access points. No new temporary or permanent roads would be constructed to access the beach or to transport the fill material to renourishment areas.

Photo 5: Example of a Pan Excavator

2.6 SUMMARY AND COMPARISON OF ALTERNATIVES

This section summarizes and compares the potential environmental impacts, presented in detail in Chapter 4, of the Proposed Action Alternatives and No Action Alternative.

The four alternatives carried forward for analysis in this PEIS are:

- Alternative One (Preferred Alternative) – Beach Fill, Seawall Extension
- Alternative Two – Beach Fill, Groin, Seawall Extension
- Alternative Three – Beach Fill, Breakwater, Seawall Extension
- No Action Alternative

For initial fill volumes under all three Proposed Action Alternatives, only Unnamed Shoal A would be used because it is closer than Unnamed Shoal B and requires less transit time and fuel. Dredging at Unnamed Shoal A and B would result in similar environmental impacts. For renourishment fill volumes, of the fill volume could be excavated from the north Wallops Island borrow site, or could be dredged entirely from either Unnamed Shoal A or Unnamed Shoal B.


2.6.1 Implementation Schedule

WFF does not expect to receive sufficient funding to implement all of the initial components (seawall extension and initial phase of the beach fill) in a single year. Instead, the initial components would be staged and completed over a three-year time span. The order in which construction would occur has been carefully considered. If the expected funding in Year 2 or Year 3 is postponed or cancelled, the completed portions of the project would be viable projects themselves and would not have negative shoreline consequences either to Wallops Island or to its neighbors (USACE, 2010a). It is expected that in Year 2, funding would be available to place approximately 917,000 m$^3$ (1.2 million yd$^3$) of fill material.

Using the total volumes listed in Table 6 and Table 7, the initial beach fill would require approximately 1,000 to 1,100 dredge trips from the offshore borrow sites to the Wallops Island shoreline and each renourishment fill would require approximately 240 to 270 dredge trips. Two dredges would be in use at the same time and would accomplish about three round trips per day. Assuming 10-percent downtime for the dredges due to weather, equipment failure, etc., the 917,000 m$^3$ (1.2 million yd$^3$) volume of fill placed in Year 2 would result in approximately 410 dredge trips and would take approximately 81 days, or about 3 months. The remaining volume to be placed under Alternative One, approximately 1,530,000 m$^3$ (2 million yd$^3$) would result in approximately 690 dredge trips and would take approximately 135 days, or about 4 and a half months. Renourishment activities (assuming all fill is taken from one of the proposed offshore shoals) would take approximately 50 days, or about 2 months each cycle.

The implementation schedule in Table 8 would apply to all of the Proposed Action Alternatives.

<table>
<thead>
<tr>
<th>Project Year</th>
<th>Activity</th>
<th>Time Required for Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>Construction of the seawall extension</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Initiation of a monitoring program</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Year 2</td>
<td>Partial initial beach fill and dredging</td>
<td>3 months</td>
</tr>
<tr>
<td></td>
<td>Continuation of the monitoring program</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Year 3</td>
<td>Completion of initial beach fill dredging</td>
<td>4.5 months</td>
</tr>
<tr>
<td></td>
<td>Construction of the groin, breakwater, or neither, depending upon the alternative chosen</td>
<td>1 month (same for both groin and breakwater)</td>
</tr>
<tr>
<td></td>
<td>Continuation of the monitoring program</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Year 8</td>
<td>First renourishment fill</td>
<td>2 months</td>
</tr>
</tbody>
</table>

2.6.2 Comparison of Costs

There would be a cost reduction in dredging sand from Unnamed Shoal A versus Unnamed Shoal B due to the shorter transit distance required for the dredger. As described in Section 2.6.5.1 (Offshore Dredging), the one-way distance from Unnamed Shoal A to the theoretical pump-out buoy location is approximately 9 km (5 mi) less than it is for Unnamed Shoal B. The reduced distance would translate into lower fuel consumption and costs for dredging sand from
Description and Comparison of Alternatives

Unnamed Shoal A. Table 9 below shows a cost reduction of approximately $3.3 million for the initial beach fill and $840,000 for each renourishment event under the Preferred Alternative if Shoal A is used instead of Shoal B.

Table 9: Approximate Cost Reduction by Dredging Sand from Shoal A versus Shoal B

<table>
<thead>
<tr>
<th></th>
<th>Initial Beach Fill</th>
<th>Single Renourishment Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative One (Preferred)</td>
<td>$3,300,000</td>
<td>$840,000</td>
</tr>
<tr>
<td>Alternative Two</td>
<td>$3,000,000</td>
<td>$750,000</td>
</tr>
<tr>
<td>Alternative Three</td>
<td>$3,000,000</td>
<td>$730,000</td>
</tr>
</tbody>
</table>

2.6.3 Comparison of Impacts

Table 10 provides a comparison of the potential impacts shown by resource for each alternative.
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<table>
<thead>
<tr>
<th>Resource</th>
<th>Alternative One</th>
<th>Alternative Two</th>
<th>Alternative Three</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology and Sediment</td>
<td>Placement of beach fill (initial and renourishment) would create and maintain a beach berm approximately 21 meters (70 feet) wide on Wallops Island. The addition of sediment to the longshore transport system would result in accretion at the southern end of Wallops Island and northern end of Assawoman Island. Over the lifetime of the SRIPP, the seawall extension and beach fill would have long-term direct beneficial impacts on geology and the Wallops Island shoreline by mitigating the current rate of shoreline retreat. Continued beach nourishment would add to this benefit by providing ongoing mitigation of shoreline retreat. North Wallops Island sand removal would result in minor adverse impacts on sediments and would lower topography within the excavated areas.</td>
<td>Placement of beach fill (initial and renourishment) would create and maintain a beach berm approximately 21 meters (70 feet) wide on Wallops Island. The addition of sediment to the longshore transport system would result in accretion at the southern end of Wallops Island and northern end of Assawoman Island; therefore, long-term direct beneficial impacts on land use, geology and sediment would occur due to creation of a beach. North Wallops Island sand removal would result in minor adverse impacts on sediments and topography. Construction of a groin would help to retain sand on the Wallops Island shoreline so that erosion and sediment transport from Wallops Island would be reduced and the beach created by the SRIPP would stay in place longer than under Alternative One. North Wallops Island sand removal would result in minor adverse impacts on sediments and would lower topography within the excavated areas.</td>
<td>Placement of beach fill (initial and renourishment) would create and maintain a beach berm approximately 21 meters (70 feet) wide on Wallops Island. The addition of sediment to the longshore transport system would result in accretion at the southern end of Wallops Island and northern end of Assawoman Island; therefore, long-term direct beneficial impacts on land use, geology and sediment would occur due to creation of a beach. North Wallops Island sand removal would result in minor adverse impacts on sediments and topography. Construction of a breakwater would help to retain sand on the Wallops Island shoreline so that erosion and sediment transport from Wallops Island would be reduced and the beach created by the SRIPP would stay in place longer than under Alternative One. North Wallops Island sand removal would result in minor adverse impacts on sediments and would lower topography within the excavated areas.</td>
<td>Adverse impacts on land use, geology and sediments from continued loss of the shoreline. Negligible adverse impacts on sediments would be caused during emergency operations over the 50-year lifetime of the SRIPP.</td>
</tr>
<tr>
<td>Offshore Shoals/Bathymetry</td>
<td>Dredging would remove a total of approximately 3,057,500 m³ (3,998,750 yd³) of sand from Unnamed Shoal A for the initial beach fill. Each of the nine anticipated renourishment cycles would require 770,000 m³ (1,007,500 yd³) or a total of approximately 9,990,000 m³ (13,066,250 yd³) over the lifetime of the SRIPP. The renourishment material may be dredged from Unnamed Shoal A, Unnamed Shoal B, and/or the northern end.</td>
<td>Dredging would remove a total of approximately 2,786,250 m³ (3,645,000 yd³) of sand from Unnamed Shoal A for the initial beach fill. Each of the nine anticipated renourishment cycles would require 690,000 m³ (915,500 yd³) or a total of approximately 8,997,500 m³ (11,767,500 yd³) over the lifetime of the SRIPP. The renourishment material may be dredged from Unnamed Shoal A, Unnamed Shoal B, and/or the northern end.</td>
<td>Dredging would remove a total of approximately 2,712,500 m³ (3,548,750 yd³) of sand from Unnamed Shoal A for the initial beach fill. Each of the nine anticipated renourishment cycles would require 671,250 m³ (878,750 yd³) or a total of approximately 8,760,000 m³ (11,457,500 yd³) over the lifetime of the SRIPP. The renourishment material may be dredged from Unnamed Shoal A, Unnamed Shoal B, and/or the northern end.</td>
<td>No impacts.</td>
</tr>
</tbody>
</table>
### Table 10: Summary of Impacts from the Proposed Action Alternatives

<table>
<thead>
<tr>
<th>Resource</th>
<th>Alternative One</th>
<th>Alternative Two</th>
<th>Alternative Three</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoreline Change</td>
<td>Placement of beach fill (initial and renourishment) would create a beach berm approximately 21 m (70 ft) wide on Wallops Island, resulting in long-term beneficial direct impacts. The addition of sediment to the longshore transport system would offset some ongoing erosion that is occurring at the northern end of Assawoman Island. Dredging of the offshore shoals would result in minimal change to local wave conditions and no impact to the Assateague Island shoreline. Sediment would continue to accrete along the northern end of Wallops Island.</td>
<td>Placement of beach fill (initial and renourishment) would create a beach berm approximately 21 m (70 ft) wide on Wallops Island, resulting in long-term beneficial direct impacts. The addition of sediment to the longshore transport system would offset some ongoing erosion that is occurring at the northern end of Assawoman Island. There would be an accumulation of sediment on the updrift side of the groin, and it is possible that groin would function as a “shadow,” causing an increase in erosion downdrift of the area within the groin shadow. Renourishing the beach would reduce the potential for downdrift erosion by providing continual sand on the Wallops Island shoreline, some of which would be available to the longshore sediment transport system. Dredging of the offshore shoals would result in minimal change to local wave conditions and no impact to the Assateague Island shoreline. Sediment would continue to accrete along the northern end of Wallops Island.</td>
<td>Placement of beach fill (initial and renourishment) would create a beach berm approximately 21 m (70 ft) wide on Wallops Island, resulting in long-term beneficial direct impacts. The addition of sediment to the longshore transport system would offset some ongoing erosion that is occurring at the northern end of Assawoman Island. The breakwater could result in erosion of the shoreline south of the structure; the direct effects would not likely occur more than 2.5 km (1.5 mi) downdrift of the breakwater. Renourishing the beach would reduce the potential for downdrift erosion by providing continual sand on the Wallops Island shoreline, some of which would be available to the longshore sediment transport system. Dredging of the offshore shoals would result in minimal change to local wave conditions and no impact to the Assateague Island shoreline. Sediment would continue to accrete along the northern end of Wallops Island.</td>
<td>The shoreline along the southern portion of Wallops Island would continue to erode at a rate of approximately 3 m (10 ft) per year. The shoreline along the seawall would be held at its current location until erosional forces and undermining of the seawall would cause it to fail. The current seawall shows 13 areas of concern where the seawall has shown a vertical drop of at least 2 m (6 ft). Sediment would continue to accrete along the northern end of Wallops Island.</td>
</tr>
<tr>
<td>Water Resources</td>
<td>Elevated turbidity in marine waters at the offshore shoals from dredging and in the nearshore environment from sand placement.</td>
<td>Elevated turbidity in marine waters at the offshore shoals from dredging and in the nearshore environment from sand placement.</td>
<td>Elevated turbidity in marine waters at the offshore shoals from dredging and in the nearshore environment from sand placement.</td>
<td>No impacts.</td>
</tr>
</tbody>
</table>
### Description and Comparison of Alternatives

#### Table 10: Summary of Impacts from the Proposed Action Alternatives

<table>
<thead>
<tr>
<th>Resource</th>
<th>Alternative One</th>
<th>Alternative Two</th>
<th>Alternative Three</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Quality</strong></td>
<td>Emissions from construction and dredging activities are not anticipated...</td>
<td>Emissions from construction and dredging activities are not anticipated...</td>
<td>Emissions from construction and dredging activities are not anticipated...</td>
<td>Emissions from construction and dredging activities are not anticipated...</td>
</tr>
<tr>
<td></td>
<td>to cause long-term adverse impacts on air quality or climate change.</td>
<td>to cause long-term adverse impacts on air quality or climate change.</td>
<td>to cause long-term adverse impacts on air quality or climate change.</td>
<td>to cause long-term adverse impacts on air quality or climate change.</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>Temporary, localized impacts...</td>
<td>Temporary, localized impacts...</td>
<td>Temporary, localized impacts...</td>
<td>Temporary, localized impacts...</td>
</tr>
<tr>
<td></td>
<td>during construction, dredging and fill, but no adverse impacts.</td>
<td>during construction, dredging and fill, but no adverse impacts.</td>
<td>during construction, dredging and fill, but no adverse impacts.</td>
<td>during construction and/or maintenance activities.</td>
</tr>
<tr>
<td></td>
<td>Temporary, localized impacts on marine mammals associated with increased...</td>
<td>Temporary, localized impacts on marine mammals associated with increased...</td>
<td>Temporary, localized impacts on marine mammals associated with increased...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>noise from vessel activities (dredging).</td>
<td>noise from vessel activities (dredging).</td>
<td>noise from vessel activities (dredging).</td>
<td></td>
</tr>
<tr>
<td><strong>Hazardous Materials</strong></td>
<td>Beneficial impact by restoring...</td>
<td>Beneficial impact by restoring...</td>
<td>Beneficial impact by restoring...</td>
<td>Potential adverse impacts from...</td>
</tr>
<tr>
<td></td>
<td>shoreline and increasing the distance between breaking waves and...</td>
<td>shoreline and increasing the distance between breaking waves and...</td>
<td>shoreline and increasing the distance between breaking waves and...</td>
<td>shoreline retreat and distance of...</td>
</tr>
<tr>
<td></td>
<td>storage areas and accumulation points.</td>
<td>storage areas and accumulation points.</td>
<td>storage areas and accumulation points.</td>
<td>of hazardous materials critical...</td>
</tr>
<tr>
<td><strong>Munitions and Explosives</strong></td>
<td>MEC are not anticipated to be encountered in...</td>
<td>MEC are not anticipated to be encountered in...</td>
<td>MEC are not anticipated to be encountered in...</td>
<td>NASA would continue to follow...</td>
</tr>
<tr>
<td>of Concern (MEC)</td>
<td>the area of seawall construction or beach fill.</td>
<td>the area of seawall construction or beach fill.</td>
<td>the area of seawall construction or beach fill.</td>
<td>the WFF MEC Avoidance Plan, conduct surveys, and remove MEC as...</td>
</tr>
<tr>
<td></td>
<td>Shoreline erosion would increase to the south of the seawall...</td>
<td>Shoreline erosion would increase to the south of the seawall...</td>
<td>Shoreline erosion would increase to the south of the seawall...</td>
<td>necessary.</td>
</tr>
<tr>
<td></td>
<td>of the seawall extension in the first one to two years of the SRIPP; MEC may migrate to the...</td>
<td>of the seawall extension in the first one to two years of the SRIPP; MEC may migrate to the...</td>
<td>of the seawall extension in the first one to two years of the SRIPP; MEC may migrate to the...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>may migrate to the ocean if further beach erosion occurs in this area.</td>
<td>may migrate to the ocean if further beach erosion occurs in this area.</td>
<td>may migrate to the ocean if further beach erosion occurs in this area.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The beach fill (starting in year two) would reduce the potential of MEC...</td>
<td>The beach fill (starting in year two) would reduce the potential of MEC...</td>
<td>The beach fill (starting in year two) would reduce the potential of MEC...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>migration into the ocean. There is a potential that MEC would be...</td>
<td>migration into the ocean. There is a potential that MEC would be...</td>
<td>migration into the ocean. There is a potential that MEC would be...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>encountered during excavation of the north Wallops Island borrow site. NASA...</td>
<td>encountered during excavation of the north Wallops Island borrow site. NASA...</td>
<td>encountered during excavation of the north Wallops Island borrow site. NASA...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>would implement an MEC Avoidance Plan, conduct surveys, and remove MEC...</td>
<td>would implement an MEC Avoidance Plan, conduct surveys, and remove MEC...</td>
<td>would implement an MEC Avoidance Plan, conduct surveys, and remove MEC...</td>
<td></td>
</tr>
<tr>
<td><strong>Biological Resources</strong></td>
<td>Direct adverse impacts on bottom communities within...</td>
<td>Direct adverse impacts on bottom communities within...</td>
<td>Direct adverse impacts on bottom communities within...</td>
<td></td>
</tr>
<tr>
<td>- Benthic Resources</td>
<td>communities with dredging area. Benthic communities and habitat would be...</td>
<td>communities with dredging area. Benthic communities and habitat would be...</td>
<td>communities with dredging area. Benthic communities and habitat would be...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>removed during dredging. Assuming the entire proposed borrow area of Shoal A...</td>
<td>removed during dredging. Assuming the entire proposed borrow area of Shoal A...</td>
<td>removed during dredging. Assuming the entire proposed borrow area of Shoal A...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>would be</td>
<td>would be</td>
<td>would be</td>
<td>No impacts.</td>
</tr>
</tbody>
</table>
Table 10: Summary of Impacts from the Proposed Action Alternatives

<table>
<thead>
<tr>
<th>Resource</th>
<th>Alternative One</th>
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<th>Alternative Three</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>dredged (uniform dredge depth of approximately 0.6 m [2 ft]) for the initial beach fill, approximately 518 hectares (ha) (1,280 acres [ac]) of benthic habitat would be removed. During each of nine renourishment cycles, approximately 140 ha (347 ac) of benthic habitat on Shoal A or Shoal B would be adversely impacted with a uniform dredging depth of approximately 0.6 m (2 ft). Placement of the initial fill would bury existing intertidal benthic community along an approximate 4,300 m (14,000 ft) length of the seawall. The mean tidal range is approximately 1.1 m (3.6 ft); therefore approximately 0.5 ha (1.2 ac) of hard-bottom, intertidal habitat would be permanently buried. In addition, approximately 91 ha (225 ac) of subtidal benthic community along the existing seawall would be buried during the initial fill placement. A new beach would be formed in front the seawall and a beach benthic community would become established.</td>
<td>dredged (uniform dredge depth of approximately 0.6 m (2 ft)) for the initial beach fill, approximately 518 ha (1,280 ac) of benthic habitat would be removed. During each of nine renourishment cycles, approximately 116 ha (287 ac) of benthic habitat on Shoal A or Shoal B would be adversely impacted with a uniform dredging depth of approximately 0.6 m (2 ft). Placement of the initial fill would bury existing intertidal benthic community along an approximate 4,300 m (14,000 ft) length of the seawall. The mean tidal range is approximately 1.1 m (3.6 ft); therefore approximately 0.5 hectare (1.2 ac) of hard-bottom, intertidal habitat would be permanently buried. Approximately 91 ha (225 ac) of subtidal benthic community along the existing seawall would also be buried during the initial fill placement. A new beach would be formed in front the seawall and a beach benthic community would become established. In addition, the construction of the groin would bury 0.08 ha (0.19 ac) of sandy, subtidal benthic habitat and replace it with hard substrate.</td>
<td>dredged (uniform dredge depth of approximately 0.6 m [2 ft]) for the initial beach fill, approximately 518 ha (1,280 ac) of benthic habitat would be removed. During each of nine renourishment cycles, approximately 116 ha (287 ac) of benthic habitat on Shoal A or Shoal B would be adversely impacted with a uniform dredging depth of approximately 0.6 m (2 ft). Placement of the initial fill would bury existing intertidal benthic community along an approximate 4,300 m (14,000 ft) length of the seawall. The mean tidal range is approximately 1.1 m (3.6 ft); therefore approximately 0.5 hectare (1.2 ac) of hard-bottom, intertidal habitat would be permanently buried. Approximately 91 ha (225 ac) of subtidal benthic community along the existing seawall would also be buried during the initial fill placement. A new beach would be formed in front the seawall and a beach benthic community would become established. In addition, the construction of the groin would bury 0.08 ha (0.19 ac) of sandy, subtidal benthic habitat and replace it with hard substrate.</td>
<td>No impacts.</td>
</tr>
</tbody>
</table>

Biological Resources - Fisheries

Direct site-specific adverse effects on EFH within: (1) the dredged area due to removal of benthic habitat and changes in shoal bathymetry and (2) the fill placement area due to burial of existing benthic habitat. However, the impacts would not be significant within a regional context. There would also be minor direct impacts to fisheries outside the dredging and fill.

Direct site-specific adverse effects on EFH within: (1) the dredged area due to removal of benthic habitat and changes in shoal bathymetry and (2) the fill placement area due to burial of existing benthic habitat. However, the impacts would not be significant within a regional context. There would also be minor direct impacts to fisheries outside the dredging and fill.

Direct site-specific adverse effects on EFH within: (1) the dredged area due to removal of benthic habitat and changes in shoal bathymetry and (2) the fill placement area due to burial of existing benthic habitat. However, the impacts would not be significant within a regional context. There would also be minor direct impacts to fisheries outside the dredging and fill.

No impacts.
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<tr>
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<th>Alternative Two</th>
<th>Alternative Three</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological Resources – Marine Mammals</td>
<td>Potential temporary, localized adverse impacts associated with (1) physical disturbance to habitats during dredging and fill, (2) vessel strike, and (3) increased noise from vessel activities (dredging).</td>
<td>Potential temporary, localized adverse impacts associated with (1) physical disturbance to habitats during dredging and fill, (2) vessel strike, and (3) increased noise from vessel activities (dredging).</td>
<td>Potential temporary, localized adverse impacts associated with (1) physical disturbance to habitats during dredging and fill, (2) vessel strike, and (3) increased noise from vessel activities (dredging).</td>
<td>No impacts.</td>
</tr>
<tr>
<td>Biological Resources - Threatened &amp; Endangered Species</td>
<td>May affect, not likely to adversely affect vegetation, whales, sea turtles (except for loggerhead), and the Red Knot. May affect, likely to adversely affect loggerhead sea turtle, Piping Plover. No adverse affect to other bird species.</td>
<td>May affect, not likely to adversely affect vegetation, whales, sea turtles (except for loggerhead), and the Red Knot. May affect, likely to adversely affect loggerhead sea turtle, Piping Plover. No adverse affect to other bird species.</td>
<td>May affect, not likely to adversely affect vegetation, whales, sea turtles (except for loggerhead), and the Red Knot. May affect, likely to adversely affect loggerhead sea turtle, Piping Plover. No adverse affect to other bird species.</td>
<td>No impacts.</td>
</tr>
<tr>
<td>Socio-economics</td>
<td>Beneficial impacts from reducing damages to infrastructure, reducing losses of work days and jobs, and from temporary construction-related job creation. Temporary minor adverse effects on surf clams and fisheries at dredge site from smothering and elevated turbidity, temporary impacts on commercial and recreational fishing resources during the placement of beach fill material on Wallops Island due to elevated turbidity levels in the nearshore environment and disruption of the benthos, which would cause fish to avoid the disturbed areas. No long-term adverse impacts on commercial and recreational fisheries.</td>
<td>Beneficial impacts from reducing damages to infrastructure, reducing losses of work days and jobs, and from temporary construction-related job creation. Temporary minor adverse effects on surf clams and fisheries at dredge site from smothering and elevated turbidity, temporary impacts on commercial and recreational fishing resources during the placement of beach fill material on Wallops Island due to elevated turbidity levels in the nearshore environment and disruption of the benthos, which would cause fish to avoid the disturbed areas. No long-term adverse impacts on commercial and recreational fisheries.</td>
<td>Beneficial impacts from reducing damages to infrastructure, reducing losses of work days and jobs, and from temporary construction-related job creation. Temporary minor adverse effects on surf clams and fisheries at dredge site from smothering and elevated turbidity, temporary impacts on commercial and recreational fishing resources during the placement of beach fill material on Wallops Island due to elevated turbidity levels in the nearshore environment and disruption of the benthos, which would cause fish to avoid the disturbed areas. No long-term adverse impacts on commercial and recreational fisheries.</td>
<td>Potential adverse impacts from interruption in WFF activities or loss of infrastructure.</td>
</tr>
</tbody>
</table>
**Table 10: Summary of Impacts from the Proposed Action Alternatives**

<table>
<thead>
<tr>
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<th>Alternative Two</th>
<th>Alternative Three</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural Resources</td>
<td>No archaeological (below ground or underwater) resources or above-ground historic properties are present within the project area; therefore no archeological resources or above-ground historic properties would be impacted.</td>
<td>No archaeological (below ground or underwater) resources or above-ground historic properties are present within the project area; therefore no archeological resources or above-ground historic properties would be impacted.</td>
<td>No archaeological (below ground or underwater) resources or above-ground historic properties are present within the project area; therefore no archeological resources or above-ground historic properties would be impacted.</td>
<td>No archaeological (below-ground) or above-ground historic properties affected.</td>
</tr>
<tr>
<td>Transportation</td>
<td>Temporary increase in upland and maritime traffic, no adverse impacts.</td>
<td>Temporary increase in upland and maritime traffic, no adverse impacts.</td>
<td>Temporary increase in upland and maritime traffic, no adverse impacts.</td>
<td>Increase in upland traffic for emergency/repair measures.</td>
</tr>
<tr>
<td>Cumulative Impacts</td>
<td>Potential adverse impacts on the geomorphic integrity of the offshore sand shoal environment and threatened or endangered species. Beneficial impacts on socio-economics.</td>
<td>Potential adverse impacts on the geomorphic integrity of the offshore sand shoal environment and threatened or endangered species. Beneficial impacts on socio-economics.</td>
<td>Potential adverse impacts on the geomorphic integrity of the offshore sand shoal environment and threatened or endangered species. Beneficial impacts on socio-economics.</td>
<td>Potential adverse impacts on socio-economics from interruption of WFF activities or loss of infrastructure.</td>
</tr>
</tbody>
</table>
2.7 SUMMARY OF MITIGATION MEASURES FOR PROPOSED ACTION ALTERNATIVES

Activities associated with the Proposed Action that are anticipated to have potential environmental impacts would be expected to utilize site-specific mitigation measures to eliminate or reduce the impacts. Table 11 below provides an overview of the mitigation measures that would be utilized under each Proposed Action Alternative; mitigation measures are presented in detail in Chapter 5 of this PEIS.

Table 11: Summary of Mitigation Measures for the Proposed Action Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Mitigation Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative One (Preferred Alternative)</td>
<td>Seawall Extension</td>
</tr>
<tr>
<td></td>
<td>- BMPs would be implemented for erosion, sediment control, and vehicle and equipment fueling spill prevention.</td>
</tr>
<tr>
<td></td>
<td>- During construction operations, biological resource monitoring and surveys would be conducted within the project area by a qualified biologist.</td>
</tr>
<tr>
<td></td>
<td>Offshore Dredging Operations</td>
</tr>
<tr>
<td></td>
<td>- Implementation of a marine pollution control plan would be required of the dredge contractor to minimize any direct impacts to water quality from construction activity.</td>
</tr>
<tr>
<td></td>
<td>- Impacts to bathymetry would be minimized by removing a shallow, uniform thickness of material from borrow area, maintaining the general profile of the shoal.</td>
</tr>
<tr>
<td></td>
<td>- USACE dredging guidelines would be followed, including dredge dragheads with rigid deflectors to reduce the risk of entrainment of sea turtles.</td>
</tr>
<tr>
<td></td>
<td>- National Marine Fisheries Service reasonable and prudent measures (terms and conditions) would be followed to avoid and minimize incidental takes of sea turtles.</td>
</tr>
<tr>
<td></td>
<td>Sand Placement Activities</td>
</tr>
<tr>
<td></td>
<td>- Beach nourishment would be conducted so the beach is restored to a comparable sediment type, grain size and color as the existing beach material to minimize impacts on sediments and listed species habitat.</td>
</tr>
<tr>
<td></td>
<td>- A qualified biologist would closely monitor the beach during sand placement activities to ensure that impacts to any listed species and their nests would be avoided or minimized. If any sea turtle or Piping Plover nests were detected, buffers would be established around the nest(s) where no sand placement activities would occur.</td>
</tr>
<tr>
<td></td>
<td>- NASA would consider native vegetative plantings on the constructed dune.</td>
</tr>
<tr>
<td></td>
<td>North Wallops Island Sand Removal</td>
</tr>
<tr>
<td></td>
<td>- BMPs would be implemented for erosion, sediment control, and vehicle and equipment fueling spill prevention.</td>
</tr>
<tr>
<td></td>
<td>- The removal of sediments during excavation activities would be mitigated by the re-deposition of sediment that would come from the addition of new sand on the beach.</td>
</tr>
</tbody>
</table>
## Description and Comparison of Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Mitigation Measures</th>
</tr>
</thead>
</table>
| Alternative Two | In addition to the mitigation techniques from Alternative One, the following would also be implemented:  
**Construction of the Groin**  
The groin would be located within the sediment transport nodal zone along the beach to ensure minimal potential downdrift impacts. Additionally, the groin footprint would be designed to minimize impacts to benthic habitat. |
| Alternative Three | In addition to the mitigation techniques from Alternative One, the following would also be implemented:  
**Construction of the Breakwater**  
The breakwater would be located within the sediment transport nodal zone along the beach to ensure minimal potential downdrift impacts. Additionally, the breakwater footprint would be designed to minimize impacts to benthic habitat. |

- A qualified biologist would closely monitor the area during excavation activities to ensure that impacts to any listed species and their nests would be avoided or minimized. If any sea turtle or Piping Plover nests were detected, buffers would be established around the nest(s) where no excavation activities would occur.
CHAPTER THREE: AFFECTED ENVIRONMENT

Chapter 3 presents information regarding existing resources at Wallops Island that may be affected by the project alternatives. This chapter contains discussions on resources under the three main categories of Physical Environment, Biological Environment, and Social and Economic Environment.

3.1 PHYSICAL ENVIRONMENT

Wallops Island is approximately 11 km (7 mi) long and 800 m (2,650 ft) wide. It is bordered by Chincoteague Inlet to the north, Assawoman Island to the south, the Atlantic Ocean to the east, and marshland to the west. The mainland area to the west is comprised mainly of rural farmland. South of Wallops Island is the former Assawoman Inlet (now closed) and Assawoman Island, a 576 hectare (1,424 acre) island managed as part of the Chincoteague National Wildlife Refuge (CNWR) by the U.S. Fish and Wildlife Service (USFWS). A string of undeveloped barrier islands extends down the coast to the mouth of Chesapeake Bay. The Eastern Shore of Virginia’s Atlantic coast shoreline on the Delmarva Peninsula is one of the longest stretches of undeveloped shoreline on the east coast of the United States.

Much of the Wallops Island beach has nearly or completely eroded and is armored with a rock seawall along 4.6 km (2.86 mi) of the shoreline. On the southern portion of the island, near the MARS launch complex, shoreline retreat has averaged about 3.7 m (12 ft) per year from 1857 to the present (USACE, 2010a). Further south, adjacent to Assawoman Inlet, shoreline retreat exceeded 5 m (16.4 ft) per year during that same time period. The northern end of Wallops Island has been accreting, both as a result of sediment bypassing of Chincoteague Inlet and northward net sediment transport on the northern end of Wallops Island (USACE, 2010a).

The SRIPP project area lies within the Northeast Continental Shelf, which is divided into four major subregions: Gulf of Maine (GOM), Georges Bank (GB), Southern New England (SNE), and the Mid-Atlantic Bight (MAB), which reflect different underlying oceanographic conditions, ecosystems, and fishery management boundaries (Figure 17). There is also variation in sea surface temperature, bathymetry, and biology (e.g., chlorophyll, and zooplankton biomass) within each of these subregions. The SRIPP study area lies within the central portion of the MAB.
3.1.1 Meteorology

WFF is located in the climatic region known as the humid continental warm summer climate zone. The climate is tempered by the proximity of the Atlantic Ocean to the east and the Chesapeake Bay to the west. Also affecting the climate is an air current, known as the Labrador Current, which originates in the polar latitudes and moves southward along the Delmarva coastline. The current creates a wedge between the warm Gulf Stream offshore and the Atlantic coast.

Four distinct seasons are discernible in the region. The climate is dominated in winter by polar continental air masses and in summer by tropical maritime air masses. Clashes between these two air masses create frontal systems, resulting in thunderstorms, high winds, and precipitation. Summer is hot and humid with precipitation occurring primarily from thunderstorm activity. Autumn is characterized by slightly decreasing temperatures and strong frontal systems with rain and sustained winds.

The storms causing the most significant coastal erosion and other damage along the Mid-Atlantic shorelines are nor’easters, or extratropical storms (Dolan et al., 1988 and references contained therein). On the east coast of North America, nor’easters most often originate from the vicinity of Cape Hatteras, North Carolina (Davis et al., 1993) between December and April, with the peak in February. Unlike a hurricane, the greatest damage from nor’easters comes not from wind, but from strong waves lasting up to several days, which is most damaging along long areas of coastal zones. Nor’easters are difficult to predict because their wind speed is not always related to their wave heights. Over the past 50 years, these storms are becoming less frequent, but more intense (EPA, 2009a). Zhang et al. (2000) conducted an analysis of hourly tide gauge records from 10 tide gauges along the East Coast; their analysis did not show any discernible long-term trend in storm activity during the twentieth century. This suggests a lack of response
of storminess to minor global warming along the U.S. Atlantic coast during the last 100 years (Zhang et al., 2000). However, increased global climate change is predicted in the next century (IPCC, 2007), which is likely to cause changes in coastal storm activity.

Hurricanes and tropical storms occur less frequently than nor’easters and usually hit between June and November. Like nor’easters, hurricanes originate from unstable atmospheric conditions, but they are comprised of a cooler air mass with a warmer temperature at their core. Hurricanes form over warm ocean waters. As opposed to a nor’easter, hurricane impacts can extend well inland from the coastal zone, but typically only affect smaller stretches of the coast (Davis et al., 1993). According to a 30-year study by Komar and Allan (2008), the waves off the east coast of the United States are gradually increasing in height, especially those generated by hurricanes. During the study, a net increase in the occurrence of waves higher than 3 m (9 ft) was found due to a rise in frequency and intensification of hurricanes. The steady increase in capacity of hurricanes to generate higher waves is attributed to gradual climate change.

The Maryland and Virginia shores have been hit by a number of major storms this century, including 39 nor’easters between 1954 and 2003 and 41 hurricanes and tropical storms between 1856 and 2003 (USACE, 2010a). Specific damaging storms on record include hurricanes in 1902 and 1933, the Ash Wednesday 1962 Nor’easter, the Halloween 1991 Nor’easter, the January 4, 1992 Nor’easter, the December 1992 Nor’easter, and the November 12, 2009 Nor’easter.

### 3.1.2 Climate Change

There is consensus by leading scientific organizations (The Intergovernmental Panel on Climate Change [IPCC, 2007], The National Academy of Sciences, The American Meteorological Society, the American Geophysical Union, and the American Association for the Advancement of Science, among others [Oreskes, 2004]) that the chemical composition of the Earth’s atmosphere is being changed. Changes to the atmosphere are occurring both naturally and due to a number of human activities, such as fossil fuel combustion, deforestation, and other land use changes, resulting in the accumulation of trace Greenhouse Gases (GHGs) in the atmosphere.

By absorbing the radiative energy from the Sun and Earth, GHGs trap heat in the atmosphere, and their accumulation in the atmosphere may be contributing to an increase in the Earth’s average surface temperature, which in turn is expected to affect weather patterns and the severity of storms/droughts, average sea levels, and increased intrusion of seawater into estuaries. Other effects are changes in precipitation rates, an increase in ozone levels due in part to changes in atmospheric photochemistry, and decreased water availability and quality (Jones & Stokes 2007).

GHGs include water vapor, carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), O₃, and several hydro and chlorofluorocarbons. Water vapor occurs naturally and accounts for the largest percentage of GHGs, while CO₂ is the second-most abundant GHG. Some GHGs are directly emitted from human processes (CO₂, chlorofluorocarbons, and water vapor), while other gases (e.g., NOₓ and VOCs) emitted from these processes contribute indirectly by forming tropospheric (ground-level) ozone and other reactive species. Those compounds then react photochemically with GHGs and control the amount of radiation penetrating through the troposphere. As GHG’s continue to increase, the average temperature of the Earth’s surface increases, leading to effects including changes in weather events and precipitation rates, an increase in ozone levels due in part to changes in atmospheric photochemistry, and decreased water availability and quality.
According to the IPCC (2009), climate change predictions are now estimated to occur within the upper range of values predicted in the 2007 report.

### 3.1.2.1 Sea-Level Rise

Global sea-level rise refers to the average increase in the level of the world’s oceans. Sea-level rise is occurring on a world-wide basis and is projected to continue to occur at an increasing rate (EPA, 2009a). As the global climate warms and glaciers retreat, water stored as continental ice is released, adding to the mass of water in the oceans and causing a corresponding rise in sea-level (EPA, 2009a). Relative mean sea level (MSL) considers both global sea-level rise and how local historical changes and unique circumstances, like rate of subsidence, shoreline retreat, wave and tidal patterns, and presence of manmade structures, affect the sea-level rise within a particular area.

By the Bruun rule (Bruun, 1962), small changes in sea level can be expected to have dramatic effects on shoreline position, with increasing sea levels causing shoreline retreat. The shoreline at Wallops Island would experience the effects of future sea-level rise, as coasts and barrier islands are particularly vulnerable to the sea-level rise and intensified storm and wave events attributed to climate change (Nicholls et al., 2007). Beaches and barrier islands may adjust naturally by growing vertically, moving inland, or expanding laterally, although at a certain point the coastline would be fundamentally altered (EPA, 2009a).

Although the scientific consensus is that the Earth’s climate is changing (NASA, 2010b; Oreskes, 2004; EPA, 2009a), there is still great uncertainty in calculating the precise contributing factors which result in sea-level rise, and new data is constantly emerging. Over the last century, relative sea-level rise rates along the Atlantic coast of the United States have ranged between 1.8 mm/year (Maine) to as much as 4.4 mm/year (Zervas, 2001). The lowest rates (1.8 mm/yr) are nearly equivalent to the average global rate for the 20th century of 1.7 ± 0.5 mm/year (Bindoff et al., 2007) and occur along coastal New England and from Georgia to southern Florida. The highest rates have been observed in the Mid-Atlantic region between northern New Jersey and northeastern North Carolina (Zervas, 2004). Subsidence of the land surface due to a range of factors contributes to the high rates of relative sea-level rise observed in the mid-Atlantic region.

A report by the EPA (2009a) assesses the effect three potential rates of increase in the relative sea level might have on the physical and social environments from the coast of New York to North Carolina. The first scenario assumes that sea-level rise will continue at the current rate of 2.4 to 4.4 mm annually throughout the 21st Century, the second scenario assumes an increase of 5 to 6 mm annually, and the third assumes an increase of 10 to 11 mm annually. According to the report, if sea-level rise continues at the third scenario rate or higher, it is “very likely that future sea-level rise will contribute to significant changes resulting in the segmentation, disintegration, and/or more rapid landward migration” of the Wallops, Assawoman, Metompkin, and Cedar barrier islands (EPA, 2009a). However, there remains uncertainty in the precise outcome of the three scenarios because they depend upon the elevation of each individual coastal area in question, and currently available data is not considered accurate enough for scientists to predict quantitatively the precise effects of sea-level rise in the Mid-Atlantic (EPA, 2009a). In addition, the IPCC has concluded that based on new satellite data, the melting of continental ice sheets may contribute more to global sea-level rise than previously reported (IPCC, 2007).
With the anticipated acceleration in the rate of global sea-level rise (e.g., IPCC, 2001; IPCC, 2007), local rates of relative sea-level rise will also accelerate. Recently, the Fourth Assessment Report of the IPCC has predicted that sea levels will rise by 10 to 59 cm over the next century, which is a somewhat smaller rise and range than reported in the Third Assessment Report (estimate of 11 to 88 cm; IPCC, 2001). Several recent criticisms of the IPCC’s Fourth Assessment Report estimates of future sea-level changes (Rahmstorf, 2007; Rahmstorf et al., 2007; Hansen et al., 2007) argue that these estimates are conservative and do not incorporate adequately the potential contributions of land-based ice melt from Greenland and western Antarctica to the global sea level. The IPCC assessment concludes that the science regarding future acceleration in ice melt and its contribution to sea-level rise is not yet sufficient to include in their sea-level projections.

### 3.1.3 Previous Erosion Prevention and Shoreline Restoration Efforts

In the early 1960s and 1970s, NASA made several attempts to keep sand on the Wallops Island beach and prevent shoreline retreat by installing wooden groins. These wooden groins were almost completely gone by the mid-1980s; their failure has been linked to the lack of a beach fill at the time of construction, along with the lack of a regular monitoring and maintenance program and renourishment plan. Photo 6 shows the wood groins that were constructed in the 1960s along Wallops Island.

**Photo 6: 1983 view looking north along Wallops Island showing wood groins (in poor condition) – the southern-most groins in this photo are approximately 100 m (330 ft) long**
In 1992, NASA obtained a VMRC Permit #98-0031 to construct a rock seawall for approximately 4,840 m (15,900 ft) along the center of the island where the majority of infrastructure is located (see Figure 2). The seawall was thought to be a solution to the high rate of shoreline retreat and currently provides protection from storm surge. The seawall has provided substantial protection to the island’s infrastructure. However, though this structure has halted the shoreline retreat, it has not halted the erosion of the underwater portion of the beach within the surf zone, which has created an over-steepened beach profile in the last 17 years and left the seawall vulnerable to storm damage. The seawall has deteriorated in spots due to settling and dislodgement of armor stone. In addition, the structure is highly permeable due to large voids; these voids allow scouring on the landward side, and additional sand loss. Because of shoreline retreat, a large portion of the seawall approximately 3.7 km (2.3 mi) long is currently in the ocean with waves continually breaking on it.

The structures placed on Wallops Island in the past, including the seawall, have prevented overwash processes (the flow of water and sediment over a beach crest that does not directly return to the water body where it originated [USACE, 2004]) from occurring, which serve to maintain beach and dune systems. Overwash is a form of coastal flooding that can move sediment landward, and it is a precursor to barrier breaching. Washover is the sediment deposited by overwash. Overwash is a regional and recurring process responsible for large-scale coastal change in low-profile coastal areas, and washover is an integral part of the sediment budget in such areas (USACE, 2004).

In 2007, NASA installed geotextile tubes (Figure 4) along the shoreline as an emergency measure to slow down the transport of sand off the beach and help protect onshore assets from wave action. Despite these efforts, the ocean has continued to encroach substantially toward the infrastructure on Wallops Island.

In mid-November 2009, Hurricane Ida combined with a coastal storm to produce a nor’easter with winds peaking at 95 km per hour (59 mi per hour) at Wallops Island (NOAA, 2009c). The storm caused island flooding and substantial damage to the geotextile tubes (Photo 7).
Bathymetry

Bathymetry is the measurement of depth below sea level. The nearshore seafloor east of Assateague Island is characterized by a discontinuous sheet of fine to medium sand molded in linear sand rides (shoals) and troughs. The shoals in this area are approximately 1 to 10 m (3.3 to 33 ft) in height, approximately 2 to 4 km (1.2 to 2.5 mi) apart, and up to tens of km in length (Swift and Field, 1981; McBride and Moslow, 1991). The long axes of the shoals are oriented directly into the predominant or prevailing storm wave approach direction, which is from the northeast in the MAB during nor’easters (Hayes and Nairn, 2004).

Offshore of Fishing Point, a series of sand ridges and shoals referred to as Chincoteague Shoals (Figure 18) are located in depths of approximately 2 to 5 m (7 to 16 ft). Bathymetry in the shoal complex area east of Assateague Island ranges from an average of about 1 m (4 ft) near the shoreline to about 30 m (100 ft) deep about 21 km (13 mi) off shore in the vicinity of Unnamed Shoal B (Figure 19).

The depth of the first sand ridge east of Chincoteague Shoals, Blackfish Bank shoal, ranges from 9 to 4 m (30 to 13 ft). Moving eastward, depth drops to about 21 m (70 ft) between Blackfish Bank and Unnamed Shoal A. Unnamed Shoal A is located in depths of 12 to 7.5 m (40 ft to 25 ft). Between Unnamed Shoals A and B, the depth ranges from 23 to 12 m (75 to 40 ft). Unnamed Shoal B is located in depths between 15 m (50 ft) to 9 m (29 ft).

The sand ridges east of Assateague Island (Chincoteague Shoals, Blackfish Bank, Unnamed Shoals A and B) disappear abruptly in a featureless basin (Chincoteague Bight) southeast of
Affected Environment

Fishing Point and east of Wallops island (Figure 18). The Chincoteague Bight is characterized by a slow and steady increase in depth seaward from the shoreline.

Bathymetric data was obtained within the 5.2-km² (2-mi²) survey areas for both Unnamed Shoal A and B during the cultural resources survey conducted in 2009 for the SRIPP (see Section 3.3.7.2). The bathymetry was recorded using an Odom Hydrotrac® digital echo sounder along 80 survey transects spaced at 15.2-m (50-ft) intervals along Unnamed Shoal A, which yielded 348.9 liner survey km (216.8 linear survey mi). Unnamed Shoal B was divided into 84 transect lines spaced at 15.2-m (50-ft) intervals, which yielded 318.3 liner survey km (197.8 linear survey mi). Figure 20 shows the plan view of the bathymetry of Unnamed Shoal A and Unnamed Shoal B. Figure 21 shows the three-dimensional bathymetry of the proposed dredge areas.


Figure 18: Bathymetry of Chincoteague Shoals and Chincoteague Bight
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3.1.5 Geology and Geomorphology

This section describes the geology and geomorphological elements of the project area including an overview of the Virginia Barrier Island system, Wallops Island, shoreline changes, and the offshore sand shoals. In addition, a summary is provided at the end of the section.

3.1.5.1 Virginia Barrier Island System

Wallops Island is part of the Virginia barrier island system that fronts the Atlantic Ocean. Barrier islands are dynamic systems formed by the interaction of wave, wind, and tidal energies that erode, transport, and deposit sediments (Leatherman, 1982). By absorbing the impact of high-energy marine processes, barrier islands reduce erosion of the mainland coast and provide shelter for sensitive coastal habitats.

Leatherman (1982) and Kochel et al. (1985) classified the 12 Virginia barrier islands into three groups based on shoreline migration rates: (1) a northern parallel beach retreat group; (2) a middle rotational instability group; and (3) a southern non-parallel beach retreat group. Wallops Island is situated in the northern parallel beach retreat group. Wallops Island also possesses a morphology and features that are indicative of mixed-energy conditions (i.e., sedimentary processes driven by the interplay of waves and tides [Hayes, 1979; Oertel and Kraft, 1994; Wikel, 2008]). While the entire Virginia barrier island chain is subject to mixed-energy conditions (average deep water wave heights = 0.86 m; tidal range = 1.24 m), the morphologic variability expressed by each group of islands (Dolan et al., 1979; Leatherman, 1982) and individual islands within those groups (Byrnes, 1988; Harris, 1992; Richardson and McBride, 2007) suggest that multiple processes operating over a variety of spatial and temporal scales have influenced and continue to influence both short- and long-term dynamics along Wallops Island. For example, the shoreline migration rates and morphology along Wallops Island have changed considerably over its distant and recent geologic past, in part because of its location at the intersection of the northern end of this mixed-energy barrier island chain and the southern end of the wave-dominated, Assateague Island and recurved spit system.

Wallops Island and the three narrow barrier islands to the south—Assawoman, Metompkin, and Cedar—are unusual in that they are concave due to rapid erosion compared to the other barrier islands along the Virginia Shore. Leatherman (1982) concludes that the combination of diminishing sediment supply, differential subsidence, and uniform wave attack has promoted the steady retreat of Assateague Island. Several causes help to shape these barrier islands, however, at Wallops Island long-term effects such as differential subsidence are not as great of a consideration as wave driven processes. The inlets between the islands approximately follow the courses of paleochannels formed during the late Wisconsin sea-level regression (Halsey, 1979).

3.1.5.2 Wallops Island

The relatively flat topography of Wallops Island is typical of barrier islands. Topography refers to the three-dimensional relief of the Earth’s surface, including both manmade and natural features, and is often expressed in elevation relative to sea level and shown as contour lines on a map. The unarmored shoreline segments at the north and south ends of Wallops Island consist of low sloping sandy beaches. The sandy portion of Wallops Island has an elevation of about 2.1 m (6.9 ft) amsl. The highest elevation on Wallops Island is approximately 4.6 m (15 ft) amsl. Most of the island is below 3.0 m (10 ft) amsl (NASA, 2005).
As is typical of barrier islands in the region, Wallops Island exhibits environmental zones related to changes in topography across the island profile. Generally, dunes are found at the highest elevations, and beaches and marshes are found at the lowest. On Wallops Island, previous structures, such as groins, weirs, beach beams, and beach prisms have modified the natural sediment transport processes, thereby changing the island’s structure. The seawall that was constructed to protect critical infrastructure on the island has fixed the shoreline position, thereby resulting in complete loss of the beach seaward of the wall and preventing long-term natural maintenance of the gently sloping nearshore and beach systems that would have existed under natural conditions. In addition, without a beach to provide a source of sand, the island’s ability to create and maintain natural dunes is limited.

Located within the Atlantic Coastal Plain Physiographic Province, Wallops Island is underlain by approximately 2,150 m (7,000 ft) of sediment. The sediment lies atop crystalline basement rock. The sedimentary section, ranging in age from Cretaceous to Quaternary (approximately 145.5 to 2.5 million years ago), consists of a thick sequence of terrestrial, continental deposits overlain by a much thinner sequence of marine sediments. These sediments are generally unconsolidated and consist of clay, silt, sand, and gravel.

The regional dip of the geologic units is eastward, toward the Atlantic Ocean. The two uppermost stratigraphic units on Wallops Island are the Yorktown Formation and the Columbia Group, which is not subdivided into formations. The Yorktown Formation is the uppermost unit in the Chesapeake Group and was deposited during the Pliocene epoch of the Tertiary Period (approximately 5.3 to 1.8 million years ago). The Yorktown Formation generally consists of fine to coarse glauconite quartz sand, which is greenish gray, clayey, silty, and in part, shelly. The Yorktown Formation occurs at depths of 18 to 43 m (60 to 140 ft) in Accomack County (Commonwealth of Virginia, 1975).

The shoreline beaches consist mostly of sand deposited by wave action subjected to daily tidal flooding. As discussed in Section 2.5 of this PEIS, sampling of the Wallops Island beach was conducted by the USACE Norfolk District in 2007 to determine the grain size of the sediment on the beach (USACE, 2010a). One-hundred and seventy samples were taken along several transects, including sampling between the top of the beach and the mean low water elevation, and at the north and south ends of Wallops Island. The mean grain sizes of the individual samples of native sand on Wallops Island were between 0.20 and 0.21 mm (USACE, 2010a).

In October 2009, sediment sampling of the north Wallops Island beach was conducted by the USACE to further evaluate the material there for suitability for use as renourishment fill (Figure 12). As discussed in Section 2.5 of this PEIS, 16 samples were collected to a depth of 1.8 m (6 ft) and analyzed for grain size. The sediments generally consisted of tan to gray, poorly graded fine to medium sand with trace shell fragments and silt. The median grain sizes of all 16 samples ranged from 0.18 to 0.27 mm.

### 3.1.5.3 Shoreline Changes

Normal wave conditions produce gradual changes in island morphology, while large changes occur during major storms (Leatherman, 1982; Pekala, 1996). Over a longer time scale, shoreline position, orientation, and length can be affected by variations in sea level, sediment supply, and wave energy (Pekala, 1996). Leatherman (1982) cites coastal storms as a major contributor to beach and dune erosion, overwash processes, and the opening of tidal inlets on barrier islands.
Like several of the Atlantic coast beaches on the southern Delmarva Peninsula, such as Parramore Island (Richardson and McBride, 2007), the beach at Wallops Island has been in a state of chronic erosion for at least the last 150 years. An analysis of the shoreline between Fishing Point and Gargathy Inlet is shown in Figure 22; this figure is oriented so that land is at the bottom and offshore is at the top. Wallops Island extends from “-2000 m” to “+6500 m” along the horizontal axis.

The 1849, 1857/1858, 1909/1911, 1933, and 1983 shorelines are taken from the U.S. Coast and Geodetic Survey charts. The 1994 shoreline was digitized from a rectified aerial photograph. The 1996 and 2005 shorelines were obtained from Light Acquisition, Detection, and Ranging (LiDAR) surveys. The dominant direction of storm wave approach for the Mid-Atlantic coastline shown in this figure is from the northeast (left) and sediment transport is generally to the south (right), though a significant transport reversal occurs on Wallops Island (for more information on waves and longshore sediment transport see 3.1.6.2 and 3.1.6.4, respectively).

Panel A of Figure 22 shows the 1849 and 1857/1858 shorelines. In the mid-1800s the shoreline was much straighter, as Fishing Point spit had not formed. The inlet shown in the 1849 shoreline, which is now called Assateague Channel, has shifted to the southwest in the 1857 shoreline, suggesting that the main direction of longshore sediment transport was to the south.

By 1909/1911, Fishing Point had started to form (Figure 22, Panel B). Assateague Channel had shifted further to the southwest. The Wallops Island shoreline had retreated by approximately 75 m (250 ft). By 1933, Fishing Point had formed a distinct hook, but it had not grown enough to redefine the mouth of Chincoteague Inlet.

By 1983 (Figure 22, Panel C) substantial changes had occurred. Fishing Point had grown to the extent that the tip of it and the northern shoulder of Wallops Island had started to re-define the location of the throat section of Chincoteague Inlet. Some aerial photographs from the 1980s show the existence of an emergent ebb shoal. However, the distance between these points was still well over 2 km (1 mi) wide.

The northern end of Wallops Island was now sheltered enough by Fishing Point that it had started to accrete, which was a change from earlier decades, as shown in Panel C. Because the mouth of Chincoteague Inlet was still so wide, it is likely that the majority of the accretion at the northern tip of Wallops Island was due to a transport reversal on Wallops Island, caused by Fishing Point blocking waves from the northeast. The rest of Wallops Island and Assawoman Island were still experiencing substantial erosion. The southern portion of Wallops Island, south of the existing seawall, is eroding at a rate of approximately 10 ft per year (USACE, 2010a).
Figure 22: Wallops Island Shoreline Changes Between 1849 and 2005
By 1996, Fishing Point and the northeastern shoulder of Wallops Island had both grown enough that the mouth of Chincoteague Inlet was less than a half mile wide, and substantial inlet bypassing (from Fishing Point to Wallops) had started to occur (Figure 22, Panel D). Because of this sedimentation, in 1995 USACE began dredging Chincoteague Inlet at intervals ranging from 1 to 3 years (USACE, 2006). On Wallops Island, the area of accretion at the northern tip had extended further to the south, though the southern part of the island continued to erode.

Figure 22, Panel E shows the 2005 shoreline. The dashed portion of this shoreline at the northern end of Wallops Island was not covered in the LiDAR survey. Instead, this shoreline is inferred from limited GPS readings taken in 2007. The northern end of Wallops Island has continued to strongly accrete, both as a result of sediment bypassing of Chincoteague Inlet and northward net sediment transport on the northern end of Wallops Island. Today, the beach at the northern tip of Wallops Island contains a series of trapped shallow sloughs. These are the result of ebb shoal bar bypassing and welding to the inlet’s downdrift shoreline. These shoals form in the channel and migrate westward, where they weld onto the northern tip of Wallops Island.

Growth of the Southern Tip of Fishing Point

The development and growth of the cape called Fishing Point and the adjacent offshore spit platform and shoal complex has captured sand that would have otherwise been available to nourish Wallops Island the islands further south along the Virginia coastline. This is one reason that these shorelines are experiencing substantial erosion. Figure 23 shows National Park Service (NPS) shoreline location data through the spring of 2009 for the very southern tip of Assateague Island and shows that the tip of the island is continuing to grow to the southwest at a rate of approximately 50 m (150 ft) per year. If this trend continues over the next 50 years, the tip will grow to the southwest by about 2.3 km (1.5 mi). This will more strongly shelter the Wallops Island shoreline from ocean waves approaching from the northeast, and will shift the transport divergent nodal point (explained in Section 3.1.6.4, Longshore Sediment Transport), which is estimated to occur between the northern part of Assawoman Island and the southern portion of Wallops Island, to the south by roughly that amount.
Narrowing of the Tom’s Cove Isthmus

Another shoreline change feature is the narrowing of the thin strip of land separating Tom’s Cove from the Atlantic Ocean. The rate at which this is happening makes it likely that there will be storm-induced breakthroughs between Tom’s Cove and the ocean during the 50-year lifetime of the SRIPP. The first breach on this isthmus occurred as a result of a November 2009 Nor’easter (USACE, 2010a). These breaches may close rapidly, or they may cause permanent or semi-permanent inlets to form.

Changes in Wallops Island Shoreline Orientation and Chincoteague Inlet Migration

The northern end of Wallops Island is rapidly accreting. This is because sediment is being delivered to this location from two directions: 1) north along the Wallops Island shoreline, and 2) westward by the westward drift of Chincoteague Inlet ebb shoals. Over the short term, sediment may be stored in swash bars, the ebb tidal delta, or the ebb/flood tidal ramp. Over the long term, it is probable that the sediment will be carried into Chincoteague Inlet by tidal currents where it
is sequestered in flood shoals. This mechanism will act to slow down the rate of sediment accumulation that would otherwise occur on northern Wallops Island.

The sediment accumulation on north Wallops Island may tend to push Chincoteague Inlet to the east: this appears to already be occurring as documented on recent aerial photographs of the western tip of Assateague Island showing that it has retreated to the east. However, future Chincoteague Inlet locations can be strongly affected by USACE dredging decisions and whether attempts are made to maintain the inlet channel in a fixed location, or to dredge whatever is found to be the current channel location. The sediment accumulation on north Wallops Island is changing the existing north-south shoreline orientation to one that is much more east-west.

3.1.5.4 **Offshore Sand Shoals**

The coastal plain and continental shelf are closely related geologically. Both originate from the deposition and erosion of sediments on the eastern edge of North America caused by changes in sea level over the geologic timescale. Section 3.1.4 provides more detailed information regarding the bathymetry in the SRIPP project area, including a map showing the bathymetry of both Unnamed Shoals A and B from data collected by NASA during a 2009 survey of the shoals.

Swift and Field (1981) categorized the shoals off Maryland into three groups based on their geomorphic characteristics: shoreface, nearshore, and offshore. Unnamed Shoals A and B are offshore sand ridges that are located at the southern end of the Assateague ridge field. In general, the offshore shoals in this ridge field are oriented with their long or main axis in a southwest/northeast orientation directly into the predominant storm wave approach direction. This orientation suggests the wave forces from nor’easters either directly or indirectly account for the origin and maintenance of these features (Hayes and Nairn, 2004). The offshore shoals are asymmetrical with their seaward flanks, approximately three times as steep as the landward flanks. The coarsest sediment generally occurs on the shoreward flanks of the shoals (Swift and Field, 1981; Hayes and Nairn, 2004). Based on numerous studies, Hayes and Nairn (2004) conclude that once formed, most ridges in depths of less than 20 m are maintained and even enlarged by present-day hydrodynamics.

See Section 2.5.3 and Appendix A for information on the USACE vibracore sampling and results.

3.1.5.5 **Summary**

The shoreline along Wallops Island has been in a state of chronic erosion for at least the last 150 years. The development and growth of Fishing Point and the adjacent offshore spit platform and shoal complex has captured sand that would have otherwise been available to nourish Wallops Island and the islands further south along the Virginia coastline. This is one reason that these shorelines are experiencing substantial erosion. The southern portion of Wallops Island, south of the existing seawall, is eroding at a rate of approximately 3 meters (10 ft) per year (USACE, 2010a).

The shoreline along northern end of Wallops Island is rapidly accreting. This is because sediment is being delivered to this location from two directions: 1) north along the Wallops Island shoreline, and 2) westward by the westward drift of Chincoteague Inlet ebb shoals. In addition, the growth of Fishing Point has sheltered the northern portion of the Wallops Island shoreline from storm waves that approach primarily from the northeast.
The Wallops Island shoreline is comprised of fine sand with a mean grain size between 0.20 and 0.21 mm. The two offshore shoals identified as potential borrow sites are located at the southern end of the Assateague ridge field and contain sand that is compatible for use as beach fill material.

3.1.6 Physical Oceanography and Coastal Processes

3.1.6.1 Tides

The project area has a semidiurnal tide (two high and two low tides occur each day). The mean ocean tide range is approximately 1.1 m (3.6 ft); the mean spring tide is approximately 1.3 m (4.4 ft). Tidal currents are generally weak except in the vicinity of the ebb and flood tidal jet of Chincoteague Inlet.

3.1.6.2 Waves

There is seasonal variability in wave height, period, and direction. The dominant wave direction is from the southeast. Dominant storm waves are from the northeast. The largest and most frequent waves originate from the east-northeast and northeast directions as a result of extratropical storms in the summer and fall, or nor’easters between October and February. Hurricanes, which occur less frequently than nor’easters, are usually fast moving and produce substantial coastal impacts with durations of a day or less. However, because of their low central pressures and high wind speeds, hurricanes can generate large storm surges. In contrast, nor’easters can cause impacts over longer time scales (several tidal cycles), but usually do not produce extremely high storm surges. Individual storms can cause the equivalent change of decades of shoreline in a matter of days (Fenster et al., 2001).

Based on USACE Wave Information Studies (WIS) hindcast data from 1980-1999, the maximum significant wave height was approximately 6 m (20 ft) high and 11 seconds apart with an 11 second period. Average wave heights vary seasonally; the lowest monthly average wave occurs in July and August; the maximum monthly average wave heights occur in December, January, and February. The largest measured wave at Ocean City was 4.4 m (14 ft); this occurred during a January 1992 nor’easter. As discussed in Section 3.1.1, according to Komar and Allan (2008), the waves off the east coast of the United States are gradually increasing in height, especially those generated by hurricanes.

Waves in the area are refracted around Fishing Point. Wave energy is reduced along northern Wallops Island and the east-west oriented section of Fishing Point due to wave sheltering by the recurved spit. Nearshore along Wallops Island there is a strong gradient in the wave height, with the height decreasing to the north (USACE, 2010a).

The most frequent wave approach direction is from the southeast quadrant; however, the waves from the northeast tend to be larger and longer in period. Moffatt & Nichol (1986) reported that waves from the northeast and east northeast account for 71 percent of the total wave energy along the Virginia coast. The general, predominant southerly littoral drift along the Maryland and Virginia coast lines is a result of waves from these directions. The presence of Fishing Point greatly affects the wave patterns seen on the shore at Wallops Island (USACE, 2010a). Wave energy coming from the northeast is largely blocked by Fishing Point, whereas wave energy coming from the southeast arrives at the beach with little change. Waves coming from the southeast have roughly the same height everywhere along the shoreline, but waves coming from
the northeast have dramatically decreasing height (and thus energy) the farther north they are along Wallops Island. This phenomenon results in diminished southerly sand transport. Storm waves also affect the submerged offshore sand shoals. Storm waves from the northeast converge along the crests of both the shore-attached and shore-detached shoal crests such that wave energy is greatest along the crests. Bed forms on the surface of the sediment such as ripple marks on the shoal crests are evidence of this effect (Appendix B).

3.1.6.3 **Currents**

The water circulation in this region of the inner continental shelf is characterized by a general southward movement of the surface and bottom water throughout the year. Average southerly currents are on the order of 10 cm/sec (0.3 ft/sec) or about 0.4 km/hr (0.2 knots) (Brooks, 1996). However, from April to September, the surface water movement may periodically reverse and move northward in association with the prevalence of south winds (USACE, 1998). The northeastwardly flowing Gulf Stream in the Atlantic Ocean is well offshore of Wallops and Assateague Islands, generally more than 320 km (200 mi) seaward. Currents may be much larger during nor’easters when synoptic pressure gradients are established north-south from Cape Cod to Cape Hatteras and across the entire MAB. Coupled to nor’easter waves which act to mobilize sediments, these relatively strong currents can transport substantial volumes of suspended sediment in short periods of time.

3.1.6.4 **Longshore Sediment Transport**

Typical longshore sediment transport along the Mid-Atlantic shoreline is north to south. However, sediment transport can occur in other directions (i.e., south to north) locally. Longshore sediment transport rates can vary significantly and are influenced by the local geomorphology and bathymetry.

Fishing Point at the southern end of Assateague Island has grown to the point that waves coming from the northeast are refracted, or bent, shadowing the northern end of Wallops Island from these high energy waves. Wave refraction around Fishing Point and the Chincoteague Inlet ebb-tidal delta has contributed to the bypassing of sand around the delta and a local reversal in longshore transport from south to north leading to sand accretion on the northern end of Wallops Island. This shoal and inlet complex serves as an efficient sediment trap, allowing only about 5 percent of longshore transport to bypass to the south (Moffatt & Nichol, 1986).

The USACE conducted sediment transport modeling and a sediment budget analyses at Wallops Island (see Appendix A). Longshore sediment transport rates along Wallops Island vary from year to year primarily because of yearly variations in the input wave field (USACE, 2010a). To determine the gross and net average transport rates along Wallops Island, the USACE used 20 years of WIS hindcast data (USACE, 2010b) between 1980 and 1999 that was broken into 20 different four-year blocks (1980-1983, 1981-1984, etc.). The GENESIS model was run using each of these blocks and the sediment transport rates during the 4th year were averaged. Bathymetry data used in the modeling were obtained from the National Ocean Survey hydrographic surveys that are available in electronic format from the Geophysical Data System (version 4.0) developed by the National Geophysical Data Center. Bathymetric surveys collected in the 1960's through the 1990's were used where available, with earlier survey data used to fill gaps in the more recent bathymetry coverage.
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Gross sediment transport volumes quantify the total flux of sediment in both directions alongshore whereas net volumes refer to the difference between volumes moving in opposite directions. As with any modeling exercise, there is inherent uncertainty within the transport modeling due to several factors, which include: (1) a short timescale of the data used compared to the timeframe of the transport processes, (2) a lack of current, detailed nearshore bathymetry, and (3) estimation of future sea level rise. To account for some of this uncertainty, the USACE calculated both average longshore sediment rates and rates within the 95 percent confidence limits, as shown on the graphs below.

Figure 24 depicts the estimated average gross sediment transport rates along Wallops Island estimated by USACE (2009a). The 95 percent confidence limits are shown along with the average gross transport rate. This figure shows average gross rates of 300,000 m³ (400,000 yd³) per year to the south of the seawall, greatly reduced transport rates in front of the seawall, and rates of 270,000 m³ (350,000 yd³) per year to the north of the seawall. The gross sediment transport rates within the 95 percent confidence limits varied up to roughly 23,000 m³ (30,000 yd³) from the average.

![Figure 24: Average Yearly Gross Sediment Transport Rates along Wallops Island](image)

Source: USACE, 2010a

The average net sediment transport rates estimated by the USACE (2009a) (Figure 25) varied between 15,000 m³ (20,000 yd³) to 46,000 m³ (60,000 yd³) per year at different locations along the shoreline – the net sediment transport rates within the 95 percent confidence limits varied by roughly 15,000 m³ (20,000 yd³) from the average, indicating the uncertainty in the estimated rates. On Figure 25, positive transport rates (indicating net transport to the south) are on the upper side of the zero value on the left vertical axis and negative rates (indicating net transport to the north) are shown below the zero line. This figure indicates that for average transport
conditions there is a divergent nodal point (a location along the shoreline where net sediment transport switches directions) on the north end of Assawoman Island. Southward of the divergent nodal point, the net sediment transport is to the south, and northward of the nodal point the net transport direction is to the north.

The 95 percent confidence limits indicate that for most years the varying wave conditions shift the divergent point along the shoreline within about a 2.1 km (1.3 mi) window, referred to as the “nodal zone.” Because of the continuing growth of Fishing Point (see Figure 23) along with the southwestward migration of the offshore shoals (Wikel, 2008), the USACE determined that the divergent nodal zone along Wallops Island has been shifting to the south over time (USACE, 2010a).

Waves coming from the southeast have roughly the same height everywhere along the shoreline, but waves coming from the northeast have dramatically decreasing height (and thus energy) the further north they are along Wallops Island. This means that they have less ability to transport sand to the south. The wave sheltering from Fishing Point and the offshore shoals is the primary reason that the net sediment transport in most years along Wallops Island is to the north. Figure 26 provides another view of the divergent nodal point (represented as zero net sediment transport) and the direction net sediment transport modeled by the USACE. Northerly sediment transport is evidenced by the accumulation of sediment on the southern side of the previously existing groins (Photo 8, taken in 1994), and evidence of southerly sediment transport in the past is shown in Photo 9 (taken in 1969).
**Affected Environment**

**Figure 26: Wallops Island Sediment Budget**

Photo 8: Groin field located at north central part of Wallops Island showing sediment transport direction to the north – photo taken March 20, 1994

Numbers shown are the average net annual transport rates in thousands of cubic yards per year. *Source: USACE, 2010a*
3.1.7 Water Resources

3.1.7.1 Surface Water and Water Quality

Wallops Island is separated from the mainland by a marshy bay. The marshes flood regularly with the tides and are drained by an extensive system of meandering creeks. Surface water on Wallops Island flows through numerous tidal tributaries that subsequently flow to the Atlantic Ocean.

The southern and eastern portions of Wallops Island are part of the Eastern Lower Delmarva watershed, while the western portion is part of the Chincoteague Bay watershed. The remaining Wallops Island surface waters flow into numerous small unnamed watersheds. The Chincoteague Bay watershed has little topographic relief and a high water table. Large areas of the watersheds on Wallops Island are comprised of tidal wetlands. The Atlantic Ocean lies to the east of Wallops Island. Figure 27 shows the water resources on and around Wallops Island.

Photo 9: Groin field located along central Wallops Island showing sediment transport direction to the south – photo taken in 1969
The northern boundary of Wallops Island is formed by Chincoteague Inlet and its western side is bounded by a series of water bodies that include (from north to south) Ballast Narrows, Bogue's Bay, Cat Creek, and Hog Creek (Figure 27). This western boundary of Wallops Island includes a section of the Virginia Inside Passage, a federally maintained navigational channel. No natural perennial streams or ponds exist on the island; however, intermittent water bodies may form after storms or in response to other physical forces such as tides. One manmade storm water detention pond is located north of building V-20 adjacent to the Navy AEGIS building.

Northeast of Wallops Island, across Chincoteague Inlet, are Assateague and Chincoteague Islands. At the southern portion of Assateague Island is Tom’s Cove. Assateague Island is separated from Chincoteague Island by a series of water bodies to its west (north to south): Assateague Bay, Oyster Bay, Little Oyster Bay, and Assateague Channel. South of Wallops Island is Assawoman Inlet, which separates it from Assawoman Island. Assawoman Creek, a tributary of Woman’s Bay, is found just south of Assawoman Island. North of the WFF Main Base is Little Mosquito Creek, a tributary of Simneaston Bay.

The Clean Water Act (CWA) (33 U.S.C. §1251 et seq.), as amended in 1977, established the basic framework for regulating discharges of pollutants into the waters of the United States. The USACE regulates the discharge of dredged or filled material into waters of the United States, including wetlands, pursuant to Section 404 of the CWA. Section 401 of the CWA requires States to certify permit compliance with Federal laws, regulations, and standards. The Virginia Department of Environmental Quality (VDEQ) is responsible for providing Section 401 Water Quality Certification for Section 404 Federal permits.

Surface waters in the vicinity of Wallops Island are saline to brackish and are influenced by the tides. Saltwater intrusion, which is the movement of salt water into a freshwater environment, occurs periodically within the marshes at WFF but is not a problem for the groundwater resources at Wallops Island because the salt water is not hydraulically connected to the groundwater aquifer. Most often, it is caused by ground-water pumping from coastal wells (Barlow, 2003), or from construction of navigation channels. Salt water intrusion can also occur as the result of a natural process like a storm surge from a hurricane.

Outgoing tidal flow is generally north and east to Chincoteague Inlet and out to the Atlantic Ocean; incoming tides flow in the reverse direction. The VDEQ has designated the surface waters around Wallops Island as Class II – Estuarine Waters (VDEQ, 2009). The Atlantic Ocean is designated as Class I – Open Ocean. Surface waters in Virginia must meet the water quality criteria specified in 9 Virginia Administrative Code (VAC) 25-260-50. This set of criteria establishes limits for minimum dissolved oxygen concentrations, pH, and maximum temperature for the different surface water classifications in Virginia. In addition, Virginia surface waters must meet the surface water criteria specified in 9 VAC 26-260-140. This set of criteria provides numerical limits for various potentially toxic parameters. For the Class I and II waters in the vicinity of Wallops Island, the saltwater numerical criterion is applied. Both sets of standards are used by the Commonwealth of Virginia to protect and maintain surface water quality.
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No wild or scenic rivers are located on, or adjacent to, Wallops, Assateague, Chincoteague, or Assawoman Islands; therefore, the Wild and Scenic Rivers Act (16 U.S.C. 1271-1287) does not apply to this project (USFWS, 2007).

3.1.7.2  Wetlands

EO 11990 (Wetland Protection) directs Federal agencies to minimize the destruction, loss, and degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetland communities. In accordance with the CWA (33 U.S.C. §1251 et seq.), projects at WFF that involve dredging or filling wetlands require Section 404 permits from the USACE. Title 14 of CFR Part 1216.2 (NASA regulations on Floodplain and Wetland Management) directs WFF and its tenants to minimize wetland impacts.

In addition, permits may be required from the VMRC, Accomack County Wetlands Board, and the VDEQ for work that may impact wetlands. A Joint Permit Application (JPA), filed with VMRC, is used to apply for permits for work in the waters of the United States, including wetlands, within Virginia. The VMRC plays a central role as an information clearinghouse for local, State, and Federal levels of review; JPAs submitted to VMRC receive independent yet concurrent reviews by local wetland boards, VMRC, VDEQ, and USACE.

Wallops Island

Extensive wetland systems border Wallops Island. Figure 28 provides further details on the types and locations of wetland communities present on Wallops Island. The island has non-tidal freshwater emergent wetlands and several small freshwater ponds in the interior. Freshwater forested/shrub wetlands, estuarine intertidal emergent wetlands, and maritime forests exist on its northern and western edges. Marsh wetlands also fringe Wallops Mainland along Arbuckle Creek, Hog Creek, and Bogues Bay.

Assateague and Assawoman Islands

The peninsula at the southernmost portion of Assateague Island, forming Tom’s Cove, has intertidal marine wetlands along its southeastern shore and slightly inland. Both estuarine intertidal unconsolidated and estuarine intertidal emergent wetlands are found in the center of the peninsula. Where the peninsula widens into the main body of Assateague Island there are numerous freshwater ponds as well as freshwater forest and shrub areas. South of Wallops Island, Assawoman Island has intertidal marine wetlands along its western shore and both estuarine intertidal unconsolidated and estuarine inter-tidal emergent wetlands inland.

3.1.7.3  Marine Waters

The continental shelf water within the SRIPP study area of the Atlantic Ocean originates from the coastal waters off Canada, moves southward over the continental shelf, and is continuously modified by river runoff and air-sea interaction as it moves to the south. In winter, the temperature of the shelf water mass is much lower than that of the slope water mass due to the cooling effects of the atmosphere. Currents in the shelf water mass have a stronger southwest-directed component in the winter season compared to all other seasons. Development of the shelf water mass along the Mid-Atlantic coast is also dependent on the variations in Gulf Stream transport from the south, as well as forces from the atmosphere and river runoff.
Marine waters in the project area maintain a fairly uniform salinity range (32 to 36 parts per thousand [ppt]) throughout the year, with pockets of high salinity water (38 ppt) found near the Gulf Stream in the fall (NASA, 2003a). The salinity of nearshore shelf water, influenced by freshwater runoff, is generally lower than offshore water masses. Over the continental shelf, the salinity concentration usually increases with depth. Water masses near the coast are at most times of the year less saline than the corresponding layer offshore, due to freshwater influence from rivers.

A thermocline is a vertical zone of rapidly changing temperature that divides the upper layer of warmer marine water from the colder, deeper layer. Because density is controlled largely by temperature, the thermocline coincides with a vertical zone of rapidly changing density. This phenomenon is referred to as stratification. There are distinct differences in stratification of the Mid-Atlantic Ocean water column between summer and winter. The density gradient causes resistance to vertical mixing and there is little exchange between the surface waters and the deeper, colder waters (Kennett, 1982). In mid-latitude waters, such as the waters within the vicinity of the proposed SRIPP offshore borrow sites, a seasonal thermocline develops in the spring and persists until fall (Hollister, 1973; Kennett, 1982; Adams et al., 1993). This occurs with the onset of stratification due to the warming of the surface waters by solar radiation and the decrease in mixing as storm activity diminishes.

In the SRIPP project area in winter, the water column is vertically well-mixed, with water temperatures averaging 14° Celsius (C) (57° Fahrenheit [F]) at the surface and 11° C (52° F) at depths greater than 20 m (656 ft). In summer, the water column is vertically stratified with 25° C (77° F) water near the surface and 10° C (50° F) water at depths greater than 200 m (656 ft) (NASA, 2003a). Results of the 2009 benthic video survey of Unnamed Shoals A and B (described in Section 3.2.2.3) showed bedforms on both shoal surfaces, which is evidence that wave energy reaches extends to the seafloor and mixing occurs throughout the water column.

3.1.8 Floodplains

EO 11988 (Floodplain Management) requires Federal agencies to take action to minimize occupancy and modification of the floodplain. Specifically, EO 11988 prohibits Federal agencies from funding construction in the 100-year floodplain unless there are no practicable alternatives. As shown on the Flood Insurance Rate Maps (FIRMs) produced by FEMA, the 100-year floodplain designates the area inundated during a storm having a 1-percent chance of occurring in any given year. The 500-year floodplain designates the area inundated during a storm having a 0.2-percent chance of occurring in any given year.

FIRM Community Panels 5100010070B and 5100010100C indicate that Wallops Island is located entirely within the 100-year and 500-year floodplains. Wallops Island is a barrier island that experiences flood waters primarily during major storm events (nor’easters, tropical storms, or hurricanes) both from waves and from the marshes and bays on its land-ward side. The wetlands on Wallops Island and the island itself retain floodwaters during storm events and therefore function as flood mitigation for the mainland during storms.
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3.1.9 Coastal Zone Management

Barrier islands such as Wallops, Assateague, Chincoteague and Assawoman Islands are elongated, narrow landforms that consist largely of unconsolidated and shifting sand, and lie parallel to the shoreline between the open ocean and the mainland. These islands provide protection to the mainland, prime recreation resources, important natural habitats to unique species, and valuable economic opportunities to the country. The northern end of Wallops Island also contains coastal primary sand dunes that serve as protective barriers from the effects of flooding and erosion caused by coastal storms (NASA, 2008).

The Coastal Barrier Resources Act (CBRA [P.L. 97-348], 16 U.S.C. 3501-3510), enacted in 1982, designated various undeveloped coastal barrier islands as units in the Coastal Barrier Resources System. Designated units are ineligible for direct or indirect Federal financial assistance programs that could support development on coastal barrier islands; exceptions are made for certain emergency and research activities. Wallops Island is not included in the Coastal Barrier Resources System; therefore, the CBRA does not apply.

VDEQ is the lead agency for the Virginia Coastal Zone Management (CZM) Program, which is authorized by NOAA to administer the Coastal Zone Management Act of 1972. Any Federal agency development in Virginia’s Coastal Management Area (CMA) must be consistent with the enforceable policies of the CZM Program. Although Federal lands are excluded from Virginia’s CMA, any activity on Federal land that has reasonably foreseeable coastal effects must be consistent with the CZM Program (VDEQ, 2008a). Enforceable policies of the CZM Program that must be considered when making a Federal Consistency Determination include:

- **Fisheries Management.** Administered by VMRC, this program stresses the conservation and enhancement of shellfish and finfish resources and the promotion of commercial and recreational fisheries.

- **Subaqueous Lands Management.** Administered by VMRC, this program establishes conditions for granting permits to use State-owned bottomlands.

- **Wetlands Management.** Administered by VMRC and VDEQ, the wetlands management program preserves and protects tidal wetlands.

- **Dunes Management.** Administered by VMRC, the purpose of this program is to prevent the destruction or alteration of primary dunes.

- **Non-Point Source Pollution Control.** Administered by the Virginia Department of Conservation and Recreation (DCR), the Virginia Erosion and Sediment Control Law is intended to minimize non-point source pollution entering Virginia’s waterways.

- **Point Source Pollution Control.** Administered by VDEQ, the Virginia Pollutant Discharge Elimination System (VPDES) permit program regulates point source discharges to Virginia’s waterways.

- **Shoreline Sanitation.** Administered by the Virginia Department of Health, this program regulates the installation of septic tanks to protect public health and the environment.

- **Air Pollution Control.** Administered by VDEQ, this program implements the Federal Clean Air Act (CAA) through a legally enforceable State Implementation Plan.
**Coastal Lands Management.** Administered by the Chesapeake Bay Local Assistance Department, the Chesapeake Bay Preservation Act guides land development in coastal areas to protect the Chesapeake Bay and its tributaries.

Because Wallops Island is within Virginia’s CMA, NASA activities are subject to the Federal Consistency requirement. The nearby barrier islands of Assateague, Chincoteague, and Assawoman Islands are also included in Virginia’s CMA.

### 3.1.10 Air Quality

The CAA (P.L. 108-201, 42 U.S.C. 85 et seq.), as amended, requires the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The CAA established two types of NAAQS: primary and secondary standards. Primary standards set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA has set NAAQS for six principal pollutants that are called “criteria” pollutants. They are: carbon monoxide (CO), nitrogen oxides (NOx), ozone (O₃)—for which volatile organic compounds (VOCs) and NOx are precursors—lead (Pb), sulfur dioxide (SO₂) and particulate matter (PM). EPA divides PM into two categories: inhalable coarse particles (i.e., PM less than 10 micrometers (PM₁₀) but larger than 2.5 micrometers) and fine particles (i.e., PM less than or equal to 2.5 micrometer (PM₂.₅)). Although States have the authority to adopt stricter standards, the Commonwealth of Virginia has accepted the Federal standards and has incorporated them by reference in 9 VAC 5-30 (VDEQ, 2008b; see Table 12).
### Table 12: National Ambient Air Quality Standards

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Time</th>
<th>Primary/Secondary NAAQS</th>
<th>NAAQS Violation Determination$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₃</td>
<td>8 hour</td>
<td>0.075 ppm $^b$</td>
<td>3-year average of the annual 4th highest daily maximum 8-hour average concentration</td>
</tr>
<tr>
<td>CO</td>
<td>8 hour</td>
<td>9.0 ppm</td>
<td>Not to be exceeded more than once per calendar year</td>
</tr>
<tr>
<td></td>
<td>1 hour</td>
<td>35.0 ppm</td>
<td>Not to be exceeded more than once per calendar year</td>
</tr>
<tr>
<td>NO₂</td>
<td>Annual arithmetic mean</td>
<td>0.053 ppm</td>
<td>Annual average</td>
</tr>
<tr>
<td>SO₂</td>
<td>Annual arithmetic mean</td>
<td>0.03 ppm</td>
<td>Not to be exceeded more than once per calendar year</td>
</tr>
<tr>
<td></td>
<td>24 hour</td>
<td>0.14 ppm</td>
<td>Not to be exceeded more than once per calendar year</td>
</tr>
<tr>
<td></td>
<td>3 hour</td>
<td>0.5 ppm</td>
<td>Not to be exceeded more than once per calendar year</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>Annual arithmetic mean</td>
<td>Revoked$^c$</td>
<td>Expected number of days per calendar year with a 24-hour average concentration above 150 μg/m$^3$ cannot be exceeded more than once per year on average over a 3-year period</td>
</tr>
<tr>
<td></td>
<td>24 hours</td>
<td>150 μg/m$^3$</td>
<td></td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>Annual arithmetic mean</td>
<td>15 μg/m$^3$</td>
<td>3-year average of annual arithmetic mean</td>
</tr>
<tr>
<td></td>
<td>24 hour</td>
<td>65 μg/m$^3$</td>
<td>3-year average of 98th percentile of the 24-hour values determined for each year</td>
</tr>
<tr>
<td>Pb</td>
<td>Quarterly average</td>
<td>1.5 μg/m$^3$</td>
<td>Quarterly arithmetic mean</td>
</tr>
</tbody>
</table>

$^a$A NAAQS violation results in the re-designation of an area; however, an exceedance of the NAAQS does not always mean a violation has occurred.


$^c$Revoked annual PM₁₀ standard December 2006.

μg/m$^3$ = micrograms per cubic meter

ppm = parts per million

NA = not applicable

NO₂ = nitrogen dioxide

Source: Derived from EPA, 2008

Federal regulations designate Air Quality Control Regions, or airsheds, that cannot attain compliance with the NAAQS as non-attainment areas. Areas meeting the NAAQS are designated as attainment areas. Wallops Island and Mainland are located in Accomack County, an attainment area for all criteria pollutants; therefore, a General Conformity Review (under Section 176(c) of the CAA) does not apply to the facilities prior to implementing a Federal action.

Wallops Island and Wallops Mainland are considered a synthetic minor source, and the two land masses are combined into a facility-wide State operating air permit for stationary emission sources (Permit Number 40909, amended August 3, 2006). A facility is considered a major source in an attainment area if all of its sources together have a potential to emit (PTE) greater than or equal to 90.7 mt per year (100 tons per year) of the criteria pollutants, or greater than or
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equal to 9.1 mt per year (10 tons per year) of a single Hazardous Air Pollutant (HAP) or 22.7 mt per year (25 tons per year) of combined HAPs. Table 13 lists the emissions for Wallops Island and Wallops Mainland based on the 2008 Emission Statement.

Table 13: Calendar Year 2008 Air Emissions at Wallops Island/Mainland

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Emissions (mt per year/tons per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>0.34 / 0.37</td>
</tr>
<tr>
<td>NO\textsubscript{X}</td>
<td>1.36 / 1.50</td>
</tr>
<tr>
<td>SO\textsubscript{2}</td>
<td>2.65 / 2.92</td>
</tr>
<tr>
<td>VOC</td>
<td>0.03 / 0.03</td>
</tr>
<tr>
<td>PM\textsubscript{10}</td>
<td>0.15 / 0.16</td>
</tr>
<tr>
<td>PM</td>
<td>0.21 / 0.23</td>
</tr>
</tbody>
</table>

Source: VDEQ, 2008b

Prevention of Significant Deterioration

Separate pre-construction review procedures have been established for projects that are proposed to be built in attainment areas versus non-attainment areas. The pre-construction review process for new or modified major sources is called New Source Review (NSR) and consists of a Prevention of Significant Deterioration (PSD) review for sources located in an attainment area. This review process is intended to keep new air emission sources from causing existing air quality to deteriorate beyond acceptable levels codified in the Federal regulations. Construction of major new stationary sources in attainment areas must be reviewed in accordance with the PSD regulations. The PSD rule defines a major source as any source with a PTE of 90.7 mt per year (100 tons per year) or more of any criteria pollutant for source categories listed in 40 CFR 52.21(b)(1)(i), or 226.8 mt per year (250 tons per year) or more of any criteria pollutant for source categories that are not listed. If a new source is determined to be a major source for any criteria pollutants, then other remaining criteria pollutants would be subject to PSD review if those pollutants are emitted at rates that exceed the following significant emission thresholds:

- 90.7 mt per year (100 tons per year) for CO
- 36.3 mt per year (40 tons per year) for NO\textsubscript{X}, VOC, or SO\textsubscript{2}
- 13.6 mt per year (15 tons per year) for PM\textsubscript{10}
- 22.7 mt per year (25 tons per year) for PM

Major sources that exceed any of the PSD thresholds are subject to PSD review for all criteria pollutants. Although Wallops Island and Wallops Mainland are assumed not to be a major source under the PSD program, nor one of the listed source categories, to continue to protect air quality in designated attainment areas, a PSD applicability analysis must be conducted for each Federal project. NASA ensures that before each project is initiated, PTE is calculated to not only assess whether a permit to construct for applicable sources is needed, but also to document that the entire project does not trigger PSD.
**Minor New Source Review**

The minor NSR permit program applies to the construction, reconstruction, relocation, or modification of any stationary source that will emit regulated air pollutants above minimum exemption levels. If a permit is required, it must be obtained before any activity on the project can begin. Prior to installing any new stationary emission sources, NASA is responsible for assessing if a permit-to-construct application is necessary, and if so, for preparing and filing the applicable Form 7 permit application forms.

**New Source Performance Standards**

New Source Performance Standards (NSPS) regulations (40 CFR 60) establish pollutant emission limits and monitoring, reporting, and recordkeeping requirements for various emission sources based on source type and size. These regulations apply to new, modified, or reconstructed sources. According to the State Operating Permit, and confirmation by NASA environmental personnel, there are no current (i.e., installed) emission sources (i.e., boilers, storage vessels, emergency generators) that are subject to NSPS. However, referencing the NASA Expansion of the Wallops Flight Facility Launch Range EA (NASA, 2009a), there were proposed emergency generators associated with the proposed action and alternatives that would be subject to NSPS Subpart III regarding emissions from stationary diesel internal combustion engines, which will eventually be included in the facility’s permit.

**National Emission Standards for Hazardous Air Pollutants**

Section 112(a) of the CAA Amendments requires the development of emission standards for listed HAPs from new and modified equipment at stationary major and area sources (i.e., a source that is not a major HAP source). Emission standards promulgated under this subsection require the maximum degree of reduction in emissions of HAPs for specific source categories. The standards are to be established by taking into consideration the cost of achieving such emission reductions, and any non-air quality health and environmental impacts and energy requirements.

National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations, codified at 40 CFR Parts 61 and 63, regulate HAP emissions. Part 61 was promulgated prior to the 1990 CAA Amendments and regulates specific HAPs: asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride. The 1990 CAA Amendments established an original list of 189 HAPs to be regulated, which resulted in the promulgation of Part 63, also known as the Maximum Achievable Control Technology (MACT) standards. These MACTs regulate emissions from major HAP sources and specific source categories that emit HAPs.

Wallops Island and Wallops Mainland are currently considered a minor (or area) HAP source, and are therefore not subject to NESHAP regulations for major sources. The facility would, however, be subject to any applicable area source NESHAP regulations when these regulations are promulgated by EPA. Condition 19 of the March 24, 2008, Stationary Source Permit to Operate establishes a federally enforceable limit of 8.5 mt per year (9.4 tons per year) of Hydrochloric acid and 0.91 mt per year (1.0 ton per year) of lead. These limits are placed on the combustion of solid fuel propellants during static rocket motor test firing events.
3.1.10.1 Greenhouse Gas Emissions

Each GHG is assigned a global warming potential (GWP), which is the ability to trap heat, and is standardized to CO₂, which has a GWP value of one. For example, N₂O has a GWP of 310, meaning it has a global warming effect 310 times greater than CO₂ on an equal-mass basis. For simplification, total GHG emissions are often expressed as a CO₂ equivalent (CO₂e). The CO₂e is calculated by multiplying each GHG emission by its GWP and adding the results to produce a combined rate to represent all GHGs.

There are a multitude of State and regional regulatory programs requiring GHG emissions reductions. Although Virginia has no current GHG legislation, the Governor issued Executive Order 59 in 2007, which established the “Governor’s Commission on Climate Change” (Bryant, 2008). Since then, VDEQ has had a Climate Change Steering Committee and GHG Emissions Workgroup who have focused on possible regional reduction targets, among other items. In addition to State programs, there is emerging Federal climate change-related legislation. In 2007, the U.S. Supreme Court determined that EPA had the regulatory authority to include GHGs as pollutants under the CAA. On October 30, 2009, EPA issued a new rule (Mandatory Reporting of GHGs) that adds substantial additional requirements, such as measurement, monitoring, and reporting, for many industries.

As GHGs are relatively stable in the atmosphere and are essentially uniformly mixed throughout the troposphere and stratosphere, the climatic impact of GHG emissions does not depend upon the source location. Therefore, regional climate impacts are likely a function of global emissions. Table 14 lists the GHG emissions for Wallops Island/Mainland based on the 2008 annual update forms for Wallops Island, which provides VDEQ with consumption rates from stationary sources. Emissions factors from the EPA’s AP-42 (EPA, 2009b) and Environment Canada’s National Inventory Report (Environment Canada, 2006) were used in conjunction with the Wallops Island/Mainland consumption rates to calculate annual GHG emissions for boilers/heating equipment, emergency generators, and mobile sources (i.e., government-owned gasoline-powered vehicles). GHG emissions were combined into one value called a CO₂ equivalent (CO₂e) using approved factors to weight each pollutant.

Table 14: Calendar Year 2008 Greenhouse Gas Air Emissions at Wallops Island/Mainland

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Emissions (Mt per year/tons per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₄</td>
<td>0.06 (0.07)</td>
</tr>
<tr>
<td>CO₂</td>
<td>2,676 (2,950)</td>
</tr>
<tr>
<td>N₂O</td>
<td>0.14 (0.15)</td>
</tr>
<tr>
<td>Total GHG Emissions</td>
<td>2,676 (2,950)</td>
</tr>
</tbody>
</table>

Table 15 depicts estimates of GHG emissions for Wallops Island/Mainland facilities by source categories. Mobile source emissions were based on fuel consumption rather than vehicle miles traveled due to unavailable data. Mobile source emissions for Wallops Island were assumed to be all gasoline dispensed from the Main Base as there was no data available to determine what percentage of gasoline dispensed was used at the Main Base versus Wallops Island/Mainland.
### Table 15: Calendar Year 2008 Greenhouse Gas Emissions at Wallops Island/Mainland in Metric Tonnes per Year (Tons per Year)

<table>
<thead>
<tr>
<th>Source</th>
<th>CH4</th>
<th>CO2</th>
<th>N2O</th>
<th>CO2e</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>External Combustion Sources</strong></td>
<td>0.021</td>
<td>1,823.60</td>
<td>0.039</td>
<td>1,835.73</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(2,010.15)</td>
<td>(0.043)</td>
<td>(2,203.96)</td>
</tr>
<tr>
<td><strong>Internal Combustion Sources</strong></td>
<td>0.0009</td>
<td>12.23</td>
<td>0.0018</td>
<td>12.81</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(13.48)</td>
<td>(0.002)</td>
<td>(14.12)</td>
</tr>
<tr>
<td><strong>Mobile Sources</strong></td>
<td>0.043</td>
<td>840.62</td>
<td>0.093</td>
<td>870.03</td>
</tr>
<tr>
<td></td>
<td>(0.047)</td>
<td>(926.61)</td>
<td>(0.10)</td>
<td>(959.25)</td>
</tr>
<tr>
<td><strong>Total GHG Emissions</strong></td>
<td>0.065</td>
<td>2,676.45</td>
<td>0.099</td>
<td>2,718.58</td>
</tr>
<tr>
<td></td>
<td>(0.070)</td>
<td>(2,950.24)</td>
<td>(0.143)</td>
<td>(2,997.33)</td>
</tr>
</tbody>
</table>

#### 3.1.11 Noise

The EPA’s Noise Control Act of 1972 (42 U.S.C. 4901 to 4918) as amended by the Quiet Communities Act of 1978, states that it is the policy of the United States to promote an environment for all Americans free from noise that jeopardizes their health or welfare.

##### 3.1.11.1 Fundamentals of Noise

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. Noise is unwanted sound that may interfere with normal activities or otherwise diminishes the quality of the environment, for either humans or wildlife. Sound is generally characterized by several variables, including frequency and intensity. Frequency describes the sound’s pitch and is measured in Hertz (Hz), while intensity describes the sound’s loudness and is expressed in decibels (dB). Decibels are measured using a logarithmic scale.

The method commonly used to quantify airborne sounds consists of evaluating all frequencies of a sound according to a weighting system that reflects that human hearing is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. This is called “A” weighting, and the decibel level measured is called the A-weighted sound level (dBA) (see Table 16). Sounds levels underwater are not weighted and measure the entire frequency range of interest. Because air and water are two different media with different densities, different reference sound pressure levels are used for each. The most commonly used reference for air is 20 microPascals (µPa) and the most commonly used reference for underwater is 1 µPa. Unless otherwise noted, all airborne noise levels are reported in dBA referenced to 20 µPa and all underwater noise levels are reported in dB re 1 µPa in this PEIS.

##### 3.1.11.2 Noise Standards and Criteria

Because sounds in the outdoor environment are usually not continuous, there are a few common metrics used to describe noise. The first is the time-averaged sound pressure level or Leq. The 1-hour Leq is the measurement unit used to describe monitored baseline in-air noise levels in the vicinity of WFF. It conforms to the requirements in 23 CFR Part 772 and is a descriptor recommended by the Federal Highway Administration for describing noise levels during peak traffic periods. The second is the Day Night Level, or DNL, which is a 24-hour average sound level with an added penalty of 10 dB during nighttime hours (10 p.m. to 7 a.m.) to account for sensitivity of the period when people are typically sleeping. EPA guidelines, and those of many
other Federal agencies, recommend that outdoor sound levels do not exceed 55 dB DNL in noise-sensitive land uses such as residences, schools, or hospitals.

The U.S. Occupational Safety and Health Administration (OSHA) regulates noise impacts on workers. OSHA regulations on in-air noise standards ensure that workers are not exposed to noise levels higher than 85 dBA. Exposure to 85 dBA is limited to 15 minutes or less during an 8-hour work shift. Exposure to impulsive or impact noise (loud, short duration sounds) is not to exceed 140 dB peak sound pressure level.

Table 16: Typical Noise Levels of Familiar Noise Sources and Public Responses

<table>
<thead>
<tr>
<th>Thresholds/Noise Sources</th>
<th>Sound Level (dBA)</th>
<th>Subjective Evaluation</th>
<th>Possible Effects on Humansa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human threshold of pain</td>
<td>140</td>
<td>Deafening</td>
<td>Continuous exposure to levels above 70 dBA can cause hearing loss in the majority of the population</td>
</tr>
<tr>
<td>Siren at 100 ft</td>
<td>130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loud rock band</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jet takeoff at 200 ft</td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto horn at 3 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chain saw</td>
<td>110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noisy snowmobile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lawn mower at 3 ft</td>
<td>100</td>
<td>Very Loud</td>
<td></td>
</tr>
<tr>
<td>Noisy motorcycle at 50 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy truck at 50 ft</td>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumatic drill at 50 ft</td>
<td>80</td>
<td>Loud</td>
<td>Speech interference</td>
</tr>
<tr>
<td>Busy urban street, daytime</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal automobile at 50 mph</td>
<td>70</td>
<td></td>
<td>Sleep interference</td>
</tr>
<tr>
<td>Vacuum cleaner at 3 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air conditioning unit at 20 ft</td>
<td>60</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>Conversation at 3 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiet residential area</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light auto traffic at 100 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Library</td>
<td>40</td>
<td>Faint</td>
<td></td>
</tr>
<tr>
<td>Quiet home</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft whisper at 15 ft</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slight rustling of leaves</td>
<td>20</td>
<td>Very Faint</td>
<td></td>
</tr>
<tr>
<td>Broadcasting studio</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threshold of Human Hearing</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aBoth the subjective evaluations and the physiological responses are continuums without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the noise receivers.

Source: EPA, 1974
The Accomack County code states that “...any loud, disturbing, or unreasonable noise in the county, which noise is of such character, intensity or duration as to be detrimental to the life, health, or safety of any person, or to disturb the quiet, comfort, or response of any reasonable person” is prohibited (Accomack County, 2001). Table 17 shows the specific noise limitations by land use as regulated by Accomack County.

### Table 17: Accomack County Noise Guidelines by Land Use

<table>
<thead>
<tr>
<th>District/Land Use</th>
<th>Daytime Level (dBA)</th>
<th>Nighttime Level (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>65</td>
<td>55</td>
</tr>
<tr>
<td>Agricultural</td>
<td>65</td>
<td>55</td>
</tr>
<tr>
<td>Business</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>Industrial</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>Barrier Island</td>
<td>65</td>
<td>55</td>
</tr>
</tbody>
</table>

Source: Accomack County, 2001

As a general rule, the above levels should not be exceeded; however, exceptions to the rule exist. According to Article II, Section 38-35 of the Accomack County code, “This article shall not apply to noises generated by commercial or industrial operations except for those noises that emanate from the boundaries of such commercial or industrial site and affect persons who are not working onsite at such commercial or industrial operation.” There are no County-specific regulations regarding unacceptable levels of dBA at noise-sensitive receptors such as schools, hospitals, courts, and churches; although the Accomack County code states that noise would be deemed excessive when it “unreasonably interferes with the workings of such institution or building, provided that conspicuous signs are displayed on or near such building or institution indicating that such is a school, church, hospital, clinic or other public building.”

### 3.1.11.3 Existing Noise Environment

In 1992, WFF performed a noise monitoring survey and modeling program to determine baseline noise levels around the facility. Of the 13 sites selected for the noise-monitoring program, four were on Wallops Island and one was in the town of Assawoman along the route to Wallops Island.

Noise levels at each site were monitored for periods ranging from 15 minutes to 1 hour, depending on the site and predominant source of noise. A period of 1 hour was used at sites monitored during peak traffic conditions. Shorter periods were used for sites monitored during off-peak traffic conditions and sites in natural environments where noise levels were relatively constant.

Wallops Island was found to contain a wide range of background noise levels. At the northern portion of Wallops Island, natural sounds of wind, trees, and birds are the predominant source of the 53-dBA noise level. At the southern end of the island, as well as along the eastern seawall, the sounds of water and waves generate a noise level of about 64 dBA. In the interior of the island, near roads and buildings, noise levels are about 61 dBA during off-peak traffic periods and 64 to 65 dBA during peak a.m. and p.m. traffic (NASA, 2005).
Existing underwater sound levels are unknown, but existing sources of underwater sound include physical (earthquakes, wind, etc.), biological (marine mammals, fish, invertebrates), and anthropogenic (commercial shipping, recreational vessels, fishing vessels, dredging, and aircrafts).

3.1.12 Hazardous Materials and Hazardous Waste

3.1.12.1 Hazardous Materials Management

The WFF Integrated Contingency Plan (ICP), developed to meet the requirements of 40 CFR Part 112 (Oil Pollution Prevention and Response), 40 CFR Part 265 Subparts C and D (Hazardous Waste Contingency Plan), and 9 VAC 25-91-10 (Oil Discharge Contingency Plan), serves as the facility’s primary guidance document for the prevention and management of oil, hazardous material, and hazardous waste releases. The ICP includes the following procedures for hazardous materials management at the entire WFF facility, including Wallops Island:

- Each container of hazardous material is labeled in English with the following minimal description: name of chemical and all appropriate hazard warnings.
- Each work area has Material Safety Data Sheets (MSDSs) on file for each hazardous material used onsite. Each MSDS is in English and contains all required information. WFF utilizes an online electronic chemical inventory that contains links to appropriate MSDSs and is accessible to all WFF personnel through the GSFC intranet. Individual WFF support contractor offices train their personnel in the applicable hazardous communication pertinent to the requirements for each employee.
- Spill contingency and response procedures are prepared and implemented.
- The WFF Environmental Office offers annual ICP training to all Wallops and tenant personnel as well as to all visiting project teams.

3.1.12.2 Hazardous Waste Management

The regulations that govern hazardous waste management are the Resource Conservation and Recovery Act (RCRA, 42 U.S.C. 6901 et seq.) and Virginia’s Hazardous Waste Management Regulations (9 VAC 20-60). A solid waste is any material that is disposed, incinerated, treated, or recycled except those exempted under 40 CFR 261.4. All hazardous wastes are classified as solid wastes. Wallops Main Base is separated from Wallops Island and Wallops Mainland by approximately 11.2 km (7 mi) of public roadway. As they are not contiguous, each has been assigned its own EPA hazardous waste generator number. Shipment of hazardous waste between the two sites is illegal except by a licensed hazardous waste transporter. To facilitate the transportation of rocket motors declared hazardous waste from the Main Base to the Wallops Island, NASA has its own hazardous waste transporter license. NASA uses licensed hazardous waste transporters to transport hazardous waste off site to licensed treatment, storage, and disposal facilities.

Wallops Island and Wallops Mainland are together classified as a Large Quantity Generator because the area has the potential to generate more than 1,000 kg (2,205 lbs) of hazardous waste per month. In calendar year 2009, 10,585 kilograms (23,335 lbs) of hazardous waste including various expired chemicals, jet fuel mixed with hydraulic fluid, used oil, oily condensate, oily
rags, paint cans, and paint thinner were generated on Wallops Island and Wallops Mainland combined. Hazardous wastes generated on Wallops Island are stored on the Mainland at Building U-081, a less-than-90-day accumulation area in which hazardous waste may be stored for up to 90 days from the date of initial accumulation. In addition, Satellite Accumulation Areas are established in individual laboratories, shops, or other facilities designated by the generator for the accumulation of waste, not to exceed 208 liters (55 gallons) of hazardous waste, or 0.95 liter (1 quart) of extremely or acutely hazardous waste.

Wallops Island hazardous waste generators are responsible for the following:

- Properly containerizing waste
- Properly labeling waste containers with information pertaining to the contents and with the words “Hazardous Waste”
- Ensuring that less than 208 liters (55 gallons) of hazardous waste or less than 0.95 liter (1 quart) of acute hazardous waste are accumulated at or near the point of generation
- Properly completing and transferring a disposal inventory sheet to the NASA Environmental Office

### 3.1.12.3 Petroleum Storage Tank Management

The Wallops Island facilities include 21 aboveground storage tanks (ASTs) and 2 underground storage tanks (USTs). Both the ASTs and USTs are used for the storage and dispensing of heating oil. Occasionally, temporary tanks are brought to Wallops Island during construction activities and typically contain diesel fuel and gasoline. All fuel storage tanks must be operated in accordance with Virginia storage tank regulations (9 VAC 25-91 [AST] and 9 VAC 25-580 [UST]), which are overseen by the VDEQ Tidewater Regional Office.

### 3.1.13 Munitions and Explosives of Concern

MEC are explosive munitions (bombs, shells, grenades, etc.) that did not function as designed and may pose a risk of detonation. MEC is composed of unexploded ordnance (UXO) and discarded military munitions (DMM).

In 2007 the USACE completed a study assessing relevant information regarding suitability of various borrow site options considered for the SRIPP identified several reported unexploded ordnance sites, one offshore explosive dumping area and two uncharacterized offshore UXO sites (USACE, 2007).

Ordnance, explosives, and pyrotechnics fired on to or dropped on one or more of the Wallops Island range areas include: Pentolite, HBX-1 Aluminum Explosive, Dynamite, Primacord, Composition C-3, Composition B, Electric Blasting Caps, T-55 Rocket Motors, 2.25-in Solid Rocket Motors, Practice Bombs, 37mm munitions, 30mm munitions, 20mm munitions, Mk 77 Fire Bomb, Mk5 Night Drift Signals, AN-Mk4 Signals, AN-Mk5/Mk23/Mk43, Mk6 Parachute Flares, and Aerial Mines.

There are nine known historic live fire and bombing areas off of Wallops Island. None of these are currently active (USACE, 2007). Four additional areas of concern were identified by the USACE and are listed in Table 18 below. Figure 29 illustrates the location of these 13 areas of potential MEC.
Table 18: Potential MEC Locations within Project Area

<table>
<thead>
<tr>
<th>ID</th>
<th>Impact Area Name</th>
<th>Impact Area Located Within SRIPP Study Area?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Target Center</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Strafing Target</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>Gunboat Point Bombing Area</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>Machine Gun and Rocket Firing Area</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Small Arms Ranges</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Explosive Ammunition Test Facility</td>
<td>Yes</td>
</tr>
<tr>
<td>PTF</td>
<td>Plate Test Facility</td>
<td>Yes</td>
</tr>
<tr>
<td>17</td>
<td>Sea Target</td>
<td>Yes</td>
</tr>
<tr>
<td>RA</td>
<td>Restricted Area Danger Zone</td>
<td>No</td>
</tr>
<tr>
<td>EOD</td>
<td>Explosive Ordnance Disposal Area</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Off-Shore Dump Site</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Off-Shore UXO site 1</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Off-Shore UXO site 2</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Source: USACE, 2007

Known historic live fire and bombing areas determined to potentially affect the project area are described below.

**Target Center**

The Target Center was the aiming point for the test range on Wallops Island and was used by the Naval Aviation Ordnance Test Station (NAOTS) to analyze aviation ordnance between 1946 and 1959. The test range was instrumented and was used to assess the delivery, aircraft separation, ballistics, and accuracy of aviation ordnance. The impact area for the Target Center was located on land only on the northern eastern tip of Wallops Island. It is inferred from the lack of references to live (high explosive) ordnance use at the Target Center that only practice munitions and pyrotechnics were used at this site. Because the Target Center was located entirely on land, it is not expected that MEC (only UXO in this instance) from this site has migrated to the Atlantic Ocean.

**Strafing Target**

The strafing target was used to test aircraft machine guns and cannons at a fixed ground target. The target impact area was located totally on land on the northeastern tip of Wallops Island and the USACE estimates that it is unlikely that MEC from this site has migrated to the Atlantic Ocean.
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**Gunboat Point Bombing Area**

The former bombing area was located on the peninsula at the northeastern extremity of Wallops Island. The Gunboat Point area was used by NAOTS to test live, high explosive aircraft delivered ordnance and incendiary devices. During the period of 24 January and 1 July 1952, the Ordnance Department had loaded, dropped, and reported on approximately 920 aircraft parachute flares. The Gunboat Point impact area has changed significantly over the years. Though most of the impact area was on Wallops Island itself, further characterization of this area is necessary to determine the extent of shoreline and offshore impact. Due to sediment movement, MEC may now be submerged beneath the Atlantic Ocean or the Chincoteague Inlet. The USACE expects that UXO might be present along the northeastern shoreline of Wallops Island (USACE, 2007). Some of the UXO could have migrated to the contiguous Atlantic Ocean beaches.

**Machine Gun and Rocket Firing Area**

The firing area had two ground ranges, a 685-m (2,250-ft) range and a 230-m (750-ft) range, that were located immediately south of the Wallops Island north boat basin and were oriented southeast toward the ocean. Targets were constructed on the sand dunes along the beach. The machine gun firing area was used to statically test aircraft machine guns and cannons primarily firing 20 and 30 mm munitions. Aircraft rockets were tested at this range. The impact area for this range can be defined as a 40 degree fan originating at the firing point on Wallops Island and extending south-south east about 5,500 m (18,000 ft) into the Atlantic Ocean. UXO is expected to be present in the target area of this range that was located on the sand berms along the Atlantic Ocean beach front.

**Sea Target**

The Sea Target was probably a pyramid target constructed from wooden slats and telephone poles driven into the ocean bed at a depth of about 10 m (33 ft). UXO from munitions and land-launched rockets fired from Naval Auxiliary Air Station Chincoteague and Wallops Island is expected to be found in the Sea Target impact area. The UXO should be concentrated in a 915-m (3,000-ft) radius circle around the Sea Target center.

**Explosive Ammunition Test Facility**

The Explosive Ammunition test complex included the Explosive Ammunition Test Facility (Building W-81) and the Environmental Chamber (Building W-140) and was used to test fire aircraft guns and munitions. The facility included gun mount slabs, target stands, and a Rocket Cluster Site. High explosive munitions were tested at this facility. Targets were constructed on the sand dunes along the beach. The impact area for this range can be defined as a 40 degree safety fan originating at the firing point and extending perpendicular to the beach line and 5,500 m (18,000 ft) into the Atlantic Ocean. MEC is expected to be present in this impact area and in the vicinity of the firing facility.

**Navy Plate Test Facility**

It is not clear whether the proposed 1953 Plate Test Facility was ever constructed. If constructed, munitions similar to the Explosive Ammunition Test Facility would have been fired east into the
Affected Environment

Atlantic Ocean. Additionally the impact area for this range would have similar dimensions as the Explosive Ammunition Test Facility. If used, MEC would be expected to be present in this impact area and in the vicinity of the firing facility.

**Explosive Ordnance Disposal Area**

The National Advisory Committee for Aeronautics and later NASA operated an Explosive Ordnance Disposal (EOD) area on the southern end of Wallops Island. This area was in service until NASA constructed the current Open Burn/Open Demolition (OB/OD) facility in the same area. The EOD area was located entirely on shore. It is not expected that MEC (both UXO and DDM) from this area has migrated to the Atlantic Ocean. However, if further beach loss occurs in this area, MEC may eventually enter the Atlantic Ocean.

**Offshore UXO sites**

There are two offshore UXO sites in the Atlantic Ocean in the proximity of Wallops Island. The nearer site is located 11.58 km (7.2 mi) from the island at a depth of 13 m (44 ft). The second site is located 21.84 km (13.6 mi) from the island at a depth of 21 m (68 ft). The extent of either ordnance site is not known.
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3.2 BIOLOGICAL ENVIRONMENT

3.2.1 Terrestrial Environment

The barrier island system along the Delmarva Peninsula contains various ecological succession stages, including beaches, dunes, swales, maritime forests, and marsh. The natural vegetative zones overlap and are constantly in a state of flux as the geographical positions of the islands slowly shift.

The beach system of the Virginia and Maryland barrier islands from east to west includes the subtidal zone, intertidal zone, and upper beach zone. The subtidal zone on the eastern side of the islands extends from the lower limit of low tide to the seaward-most limit of wave action. Because of the dynamics of wave action, few plants exist in the sub-tidal zone. Due to shoreline erosion and the presence of the seawall, beach habitat is absent seaward of the seawall on Wallops Island.

The intertidal zone is a transition zone exposed during low tide and totally submerged at high tide. This zone is an extremely dynamic area. Plant species are virtually nonexistent in the intertidal zone located on the eastern portion of Wallops Island because of the deleterious effects of wave action on the stability of the zone. Microscopic plants and animals exist in the minute spaces between individual sand grains in the eastern intertidal zone.

The fauna of the intertidal and subtidal zones of the beach are described under the benthic and fisheries sections below (within Section 3.2.2).

The upper beach zone is an extremely harsh environment. Biotic resources in this zone must be very adaptable to contend with high temperatures, winds, salt, sandblasting, drought, and low nutrient levels in the sandy soil medium (NASA, 2008). There is not a dune system present within the SRIPP project area on Wallops Island.

3.2.1.1 Vegetation

The northern and southern dune vegetation on Wallops Island directly borders salt marshes (Figure 30). On the southern portion of Wallops Island, the dune and swale zone extends to the tidal marsh on the western side. No maritime forest exists on this part of the island. In the central and northern areas, the dune and swale zone extends to the maritime zone that starts where the secondary dune line once existed. The northern part of Wallops Island within the dune and swale zone is in an almost natural state, and is dominated by northern bayberry (*Morella pensylvanica*), wax myrtle (*Morella cerifera*), groundsel bush (*Baccharis halimifolia*), and American beach grass. The central portion of Wallops Island is dominated by common reed and maintained lawn areas. Common reed is invasive and has the ability to grow in areas with very low habitat value; it is considered to be an undesirable plant. Due to its successful competition with many other plant species, common reed has virtually taken over much of the area in the center of Wallops Island.

A small area of maritime forest zone exists on the central portion of the island, with an expansive thicket zone on the northern part. The thicket zone is dominated by extensive clusters of northern bayberry, wax myrtle, and groundsel-tree. The thicket zone in some areas is virtually impenetrable due to dense stands of poison-ivy (*Toxicodendron radicans*) and greenbriar (*Smilax* spp.), which is also pervasive on other areas of Wallops Island. The northern maritime forest
Affected Environment

zone is dominated by loblolly pine (*Pinus taeda*) and cherry trees (*Prunus* spp.), with an
understory of northern bayberry, wax myrtle, and groundsel-tree. These species are able to thrive
in sandy soils with poor drainage.

Between Wallops Island and Mainland extends 461 hectares (1,140 acres) of tidal marsh. A tidal
marsh is an area of low-lying wetlands that is influenced by the tides. The marsh is interlaced
with small streams known locally as “guts.” The marsh itself can be divided into the low marsh
and the high marsh—each a distinctive community. The low marsh, which is inundated at high
tide, is dominated by salt marsh cordgrass (*Spartina alterniflora*). The high marsh, which is
flooded by approximately 50 percent of the high tides, is dominated by salt meadow cordgrass
(*S. patens*). As the marshes provide suitable habitat for both feeding and reproduction, these
areas are of tremendous importance to marine life and to the terrestrial and avian species that
depend on the marshes for their existence (NASA, 2008).
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3.2.1.2 **Wildlife**

The northern (Maryland) portion of Assateague Island is part of the Assateague Island National Seashore, while the southern (Virginia) portion closest to Wallops Island is part of CNWR. Both protected park areas provide excellent habitat for a variety of wildlife. Assawoman Island is also owned by USFWS and is part of CNWR.

**Invertebrates**

Wallops Island, particularly the tidal marsh area, has an extensive variety of invertebrates. Saltmarsh cordgrass marshes provide habitat to herbivorous (plant eating) insects such as the saltmarsh grasshopper (*Orchelimum fidicinium*) and the tiny plant hopper (*Megamelus* spp.). Plant hopper eggs are in turn preyed upon by a variety of arthropods, the group of animals that includes insects, spiders, and crustaceans. The tidal marshes are inhabited by a number of parasitic flies, wasps, spiders, and mites. The spiders prey mostly on herbivorous insects, and mites prey primarily on microarthropods (small invertebrates) found in dead smooth cordgrass. Saltmarsh mosquitoes (*Ochlerotatus sollicitans*) and greenhead flies (*Tabanus nigrovittatus*) are prevalent insects on Wallops Island.

Particular species inhabit different areas of the marsh depending on their ability to adapt to the fluctuating tides. Many insects and arachnids (e.g., spiders and ticks) can tolerate lengthy submersions. Insects that cannot sustain long submersions tend to move up the marsh vegetation during high tide. For example, periwinkle snails (*Littorina irrorata*) and mud snails (*Ilyanassa obsoleta*) can withstand lengthy submersions and are found mainly on the marsh surface, while the majority of the predatory spiders, which are unable to withstand submersions, live within the vegetation above the mean high water level.

On the Atlantic side of the island, the upper beach zone is dominated by burrowing organisms such as ghost crabs (*Ocypode quadrata*), sand fleas (taltrid amphipods), and insects. Ghost crabs are important predators on mole crabs and coquina clams that live in the lower portions of the beach. They dig burrows up to 1.3 m (4 ft) deep and feed typically at night.

**Amphibians and Reptiles**

A variety of amphibians and reptiles use the dune and swale zones for foraging. Fowler’s toad (*Bufo fowleri*) can be found under stands of bayberry. The green tree frog (*Hyla cinerea*) is found in the wetter areas in the northern portion of Wallops Island. Other frogs include the gray tree frog (*Hyla versicolor*) and southern leopard frog (*Rana sphenocephala*). Some species of reptiles such as the black rat snake (*Elapha obsoleta*), hognose snake (*Heterodon platyrhinos*), box turtle (*Terrapene carolina*), and northern fence lizard (*Sceloporus undulatus*) can be found in low-lying shrubby areas. The northern water snake (*Nerodia sipedon sipedon*) is generally located in close proximity to freshwater and brackish ponds and also in marshes on the western side of the islands. Snapping turtle (*Chelydra serpentina*) and diamondback terrapin (*Malaclemys terrapin*) can be found in saltmarsh estuaries, tidal flats, and lagoons; while the box turtle is found in central areas where cover under shrubs and other vegetation is readily available.

**Mammals**

On Wallops Island, mammals such as white-tailed deer (*Odocoileus virginianus*), opossum (*Didelphis marsupialis*), raccoon (*Procyon lotor*), and gray squirrel (*Sciurus carolinensis*) are...
plentiful. Raccoon and red fox (*Vulpes vulpes*) are occasionally found in the upper beach zone and the inter-tidal zone. The gray squirrel and opossum inhabit the maritime forest along with other mammals that use other sections of the island for forage and shelter. Raccoon, red fox, white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), rice rat (*Oryzomys palustris*), white-tailed deer, and Eastern cottontail rabbit (*Sylvilagus floridanus*) are found in the dune and swale zone.

While most mammals found on Assateague Island are comparable to those found on Wallops Island, Chincoteague National Wildlife Refuge provides protected habitats to a several additional species. Wild horses (*Equus caballus*) roam freely on the northern side of the island, and are restricted by fencing on the southern portion which is closest to Wallops Island. The feral horses and non-native sika deer (*Cervus nippon*) feed on the abundant vegetation commonly found in the interdune swale zone and thickets. Assateague Island also provides habitat for the federally and State-endangered Delmarva fox squirrel (*Sciurus niger cinereus*), which can be found in pine and oak forests in the central portion of the island. Lobolly pines on the island provide habitat for the little brown bat (*Myotis lucifugus*), red bat (*Lasiurus borealis*), and silver-haired bat (*Lasionycteris noctivagans*). Musk rat (*Ondatra zibethicus*) are found in brackish and freshwater impoundments, along with the occasional river otter (*Lutra canadensis*).

**Avifauna**

Laughing gulls (*Larus atricilla*), herring gulls (*L. argentatus*), and great black-backed gulls (*L. marinus*) commonly forage in the upper beach zone and the intertidal zone. Forster’s terns (*S. forsteri*) are common in the marshes and on occasion may winter on Wallops Island. Birds that use the shrub zones include various species of sparrows, red-winged blackbirds (*Agelaius phoeniceus*), boat-tailed grackles (*Quiscalus major*), and fish crows (*Corvus ossifragus*). Birds common in the shrub zone include song sparrow (*Melopiza melodia*), gray catbird (*Dumetella carolinensis*), yellowthroat (*Geothlypis trichas*), and mourning dove (*Zenaida macroura*). Resident Canada geese (*Branta canadensis*) are found year-round in open upland portions of the property.

Raptors, including northern harrier (*Circus cyaneus*), osprey (*Pandion haliaetus*), and the State threatened peregrine falcon (*Falco peregrinus*), inhabit the marsh areas, including the marsh west of Wallops Island. The marshland on the western side of the barrier islands provides habitat to wading birds such as the great egret (*Ardea alba egretta*), snowy egret (*Egretta thula*), tricolored heron (*Ardea carolinensis*), snowy egret (*Egretta tricolor*), green heron (*Butorides virescens*), great blue heron (*Ardea herodias*), and clapper rails (*Rallus longirostris*).

Great horned owls (*Bubo virginianus*) can be found in the maritime forest, and bald eagles (*Haliaeetus leucocephalus*) can often be seen flying over WFF; a recently discovered bald eagle nest is located on the northern end of Wallops Island. The maritime forests may also give shelter to ruby-crowned kinglet (*Regulus calendula*), downy woodpecker (*Picoides pubescens*), white-eyed vireo (*Vireo griseus*), and the northern saw-whet owl (*Aegolius acadicus*) during migration stopovers.

**Migratory Bird Treaty Act**

The Migratory Bird Treaty Act (MBTA, 16 U.S.C. 703-712) was enacted to ensure the protection of shared migratory bird resources. The MBTA prohibits the take and possession of
any migratory bird, their eggs, or nests, except as authorized by a valid permit or license. The statutory definition of “take” is “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill.” A migratory bird is any species that lives, reproduces, or migrates within or across international borders at some point during its annual life cycle.

The Atlantic Flyway is of great importance to migratory waterfowl and other birds during the spring and fall. The coastal route of the Atlantic Flyway, which in general follows the eastern seaboard, is a regular avenue of travel for migrating land and water birds that winter on the waters and marshes south of Delaware Bay. Ducks, geese, shorebirds, songbirds, and raptors pass through the Atlantic Flyway. The barrier islands, including Wallops, Assateague, Chincoteague, and Assawoman Islands, are particularly important for migratory birds. Some species use these islands as a stopover point, while others use the island and surrounding habitats as an overwintering area. The bay side of the islands tends to contain the highest concentrations of migratory birds.

### 3.2.2 Marine Environment

#### 3.2.2.1 Submerged Aquatic Vegetation

The bay side of the Virginia barrier island system has a substantial population of submerged aquatic vegetation (SAV), including a variety of seagrasses. Two true seagrasses, eelgrass and widgeon grass; provide erosion control, habitat, and foraging area for fish, waterfowl, and mammals such as river otters. Water clarity is the most vital component of seagrass survival (Virginia Institute of Marine Science, nd). Increases in water turbidity and changes in sediment content and nutrient levels can be detrimental to seagrass growth, the majority of which occurs from March through November. About 85 percent of the SAV within the barrier islands is found on the western side of Assateague Island in Chincoteague and Sinepuxent Bays. Smaller amounts of eelgrass and widgeon grass can be found in the coastal bays of Wallops, Assawoman, and Chincoteague Islands. During the October, 2009 survey, small areas of widgeon grass was observed in the shallow water area located between the sand flats and the beach berm offshore, in addition to stems of eelgrass (*Zostera marina*). However, according to the 2008 SAV online mapper prepared by the Virginia Institute of Marine Science (VIMS), the nearest mapped SAV bed to the SRIPP project area is in New Virginia Cove, approximately 11 km (7 mi) from the northernmost point of proposed beach fill on Wallops Island shoreline and approximately 8 km (5 mi) from the mouth of Chincotage Inlet. The VIMS mapper did not indicate any SAV on the ocean side of Wallops or Assateague Islands, nor in the open ocean waters of the Atlantic off Wallops Island (VIMS, no date).

#### 3.2.2.2 Plankton

**Phytoplankton**

Phytoplankton are small floating plants. Nutrients supplied from coastal runoff and vertical mixing in the water column support a relatively high abundance of phytoplankton out to a depth of about 20 m (65 ft) in the MAB. Peaks in phytoplankton populations vary annually, with highest abundances occurring in spring and late summer to late fall. Phytoplankton are important primary producers and are key prey for zooplankton and fish.
Zooplankton

Zooplankton are small floating or weakly swimming animals. Zooplankton include those species that spend their entire lives as plankton (holoplankton) as well as the eggs and larvae of many fish and invertebrates (meroplankton). Holoplankton abundance is highest in late spring, summer, and fall. Meroplankton are most numerous during late spring and summer. There are approximately 400 taxa of zooplankton in this portion of the MAB including copepods, chaetognaths, cladocerans, and larvae of several benthic groups such as barnacles, brachyurans (e.g., crabs), and echinoderms (e.g., sand dollars and starfish) (Sherman et al., 1996). Zooplankton are important prey for many fish.

Ichthyoplankton

Ichthyoplankton are the eggs and larvae of fish that are carried passively along with the currents. Olney and Bilkovic (1998) reviewed and presented a synthesis on the ichthyoplankton in the MAB. Ichthyoplankton populations are highly variable due to seasonal and climatic changes, diverse life histories, hydrodynamic processes, natural cycles of abundance, and fishing pressure. In general, fish that spawn in the MAB broadcast pelagic eggs. However, some species such as Atlantic herring (Clupea harengus harengus), common mummichog (Fundulus heteroclitus), sand eel (Ammodytes spp.), silverside (Menidia menidia), and winter flounder (Pseudopleuronectes americanus), have benthic eggs with a dispersive pelagic larval stage. The ichthyoplankton have the potential to be dispersed throughout the region and into habitats different than the spawning grounds.

Spawning and ichthyoplankton populations vary seasonally in the MAB. The majority of species have a spawning period that includes spring and/or summer (Olney and Bilkovic, 1998). However, Grosslein and Azarovitz (1982) reported that significant quantities of fish larvae are present throughout the MAB all year.

3.2.2.3 Benthos

Overview

Benthos are bottom-dwelling invertebrates that provide a critical link in the productivity of the marine waters off of Wallops Island. The benthos includes organisms that live on the sediment surface (epifauna) such as starfish and sand dollars, as well as organisms that live within the sediment (infauna) such as clams and worms. The majority of the benthos live in the upper 6 inches (in) (15 centimeters [cm]) of sediment. Benthic organisms are an important food resource for fish, including those caught by recreational and commercial fishermen.

Benthic habitats within the project area consist of: (1) the intertidal portions of the beach including the surf and swash zones, (2) the intertidal and subtidal portions of the rock seawall, and (3) the offshore or subtidal habitats.

The distribution of beach infauna is controlled by physical factors, particularly sediment grain size, wave energy and tidal range. Beach slope and wave height, in turn, have been identified as the two factors associated the most with different beach assemblages (McLachlan, 1990). Wave height is important because it is a measure of wave energy: the higher the wave energy, the more stressed and therefore less diverse and abundant the infaunal assemblage. Beach slope is important because beaches with steep slopes have a relatively small swash zone and species such
as mole crabs (Emerita spp.) which “ride” the tides in the swash zone may not have sufficient scope for feeding and thus be unable to establish large populations.

In addition to wave energy and tidal range, the distribution of beach infauna is dependent on other physical factors such as sediment texture. Intertidal infauna are usually highest in both abundance and biomass in the summer and lowest during mid-winter. Population numbers are seasonal, with highest abundances in the summer and lowest in the winter. Species composition varies within elevations of the beach, with lower species diversity occurring in the upper beach zone.

The offshore benthic habitats of the nearshore northern Virginia continental shelf, within the region of the SRIPP study area, consist of unvegetated and unconsolidated sand of varying grain size. As described in Section 3.1.4, the shelf also contains topographically high shoals. A detailed description of the underwater sedimentary environment of the project area is provided in Section 3.1.5.

Physical factors play a role in determining the structure of benthic communities of the shallow continental shelf including sediment type, hydrodynamics, and bottom topography. Sedimentary characteristics, such as grain size and organic content, are particularly important factors in determining the distribution and structure of benthic communities on open continental shelf areas (Theroux and Wigley, 1998). Sediment grain size distribution plays an important role in determining substrate stability and food availability which in turn affects benthic community structure and the benthic trophic groups that may be present as suspension or deposit-feeding taxa (e.g., Rhoads, 1974, Fauchald and Jumars, 1979). Although infaunal species occur across a range of sediment types, the distribution of many infaunal taxa tend to be correlated to specific sedimentary habitats. For this region of the MAB, Wigley and Theroux (1981) reported that bivalves were the most abundant taxonomic group in the sand/shell sediment while the second most abundant group in this sediment, crustaceans, were in turn the most abundant in sand-dominated sediment.

Hydrodynamic processes (e.g., currents and waves) also affect benthic community structure (e.g., Eckman, 1983; Hall, 1994). Hydrodynamic processes affect benthic larval transport, sediment characteristics, and food resources at a variety of spatial scales (Butman, 1987; Zajac et al. 1998; Palmer, 1988). Storms may affect benthic community composition, especially in shallow water (Hall, 1994; Posey et al., 1996, Posey and Alphin, 2002). Diaz et al. (2004) report that storms are important in structuring benthic communities. Even though individual storm events are unpredictable, their seasonality and frequency have a relatively narrow range over the course of a year. Storms can affect surface sedimentology over relatively short time periods. Niederoroda et al. (1989) concluded that a major storm can deposit a layer of sediment several cm thick at 20 m (65 ft) water depth and several millimeters thick at 40 m (130 ft) water depth.

Local bottom topographic features, such as ridges and troughs, also play a role in determining shallow continental shelf macrobenthic communities. Diaz et al. (2004) reported that shoal-ridge communities are different from the mid-shoal and trough communities. Viscido et al. (1997) reported that the presence of a ridge has a clear influence on the local abundance and distribution of shrimp and crab populations. They reported that the ridge has an assemblage of crab and shrimp different from that on either side of the ridge. The differences may be attributable to the ridge being a high-energy environment or its sediment composition.
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In general, the overall abundance of benthic communities is highest in the late spring and early summer. However, a range of reproductive cycles exist for the benthos at the individual species level. Some species reproduce year-round, while others spawn during one or multiple seasons. The project area encompasses two general benthic habitats: (1) the offshore sand shoals and (2) the nearshore beach and surf zone. Currently, beach habitat is absent seaward of the seawall on Wallops Island. An overview of the benthic communities within the offshore and nearshore habitats is provided below.

Beach, Swash, and Surf Zones

Currently, exposed beach exists only north and south of the seawall (Figure 3). Along the Mid-Atlantic coast, the uppermost zone of the beach is dominated by air-breathing crustaceans such as beach hoppers (taltrid amphipods) and ghost crabs. Between the drift line and midtide level is the swash zone, an area dominated by isopods, haustoriid amphipods, polychaetes (e.g., Scolelepis squamata), and mole crabs (Emerita talpoida). Below midtide is the surf zone where coquina, or bean, clams (Donax spp.) and a variety of haustoriid amphipods dominate the benthic assemblage. Beyond the surf zone, benthic assemblages are characterized by increasing representation of fauna that is characteristic of offshore waters (described below).

Donax and Emerita are key members of the beach benthic community and important prey items for a range of higher trophic levels organisms including ghost crabs, blue crabs, fish that inhabit the surf zone (e.g., Florida pompano), and shorebirds (e.g., Sanderling). Donax and Emerita are filter feeders and require moving water to feed. They are sensitive to physical characteristics of the beach. Dolan et al. (2004) reported that Emerita and Donax populations were reduced in finer-grained sediment deposited over time from sand bypassing from the Oregon Inlet to Pea Island, North Carolina. The population reductions were correlated to a higher heavy mineral content which increased the sand density and increased compaction. These physical changes affected the ability of Emerita and Donax to burrow into and out of the sand. In addition, Bowman and Dolan (1985) report that Emerita population densities are strongly influenced by physical processes (e.g., wave energy) and physical attributes of the foreshore (e.g., grain size and beach slope). Emerita may be sensitive to sediment grain size because of implications for burrowing and or the effects of turbidity on feeding. Emerita abundances are highest in the late summer and early fall (Bowman and Dolan, 1985). Alexander et al. (1993) report that Donax burrowing rates are slowed by elevated coarse components of sediment including shell hash.

Seawall

In its current state with no beach in front of it, the rock seawall provides habitat for benthic organisms. As shown in Photo 10, green algae are present in the upper intertidal and splash zones. Barnacles and mussels are present in the lower tidal zones. The rocks also provide habitat for a variety of benthic organisms such as polychaete worms and amphipods, as well as crabs. The seawall also provides habitat for a variety of insects. Wilber et al. (2003) report that insects comprised a small but consistent component of the food supply of surf zone fish off the northern coast of New Jersey.
Offshore

Relevant recent studies have been conducted of the offshore benthic communities in this region (Maryland and Virginia) of the MAB. Cutter and Diaz (2000), Diaz et al. (2004), and Slacum et al. (2006) reported on the benthic communities of the sand shoals and reference areas offshore of northern Maryland (approximately 35 to 50 km [20 to 35 mi] north of the proposed SRIPP borrow sites). The sampling sites were located approximately 16 to 25 km (10 to 15 mi) offshore in water depths between 10 and 20 m (6 and 12 ft). In addition, VIMS (2006) has examined the Sandbridge Shoal offshore of Virginia Beach approximately 120 km (75 mi) southwest of the SRIPP study area.

Cutter and Diaz (2000) collected benthic grab samples, video, and sediment profile imaging data of sand shoals offshore of northern Maryland and southern Delaware in 1998 and 1999. Cutter and Diaz (2000) and Diaz et al. (2004) reported that in the sediment grab samples they collected offshore of northern Maryland and southern Delaware, they found that the infaunal communities were dominated by annelid worms, followed by mollusks and crustaceans. Mollusks accounted for over 85 percent of the biomass.

Cutter and Diaz (2000) also reported on the epifauna of the area. They found that three crabs (hermit crabs [Pagurus spp.], portly spider crab [Libinia emarginata], and Atlantic rock crab [Cancer irroratus]) were most abundant. Large gastropods such as the whelk (Busycon canaliculatum) and moon snail (Polinices spp.) were also collected. Other large benthos collected were the infaunal bivalves such as the surf clam (Spisula solidissima) and common razor clam (Ensis directus). Astartes (Astarte spp.), bivalves known to lie on the sediment surface, were collected along with starfish (Asterias spp.) and common sand dollar (Echinarachnius parma). Overall, crabs were most abundant in the habitats with biogenic
structure, such as tubes created by the polychaetes *Asabellides* and *Diopatra*, and appeared to be using these habitats as nursery areas since most of the individuals were small (<5 cm [<2 in]). Other species were broadly distributed across all habitats such as nudibranchs, *Pagurus* spp., sand shrimp (*Crangon septemspinosa*), and *Asterias* spp. The two species that appeared to prefer the sandy and more dynamic habitats were *Polinices* spp. and sand dollar.

Slacum et al. (2006) collected large epifauna during their trawling efforts on shoals offshore of Maryland (Table 19). These organisms are expected to occur on the offshore shoals in the project area.

**Table 19: Organisms Collected by Slacum et al. (2006) in Trawls Collected on Shoals Offshore of Maryland**

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asteroidea</td>
<td>Starfishes</td>
</tr>
<tr>
<td><em>Busycotypus canaliculatus</em></td>
<td>Channeled whelk</td>
</tr>
<tr>
<td><em>Callinectes sapidus</em></td>
<td>Blue crab</td>
</tr>
<tr>
<td><em>Cancer irroratus</em></td>
<td>Atlantic rock crab</td>
</tr>
<tr>
<td><em>Crangon septemspinosa</em></td>
<td>Sand shrimp</td>
</tr>
<tr>
<td>Echinodermidae</td>
<td>Heart urchins</td>
</tr>
<tr>
<td>Gastropoda</td>
<td>Gastropods</td>
</tr>
<tr>
<td><em>Libinia emarginata</em></td>
<td>Portly spider crab</td>
</tr>
<tr>
<td><em>Limulus polyphemus</em></td>
<td>Horseshoe crab</td>
</tr>
<tr>
<td>Nudibranchia</td>
<td>Nudibranchs</td>
</tr>
<tr>
<td><em>Octopus vulgaris</em></td>
<td>Common octopus</td>
</tr>
<tr>
<td><em>Ovalipes ocellatus</em></td>
<td>Lady crab</td>
</tr>
<tr>
<td><em>Ovalipes stephensoni</em></td>
<td>Coarsehand lady crab</td>
</tr>
<tr>
<td>Paguridae</td>
<td>Right-handed hermit crabs</td>
</tr>
<tr>
<td><em>Polinices</em> spp.</td>
<td>Moon snails</td>
</tr>
</tbody>
</table>

Slacum et al. (2006) reported that the abundance of epifaunal groups between two habitats, i.e., the shoal and uniform bottom, showed no differences; suggesting that shoals are not preferred by epifaunal species when compared to their reference site habitat.

**2009 Benthic Video Survey of Offshore Shoals**

In July 2009, a video survey was conducted of the benthic habitat of the two unnamed sand shoals as part of the baseline data collection for this PEIS (NASA, 2009b) (Appendix B). Video was collected at 40 stations (Figure 32) on each of the shoals (80 stations total) for approximately 5 minutes at each station. During collection of the video, the vessel was allowed to drift with the currents. Still images were extracted from the video during post-processing review. Five stations were established along each of eight transects oriented roughly perpendicular to alignment of the shoal crest (a total of 40 stations per shoal).
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The survey concluded that both the shoals are similar from a benthic habitat perspective and are comprised of unconsolidated sand with no hard substrate present. In addition, a sub-bottom profile survey conducted in June and July for the offshore cultural resource investigation reached the same conclusion (NASA, 2009c).

The photos provided below are representative of the habitats present on the shoals. Figure 32 depicts the location of these photo stations. Appendix B provides a more thorough description of the video survey as well as figures depicting all the video stations.

In general, results of the video survey indicated that sediment on the crests and topographically higher portions of the shoals were dominated by physical features such as ripple marks (Photos 11 and 12). The lack of apparent biogenic features does not necessarily indicate a paucity of biological resources (Cutter and Diaz, 2000). In general, benthic organisms in this habitat are dominated by infauna such as polychaete worms and epifauna such as sand dollars that burrow through the sediment and do not construct tubes; therefore, creating the “clean” appearance of the sand (Cutter and Diaz, 2000).

The deeper portions of the shoals were dominated by shell fragments and hash as well as biological features such as tubes and feeding cones created by benthic organisms. Little or no evidence of ripple marks (Photos 13 and 14) were seen in the deeper portions. Dominant epifaunal benthos included sand dollars (*Echinarchinus parma*) (Photo 15), hermit crabs (*Pagurus* spp.), crabs (*Libinia* spp., *Cancer* spp.), moon shell (*Polinices* spp.) and whelk (*Busycon* spp.). Fish were rarely seen on the video; those observed were sea robins (*Prionotus* spp.) (Photo 16).
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Photo 11: Ripple marks characteristic of Station #20 from Unnamed Shoal B at a depth of approximately 14 m (45 ft). (Photo contains the date and time of collection in upper left and easting and northing coordinates in upper right)

Photo 12: Ripple marks characteristic of Station #39 from Unnamed Shoal B at a depth of approximately 17 m (56 ft).
Photo 13: Shell hash and absence of bedforms characteristic of Station #2 from Unnamed Shoal A at a depth of approximately 17 m (55 ft).

Photo 14: Shell hash and absence of bedforms characteristic of Station #17 from Unnamed Shoal A at a depth of approximately 19 m (64 ft).
Photo 15: Sand dollars (*Echinarchinus parma*) from Station #14 from Unnamed Shoal B at a depth of approximately 15 m (48 ft).

Photo 16: Sea robin (*Prionotus* spp.) in lower right of photo from Station #39 from Unnamed Shoal B at a depth of approximately 17 m (56 ft).
3.2.2.4  **Invertebrate Nekton**

The Atlantic waters offshore of Wallops Island include invertebrates that live in the water column. These organisms include a variety of squid, jellyfish, and comb jellies (ctenophores). Comb jellies and jellyfish have limited mobility and generally are carried by currents. Comb jellies were frequently seen in the video collected from the shoals (Appendix B). Diaz et al. (2006) reported two species of squid were present at Sandbridge Shoal which is located in approximately 13 m (43 ft) of water and 5 km (3 mi) offshore and to the south of the opening of the Chesapeake Bay. The squid species were the Atlantic brief squid (*Lolliguncula brevis*) and Atlantic bobtail squid (*Rossia* spp.). A variety of jellyfish species occur in the area including the sea nettle (*Chrysaora quinquecirrha*) and the moon jellyfish (*Aurelia aurita*). These squid and jellyfish species would likely be present within the SRIPP project area.

3.2.2.5  **Finfish**

The project area contains a broad diversity of fish species. The MAB contains over 300 species of fish, most of which are seasonal migrants with only a few species considered endemic to the area (Sherman et al., 1996). The diversity results from the MAB being an area of transition from cold water in the north and warmer waters to the south. Boreal (northern) species are present in the winter and warm-temperate/sub-tropical species are present in the summer (Musick et al., 1986). Many of the species migrate from nearshore to areas offshore or southward seasonally, as dictated by temperature cycles, feeding opportunities, and spawning cycles (MMS, 1999). Generally, fish abundance is low in the winter with a progressive influx in the spring and peak abundances in the fall. In addition, diversity is highest in September and lowest in late winter (February/March) (MMS, 1998). In the offshore waters, spawning occurs over a wide geographical area with the production of pelagic eggs and larvae that are dispersed throughout the shelf water.

In winter, the fauna is dominated by wide-ranging species such as sea herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*), hakes (*Urophycis* spp., *Merluccius* spp.), monkfish (*Lophius americanus*), and spiny dogfish (*Squalus acanthias*), (Musick, 1974; Phoel, 1985; Nammack et al., 1985). In summer the fauna is dominated by warm temperate and sub-tropical species such as summer flounder (*Paralichthys dentatus*), croakers, drums, and sea trouts (*Sciaenids*), menhaden (*Brevoortia tyrannus*), and large coastal sharks (*Carcharhinidae*) (Desfosse et al., 1990). In spring and fall the area is an important migration corridor for striped bass (*Morone saxatilis*) and bluefish (*Pomatomus saltatrix*).

Warm water species such as bluefish and weakfish (*Cynoscion regalis*) enter the region as temperatures rise in the spring and summer, while cold water species such as Atlantic cod (*Gadus morhua*), Atlantic herring, and American shad (*Alosa sapidissima*) migrate north. Similarly, as fall approaches, warm water species such as summer flounder (*Paralichthys dentatus*), butterfish (*Peprilus triacanthus*), and black sea bass (*Centropristis striata*) may migrate offshore toward deeper waters and then move southward, while cold water species move south into the MAB (Grosslein and Azarovitz, 1982). It is also possible for a pelagic species such as Atlantic mackerel to have both a southern and a northern contingent which spawns within the MAB during different periods, or in the case of menhaden, spawning episodes during migrations into and out of the MAB.

Specific discussions of the surf zone and offshore shoals are provided below.
**Affected Environment**

**Surf Zone**

The surf zone provides important habitat for a variety of fish species. It provides foraging areas for adult and juvenile fish as well refugia from aquatic predators for juvenile fishes. A site-specific study of surf zone fish was not conducted for the SRIPP. However, Layman (2000) conducted a survey (in water depths less than 0.4 m [1.3 ft]) of surf zone fish at the north end of Hog Island which is located approximately 40 km (25 mi) to the south of the SRIPP project area. The results of his study adequately characterize the anticipated surf zone fish assemblage off Wallops Island.

During his survey from August 1997 to October 1998, Layman (2000) caught 23 fish species of which three species accounted for 94 percent of the total number of fish collected. This low species diversity was characterized by three dominant species that included, in order of abundance, the rough silverside (*Membras martinica*), Florida pompano (*Trachinotus carolinus*), and gulf kingfish (*Menticirrhus littoralis*). The majority of species were either seasonal juveniles or adult transient species that are much more common in other marine habitats. Only two species, rough silverside and white mullet (*Mugil curema*), were year-round residents. Most species utilize the shallow surf during the summer and early fall and migrate to deeper waters or southward during the cooler months (Layman, 2000). The survey also indicated an increase in species at night. Layman also reported higher species richness and abundance in runnels (the isolated troughs of water behind small sand bars).

**Offshore Sand Shoals**

Recent relevant studies have been conducted of the fish fauna of the sand shoals offshore of Ocean City, MD, located approximately 32 km (20 mi) north of the proposed SRIPP borrow sites (Slacum et al., 2006). Slacum et al. (2006) collected 57 taxa of finfish during seasonal sampling from the fall 2002 to the summer of 2004 using a combination of small otter trawls, large commercial trawls, and gill net sets. Spotted hake (*Urophycis regia*), scup (*Stenotomus chrysops*), and winter skate (*Raja ocellata*) were the dominant species collected, while windowpane flounder (*Scophthalmus aquosus*) and winter skate were highly prevalent species, being collected at nearly every site throughout the entire year. This study also included non-species specific bioacoustic studies to assess fish movement and relative abundances.

After two consecutive years of fisheries monitoring in Federal waters off the coast of Maryland and Delaware, Slacum et al. (2006) documented that there are significant seasonal variations in species richness and abundances at the shoals and reference sites in this region of the Mid-Atlantic Bight. They noted yearly variations in abundance, but overall the seasonal patterns of species assemblages were consistent and the majority of the species inhabiting the shoals and reference site habitats were seasonal residents. Comparisons between the net and bioacoustic data suggested that pelagic fish are using habitats differently between day and night. They concluded that: 1) fish occurring in the MAB either have no preference or prefer substrates at uniform-bottom types to sandy shoals during the day; and 2) there are diel (day/night) differences in the abundance of pelagic fish using the shoals and reference sites. Their data suggest fish could be using the adjacent uniform-bottom habitats during the day and move onto the shoals at night to exploit new habitat, in which case shoals could represent an important resource for fish at night.
Finfish abundance and species diversity were generally higher over the seafloor flats than on the shoals. Windowpane flounder (*Scophthalmus aquosus*), butterfish (*Peprilus triacanthus*), and spotted hake (*Urophycis regia*) were caught throughout seasonal samples in higher numbers over the seafloor flats than over the shoals. Other finfish species showed seasonal patterns of distribution. Scup (*Stenotomus chrysops*) in fall, winter skate (*Raja ocellata*) in winter, and northern sea robin (*Prionotus carolinus*) in summer are examples of common species that were captured in daytime netting more frequently on the flat uniform-bottom areas than on the shoals. Sand lance were netted more frequently on the shoals. Finfish netted from the shoals and seafloor flats differed the most in species composition in fall and winter, and were more similar in spring and summer. Nineteen species of finfish were collected only on either shoals or seafloor flat sites but not both. However, 18 of these species were infrequently collected and it is unclear whether their presence/absence resulted from habitat preference or chance. Among these, only bay anchovy (*Anchoa mitchilli*) was commonly captured; it was collected only at seafloor flat sites. Nighttime bioacoustic surveys conducted during spring, summer, and fall found that finfish concentrated on two of the four shoals studied had the greatest topographic relief (Fenwick and Weaver Shoals), indicating that finfish migrate back and forth between the shoals and seafloor flats during the course of the day. Data was not collected to adequately determine which finfish species are making preferential use of these two shoals at night.

Cutter and Diaz (2000) conducted beam trawls to characterize demersal, juvenile fish on shoals offshore of Ocean City. Many fish use the shallow continental shelf as a nursery ground (Able and Fahey 1998). Cutter and Diaz (2000) collected 20 species, with spotted hake the most abundant species, followed by small mouth flounder (*Etropus microstomus*). These two species accounted for approximately 70 percent of the fish caught. Other species collected included northern sea robin, clearnose skate (*Raja eglanteria*), and sand lance (*Ammodytes spp.*). Differences were noted in the day/night trawls in the polychaete *Asabellides* tube habitats and some of the sand habitats. Associations of fish between habitats appeared related to sediment grain size, bed roughness, and the presence of biogenic structures.

Vasslides and Able (2008) in a study offshore of Little Egg Inlet, NJ, reported that sand ridges of the inner continental shelf appear to be important habitat for a number of fish species. From their trawl studies, they found that the near-ridge habitats had higher species abundances and richness compared to the surrounding inner continental shelf and also contained a distinct species assemblage including both recreationally and commercially important species. They reported that the sandy substrate at the top of the sand ridges provides important habitat for species that bury themselves in the sand such as the northern stargazer (*Astroscopus guttatus*) and snakefish (*Trachinocephalus myops*). In addition, sand lance which also buries itself in the sand, was found predominantly in the sand substrate.

### Essential Fish Habitat

In accordance with provisions of the Magnuson-Stevens Fishery Conservation and Management Act of 1976 and the 1996 Sustainable Fisheries Act, Federal agencies must consult for activities that may adversely influence Essential Fish Habitat (EFH) that is designated in a Federal fishery management plan (FMP). An EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” *Waters* consist of aquatic areas and their associated physical, chemical, and biological properties that are currently utilized by fish and may include areas historically used by fish. *Substrate* is defined as sediment, hardbottom,
structures beneath the waters, and any associated biological communities. *Necessary* means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem. *Spawning, breeding, feeding, or growth to maturity* covers all habitat types used by a species throughout its life cycle. Only species managed under a FMP are covered (50 CFR 600). The activities may have direct (e.g., physical disruption) or indirect (e.g., loss of prey species) effects on EFH and may be site-specific or habitat-wide. The adverse results must be evaluated individually and cumulatively.

The National Marine Fisheries Service (NMFS) has designated the “mixing” and “seawater” portions of estuaries, nearshore and offshore bottom, and water column areas within the project area as EFH, in compliance with the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801-1882), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267). Managed species that commonly inhabit the study area are shown in Table 20.

### Table 20: NMFS Managed Species that May Occur in Waters Surrounding Wallops Island, VA and Proposed Offshore Borrow Sites

<table>
<thead>
<tr>
<th>Common Name (Scientific Name)</th>
<th>Eggs</th>
<th>Larvae</th>
<th>Juveniles</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic angel shark (<em>Squatina dumerili</em>)</td>
<td>---</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Atlantic butterfish (<em>Peprilus triacanthus</em>)</td>
<td>---</td>
<td>---</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Atlantic sea herring (<em>Clupea harengus</em>)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>X</td>
</tr>
<tr>
<td>Atlantic sharpnose shark (<em>Rhizoprionodon terraenovae</em>)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>X</td>
</tr>
<tr>
<td>black sea bass (<em>Centropristus striata</em>)</td>
<td>n/a</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>bluefish (<em>Pomatomus saltatrix</em>)</td>
<td>---</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>cobia (<em>Rachycentron canadum</em>)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>dusky shark (<em>Charcharinus obscurus</em>)</td>
<td>---</td>
<td>X</td>
<td>X</td>
<td>---</td>
</tr>
<tr>
<td>king mackerel (<em>Scomberomorus cavalla</em>)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>monkfish (<em>Lophius americanus</em>)</td>
<td>X</td>
<td>X</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>red drum (<em>Sciaenops ocellatus</em>)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>red hake (<em>Urophycis chuss</em>)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>---</td>
</tr>
<tr>
<td>sand tiger shark (<em>Odontaspis taurus</em>)</td>
<td>---</td>
<td>X</td>
<td>---</td>
<td>X</td>
</tr>
<tr>
<td>sandbar shark (<em>Charcharinus plumbeus</em>)</td>
<td>---</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>scalloped hammerhead shark (<em>Sphyrna lewini</em>)</td>
<td>---</td>
<td>---</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>scup (<em>Stenotomus chrysops</em>)</td>
<td>n/a</td>
<td>n/a</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Spanish mackerel (<em>Scomberomorus maculatus</em>)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>spiny dogfish (<em>Squalus acantbias</em>)</td>
<td>n/a</td>
<td>n/a</td>
<td>---</td>
<td>X</td>
</tr>
<tr>
<td>summer flounder (<em>Paralicthys dentatus</em>)</td>
<td>---</td>
<td>---</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>surf clam (<em>Spisula solidissima</em>)</td>
<td>n/a</td>
<td>n/a</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
## Affected Environment

<table>
<thead>
<tr>
<th>Common Name (Scientific Name)</th>
<th>Eggs</th>
<th>Larvae</th>
<th>Juveniles</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>tiger shark (<em>Galeocerdo cuvieri</em>)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>windowpane flounder (<em>Scopthalmus aquosus</em>)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>winter flounder (<em>Pleuronectes americanus</em>)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>witch flounder (<em>Glyptocephalus cynoglossus</em>)</td>
<td>X</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>clearnose skate (<em>Raja eglanteria</em>)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>little skate (<em>Leucoraja erinacea</em>)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>winter skate (<em>Leucoraja ocellata</em>)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: NMFS, No date

The notation “X” in the above table indicates that EFH has been designated within the project area for a given species and life stage. The notation “n/a” in the table indicates that the species either has no data available for the designated stage, or the particular stage is not present in the species’ reproductive cycle. These species are: spiny dogfish, surf clam, which are referred to as pre-recruits and recruits (this corresponds with juveniles and adults in the table); scup and black sea bass, for which there is insufficient data for the life stages listed, and no EFH designation has been made as of yet for certain life stages, although data is available to describe the applicable life stages for these species.

### 3.2.2.7 Marine Birds

Marine birds are birds that have adapted to life within and near the marine environment and are generally divided into two groups: shorebirds and seabirds. Marine birds expected to occur within the project area are discussed in this section. Marine birds protected under the ESA are discussed in Section 3.2.3 Threatened and Endangered Species.

#### Shorebirds

During spring and fall migrations, shorebirds feed on plants and animals in the intertidal zone of the Virginia barrier islands.

The sanderling (*Calidris alba*) is a small pale sandpiper. The Sanderling is most commonly seen in flocks chasing receding waves on ocean beaches, and running away from them when they return. It breeds in the high Arctic and winters along the Atlantic and Pacific coasts from Canada to Argentina (MacWhirter et al., 2002).

A small dark shorebird with a single band across its chest, the semi-palmated plover (*Charadrius semipalmatus*), is the most common plover seen during migration. The semi-palmated plover feeds primarily on insects and can be found on the Atlantic coast during the non-breeding winter season (Nol and Blanken, 1999).

The short-billed dowitcher (*Limnodromus griseus*) is a speckled shorebird that winters on coastal mud flats and brackish lagoons. The dowitcher and can be seen on the beaches within the project area during migration and feeds primarily on aquatic invertebrates such as mollusks, marine worms (Jehl et al., 2000).

The dunlin (*Calidris alpina*) can be found within the project area during the non-breeding season. Non-breeding plumage for the dunlin is a dull brownish gray, with a whitish belly. The main source of food for this shorebird is insects.
The American oystercatcher (*Haematopus palliatus*) is a large shorebird, common in coastal salt marshes and sand beaches throughout the central part of its range. One of the few birds to feed mainly on bivalve mollusks living in saltwater, this species is completely restricted to marine habitats. Eastern oystercatchers regularly winter in large flocks, from Virginia south along the Atlantic coast (Nol and Humphrey, 1994).

The double-crested cormorant (*Phalacrocorax auritus*) is found in flocks in diverse aquatic habitats, such as the coastline and estuaries, as well as inland in rivers, lakes, and other bodies of water. They build flat nests made of twigs, seaweed, and flotsam, either in trees or on the ground. The primary prey of the cormorant is small, bottom-dwelling or schooling fish (USFWS, 2009a), but they are also known to eat insects and amphibians (Hatch and Weseloh, 1999).

**Seabirds**

The black skimmer (*Rynchops niger*) is active at all times of the day, especially at dawn and dusk, and occasionally at night, feeding on fish. It builds its nest on the ground (Gochfeld and Burger, 1994).

The brown pelican (*Pelecanus occidentalis*) lives along warm marine coastlines and estuarine areas. Its primary prey is fish, as well as the occasional marine invertebrate. Pelicans are known for swooping down on fish from the air and trapping them in their bills. They build their nests in short trees or shrubs and on the ground, frequently in colonies with other shorebirds (Shields, 2002).

Various species of terns can be found on the beaches of Wallops, Assateague, and Chincoteague Islands. Terns are closely related to gulls and skimmers, but are more specialized in their nesting habitats, diet, and foraging methods. Most nest in colonies, frequently in proximity to groups of other nesting shorebirds (Gotchfeld and Burger, 1996).

The caspian tern (*Sterna caspia*) lives and breeds in a wide variety of coastal habitats, including salt marshes and barrier islands. Nesting occurs in colonies on beaches. The nest is a small indentation in the sand, lined with twigs, pebbles, or leaves. During the winter, they are found along beaches, and roosting on islands. The caspian tern feeds mainly on fish, but also on insects and small crustaceans (Cuthbert and Wires, 1999).

The common tern (*Sterna antillarum*) nests on barrier islands, beaches, and in saltwater marshes. The nests are well-disguised, appearing to be a pile of dead leaves or vegetation on the ground. Its primary prey is fish, with some invertebrates (Nisbet, 2002).

Forster’s tern (*Sterna forsteri*) is very similar in appearance to several other species of tern. It breeds in the marshes in areas of open water with stands of vegetation. Floating nests are fabricated out of vegetation and are found in open water or on floating vegetation. The Forster’s tern also occasionally makes its nest in mud or sand. In the winter, the tern is found along the coastline. Prey includes various small fish and arthropods (McNicholl et al., 2001).

The least tern (*Sterna hirundo*) is found on the coast, in bays, and in estuaries. Sandy coastal beaches are used for nesting, but the birds will also nest on flat elevated surfaces like roofs. On beaches, the nest will be a small indentation or “scrape” in the sand, soil, or in pebbles. Like most other terns found on and near Wallops Island, fish and invertebrates are its primary food source (Thompson et al., 1997).
The royal tern (*Sterna maxima*) nests on low-lying barrier island beaches, in nest scrapes in the sand. The birds are frequently found in colonies, nesting and feeding on fish and shrimp (Buckley and Buckley, 2002). The peak nesting season for the royal tern in the coastal Virginia area is June.

### 3.2.2.8 Marine Mammals

The Marine Mammal Protection Act of 1972 (MMPA, 16 U.S.C. 1361 et seq.) prohibits the taking of marine mammals on the high seas. Section 101(a)(5) of the MMPA directs the Secretary of the Department of Commerce to allow, upon request, the incidental (but not intentional) take of marine mammals. A discussion of marine mammals likely to occur within the project area is provided below. Marine mammals protected under the Endangered Species Act (ESA) are discussed in Section 3.2.3, Threatened and Endangered Species.

Table 21 lists marine mammal species that are likely to occur within the area offshore of Wallops Island.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humpback Whale</td>
<td><em>Megaptera novaeangliae</em></td>
</tr>
<tr>
<td>Fin Whale</td>
<td><em>Balaenoptera physalus</em></td>
</tr>
<tr>
<td>Right Whale</td>
<td><em>Eubalaena glacialis</em></td>
</tr>
<tr>
<td>Dwarf Sperm Whale</td>
<td><em>Kogia simus</em></td>
</tr>
<tr>
<td>True’s Beaked Whale</td>
<td><em>Mesoplodon mirus</em></td>
</tr>
<tr>
<td>Blainville’s Beaked Whale</td>
<td><em>Mesoplodon densirostris</em></td>
</tr>
<tr>
<td>Sowerby’s Beaked Whale</td>
<td><em>Mesoplodon bidens</em></td>
</tr>
<tr>
<td>Cuvier’s Beaked Whale</td>
<td><em>Ziphius cavirostris</em></td>
</tr>
<tr>
<td>Melon-Headed Whale</td>
<td><em>Peponocephala crassidens</em></td>
</tr>
<tr>
<td>Short-Finned Pilot Whale</td>
<td><em>Globicephala macrorhynchus</em></td>
</tr>
<tr>
<td>Long-Finned Pilot Whale</td>
<td><em>Globicephala melas</em></td>
</tr>
<tr>
<td>Rough-Toothed Dolphin</td>
<td><em>Steno bredanensis</em></td>
</tr>
<tr>
<td>Bottlenose Dolphin</td>
<td><em>Tursiops truncatus</em></td>
</tr>
<tr>
<td>Atlantic Spotted Dolphin</td>
<td><em>Stenella frontalis</em></td>
</tr>
<tr>
<td>Common Dolphin</td>
<td><em>Delphinus spp.</em></td>
</tr>
<tr>
<td>Atlantic White-Sided Dolphin</td>
<td><em>Lagenorhynchus acutus</em></td>
</tr>
<tr>
<td>Risso’s Dolphin</td>
<td><em>Grampus griseus</em></td>
</tr>
<tr>
<td>Striped Dolphin</td>
<td><em>Stenella coeruleoalba</em></td>
</tr>
<tr>
<td>Spinner Dolphin</td>
<td><em>Stenella longirostris</em></td>
</tr>
<tr>
<td>Clymene Dolphin</td>
<td><em>Stenella clymene</em></td>
</tr>
<tr>
<td>Harbor Seal</td>
<td><em>Phoca vitulina</em></td>
</tr>
</tbody>
</table>

Whales, dolphins, and porpoises are known as cetaceans. Cetaceans are completely aquatic mammals, living their entire lives in the water. Because their bodies are constantly supported by water, animals in this order include some of Earth’s largest species. Cetaceans are specialized swimmers, with some species able to sustain speeds up to 40 km per hour (25 miles per hour),
dive to 3,000 m (10,000 ft), or remain submerged for up to 2 hours (Wynne and Schwartz, 1999). Cetaceans are grouped into two taxonomic suborders: the baleen whales and toothed whales. Baleen whales are filter feeders that catch zooplankton or small schooling fish by skimming or gulping large volumes of prey and water. Toothed whales have a variable number of identical conical or spade-shaped teeth that are used to strain or grasp prey, primarily fish and squid (Wynne and Schwartz, 1999).

The northern right whale, fin whale, humpback whale, sperm whale, sei whale, blue whales, and manatees are discussed under marine mammals within Section 3.2.3.6 Threatened and Endangered Species.

**Dwarf Sperm Whale**

Dwarf sperm whales attain lengths of 2.1-2.7 m (7-9 ft) and weigh approximately 280 kilograms (600 pounds) as adults. They are robust, with a shark-like head, dark gray back, and falcate dorsal fin (Wynne and Schwartz, 1999). Dwarf sperm whales are difficult to distinguish from pygmy sperm whales (*Kogia breviceps*) at sea, so abundance estimates include both species. The best abundance estimate for *Kogia* sp. along the U.S. Atlantic coast is 395, derived by combining estimates from two 2004 surveys: Florida to Maryland (37) and from Maryland to the Bay of Fundy (358) (Waring et al., 2007).

Dwarf sperm whales occur worldwide in temperate and tropical waters. Sightings in the western North Atlantic tend to be oceanic—over the continental shelf edge and continental slope, and, occasionally, on the continental shelf (Mullin and Fulling, 2003; Waring et al., 2007; Wynne and Schwartz, 1999).

**Beaked Whales**

Cuvier’s and *Mesoplodon* spp. beaked whales (including True’s, Blainville’s, and Sowerby’s beaked whales) are difficult to identify to the species level at sea. Much available population and distribution information is, therefore, to the genus level only, and the genera are grouped together for the purposes of stock assessments. The stock structure is unknown, as are the total numbers of either Cuvier’s beaked whales or *Mesoplodon* spp. beaked whales off the eastern U.S. Atlantic coast (Waring et al., 2009). The best abundance estimate for beaked whales is a sum of estimates from two 2004 U.S. Atlantic surveys (3,513 whales), where the estimate from the northern U.S. Atlantic is 2,839, and the southern U.S. Atlantic is 674. Beaked whale abundance may be highest in association with Gulf Stream and warm-core ring features (Waring et al., 2009).

Beaked whales occur principally along the continental shelf edge and in deeper oceanic waters (CeTAP, 1982; Waring et al., 2007). Most sightings are in late spring and summer, which corresponds to the survey efforts. The distribution is otherwise derived from stranding reports (Waring et al., 2009).

**Melon-Headed Whale**

Adult melon-headed whales can be 2.6-2.7 m (8.5-9 ft) in length. They are long and slim, with a dark back and cape and prominent dorsal fin. Their distribution is worldwide in tropical and sub-tropical waters. Their prey is primarily squid and small fish (Wynne and Schwartz, 1999). The abundance of melon-headed whales along the U.S. Atlantic coast is unknown. No estimates are
available, as the species is rarely seen during population surveys. Both groups sighted during NMFS surveys (one in 1999 and one in 2002) were in waters >2500 m (>8,200 ft) deep east of Cape Hatteras, NC (Waring et al., 2007).

**Pilot Whales (Short-finned and Long-finned)**

Pilot whales are recognizable by their bulbous heads, large melons, and diminutive beaks. Sexual dimorphism exists, with males larger in size and exhibiting more rounded dorsal fins than females. Long-finned pilot whales reach 7.6 m (25 ft) for males and 5.7 m (19 ft) for females. Short-finned pilot whales range from 5.2 m (17 ft) for adult females to 6 m (20 ft) for adult males (Wynne and Schwartz, 1999).

The two species of pilot whales in the western Atlantic—the long-finned pilot whale and the short-finned pilot whale—are difficult to distinguish at sea. Therefore, most information below, including seasonal abundance estimates, refers to Globicephala sp. The best available estimate is the sum of estimates from two 2004 U.S. Atlantic surveys. This joint estimate \((15,728 + 15,411 = 31,139\) whales) is considered best because the two surveys together most comprehensively cover the species’ habitat. The minimum population estimate for Globicephala sp. is 24,866 (Waring et al., 2009).

Short-finned and long-finned pilot whale distributions overlap in the Mid-Atlantic region (Wynne and Schwartz, 1999). Short-finned pilot whales occupy tropical to warm temperate waters and may seasonally extend into shelf-edge waters north of Cape Hatteras (Leatherwood and Reeves, 1983). The long-finned pilot whale is distributed in cold temperate waters, ranging in the North Atlantic from Iceland and West Greenland south to Cape Hatteras (Leatherwood and Reeves, 1983). Pilot whales generally occur in areas of high relief or submerged banks and are also associated with the Gulf Stream wall and thermal fronts along the continental shelf edge (Waring et al., 1992; NMFS unpublished data, cited in Waring et al., 2009).

**Rough-Toothed Dolphin**

Rough-toothed dolphins grow to 2.4-2.7 m (8-9 ft) in length. They are dark in coloration, with a long, slender beak and white lips, throat, and blotches on the sides and belly (Wynne and Schwartz, 1999). The number of rough-toothed dolphins off the U.S. east coast is unknown, and abundance estimates are not available. This species is rarely seen during population surveys; there have been no sightings during shipboard or aerial surveys since 1999, except in the Caribbean (Waring et al., 2009).

Rough-toothed dolphin distribution is not well known. They are considered a tropical to warm-temperate species that frequents deep oceanic waters (Leatherwood and Reeves, 1983). They have been seen in both shelf and oceanic waters in the Gulf of Mexico (Mullin and Fulling, 2003).

**Bottlenose Dolphin**

There are two morphologically and genetically distinct bottlenose dolphin morphotypes (Hoezel et al., 1998) described as the coastal and offshore forms. Both inhabit waters along the U.S. Atlantic coast. North of Cape Hatteras, there is separation along bathymetric lines during summer months (Waring et al., 2009).
Coastal Morphotype

The coastal migratory stock is designated as depleted under the MMPA. Stock structure was revised in 2002 to recognize both multiple stocks and seasonal management units. The 2008 stock assessment report (Waring et al., 2009) identifies seven prospective stocks of coastal morphotype bottlenose dolphins along the Atlantic coast that replace these management units. These are the Central Florida, Northern Florida, Georgia, South Carolina, and Southern North Carolina stocks, and the Southern Migratory and Northern Migratory stocks. Since one or more of the stocks may be depleted, all stocks retain the depleted designation. The species is not listed as threatened or endangered under the Endangered Species Act (Waring et al., 2009).

The best abundance estimate for the Northern and Southern Migratory stocks is from a summer 2002 survey. There was an apparent separation between the two stocks at approximately 37.5°N latitude and they overlapped little. The resulting abundance estimate was 7,489 for the Northern Migratory stock and 10,341 for the Southern Migratory (Waring et al., 2009).

The coastal morphotype of bottlenose dolphins is continuously distributed along the Atlantic coast south of Long Island, NY, around the Florida peninsula, and into the Gulf of Mexico, although there are strong seasonal differences. During summer, they range from Florida to New Jersey in waters < 20 m (66 ft) deep, including estuarine and inshore waters (Waring et al., 2009). During winter, bottlenose dolphins are rarely observed north of the North Carolina-Virginia border; distribution may be limited by water temperatures < 9.5°C. The Northern Migratory stock migrates south during winter and to waters along the North Carolina coast north of Cape Lookout. The Southern Migratory stock overlaps with the Northern Florida, Georgia, South Carolina, and Southern North Carolina stocks during winter months (Waring et al., 2009).

Offshore Morphotype

The western North Atlantic offshore bottlenose dolphin is not listed as depleted under the MMPA, or as threatened or endangered under the Endangered Species Act. Stock status within U.S. Atlantic waters is unknown and data are insufficient to determine population trends. The best available abundance estimate for offshore bottlenose dolphins combines estimates from surveys in 2002 and 2004 that, together, provided complete coverage of the offshore habitat from central Florida to Canada during the summer months. The resulting estimate is 81,588 (Waring et al., 2009).

Offshore bottlenose dolphins distribute primarily along the outer continental shelf and continental slope. Spatial distribution varies seasonally. Sightings occurred along the continental shelf break from Georges Bank to Cape Hatteras during spring and summer (CeTAP, 1982; Kenney, 1990). Genetic analysis showed that bottlenose dolphins in waters >40 m depth were from the offshore morphotype (Garrison et al., 2003). Torres et al. (2003) found a statistically significant break in the distribution of the morphotypes at 34 km from shore, based upon the genetic analysis of tissue samples collected in nearshore and offshore waters. During the winter and over the continental shelf south of Cape Hatteras, the two morphotypes overlap spatially (Garrison et al., 2003; Waring et al., 2009).

Atlantic Spotted Dolphin

The species of spotted dolphins were not differentiated during surveys before 1998, resulting in inadequate data to determine the population trends along the U.S. Atlantic coast. Abundance
estimates for Atlantic spotted dolphins were derived from ship and aerial surveys in 2004. The resulting estimate for the area from Maryland to the Bay of Fundy was 3,578 dolphins, and between Florida and Maryland, the abundance estimate was 47,400 (Waring et al., 2007).

Atlantic spotted dolphins occur in tropical and warm temperate waters of the western North Atlantic. Their range extends from southern New England to the Gulf of Mexico and the Caribbean (Leatherwood et al., 1976, cited in Waring et al., 2007). South of the Chesapeake Bay, they may occur in inshore waters. North of the Chesapeake Bay, they are found in waters near the continental shelf edge and continental slope (Payne et al., 1984; Mullin and Fulling, 2003). Atlantic spotted dolphins also associate with the north wall of the Gulf Stream and warm-core rings (Waring et al., 1992).

**Common Dolphin**

The common dolphin is one of the most widely distributed cetacean species, yet the total number off the U.S. Atlantic coast is unknown. Data are insufficient to determine population trends or stock status. The best abundance estimate for common dolphins (120,743 animals) is the sum of estimates from two 2004 U.S. Atlantic summertime surveys. Together, they offer the most complete coverage of the species’ range. The estimate for the northern U.S. Atlantic (Maryland to the Bay of Fundy) is 90,547, and for the southern U.S. Atlantic (Florida to Maryland) is 30,196 (Waring et al., 2007).

Common dolphins occur worldwide in temperate, tropical, and subtropical waters. In the North Atlantic, they are found over the continental shelf along the 200-2,000-m isobaths or in areas with prominent underwater topography (Evans 1994, cited in Waring et al., 2007). They are widespread from Cape Hatteras to Georges Bank (35° to 42° N) in outer continental shelf waters between mid-January and May (CeTAP, 1982; Payne et al., 1984), then move northward onto Georges Bank and the Scotian Shelf from mid-summer to autumn.

**Atlantic White-sided Dolphin**

Population trends and total numbers of western North Atlantic white-sided dolphins along the eastern United States are unknown due to insufficient data (Waring et al., 2009). The best abundance estimate currently available (63,368 dolphins) is an average based on surveys conducted in August of 2002 and 2006 (Waring et al., 2009).

Atlantic white-sided dolphins occur primarily in continental shelf waters, out to the 100-m depth contour, in temperate and sub-polar areas of the North Atlantic. Three separate stocks might exist: Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea stocks (Palka et al., 1997). The Gulf of Maine stock is common in continental shelf waters from Hudson Canyon (approximately 39° N) north through Georges Bank, and in the Gulf of Maine to the lower Bay of Fundy. Observations south of this area consist of a few strandings on beaches of Virginia and North Carolina between January and May. These strandings may represent the southern extent of the species’ range (Waring et al., 2009).

**Risso’s Dolphin**

The total numbers of Risso’s dolphins off the U.S. Atlantic coast is unknown, and data are insufficient for determining population trends (Waring et al., 2009). The best abundance estimate (20,479) combines estimates from two 2004 U.S. Atlantic surveys. The estimate from the
northern U.S. Atlantic (Maryland to the Bay of Fundy) is 15,053, and from the southern U.S. Atlantic (Florida to Maryland) is 5,426 (Waring et al., 2009).

Risso’s dolphins distribute along the continental shelf edge from Cape Hatteras to Georges Bank during the spring, summer, and fall (CeTAP, 1982; Payne et al., 1984). In winter, they range from the MAB to offshore oceanic waters. Risso’s dolphins occur year round on the MAB continental shelf edge (Payne et al., 1984). They are known to associate with prevalent bathymetric features, Gulf Stream warm-core rings, and the Gulf Stream north wall (Waring et al., 1992).

**Striped Dolphin**

Little is known about the stock structure of striped dolphins in the western North Atlantic, or how many occur off the U.S. Atlantic coast. The best abundance estimate for striped dolphins derives from the sum (94,462) of estimates from the two 2004 U.S. Atlantic surveys. The estimate for the northern U.S. Atlantic (Maryland to the Bay of Fundy) is 52,055, and the southern U.S. Atlantic (Florida to Maryland) estimate is 42,407 (Waring et al., 2007).

Striped dolphins off the U.S. east coast distribute along the continental shelf edge from Cape Hatteras to the southern margin of Georges Bank, and offshore over the continental slope and rise in the Mid-Atlantic region (CeTAP, 1982; Mullin and Fulling, 2003). Continental shelf edge sightings were generally associated with the 1,000-m (3,280-ft) depth contour during all times of the year (CeTAP 1982).

**Spinner Dolphin**

Adult spinner dolphins range in size from 1.8 to 2.2 m (6-7.2 ft). They are long and slender, with a tricolor pattern that may be obscure, and a distinct dark stripe from eye to flipper (Wynne and Schwartz, 1999). The number of spinner dolphins off the U.S. Atlantic coast is unknown. Estimates are also unavailable for seasonal abundance, since spinner dolphins are rarely seen during population surveys (Waring et al., 2007).

Spinner dolphin distribution in the Atlantic is not well known. In the western North Atlantic, they are found in deep water along most of the U.S. coast south to the West Indies, Venezuela, and in the Gulf of Mexico. Sightings off the northeast U.S. coast have been exclusively in deeper (>2,000 m [>6,560 ft]) waters (Waring et al., 2007).

**Clymene Dolphin**

Clymene dolphin adults reach lengths of 1.8-2.0 m (6-6.6 ft). They have a relatively short, broad beak, falcate dorsal fin, and are tri-colored (dark gray back, gray sides, white belly) (Wynne and Schwartz, 1999). They generally inhabit pelagic and deep waters where they prey upon squid and fish (Wynne and Schwartz, 1999). The number of Clymene dolphins off the U.S. Atlantic coast is unknown, and seasonal abundance estimates are unavailable for this species, since it is rarely seen during population surveys (Waring et al., 2007).

Clymene dolphins occur in tropical and sub-tropical waters of the western North Atlantic, with sightings recorded off the southeastern United States (as far north as New Jersey), the Gulf of Mexico, and the Caribbean Sea (Leatherwood and Reeves, 1983). Four groups were observed in 1998, primarily on the continental slope east of Cape Hatteras, NC; none have been observed during surveys since (Waring et al., 2007).
Seals and Manatee

Seals and manatees are only distantly related mammals that have successfully adapted to a marine existence. Seals belong to a family known as pinnipeds (fin-footed carnivores). Pinnipeds have adapted to an amphibious marine existence. They forage at sea but come ashore for resting and breeding. Pinnipeds are carnivores and consume their prey whole. Many pinnipeds are capable of long, deep, repetitive dives because of their high blood volume and reduced heart rate. Manatees are more closely related to elephants than to other marine mammals. They are completely aquatic and herbivorous, feeding on submerged vegetation along tropical coasts, rivers, and estuaries. Unlike most marine mammals, manatees have poorly developed brains and have physical and behavioral traits that enhance their exposure to manmade hazards.

Harbor Seal

The harbor seal population along the New England coast has been increasing steadily since passage of the Marine Mammal Protection Act in 1972. The most recent abundance estimate, corrected for seals not hauled out, was 99,340 in 2001 (Waring et al., 2009). Increased abundance has also been documented at overwintering haul-out sites from the Maine/New Hampshire border to eastern Long Island and New Jersey (Payne and Selzer, 1989; Waring et al., 2007).

In the western north Atlantic, harbor seals range from the eastern Canadian Arctic and Greenland south to southern New England and New York, and occasionally to the Carolinas (Boulva and McLaren, 1979; Katona et al., 1993; Gilbert and Guldager, 1998; Baird, 2001). Harbor seals occur year-round off eastern Canada and Maine (Katona et al., 1993) and along the southern New England and New York coasts from September through late May (Schneider and Payne, 1983). Harbor seals move north to Maine and Canada prior to pupping from mid-May through June along the Maine coast (Richardson, 1976; Whitman and Payne, 1990; Waring et al., 2007). Scattered sightings and strandings have been recorded as far south as Florida (NMFS unpublished data, cited in Waring et al., 2009).

3.2.3 Threatened and Endangered Species

Under Section 7 of the Federal Endangered Species Act (ESA), as amended, (U.S.C. 1531-1544) Federal agencies, in consultation with the USFWS and NMFS, are required to evaluate the effects of their actions on special status species of fish, wildlife, and plants, and their habitats, and to take steps to conserve and protect these species. Special status species are defined as plants or animals that are candidates for, proposed as, or listed as sensitive, threatened, or endangered by USFWS.

The Virginia Endangered Species Act (29 VAC 1-563 – 29.1-570) is administered by the Virginia Department of Game and Inland Fisheries (VDGIF) and prohibits the taking, transportation, processing, sale, or offer for sale of any State or federally listed threatened or endangered species. As a Federal agency, NASA voluntarily complies with Virginia’s Endangered Species Act.

Table 22 shows the State and federally listed threatened or endangered species that may occur within the vicinity of Wallops Island. Figure 33 shows the locations of federally listed threatened or endangered species that may occur or have historically occurred on Wallops Island.
### Table 22: Protected Species that May Occur in the SRIPP Project Area

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Likelihood of Occurrence Within Onshore Action Area</th>
<th>Likelihood of Occurrence Within Offshore Action Area</th>
<th>Potential Seasonal Presence</th>
<th>Federal Status</th>
<th>State Status</th>
<th>Jurisdiction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seabeach amaranth</td>
<td><em>Amaranthus pumilus</em></td>
<td>possible</td>
<td>n/a</td>
<td>All</td>
<td>Threatened</td>
<td>n/a</td>
<td>USFWS</td>
</tr>
<tr>
<td>Virginia least trillium</td>
<td><em>Trillium pusillum</em></td>
<td>possible</td>
<td>n/a</td>
<td>All</td>
<td>n/a</td>
<td>Species of Concern</td>
<td>VDGIF</td>
</tr>
<tr>
<td>Northeastern beach tiger beetle</td>
<td><em>Cicindela dorsalis dorsalis</em></td>
<td>highly unlikely</td>
<td>n/a</td>
<td>All</td>
<td>Threatened</td>
<td>Threatened</td>
<td>USFWS</td>
</tr>
<tr>
<td>Delmarva Peninsula fox squirrel</td>
<td><em>Sciurus niger cinereus</em></td>
<td>highly unlikely</td>
<td>n/a</td>
<td>All</td>
<td>Endangered</td>
<td>Endangered</td>
<td>USFWS</td>
</tr>
<tr>
<td>Wilson’s Plover</td>
<td><em>Charadrius wilsonia</em></td>
<td>Possible</td>
<td>n/a</td>
<td>All</td>
<td>n/a</td>
<td>Endangered</td>
<td>VDGIF</td>
</tr>
<tr>
<td>Peregrine Falcon</td>
<td><em>Falco peregrinus</em></td>
<td>possible</td>
<td>unlikely</td>
<td>Fall</td>
<td>n/a</td>
<td>Threatened</td>
<td>VDGIF</td>
</tr>
<tr>
<td>Upland Sandpiper</td>
<td><em>Bartramia longicauda</em></td>
<td>possible</td>
<td>n/a</td>
<td>Spring/Fall Migration</td>
<td>n/a</td>
<td>Threatened</td>
<td>VDGIF</td>
</tr>
<tr>
<td>Gull-billed Tern</td>
<td><em>Sternula nilotica</em></td>
<td>possible</td>
<td>n/a</td>
<td>Spring/Fall Migration</td>
<td>n/a</td>
<td>Threatened</td>
<td>VDGIF</td>
</tr>
<tr>
<td>Roseate Tern</td>
<td><em>Sternus dougallii dougallii</em></td>
<td>possible</td>
<td>possible</td>
<td>Spring, Fall Migration</td>
<td>Threatened</td>
<td>Threatened</td>
<td>USFWS</td>
</tr>
<tr>
<td>Bald Eagle</td>
<td><em>Haliaeetus leucocephalus</em></td>
<td>possible</td>
<td>unlikely</td>
<td>All</td>
<td>n/a</td>
<td>Threatened</td>
<td>VDGIF</td>
</tr>
<tr>
<td>Red Knot (^1)</td>
<td><em>Charadrius canutus rufa</em></td>
<td>known to occur</td>
<td>n/a</td>
<td>Spring/Fall Migration</td>
<td>Candidate Species</td>
<td>n/a</td>
<td>USFWS</td>
</tr>
<tr>
<td>Piping Plover</td>
<td><em>Charadrius melodus</em></td>
<td>known to occur</td>
<td>n/a</td>
<td>All</td>
<td>Threatened</td>
<td>Threatened</td>
<td>USFWS</td>
</tr>
<tr>
<td>Leatherback sea turtle</td>
<td><em>Dermochelys coriacea</em></td>
<td>possible</td>
<td>possible</td>
<td>Summer</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS/USFWS</td>
</tr>
<tr>
<td>Common Name</td>
<td>Scientific Name</td>
<td>Likelihood of Occurrence Within Onshore Action Area&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Likelihood of Occurrence Within Offshore Action Area&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Potential Seasonal Presence</td>
<td>Federal Status</td>
<td>State Status</td>
<td>Jurisdiction</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>---------------------------</td>
<td>----------------------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
<td>----------------------------</td>
<td>----------------</td>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Hawksbill sea turtle</td>
<td><em>Eretmochelys imbricate</em></td>
<td>highly unlikely</td>
<td>highly unlikely</td>
<td>Unknown</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS/USFWS</td>
</tr>
<tr>
<td>Kemp’s ridley sea turtle</td>
<td><em>Lepidochelys kempii</em></td>
<td>possible</td>
<td>possible</td>
<td>Spring, Summer</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS/USFWS</td>
</tr>
<tr>
<td>Loggerhead sea turtle</td>
<td><em>Caretta caretta</em></td>
<td>likely</td>
<td>likely</td>
<td>Spring, Summer</td>
<td>Threatened</td>
<td>Threatened</td>
<td>NMFS/USFWS</td>
</tr>
<tr>
<td>Atlantic green sea turtle</td>
<td><em>Chelonia mydas</em></td>
<td>possible</td>
<td>possible</td>
<td>Summer</td>
<td>Threatened</td>
<td>Threatened</td>
<td>NMFS/USFWS</td>
</tr>
<tr>
<td>Shortnose sturgeon</td>
<td><em>Acipenser brevirostrum</em></td>
<td>n/a</td>
<td>highly unlikely</td>
<td>All</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS</td>
</tr>
<tr>
<td>Humpback whale</td>
<td><em>Megaptera novaeangliae</em></td>
<td>n/a</td>
<td>possible</td>
<td>All</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS</td>
</tr>
<tr>
<td>Fin whale</td>
<td><em>Balaenoptera physalus</em></td>
<td>n/a</td>
<td>possible</td>
<td>Spring/Summer</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS</td>
</tr>
<tr>
<td>Right whale</td>
<td><em>Eubalaena glacialis</em></td>
<td>n/a</td>
<td>possible</td>
<td>Fall/Winter</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS</td>
</tr>
<tr>
<td>Sperm Whale</td>
<td><em>Physeter macrocephalus</em></td>
<td>n/a</td>
<td>highly unlikely</td>
<td>Summer/Fall</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS</td>
</tr>
<tr>
<td>Sei whale</td>
<td><em>Balaenoptera borealis</em></td>
<td>n/a</td>
<td>highly unlikely</td>
<td>All</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS</td>
</tr>
<tr>
<td>Blue Whale</td>
<td><em>Balaenoptera musculus</em></td>
<td>n/a</td>
<td>highly unlikely</td>
<td>Spring/Fall</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS</td>
</tr>
<tr>
<td>Florida Manatee</td>
<td><em>Trichechus manatus latirostris</em></td>
<td>n/a</td>
<td>highly unlikely</td>
<td>Summer</td>
<td>Endangered</td>
<td>Endangered</td>
<td>NMFS</td>
</tr>
</tbody>
</table>

<sup>1</sup>Although candidate species are not protected under the ESA, NASA was requested by the USFWS to include the Red Knot.

<sup>2</sup>n/a = not applicable; Highly unlikely = habitat not available and species is not documented in the action area; Possible = habitat available but species is rarely, if ever, documented in the action area; Likely = habitat available and species is occasionally documented in the action area; Known to occur = habitat available and species regularly documented in the action area.

Sources: USFWS, 2000; USFWS, 2009; NASA, 2007; NASA, 2009
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3.2.3.1 Vegetation

Seabeach Amaranth

Seabeach amaranth habitat is restricted to sandy ocean beaches and consists of the sparsely vegetated zone between the high tide line and the toe of the primary dune. There have been no recorded occurrences of seabeach amaranth on Wallops Island to date, and no designated protected populations exist in the SRIPP action areas. However, there is potential habitat on the north end of Wallops Island.

Virginia Least Trillium

A globally rare plant and a member of the lily family, Virginia least trillium, is found only in Virginia, Maryland, West Virginia, and North Carolina (VDCR, 2008). There have been no recorded occurrences of Virginia least trillium on Wallops Island to date, and no designated protected populations exist in the SRIPP action areas. However, there is potential habitat on the north end of Wallops Island.

3.2.3.2 Invertebrates

Northeastern beach tiger beetles inhabit wide, sandy, ocean beaches from the intertidal zone to the upper beach. Eggs are deposited in the mid- to above-high tide drift zone. Larval beetles occur in a relatively narrow band of the upper intertidal to high drift zone, where they can be regularly inundated by high tides. Eight protected populations exist within the Eastern Shore of the Chesapeake Bay, VA geographic recovery area; however, there are no protected populations on Wallops Island. The closest documented population is approximately 30 km (20 mi) southwest of Wallops Island (USFWS, 2008).

3.2.3.3 Terrestrial Mammals

The Delmarva Peninsula Fox Squirrel lives in mature forests of mixed hardwoods and pines with a closed canopy and open understory on the Delmarva Peninsula. The CNWR, located approximately 3.2 km (2 mi) northeast of Wallops Island, is home to a large population of these squirrels. The Delmarva Peninsula Fox Squirrel has not been documented on Wallops Island.

3.2.3.4 Birds

Peregrine Falcon

The peregrine falcon is found in a variety of habitats, but prefer cliffs for nesting and open areas for foraging (White et al., 2002). A resident pair of peregrine falcons nests on a hacking tower on the northwest side of Wallops Island, outside of the project area. Migrating peregrine falcons occur along the Wallops Island beach during fall migration (NASA, 2009a).

Bald Eagles

Bald eagles can often be seen flying over WFF. An active nest was discovered on the northern end of Wallops Island in 2009 and there is an active bald eagle nest just north of the WFF Main Base (NASA, 2009a).
**Affected Environment**

**Upland Sandpipers**

These birds are almost never found on mudflats or in wetland environments where other shorebirds are found. Upland sandpipers are birds of open country and are typically found in large fallow fields, pastures, and grassy areas (NASA, 2009a). Upland sandpipers migrate through the WFF area, with fall migration typically lasting from mid-July through September and spring migration from March through May. Upland Sandpipers typically feed in shortgrass areas, but require taller grass for nesting. The Upland Sandpiper population in Virginia has been declining ever since the 1940s and these birds rarely breed in Virginia (Paxton and Wilson, 2009).

**Terns**

The gull-billed (*Sterna nilotica*) tern is medium size and has a black cap, a heavy bill and long legs (Molina et al., 2009). The Gull-billed tern nests in coastal colonies along the Atlantic. North American gull-billed terns winter along the Gulf Coast, Pacific coast of Mexico, and into Central and South America. The gull-billed tern can be found nesting on the beaches or mud flats on Wallops Island. Although it does feed on fish occasionally, the gull-billed tern feeds mostly on insects, small crabs, and occasionally the chicks of other bird species in the area. Breeding and nesting takes place on sandy beaches in the spring and summer. In the winter, the tern moves to salt marshes, estuaries, and lagoons (Parnell, 1995). Gull-billed terns can be found nesting on the beaches or mud flats on Wallops Island.

The roseate tern (*Sterna dougallii*) is a medium-sized tern similar in appearance to several other terns and is primarily a tropical bird, breeding across the globe in tropical oceans habitats. When the roseate tern reaches the temperate zone in the northern Atlantic, it breeds on rocky offshore islands, barrier beaches, and salt marsh islands. In the winter, the roseate tern is found offshore or along coasts.

A medium-sized tern similar in appearance to several other species, the Roseate Tern is primarily a tropical bird. It breeds across the globe in tropical oceans, and reaches into the temperate zone in the northern Atlantic, where it breeds in on rocky offshore islands, barrier beaches, and salt marsh islands. The Roseate Tern winters offshore or along coasts (Gochfeld et al., 1998).

**Red Knot**

The Red Knot is a medium sized, bulky sandpiper. It is a relatively short bird, with short legs. The head and breast are rusty in breeding plumage and grey the rest of the year. Outside of the breeding season, it is found primarily in intertidal, marine habitats, especially near coastal inlets, estuaries, and bays. The Red Knot breeds in drier tundra areas, such as sparsely vegetated hillsides. The Red Knot typically feeds on invertebrates, especially bivalves, small snails, and crustaceans. During the breeding season, the Red Knot also eats terrestrial invertebrates (Harrington, 2001).

During its northern migration, the Virginia barrier islands provide an important stopover area for a large number of red knots. In the mid-1990s, 3 years of aerial surveys showed that numbers of red knots moving through the barrier islands of Virginia between mid-May and the second week of June reach 8,000 to 10,000 individuals (Watts and Truitt, 2000). During the 2009 migration season, flock sizes of 100 to 145 birds were observed in the Overwash and Hook areas of Assateague Island. In late May 2009, flocks of 5 to 30 individuals were observed on south
Assawoman Island. On May 8, 2009, USFWS observed a flock size of almost 1,300 individuals on north Wallops Island (USWS, 2009c). In late May 2009, flocks of approximately 20 to 200 red knots were observed on north Wallops Island (USFWS, 2009c).

Wilson’s Plovers
Wilson’s Plovers are found exclusively on southern beaches and tidal mudflats, typically in sparsely vegetated areas, including along beaches, sandbars, salt flats, and lagoons. They forage along intertidal mudflats during low tide. They nest either in isolated pairs or in colonies on beaches, commonly near a piece of driftwood or clump of grass. They are known to breed on the northern and southern beaches of Wallops Island and commonly share habitat with Piping Plovers.

Piping Plovers
Piping Plover nesting habitat has been delineated on the beaches and dunes at the northern and southern ends of Wallops Island (Figure 33). Although Wallops Island is not designated as critical habitat, the piping plover is known to breed on Wallops Island; therefore, portions of the island are managed as protected areas by NASA. The northern and southern beaches have been closed to vehicle and human traffic during the plover’s nesting season (March 15 through September 1) since 1986. Biologists from the USFWS, CNWR, and VDGIF monitor Piping Plover nesting activities and provide advice to NASA on protection and management of the species. Biologists from the WFF USDA Wildlife Service Office aid with predator control.

As the southern portion of Wallops Island has experienced substantial erosion (3.3 m [11 ft]/year), suitable habitat is increasingly less abundant. In addition, there is a general absence of beach habitat seaward of the existing seawall. According to Mitchell (2009, pers. comm.), no nesting plovers have been observed on south Wallops Island since at least 2000. Simultaneously, north Wallops Island has been accreting, thus presenting additional potential habitat for plover nesting.

There has been an increasing trend in the number of nesting pairs of piping plovers at all CNWR units (including Assateague, Assawoman, and Metompkin Islands). Annually between 1996 and 2008, Piping Plovers were observed feeding, although exact numbers were not recorded. In 2009, four Piping Plover pairs attempted nests on north Wallops Island. Of these, three have been successful, producing a total of at least seven fledglings (Scharle, 2009). Five nesting attempts were made on north Wallops Island during 2007 and 2008 but none were successful in producing fledglings. During 2006, one pair of plovers nested but the nest was abandoned due to attempted predation by a fox. Nests were also observed in 2005 (2 pairs, 1 nest lost to fox predation and second pair of chicks were lost); 2004 (1 pair with 3 chicks fledged); 2001 (1 pair unsuccessful); 1998 (1 pair unsuccessful); 1996 (3 pairs with 2 chicks total fledged). There were no nests observed in 2003, 2002, 2000, 1999, and 1997.

Sea Turtles
Sea turtles, air-breathing reptiles with streamlined bodies and large flippers, are well adapted to life in the marine environment. They inhabit tropical and subtropical ocean waters throughout the world (NOAA, 2009b).
There are two families of sea turtles (Wynne and Schultz, 1999). The Cheloniidae family contains six genera and six distinct species. These species are loggerhead, green, flatback, hawksbill, Kemp’s ridley, and olive ridley. The family Dermochelyidae is comprised of only one genus and species, commonly referred to as the leatherback sea turtle.

Sea turtles have short, thick, incompletely retractile necks and legs that have been evolved to become flippers (Bustard, 1972). All species, excepting the leatherback, have a hard, bony carapace (top shell) modified for marine existence by streamlining and weight reduction (Bustard, 1972). The leatherback lacks shell scutes, head and body scales. The shell is covered by leathery skin. The Carapace is divided longitudinally by 7 ridges (Wynne and Schwartz, 1999). These physiological differences are the reason for their separate designation as the only species in the family Dermochelyidae.

Much of a sea turtle’s life is spent in the water and males of many species may never leave an aquatic environment (Wynne and Schwartz, 1999). The recognized life stages for these turtles are egg, hatchling, juvenile/subadult, and adult (Hirth, 1971). Reproductive cycles in adults of all species involve some degree of migration in which the animals endeavor to return to nest at the same beach year after year (Hopkins and Richardson, 1984). The nesting season ranges from April through September (Hopkins and Richardson, 1984; Nelson, 1988). It is believed that mating occurs just off the nesting beach, although solid evidence of this is lacking. After mating, the nesting female emerges from the water and digs a flask-shaped nest in the sand with her hind slippers, then lays 50 to 170 (depending on the species) ping-pong ball-shaped eggs. After covering the eggs with sand, she returns to the water. The female sea turtle will nest several times in one season. Incubation periods for sea turtles will vary by species from 45 to 65 days (Nelson, 1988; Wynne and Schwartz, 1999).

Hatchlings break their shells and dig their way out of the nest at night (Wynne and Schwartz, 1999). They orient themselves toward the sea by following the reflected light from the breaking surf (Hopkins and Richardson, 1984). After entering the surf, hatchlings engage in behavior referred to as “swim frenzy,” during which they swim in a straight line for many hours (Carr, 1986). Once into the waters off the nesting beach, hatchlings enter a period referred to as the “lost years” where many species live and feed in floating sargassum (Wynne and Schwartz, 1999). They “reappear” as juveniles in feeding grounds shared with adults, or in some cases, migrate to developmental feeding grounds. Some species, such as the leatherback, spend their entire lives in a pelagic existence, coming inshore only to mate and nest (Wynne and Schwartz, 1999).

The functional ecology of sea turtles in the marine and/or estuarine ecosystem varies by species. The Kemp’s ridley sea turtle is omnivorous and feeds on swimming crabs and crustaceans. The green turtle is an herbivore and grazes on marine grasses and algae, while the leatherback is a specialized feeder preying primarily upon jellyfish. The loggerhead is primarily carnivorous and has jaws well adapted to crushing mollusks and crustaceans, and grazing on organisms attached to reefs, pilings, and wrecks.

Sea turtles are believed to play a significant role in marine and estuarine ecosystems. This role has likely been greatly reduced in most locations as a result of declining turtle populations. Population declines are a result of numerous factors, such as disease and predation, habitat loss, commercial fisheries conflicts, and inadequate regulatory mechanisms for their protection. As a result, all sea turtle species have been classified as endangered or threatened.
Due to complex life histories and multiple habitats used by the various species, sea turtle populations have proven difficult to accurately census (Meylan, 1982). Because of these problems, estimates of population numbers have been derived from various indices, such as numbers of nesting females, numbers of hatchlings per kilometer of nesting beach, and number of subadult carcasses washed ashore (Hopkins and Richardson, 1984).

The leatherback, hawksbill, Kemp’s Ridley, loggerhead, and Atlantic green sea turtles are known to migrate along East Coast beaches. One loggerhead sea turtle nest was discovered on north Wallops Island in summer 2008 (Figure 33). Following flood inundation from several fall storms, CNWR personnel recovered approximately 170 eggs from the nest in October 2008. None were viable. Sea turtle crawl tracks, a sign of potential nesting activity, have seldom been found on Wallops Island beaches. NASA coordinates with CNWR and USDA personnel in monitoring the Wallops Island beaches for sea turtle activity. According to a 2009 biological memorandum (USFWS), staff did not locate any sea turtle crawl tracks or nesting related activity on CNWR or Wallops Island from June to September 2009. According to the USFWS, five nests have been recorded on Wallops Island between 1974 and 2009 (2009e).

**Leatherback Sea Turtle**

The leatherback is the largest, deepest diving, most migratory, and widest ranging of all sea turtles. The adult leatherback can reach 1.3 to 2.4 m (4 to 8 ft) in length and 226 to 907 kilograms (500 to 2000 pounds) in weight. Also the largest living reptile in the world, the endangered leatherback turtle lacks a hard shell and is covered by leathery skin. The leatherback is the only black marine turtle in the Atlantic (Wynne and Schwartz, 1999). The most recent population estimate for the North Atlantic is a range of 34,000-94,000 adult leatherbacks, which is considered a stable population (NMFS, 2007). Leatherbacks are predominantly a pelagic species and feed on jellyfish. The greatest causes of decline and the continuing primary threats to leatherbacks worldwide are long-term harvest and incidental capture in fishing gear. Harvest of eggs and adults occurs on nesting beaches while juveniles and adults are harvested on feeding grounds. Incidental capture primarily occurs in gillnets, but also in trawls, traps and pots, longlines, and dredges (NOAA, 2009b).

The leatherback turtle may pass through the Mid-Atlantic during migration. Concentrations may be found between the Gulf of Maine and Long Island (Shoop and Kenney, 1992), in coastal areas of New Jersey and Delaware, and around the mouth of the Delaware Bay (USACE, 1995).

**Hawksbill Sea Turtle**

The hawksbill turtle is small to medium-sized compared to other sea turtle species. Adults weigh 45-68 kilograms (100-150 pounds) on average, but can grow as large as 91 kilograms (200 pounds). The carapace (top shell) of an adult ranges from 0.63 to 0.90 m (2 to 3 ft) in length and has a “tortoiseshell” coloring (NOAA, 2009b). The hawksbill turtle primarily feeds on sponges and benthic invertebrates. The hawksbill turtle occurs worldwide, but is most common in the tropics. According to NMFS, there is no evidence that the hawksbill turtle occurs in the project area at all (NMFS, 2007).
Kemp’s Ridley Sea Turtle

The smallest sea turtle, the Kemp’s ridley turtle’s shell ranges from 0.6 m (2 ft) to 0.8 m (3 ft) in size. The average Kemp’s ridley turtle weighs between 40-50 kilograms (88-110 pounds) (Wynne and Schwartz, 1999). Kemp’s ridley turtles are less widespread than many other sea turtle species, occurring primarily in the Gulf of Mexico and the northern half of the Atlantic Ocean, with an unknown portion of the population migrating to U.S. Atlantic Ocean waters (NMFS, 2007). Kemp’s ridley sea turtles are relatively common in Virginia and Maryland State waters in May and June, to feed on crabs, mollusks, shrimp and sometimes fish. In addition to poaching and impacts from fishery interactions, Kemp’s Ridleys face natural threats such as destruction of nesting habitat from storm events and natural predators.

Loggerhead Sea Turtle

Loggerhead turtles reach 1.2 m (4 ft) in length and weigh on average approximately 115 kilograms (254 pounds) (Wynne and Schwartz, 1999). Loggerhead turtles are found in temperate and subtropical waters and inhabit pelagic waters, continental shelves, bays estuaries and lagoons. Loggerheads are primarily benthic feeders and prefer crustaceans and mollusks. NMFS estimates that there are at least five western Atlantic loggerhead subpopulations, and that individuals from three of these are expected to occur within the project area (NMFS, 2007).

In Maryland and Virginia waters, loggerheads are the most common sea turtle species. Loggerheads can be found in the Chesapeake Bay from April through November, and the Bay is an important summer feeding ground. Loggerheads can be found in the Bay south of Baltimore within all the major tributaries, along the Virginia and Maryland Atlantic coast, and in the lagoons and channels in the barrier island systems (Lutcavage, 1981; Lutcavage and Musick, 1985; Byles and Dodd, 1989). The lower Chesapeake Bay estuary and the Atlantic Coastline provide important developmental habitat for immature sea turtles because of submergent vegetation beds and a rich diversity of bottom-dwelling fauna that afford cover and forage. Occasionally, adult females use Virginia’s ocean facing beaches as nesting sites (VDGIF, no date). The horseshoe crab is an important benthic food species. This crab species favors water depths from 4 to 20 meters (13 to 67 feet).

Loggerheads face the same danger as other sea turtles, including boat collisions, poaching and fisheries interactions.

Atlantic Green Sea Turtle

Green turtles are the largest hard-shelled sea turtle, with an average span of 1 m (3.3 ft) and weighing 150 kilograms (331 pounds) (Wynne and Schwartz, 1999). Pelagic-stage hatchlings and juveniles eat mollusks, jellyfish and crustaceans. As juveniles mature, the diet shifts to seagrasses and macroalgae. Green turtles can be found worldwide. The Atlantic population of the green sea turtle, which ranges from Massachusetts to Argentina, is listed as threatened under the ESA, while the breeding populations in Florida and on the Pacific Coast of Mexico are listed as endangered. Since it is difficult to differentiate between breeding populations away from the nesting beaches, all green sea turtles are considered endangered (NMFS, 2007). Green sea turtles are occasionally encountered in the Action Area, but their occurrence is expected to be rare.
3.2.3.5  **Finfish**

The shortnose sturgeon is the smallest of the three sturgeon species that occur in eastern North America, having a maximum known total length of 1.4 m (4.7 ft) and weight of 23 kilograms (50.7 pounds). The shortnose sturgeon is a benthic feeder and lives mainly in the slower moving riverine waters or nearshore marine waters, and migrates periodically into faster moving fresh water areas to spawn. Juveniles are believed to feed on benthic insects and crustaceans. Mollusks and large crustaceans are the primary food of adult shortnose sturgeon.

Shortnose sturgeon occur in most major river systems along the eastern seaboard of the United States. The shortnose sturgeon is found in the Chesapeake Bay system and in South Carolina, but no populations are reported in Virginia or North Carolina (NOAA Office of Protected Resources, 2009). No protected populations exist in the vicinity of the project area.

3.2.3.6  **Marine Mammals**

**Humpback Whale**

Adult humpback whales grow to be about 11 to 16 m (36 to 52 ft) in length. The body is black or dark gray, with very long flippers that are usually partially white (Jefferson et al., 1993; Clapham and Mead, 1999). Humpback whales feed on a variety of invertebrates and small schooling fish including krill, herring, mackerel, sand lance, sardines, anchovies and capelin. An estimated 11,570 humpback whales occur in the North Atlantic (Stevick et al., 2003). Humpback whales are listed as endangered under the ESA. A Recovery Plan was published in 1991 and is currently in effect (NMFS, 1991).

Although humpback whales typically travel over deep, oceanic waters during migration, their feeding and breeding habitats are mostly in shallow, coastal waters over continental shelves (Clapham and Mead, 1999). Humpback whales occur on the continental shelf and in deep water in the vicinity of Wallops Island in fall, winter and spring, as they migrate between calving and breeding grounds in the Caribbean and feeding grounds off the New England coast (Corkeron and Connor, 1999; Stern, 2002). Humpback whales have recently been observed (as sightings and as strandings) along the Mid-Atlantic States from New Jersey to North Carolina, primarily during the winter months. This may represent a supplemental winter feeding area for humpback whales (Barco et al., 2002).

**Fin Whale**

The adult fin whale can reach 24 m (79 ft) in length, making it the second largest whale species after the blue whale. Fin whales feed on a variety of small, schooling prey such as herring, capelin, sand lance, squid, krill and copepods (Kenney et al., 1985; NMFS, 2006a). The fin whale is listed as endangered under the ESA and is managed by the NMFS. NOAA estimates that there are about 2,250 individual fin whales in the U.S. Atlantic waters, though the accuracy of this number is unclear (Waring et al., 2007). A Draft Recovery Plan for fin whales is currently available for review (NMFS, 2006a).

Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes (NOAA, 2009a). Off the U.S. Atlantic coast, sightings are almost exclusively limited to continental shelf waters from the southern Gulf of Maine to Cape Hatteras, North Carolina (CETAP, 1982; Hain et al., 1992). Survey data from Cape Hatteras to Nova Scotia, 1978-1982,
suggest that fin whales prefer mid-depths, with 65 percent of sightings in the 21-100 m (69-330 ft) range. The mid-shelf in the MAB appears to be a seasonally important area for fin whales. Density off the mouth of Delaware Bay is highest in winter and summer and highest in spring off Chesapeake Bay (Hain et al., 1992). The fin whale may occur offshore of Wallops Island during these times.

**Right Whale**

North Atlantic right whales can reach up to 18 m (59 ft) in length. Right whales feed on zooplankton, particularly large copepods. The North Atlantic right whale is one of the most endangered large whale species (Clapham and Mead, 1999; Perry et al., 1999; IWC, 2001). According to the North Atlantic Right Whale Consortium (NARWC), the North Atlantic right whale is not showing any signs of recovering from historical whaling and estimate that there are only approximately 350 individuals left (NARWC, 2009). A Recovery Plan is in effect for the North Atlantic right whale. Originally published in 1991, it was recently revised in 2004 (NMFS, 2005).

Right whales migrate from their calving grounds off the coast of Florida and Georgia towards their feeding grounds in New England and Canada during the spring and early summer months and would be expected to pass through the project area during this time (Winn et al., 1986). According to the NARWC, the migration routes and wintering grounds of most right whales are not known and remain a mystery to scientists (NARWC, 2009).

Right whales seasonally transit Mid-Atlantic waters between November and April, with peaks in December, March and April. Knowlton et al. (2002) analyzed survey data, satellite tag data, whale strandings, and opportunistic sightings from the Mid-Atlantic migratory corridor (Georgia/South Carolina border to waters off southern New England). Most sightings (94 percent) were within 56 km (35 mi) of shore, with over half (64 percent) within 18.5 km (11.5 mi) of shore. Right whales preferred shallow waters, with 80 percent of all sightings in depths <27 m (17 mi), and 93 percent in depths <45 m (28 mi) (Knowlton et al., 2002). Of the ports cited in the study, Chesapeake Bay and Delaware Bay are closest to Wallops Island. Sightings near Chesapeake Bay occurred in October through December, February and March. There are few sightings from Delaware Bay (one each in October, December, May and July), making it difficult to discern any patterns of occurrence there (Knowlton et al., 2002).

**Sperm Whale**

The sperm whale is the largest toothed whale species. Adult females may grow to lengths of 11 m (36 ft), while adult males can be as long as 16 m (52 ft) and weigh three times as much as the female (NOAA, 2009a). The sperm whale is distinguished by its extremely large head which can take up as much as 35 percent of its body length. The sperm whale prefers large squid but will also eat large demersal and mesopelagic sharks, skates, and fishes (NOAA, 2009a). The best available estimate for sperm whales in the U.S. North Atlantic is 4,702 individuals (NOAA, 2009a). Sperm whales are listed as endangered under the ESA. A Draft Recovery Plan for sperm whales was written and is available for review (NMFS, 2006b).

Sperm whales spend most of their time at great depths, and are capable of dives that last over an hour at depths of 1,000 m (3,280 ft). Sperm whales are abundant east and northeast of Cape Hatteras in the winter. In spring, the distribution shifts northward to east of Delaware and
Virginia, but is widespread (NOAA, 2009a). Sperm whales may occur landward of the shelf break in the vicinity of the project area during all seasons.

Sei Whale

The sei whale can reach lengths of about 12-18 m (40-60 ft) and weigh 45,000 kilograms (100,000 pounds). Sei whales have a long, sleek body that is dark blush-gray to black in color and pale underneath (NOAA, 2009a). In the North Atlantic, the sei whale’s major prey species are copepods and krill (Kenney et al., 1985). While there are no estimates for the North Atlantic population of sei whales, NOAA estimates that the worldwide population is about 80,000 individuals (NOAA, 2009a). Sei whales are listed as endangered under the ESA. A Recovery Plan for this species was written and is awaiting legal clearance (Waring et al., 2009).

The sei whale can be found worldwide, though they appear to prefer temperate waters in the mid-latitudes (NOAA, 2009a). In the Atlantic Ocean, the sei whale is primarily seen on Georges Bank (Wynne and Schwartz, 1999). The distribution and movement patterns of sei whales are not well known, but they may occur in the vicinity of the project area year round, more likely however, they occur in deeper offshore waters (Rice, 1998; Perry et al., 1999).

Blue Whale

The blue whale is the largest animal ever known to have lived on earth. Adult blue whales range from 23-27 m (75-89 ft) and can weigh over 150,000 kilograms (330,000 pounds) (NOAA, 2009a). Blue whales have a long, sleek body and have a mottled grey color pattern that appears light blue when seen through the water (NOAA, 2009a). It is estimated that less than 1,500 individuals currently exist in the North Atlantic (Wynne and Schwartz, 1999). The blue whale is listed as endangered under the ESA and a Recovery Plan for this species was published in 1998 (Reeves et al., 1998).

The overall distribution of blue whales in the North Atlantic extends from the subtropics to Baffin Bay and the Greenland Sea. Blue whales are most frequently sighted in the waters off eastern Canada, with the majority of recent records from the Gulf of St. Lawrence, where they are present throughout most of the year. They are most common during the summer and fall feeding seasons and typically leave by early winter to avoid ice entrapment. Although they are rare in the shelf waters of the eastern United States, occasional sightings of blue whales have occurred off Cape Cod, Massachusetts. It is believed this region may represent the current southern limit of the blue whales’ feeding range (NOAA, 2009a).

Manatee

West Indian manatee and Florida manatee are large grayish marine mammals that grow to be about 2.5 to 4.5 m (8 to 15 ft) long and 1,600 kilograms (3,530 pounds). Manatees prefer warm, tropical waters. In the West Atlantic Ocean, the manatee is most common in the Florida peninsula and south east Georgia, but range from the Texas gulf coast all the way to Rhode Island (Wynne and Schwartz, 1999). Sightings as far north as Virginia (Waring et al., 2002) and Rhode Island are rare and considered extralimital. It is highly unlikely that the manatee would be encountered within the project area.
3.3 **SOCIAL AND ECONOMIC ENVIRONMENT**

The following sections provide background information on the social and economic characteristics of Wallops Island and the surrounding area. The majority of the data presented was collected from the U.S. Department of Commerce Bureau of Census 2000 data, with supplemental information gathered from WFF and local sources.

### 3.3.1 Land Use

Wallops Island consists of 1,680 hectares (4,150 acres), most of which is marshland, and includes launch and testing facilities, blockhouses, rocket storage buildings, assembly shops, dynamic balancing facilities, tracking facilities, U.S. Navy facilities, and other related support structures. Wallops Island is zoned for industrial use by Accomack County. The marsh area between Wallops Mainland and Wallops Island is designated as undeveloped in the County’s Comprehensive Plan. Wallops Mainland consists mostly of marshland and is bordered by agricultural land to the west, Bogues Bay to the north, and an estuary to the south. The area surrounding Wallops Island consists of rural farmland and small villages and is regulated by local county government and several town councils (NASA, 2008). Corn, wheat, soybeans, cabbage, potatoes, cucumbers, and tomatoes are examples of the commodities produced on the surrounding farms. Area businesses include fuel stations, retail stores, markets, and restaurants.

### 3.3.2 Recreation

Virginia’s Eastern Shore is a popular tourist destination. Many tourists and vacationers visit Accomack County throughout the late spring, summer, and early fall. Regional attractions include the Assateague Island National Seashore and CNWR. Winter hunting season draws people to hunt local game including dove, quail, deer, fox, and many types of geese and ducks. The Wallops Island shoreline is also a popular location for local fishermen who fish from their boats in the nearshore environment.

Recreational boating occurs occasionally on the open ocean throughout the project area, depending on season and weather conditions. Recreational boating typically occurs during summer months in the area. Travel between the most popular cruising destinations along the Virginia coast does not require traversing the project area. Large recreational vessels may sometimes use the area, but there are few vessels of this type and their presence is uncommon. The most popular diving sites off the coast of Virginia are shipwrecks and five artificial reefs. Popular shipwreck diving destinations occur at depths between 50 ft and 160 ft. However, despite the presence of potential offshore diving locations, in a statewide survey, diving was not given as a significant reason for recreational boating among boat owners (Responsive Management, 2000).

### 3.3.3 Commercial and Recreational Fisheries

WFF is located on one of several Atlantic Ocean barrier islands that contribute to a diverse marine ecosystem. This ecosystem supported what historically was a robust local recreational and commercial fishing industry on Chincoteague Island and in the region. Over the last 60 years, however, the economy of commercial fishing has gradually diminished, although some parts of the commercial fishing industry have seen improvement since the 1990s. Diseases destroyed much of the oyster harvesting potential, and this change spurred the establishment of
the clam aquaculture industry throughout Chincoteague. Since the 1990s, clam farming has become increasingly important to the island’s economy, producing close to $30 million annually and increasing average employment rates in the area by 13 percent (based on 2005-2006 data). Commercial fishing, along with agriculture and forestry industries, makes up more than 6 percent of the Chincoteague labor force (U.S. Census Bureau, 2000). The Draft Chincoteague Comprehensive Plan establishes as one of its primary objectives: “To maintain the protections afforded by these barrier islands from storm events and to protect the diverse and unique ecology of the areas that serves as the basis for the Town’s economy…” (Town of Chincoteague, 2009).

A popular recreational fishing spot, Blackfish Bank Shoal, is located approximately 8 km (5 mi) east of Assateague Island and approximately 11 km (7 mi) northeast of the Wallops Island shoreline. Blackfish Bank Shoal has been developed as an artificial reef (by sinking subway cars on the shoal) through the efforts of the Town of Chincoteague and the Chincoteague Island Charterboat Association. Blackfish Bank’s artificial reef is the closest artificial reef to the proposed SRIPP borrow sites – the next closest are two artificial reefs, both approximately 32 km (20 mi) away: Parramore Reef, located southwest of the proposed SRIPP borrow sites, and Jackspot artificial reef to the northwest.

2009 SRIPP Survey

In April and May 2009, guides and recreational fishermen¹ in Chincoteague, Wachapreague, and Ocean City were surveyed to determine their use of Blackfish Bank Shoal, Unnamed Shoal A, and the Wallops Island shoreline. At the time of the survey, Unnamed Shoal B had not been selected as a potential borrow site therefore was not include in the survey. The survey was designed to assess commercial and recreational fishermen’s perceptions of potential impacts on the fishing industry from SRIPP activities. The fishermen were encountered by visiting known ports of entry in Chincoteague, VA; Wachapreague, VA; and Ocean City, MD, from April 7–10, 2009. The harbormaster at Chincoteague and the Chincoteague Fisheries Cooperative were also contacted, as were fishermen and staff at the various marinas and bait and tackle shops in all three towns (NASA, 2009d). A total of 66 responses were received during the survey.

Slightly less than half the survey respondents (30) indicated that they did fish in the study area. Eighty-six percent of survey respondents who reported fishing in the area indicated they fished there at least in the spring and summer, with several respondents also fishing the area in the fall. About 30 percent of the same survey respondents reported fishing in the area all year. Thirty-six of the respondents (55 percent) reported fishing within 8 km (5 mi) of either Blackfish Bank Shoal or the Wallops Island shoreline. Of those 36 respondents, 24 said they fished at Blackfish Bank Shoal (NASA, 2009d).

According to the 2008 NOAA permit database, 13 commercial fishing vessels are registered with Chincoteague as their home port city and 8 vessels are registered with Wachapreague as their home port city. Three vessels were identified as having Ocean City as their principal port, though those vessels had Norfolk as their home port city. According to NMFS Northeast Regional

¹ Survey respondents who indicated that they are “guides/commercial/recreational” fishermen, meaning they own and/or operate charter boats are categorized as “guides” rather than “commercial” fishermen. This is to distinguish charter activities from fishermen who are associated with commercial fisheries, even though the guides are technically commercial fishermen for licensing purposes. Commercial fishermen were also included in the study, but they were largely unresponsive and are not discussed here.
Office, the majority of vessels that list their home port in the vicinity of the project area had permits for bluefish, black sea bass, scup, squid/mackerel/butterfish, and summer flounder, indicating those are the most commonly harvested species in the area. The VRMC tracks finfish and shellfish landings in Virginia waters. This provides information on the economic contribution to the Accomack County as well as an inventory of aquatic life in county waters. According to the 2008 updated Accomack County Comprehensive Plan (Accomack County, 2008), 1,066,604 kilograms (2,351,459 pounds) of finfish were sold dock-side in 1992 at a value of $1,209,789. Total landings for shellfish were 383,719 kilograms (845,956 pounds) with an economic value of $1,258,308. The economic value of the landings represents 4 percent of all landings in Virginia. This information was obtained from mandatory reporting by fishermen in the area.

### 3.3.4 Population

In 2006, the U.S. Census Bureau reported that the population of the Commonwealth of Virginia was about 7.6 million, and Accomack County’s population was 39,345, with a population density of 218 people per mi² (84.2 people per mi²) (U.S. Census Bureau, 2000). The population growth rate in Accomack County between 2000 and 2006 was approximately 2.7 percent (U.S. Census Bureau, 2008a).

The village of Assawoman, approximately 8 kilometers (5 miles) to the southwest, is the closest residential community to Wallops Island. The towns of Wattsville and Atlantic are the closest incorporated communities to Wallops Island and are located approximately 13 kilometers (8 miles) and 8 kilometers (5 miles) northwest of Wallops Island, respectively. There is no specific census data available for Wattsville because it is an unincorporated residential area.

Chincoteague Island, Virginia, is approximately 13 kilometers (8 miles) northeast of Wallops Island. The Town of Chincoteague is the most densely populated area in Accomack County, with a resident population of 4,317 people. Area populations fluctuate seasonally. During the summer months the population increases due to tourism and vacationers who visit the nature reserve and beaches of Assateague Island. Daily populations often reach up to 15,000 in the summer months. Special events, such as the annual pony swim and roundup/auction, sponsored by the Chincoteague Volunteer Fire Department in July, draw crowds of up to 40,000.

### 3.3.5 Employment and Income

This section provides general background information on employment and income data for the WFF region. Information includes employment, unemployment, income, and poverty characteristics of the region compiled by the 2000 U.S. Census, the Virginia Employment Commission (VEC) and by Virginia Polytechnic Institute (Eastern Shore Chamber of Commerce, 2007). The section also includes employment statistics for WFF itself.

In 2008, the monthly unemployment rates in Virginia were as low as 4.1 percent and as high as 7.0 percent (VEC, 2009a). In 2008, Accomack County was approximately average in the Delmarva region in terms of unemployment rates. The total labor force of Accomack County is 19,375 people, 18,202 of whom are employed, resulting in an average annual unemployment rate of 6.1 percent (VEC, 2009b). Employment fluctuates seasonally in Accomack County and the Town of Chincoteague, with decreased unemployment occurring from June through October (VEC,
Overall, the unemployment rates in Virginia and Accomack County have been declining since 2000 (VEC, 2009a; VEC, 2009b).

Table 23 lists the distribution by broad occupational categories for Virginia, Accomack County, and Chincoteague, as reported by the U.S. Census Bureau.

**Table 23: Occupational Distribution (percent)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Virginia</th>
<th>Accomack County</th>
<th>Chincoteague</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management, professional, and related occupations</td>
<td>38</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>Sales and office occupations</td>
<td>26</td>
<td>22</td>
<td>26</td>
</tr>
<tr>
<td>Production, transportation, and material moving occupations</td>
<td>13</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>Service occupations</td>
<td>14</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Construction, extraction, and maintenance occupations</td>
<td>10</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Farming, fishing, and forestry occupations</td>
<td>1</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2000

Table 24 shows the income and poverty rates of the Commonwealth of Virginia, Accomack County, and Chincoteague. Accomack County and Chincoteague both have a higher percentage of families below the poverty level and a lower per capita income than Virginia as a whole; however, Accomack County and Chincoteague do not include major urban centers.

**Table 24: Income and Poverty**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>$59,575</td>
<td>$41,727</td>
<td>11.9</td>
</tr>
<tr>
<td>Accomack County</td>
<td>$36,616</td>
<td>$24,342</td>
<td>23.4</td>
</tr>
<tr>
<td>Chincoteague</td>
<td>$36,566</td>
<td>$24,549</td>
<td>13.4</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2008

In 2008, WFF employed a total of 1,485 people; 1,027 of those supported NASA (including 238 civil servants and 789 contractors), MARS employed 3 full-time people, and the remainder worked for either NOAA or the U.S. Navy (NASA, 2008). The VEC reported that in 2008 NASA was the fourth largest employer in Accomack County; other large employers on the Eastern Shore are Perdue Farms (1,900 employees) and Tyson Foods (950 employees) (VEC, 2009b).

Employment categories at WFF consist largely of managerial, professional, and technical disciplines with higher than regional average salaries. The mean salary of NASA employees for fiscal year 2008 was $88,047, while the median salary is in the $80,000-$90,000 range (NASA,
2008). The median family income for Accomack County in 2008 was $41,845. Due to the wide gap between salaries of WFF employees and most area residents, the facility contributes considerably to the local economy (NASA, 2009a).

### 3.3.6 Health and Safety

Three local emergency health services are located in the vicinity of WFF. WFF has its own health unit which operates from 8:00 a.m. to 4:30 p.m.; after-hours emergency medical care is provided by Emergency Medical Services staff of the WFF Fire Department. The Chincoteague Medical Center on Chincoteague Island and the Atlantic Medical Center in Oak Hall, VA, also provide emergency assistance, and both are located within 8 km (5 mi) of WFF. Four hospitals are also located in the region, all within 64 km (40 mi) of WFF. These hospitals include:

- Atlantic General Hospital in Berlin, MD;
- McCready Memorial Hospital in Crisfield, MD;
- Peninsula Regional Medical Center in Salisbury, MD; and
- Shore Memorial Hospital in Nassawadox, VA.

The Peninsula Regional Medical Center in Salisbury serves as the regional trauma center for the Delmarva Peninsula. If additional trauma care is needed, Sentara Norfolk General Hospital is 19 minutes away (by helicopter) from the Shore Memorial Hospital in Nassawadox, VA. Accomack and Northampton County Health Departments offer clinical services. Worcester, Somerset, and Wicomico Counties also have health departments. Five nursing homes on Virginia’s Eastern Shore and eight nursing homes on Maryland’s Lower Eastern Shore are available to the surrounding communities.

The WFF Fire Department provides emergency services to the neighboring community and has a Mutual Aid Agreement with the Accomack-Northampton Fireman’s Association for any outside assistance needed at WFF (NASA, 2008). There are 24-hour fire and protection services, and personnel are also trained as first responders for hazardous materials, waste, and oil spills. There are 21 existing Fire and Rescue stations in Accomack County. The local fire companies closest to Wallops are in the towns of Atlantic, Chincoteague, and New Church, VA.

WFF maintains a security force that is responsible for the internal security of the base and provides 24-hour-per-day protection services. On the Main Base, one entrance gate to WFF, one to NOAA, and one to the U.S. Navy are used to control and monitor daily employee and visitor traffic. One entrance gate serves as the control and monitoring point for Wallops Mainland and Wallops Island, combined. Other services provided by the security force include security patrols, employee and visitor identification, mail delivery, after-hours security checks, and police services.

### 3.3.7 Cultural Resources

The National Historic Preservation Act (NHPA) of 1966, (P.L. 89-665; 16 U.S.C. 470 et seq.) as amended, outlines Federal policy to protect historic sites and values in cooperation with other nations, Tribal Governments, States, and local governments. Subsequent amendments designated the State Historic Preservation Officer as the individual responsible for administering State-level programs. The NHPA also created the Advisory Council on Historic Preservation, the Federal
agency responsible for providing commentary on Federal activities, programs, and policies that affect historic resources.

Section 106 and Section 110 of the NHPA and its implementing regulations (36 CFR 800) outline the procedures to be followed in the documentation, evaluation, and mitigation of impacts for cultural resources. The Section 106 process applies to any Federal undertaking that has the potential to affect cultural resources. This process includes identifying significant historic properties that may be affected by an action and mitigating adverse effects to properties listed, or eligible for listing, in the National Register of Historic Places (NRHP) (30 CFR 60.4). Section 110 of the NHPA outlines the obligations Federal agencies have in regard to historic resources under their ownership.

Section 106 of the NHPA requires Federal agencies take into consideration the effects of their undertakings on historic properties and to allow the Advisory Council on Historic Preservation (ACHP) the opportunity to comment on such undertakings. As defined in the NHPA, “historic properties” are one of five resource types—buildings, structures, object, sites, or districts—that are listed in or eligible for listing in the NRHP. Resources less than 50 years of age are not generally eligible for listing in the NRHP, but may be if they are of exceptional importance. Accordingly, to be in compliance with Section 106 of the NHPA, NASA must consider the effects of the proposed undertaking on all properties that are listed in or eligible for listing in the NRHP—both those owned by NASA within the boundaries of WFF, as well as those located outside of WFF that may be affected.

In November 2003, NASA prepared a Cultural Resources Assessment of Wallops Flight Facility, Accomack County, Virginia (CRA) that examined each of the three land areas of the facility within WFF’s property boundaries: Wallops Main Base, Wallops Mainland, and Wallops Island (NASA, 2003b). The study was completed to assist NASA in meeting its obligations under Sections 106 and 110 of the NHPA. For planning purposes, this study evaluated properties constructed prior to 1955, using 1955–2005 as the youngest applicable 50-year period. Additionally, the CRA established a predictive model for understanding the archaeological potential over the entire WFF property.

3.3.7.1 Terrestrial

Archaeology

The CRA determined that the cultural resources at WFF consist of six archaeological sites, two of which are historic sites on Wallops Island (Figures 34 and 35); and a total of 166 structures that are at least 55 years old, 25 of which are located on Wallops Island. In a letter dated December 4, 2003, the Virginia Department of Historic Resources (VDHR) concurred with the recommendations of the CRA and VDHR accepted the predictive model for archaeology at WFF, noting that many of the areas with moderate to high archaeological potential are unlikely to be disturbed by future construction or site use.

In anticipation of the need for shoreline restoration measures, NASA conducted a pedestrian survey of 6.2 km (3.85 mi) of beach/coastline on Wallops Island on September 18, 2006 (Appendix C). The purpose of the archaeological survey was to identify any potentially significant cultural resources, including both aboveground resources, i.e., historic structures, and archaeological sites, which may contribute to knowledge of the cultural resources heritage of
Accomack County. During the survey, field archaeologists searched for all significant cultural materials within the project area. No significant cultural remains or archaeological sites were discovered during this evaluation. Based upon this information, no further archaeological evaluation of the beachfront was necessary.

In anticipation of the need for slurry pits for installation of geotextile tubes, NASA conducted a limited cultural resources survey along 2.98 km (1.85 mi) of beach on January 22, 2007. This survey included a portion of beachfront that was revealed by the predictive model to have moderate potential for the presence of historic archaeological sites. During the survey, field archaeologists searched for all significant cultural materials within the geotextile tubes project area. No significant cultural remains or archaeological sites were discovered during this evaluation. An architectural historian identified and evaluated three buildings on the beach within the Area of Potential Effects (APE). The Tracking Camera Turret with Dome (WFF #Z-35, VDHR #001-0027-0122), was previously determined to be ineligible for listing in the NRHP in the *Historic Resources Survey and Eligibility Report for Wallops Flight Facility* (2004). The two other buildings—the Launch Pad Terminal Building (WFF #Z-42) and Launch Control Center (WFF #Z-40)—were evaluated and found to be ineligible for listing in the NRHP. Based upon the findings of the cultural resources survey of the APE, NASA determined no further archaeological evaluation of this beachfront was necessary and that no historic properties would be affected by the installation of the geotextile tubes. NASA submitted this determination to VDHR in a letter dated January 24, 2007 (see appendices to the *SRIPP Proposed Groin, Breakwater, and Shoreline Cultural Resource Surveys* in Appendix E). In a response letter dated January 25, 2007, VDHR concurred with NASA’s determination that the proposed undertaking would have no adverse effect on historic properties and stated that no further consultation or work was required.
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Aboveground Resources

Following the initial 2003 reconnaissance survey task, an intensive-level historic resource survey and historic research were conducted to develop a historic context for WFF. This context provided the necessary information with which to make NRHP eligibility determinations for the surveyed buildings and structures constructed prior to 1956. The findings were presented in the Historic Resources Survey and Eligibility Report for Wallops Flight Facility (NASA, 2004). The historic context developed for the report, in conjunction with field observations, served as the basis of evaluation for the buildings and structures determined to be (or soon to be) 50 years of age or older at Wallops. Of the 124 buildings assessed that pre-date 1956, 25 still exist on Wallops Island.

Two resources—the Wallops Coast Guard Lifesaving Station (VDHR #001-0027-0100; WFF# V-065) and its associated Coast Guard Observation Tower (001-0027-0101; WFF# V-070)—were determined to be eligible for listing in the NRHP and Virginia Landmarks Register (NASA, 2004). The other surveyed resources were determined not to be NRHP eligible because they lacked the historical significance or integrity necessary to convey significance.

In a letter dated November 4, 2004, the VDHR concurred with the findings and determinations in the Historic Resources Survey and Eligibility Report, confirming that the Wallops Coast Guard Lifesaving Station is eligible for listing in the NRHP, with the Observation Tower as a contributing structure to the historic property (NASA, 2004). NASA has determined that the Wallops Coast Guard Lifesaving Station is located inside the explosive hazard arc of a nearby rocket motor storage facility and as a result, is planning the demolition or removal of the Lifesaving Station and Observation Tower. In compliance with Section 106 of the NHPA, NASA and VDHR are currently negotiating a Memorandum of Agreement to resolve the effects of demolition or removal.

Since the 2004 report, no additional identification and evaluation of above-ground historic properties has been conducted at WFF. Accordingly, as the inventory of facilities age, there will be a need to survey buildings as they turn 50 and update the 2004 study.

3.3.7.2 Underwater

Virginia regulates and permits activities in Commonwealth waters from the shoreline out to 5.5 km (3 nautical miles [nmi]). MMS regulates and permits activities within Federal waters (outside 5.5 km [3 nmi]) of the OCS for projects that would potentially disturb the sand and gravel resources on the ocean floor. NASA, however, has been designated as the lead Federal agency for Section 106 compliance.

Cultural Resources Study of Unnamed Shoal A and Unnamed Shoal B

Between March and September 2009, NASA conducted a cultural resources study within a 5.2-km² (2-mi²) block on each of the two proposed SRIPP offshore borrow sites (NASA, 2009c) (Appendix D). The primary objective of this study, which included archival research and a remote sensing survey, was to identify maritime related cultural resources, particularly submerged watercraft, and buried prehistoric sites within the two survey areas. This survey was undertaken in consultation with MMS, and in accordance with guidelines established in MMS Notice to Lessee (NTL) 2005-G07 (MMS, 2005).
Survey operations were conducted from a 14 m (46 ft) research vessel, and the survey array consisted of a Hemisphere Crescent R130 Digital Positioning System (DGPS), a Geometrics G882 marine cesium magnetometer, an Odom Hydrotrac digital echo sounder, and a 600 kHz Marine Sonics side scan sonar system. Survey control and data quality control were achieved with Hypack’s Hypack 2009a survey software. Magnetic and acoustic (side scan sonar, sub bottom profiler, and echo sounder) bathymetric data were reviewed during data collection for anomalies, and reviewed a second time during post-processing efforts using the Hypack (version 2009a) data review module and Golden Software’s Surfer (Version 8). These software programs were used to assess the duration, amplitude, and complexity of individual magnetic disturbances, and to plot the positions of these anomalies within the survey areas to better understand spatial patterning and their association with acoustic and bathymetric anomalies.

Archaeologists maintained field notes on the locations of modern sources of ferrous material such as discarded or lost fishing equipment (clamming and crab trawls, anchors, or other jettisoned debris). Acoustic imaging data (Side scan sonar and sub bottom profiler) were reviewed for anomalous returns that could be associated with significant submerged cultural resources. Acoustic images and magnetic contouring were checked against bathymetric data for potential correlation.

The sub bottom profiler data was reviewed in conjunction with the other remote sensing instruments in order to map out the extent of the objects encountered. The sub bottom profiler did not record any buried cultural resources or geomorphic features associated with prehistoric actives.

Sub bottom profiler data indicated that sediment patterns varied little between Unnamed Shoal A and Unnamed Shoal B; both shoals are comprised of relatively homogenous sand (similar grain sizes throughout the shoal). This sediment homogeneity has likely resulted from long term grain size sorting by currents, wave action, and large storm events. This sediment sorting has reduced the potential for these shoals to contain intact maritime cultural resources and prehistoric features.

A total of 28 magnetic anomalies and 30 acoustic anomalies (side scan sonar) were recorded during the remote sensing survey of both shoals. Unnamed Shoal A contains 18 side scan sonar anomalies and 24 magnetic anomalies, which yielded five target clusters for further analysis. Unnamed Shoal B contained 12 side scan sonar anomalies, four magnetic anomalies, and no target clusters.

The greatest amount of ferrous material was detected in Unnamed Shoal A, which is located approximately 2.4 km (1.5 mi) east of Blackfish Bank Shoal. The acoustic and magnetic anomalies on Unnamed Shoal A are consistent with debris that originated from two sources: 1) sport and commercial fishermen, who often lose anchors, chains, wire rope sections, trawls and general flotsam, and 2) barges that have transported and dropped a variety of ferrous debris to create an artificial reef on Blackfish Bank Shoal. Some of these objects have slowly migrated east and then “hung up” on the shoals, which is supported by the fact that there are far fewer anomalies at Unnamed Shoal B, which is over 3 km (2 mi) east of Unnamed Shoal A. The greater the distance from the more commonly trafficked and fished areas, the lower the number of recorded ferrous materials and acoustic anomalies.

Data analysis, when coupled with the commercial and recreational fishing that takes place at or near Unnamed Shoal A and Unnamed Shoal B, indicated that none of the detected anomalies
have potential to represent significant submerged cultural resources. MMS concurred with these findings and stated that archaeological mitigation is not required for the SRIPP. MMS also stated that an unanticipated discovery of archaeological resources would result in the immediate halt of operations within 305 m (1,000 ft) of the area of the discovery. NASA would then be required to report the discovery to the Regional Supervisor, Leasing and Environment, Gulf of Mexico Region within 72 hours of discovery. The Regional Supervisor would then inform NASA as to how to proceed (Herkhof, pers. comm.).

**Cultural Resources Study of Proposed Breakwater and Groin Locations**

A cultural resources study was conducted in August 2009 to identify maritime related cultural resources, particularly submerged watercraft, and buried archaeological sites within the survey areas (NASA, 2009e) (Appendix E). The survey consisted of four tasks: remote sensing of the proposed breakwater location, a scientific diving survey of the proposed groin location, a pedestrian survey of the Wallops Island shoreline, and archaeological monitoring of geotextile tube installation on the shoreline. A total of 37 hectares (92 acres) was evaluated during the survey efforts.

The archaeological predictive model presented in the CRA identified the potential to encounter pre-historic and historic sites on WFF (which was approved by VDHR in a letter dated December 3, 2003), including the Atlantic coast shoreline and near shore waters. This report indicated that there was a moderate potential to encounter significant historic resources on this portion of WFF.

No significant cultural resources were identified during the Phase I pedestrian survey of the Wallops Island shoreline, the archaeological monitoring of geotextile tube placement, and the scientific diving survey of the proposed groin location. A total of five target groups were identified during the remote sensing survey of the proposed breakwater. These target groups consisted of magnetic or acoustic anomalies that may be potentially associated with adjacent anomalies based upon magnetic signature, duration of magnetic signal response or side scan sonar data that records an image of an anomaly in close proximity to recorded magnetic anomalies. Analysis of the target groups indicates that none of the target groups have the potential to represent significant submerged cultural resources. They instead represent debris associated with the previous structure (evidenced by wooden piling and steel cable) that was demolished or debris that was dumped at the location of the proposed breakwater. The archaeological studies undertaken for the SRIPP did not identify any significant cultural resources.

**3.3.8 Environmental Justice**

The goal of environmental justice from a Federal perspective is to ensure fair treatment of people of all races, cultures, and economic situations with regard to the implementation and enforcement of environmental laws and regulations, and Federal policies and programs. EO 12898, *Federal Action to Address Environmental Justice in Minority Populations and Low Income Populations*, (and the February 11, 1994, Presidential Memorandum providing additional guidance for this EO) requires Federal agencies to develop strategies for protecting minority and low-income populations from disproportionate and adverse effects of Federal programs and activities. The EO is “intended to promote non-discrimination in Federal programs substantially affecting human health and the environment.”
Accomack County is on the lower end of income measures in the region, with a 2005 median family income of $32,837. As a result, the county is also on the higher end of poverty levels in the region based on U.S. Census Bureau data reports. The per capita income in Accomack County in 2007 was reported to be $18,468, with an estimated 18 percent of people below the poverty level (U.S. Census Bureau, 2008a). The per capita income in the Commonwealth of Virginia in 2007 was reported to be $28,255, with an estimated 9.9 percent of people below the poverty level statewide (U.S. Census Bureau, 2008b).

In order to ensure compliance with Executive Order 12898, NASA prepared an Environmental Justice Implementation Plan (EJIP) in 1996. NASA evaluated the demographic information in the vicinity of WFF and identified areas that have a higher concentration of minority persons and low-income persons based on Federal guidelines. The EJIP also includes an extensive evaluation of all programs at WFF, including tenant activities that could potentially affect human health and the environment. The EJIP demonstrates that NASA will continue to incorporate environmental justice in all its activities and monitor all programs to determine any potential environmental justice impacts to persons in the area. The EPA’s Environmental Justice Coordinators Council has defined minority communities as those exceeding a 50 percent minority population. Table 25 provides a review of Accomack County Census data used to determine the baseline for the facility’s EJIP.

Table 25: Environmental Justice Concerns – by Census Tract, Accomack County, VA

<table>
<thead>
<tr>
<th>Tract</th>
<th>Location</th>
<th>Percent Minority 2000</th>
<th>Percent Low Income 2000</th>
<th>Percent Poverty 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>9901</td>
<td>MD/VA line south including Fisher’s Point</td>
<td>1.97</td>
<td>51.53</td>
<td>12.80</td>
</tr>
<tr>
<td>9902</td>
<td>MD/VA line south including Wallops Island to Assawoman Inlet</td>
<td>41.75</td>
<td>49.96</td>
<td>16.38</td>
</tr>
<tr>
<td>9903</td>
<td>West of 9902 and 9904, MD/VA line south to Ann’s Cove Road</td>
<td>24.66</td>
<td>55.94</td>
<td>19.28</td>
</tr>
<tr>
<td>9904</td>
<td>East of Mears Station Road, South of 9902 south to Horseshoe Lead</td>
<td>59.14</td>
<td>51.61</td>
<td>27.14</td>
</tr>
</tbody>
</table>

Source: NASA, 2008

Chincoteague Island, at approximately 13 km (8 mi) northeast of Wallops Island, is the closest populated area to the seaward side of Wallops Island. No minority or low-income communities exist on the portion of Chincoteague Island that lies within a 4-km (2.5-mi) radius of Wallops Island.

Assateague Island has no year-round residents, as it is comprised of several protected parks controlled by Assateague Island National Seashore, Assateague State Park, and Chincoteague National Wildlife Refuge.

EO 13045, Protection of Children from Environmental Health Risks and Safety Risks, encourages Federal agencies to consider the potential effects of Federal policies, programs, and
activities on children. The closest day care centers, schools, camps, nursing homes, and hospitals are addressed within the EJIP.

No nursing homes, hospitals, or schools are located near WFF. The closest hospital, McCready Memorial Hospital in Crisfield, MD, is located approximately 32 km (20 mi) northwest of Wallops Island. One public campground, Trail’s End, is located approximately 13 km (8 mi) northwest of the Wallops Island launch pads. One day care center, Emma’s World Daycare & Preschool, is located approximately 9 km (5.5 mi) northwest of central Wallops Island. The closest schools are: Arcadia High School, located approximately 10 km (6 mi) northwest of central Wallops Island, and Kegotank Elementary School, located 6 km (4 mi) west of central Wallops Island.

3.3.9 Transportation

3.3.9.1 Upland

The Eastern Shore of Virginia is connected to the rest of the State by the Chesapeake Bay Bridge-Tunnel. The primary north-south route that spans the Delmarva Peninsula is U.S. Route 13, a four-lane divided highway. Local traffic travels by arteries branching off U.S. Route 13. Activities at Wallops Island and Wallops Mainland generate traffic along Route 803. Primary access to WFF is provided by Route 175, a two-lane secondary road. Traffic in the region varies with the seasons. During the winter and early spring, traffic is minimal; during the summer and early fall, traffic increases due to the number of tourists in the area.

Wallops Main Base and Wallops Mainland are connected by approximately 10 km (6 mi) of the paved, two-lane Route 679. A NASA-owned road, bridge, and causeway link Wallops Mainland to Wallops Island. Hard surface roads provide access to most buildings at WFF and are maintained by NASA and its tenants. Most organizations at WFF own and maintain a variety of vehicles ranging from sedans and vans to trucks. There is no public transportation on the facility. Many WFF employees carpool to and from the facility.

Commercial air service to the area is provided through the Norfolk International Airport, about 145 km (90 mi) to the south, and the Salisbury Regional Airport, about 64 km (40 mi) to the north. Air service is also available approximately 40 km (25 mi) south of WFF through the Accomack County Airport in Melfa, which normally provides flights during daylight hours. Surface transportation from the airports to WFF is by private rental vehicles, government vehicles, and commercial bus or taxi. In addition, ground transportation to the Salisbury Airport is occasionally provided by a WFF Shuttle Bus for WFF employees. Chartered and private aircraft that have the appropriate clearance may land at the WFF Airport for business purposes. Air-freight services are available from the Salisbury Regional Airport.

Rail freight service is provided to the Delmarva Peninsula by Bay Coast Railroad, although no rail freight service is available directly to WFF. No rail passenger service is available to WFF. Eleven motor freight carriers that serve the eastern United States are authorized to provide service to the Accomack-Northampton District, and therefore, WFF.

3.3.9.2 Maritime

Commercial, recreational, and military maritime traffic all use the area off the coast of Virginia, one of the busiest areas in the world for maritime traffic. Traffic Separation Schemes (TSSs),
Affected Environment

specified in 33 CFR, are one-way ship traffic lanes marked by buoys. The purpose of the TSS system is to prevent vessels from striking each other. The nearest TSS lanes to the project area are the southernmost approaches of the Delaware Bay, which are approximately 44 miles north of Unnamed Shoal B, and the northernmost lanes of the Chesapeake Bay approach, which are approximately 65 miles south of Blackfish Bank Shoal. The triangle-shaped Wallops Island Approach Zone is found at the mouth of the Chincoteague Inlet. This zone is designated to encourage boaters to exercise caution while entering and exiting the Inlet, a popular waterway for recreational and fishing boats.

In addition, the USCG designates Regulated Navigation Areas (RNAs) to control vessel traffic by specifying times of vessel entry, movement, or departure to, from, within, or through ports, harbors, or other waters. The closest RNA to the project area is in the Chesapeake Bay Entrance, near Hampton Roads, VA; the SRIPP study area is also outside of this RNA. A Private Aid to Navigation (PATON) permit would need to be obtained from the USCG to place temporary buoys for dredging activities (USCG, 2009b).

Military and Government Traffic

The Virginia Capes Operating Area (VACAPES) is the location of maritime combat testing and training for the Navy. This 94,875 km² (27,661 square nautical miles [nmi²]) area of the Atlantic Ocean extends from Rehoboth Beach, DE, to Cape Fear, NC. The boundary starts 6 km (3 nmi) off the coast and terminates approximately 278 km (150 nmi) east in certain areas. The Navy also harbors approximately 67 vessels in the Port of Virginia, located in Norfolk, up to 10 of which are typically operating in the VACAPES area on any given day. These vessels include submarines and surface vessels like aircraft carriers. However, the submarine transit lanes are over 111 km (60 nmi) southeast of the Chincoteague Shoals area. Operations involving the use of the surface vessels vary widely, from several hours up to two weeks (U.S. Department of the Navy, 2009). Data from a study conducted by R.J. Filadelfo for the Center for Naval Analyses from February 2000 to January 2001 reported that the total number of Navy ships on the east coast within 370 km (200 nmi) was 12 at any given time (NOAA/NMFS, 2008). In addition to the Navy, USACE and USCG vessels are regularly found in the SRIPP study area (NOAA/NMFS, 2008). The USCG issues periodic notices to mariners regarding information about navigation, hazards to navigation, and navigational safety, which can be obtained on their Web site.

Commercial Traffic

Numerous small harbors are located throughout Accomack and Northampton Counties, which are used primarily for commercial and recreational boats. Commercial ocean cargo shipments are typically offloaded at the Port of Baltimore, MD, or Cape Charles, VA, and transferred to commercial trucks or rail for transport to WFF. A sea-based option also exists, utilizing Chincoteague Inlet and offloading cargo at one of two boat docks at WFF (one on Wallops Main Base and one on the north end of Wallops Island). Commercial cargo, container ships, and tankers pass by the Virginia barrier islands daily en route to destinations such as the Port of Baltimore, MD, and the Port of Virginia.

From February, 2000 to January, 2001, commercial traffic density averaged about 202 ships within 93 km (50 nmi) of the coast, and increased to 266 ships within 100 nmi, and 358 ships
within 370 km (200 nmi). In terms of spatial distribution, commercial ship traffic is relatively uniform along the coast, with certain concentrations around major port areas (Filadelfo, 2001).

Recreational Traffic

Fishing and recreational boating traffic occurs throughout the SRIPP study area in the inlets of Wallops and Assateague Islands, and at offshore shoals and artificial reefs year round. However, the majority of recreational and fishing traffic occurs in the spring and summer.

In April and May 2009, guides and recreational fishermen in Chincoteague, Wachapreague, and Ocean City were surveyed to assess their use of the SRIPP project area, and were asked to indicate if they utilized Wallops Island shoreline, Blackfish Bank Shoal (located 11 km [7 mi] from the Wallops Island shoreline), Unnamed Shoal A (15 km [10 mi] offshore), or any combination of the above, for commercial, recreational, or guided fishing (NASA, 2009d). At the time of the survey, Unnamed Shoal B (21 km [13 mi] offshore) had not been identified as a potential SRIPP borrow site, so no data for it was collected in this survey. Of the 66 surveys that were collected, 14 respondents indicated that they used Unnamed Shoal A for recreational fishing and/or guide use. Twenty-one of the respondents indicated that they used the Wallops Island shoreline for recreational fishing and/or guide use.

The DEQ’s 161 km (100 mi) long Seaside Water Trail runs between the Eastern Shore of Virginia National Wildlife Refuge at Cape Charles and Chincoteague Island. The trail is utilized by recreational boaters and kayakers. The “Wisharts Point Landing to Curtis Merritt Harbor” leg of the trail is approximately 11 km (7 mi) long and originates on the western shore of Bogue’s Bay, crosses Chincoteague Inlet, and ends on the southern tip of Assateague Island. Chincoteague Inlet, located between Assateague Island and Wallops Island, is considered to be the most trafficked natural inlet by both commercial and recreational fishing boats on the Atlantic coast (The Local Fisherman, 2009).
CHAPTER FOUR: ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Chapter 4 presents the potential impacts on existing resources described in Chapter 3 that may result from the alternatives described in Chapter 2. This chapter contains discussions on potential impacts on resources under the three main categories of Physical Environment, Biological Environment, and Social and Economic Environment.

Chapter 4 focuses on addressing the type, context, intensity, and duration of the project-related environmental impacts for each resource area included in this PEIS. The impacts can be described in different ways including:

- Type (beneficial or adverse)
- Context (site-specific, local, or regional)
- Intensity (negligible, minor, moderate, or substantial)
- Duration (short- or long-term)

The levels of impacts and their specific definitions vary based on the resource that is being evaluated. For example, the scale at which an impact may occur (local, regional, etc.) would be different for wetland impacts as compared to economic resources.

Under NEPA (42 U.S.C. 4321 et seq.), significant impacts are those that have the potential to significantly affect the quality of the human environment. Human environment is a comprehensive phrase that includes the natural and physical environments and the relationship of people to those environments (40 CFR Section 1508.14). Whether an alternative significantly affects the quality of the human environment is determined by considering the context in which it would occur, along with the intensity of the action (40 CFR Section 1508.27).

Additionally, mitigation measures that would reduce the potential for an impact are identified in Chapter 5.

4.2 PHYSICAL ENVIRONMENT

4.2.1 Bathymetry

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance activities and emergency repairs such as hauling in additional rock to add to the existing seawall, hauling and placing sand on the beach or behind the existing seawall or geotextile tubes, installing sheet piling in or near the high tide level, or emergency geotextile tube installation would occur. Sand would only come from upland sources, so no impacts on bathymetry would occur as a result of emergency and maintenance activities. Due to the dynamic nature of offshore environments, bathymetry would continue to change in response to physical processes such as waves, wind, and tides. Water depths immediately seaward of the existing seawall may increase due to wave reflection and continued undermining of the seawall. Direct adverse effects on the bathymetry in the area immediately east of the seawall would continue.
Alternative One

The extension of the existing rock seawall would limit shoreline retreat along the additional 1,400 m (4,600 ft) of the extension. During Year 1 of the SRIPP, the seawall extension without beach fill would result in direct impacts on nearshore bathymetry by fixing the shoreline position and preventing natural maintenance of beach and nearshore slopes (effectively resulting in lowering of the bathymetric profile). In Year 2 when beach fill is placed (sand placement would first occur in the area of the new seawall extension), the nearshore bathymetric profile would be raised, reversing the impacts of the seawall extension from Year 1. The bathymetric profile after the initial beach fill would extend seaward underwater for an additional 52 m (170 ft) (Figure 15) from the newly constructed beach. Direct long-term beneficial impacts on bathymetry in the nearshore environment east of Wallops Island would occur by restoring a beach profile at the shoreline.

Dredging activities would result in direct long-term changes to the bathymetry of the selected offshore borrow site. The crest of Unnamed Shoal A is approximately 8 m (25 ft) below msl with the adjacent troughs approximately 20 m (70 ft) below msl. The crest of Unnamed Shoal B is approximately 9 m (30 ft) deep (see Figures 20 and 21). Dredging would be conducted in a manner to remove a uniform thickness of material from the chosen borrow area. Dredging could deepen parts of the shoal within the proposed borrow area by approximately 0.3 to 1.5 m (1 to 5 ft) during each dredging event (initial nourishment and renourishment cycles). The shoal’s general profile would be maintained, though at a lower elevation than pre-project conditions.

Within the borrow area, dredging would remove sediment up to several feet deep, therefore increasing the water depths. Based on the final dredging design, dredging may occur once in a given area of a shoal or multiple times. The area impacted within the borrow site during a typical renourishment event would depend on the volume of sand needed and the thickness of material dredged. Although the limits of the offshore shoals are difficult to define, NASA estimates that the proposed 5.2 km² (2 mi²) borrow site area covers approximately 70 percent of the total surface area of Unnamed Shoal A. The proposed 5.2 km² (2 mi²) borrow area covers approximately 33 percent of the total surface area of Unnamed Shoal B. Therefore, the SRIPP would result in direct, long-term impacts on the bathymetry at either of the shoals.

Alternative Two

For the seawall construction and beach fill, impacts would be the same as those described under Alternative One. The construction of a groin structure would result in long-term site-specific changes to bathymetry at the construction site. Indirect impacts resulting from changes to the physical oceanographic processes due to the groin structure are anticipated and are discussed in Sections 4.2.2.1 and 4.2.3.4. The impacts of dredging activities under Alternative Two are the same as those described under Alternative One.

Alternative Three

For the seawall construction and beach fill, impacts would be the same as those described under Alternative One. The construction of a nearshore breakwater structure would result in long-term site-specific changes to bathymetry at the construction site. Additional changes may occur in the nearshore bathymetry due to movement of finer sand transported from the newly placed beach fill through tidal wave action. Impacts on sediment transport from the construction of the breakwater structure would occur and are discussed in Sections 4.2.2.1 and 4.2.3.4. The impacts
of dredging activities under Alternative Three are the same as those described under Alternative One.

### 4.2.2 Geology and Geomorphology

#### 4.2.2.1 Virginia Barrier Island System

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented, but emergency measures may still be implemented to protect at-risk infrastructure. Impacts on sediments, including compaction and displacement, would be caused by the equipment used to reach facilities to perform emergency operations. In addition, without a beach to provide a source of sand, the island’s ability to create and maintain natural dunes is limited. As mentioned in Chapter 2, emergency measures could include hauling in additional rock to add to the existing seawall, hauling and placing sand on the beach or behind the existing seawall or geotextile tubes, installing sheet piling in or near the high-tide level, or emergency geotextile tube installation, which would result in changes to topography and effect shoreline processes at Wallops Island.

Erosion of the shoreline south of the end of the existing seawall would continue. Using the 2005 LiDAR-mapped shoreline, USACE used GENESIS to estimate the amount of shoreline erosion that would occur at Assawoman Inlet if the SRIPP was not implemented. The results are based on 10 years of estimates. The USACE modeling predicted that between 2.8 m (9.3 ft) and 3.4 m (11.3 ft) per year of the shoreline south of the seawall (no loss of the shore would occur north because there is no beach) at Assawoman Inlet would be eroded (Appendix A). Table 26 shows results of USACE GENESIS modeling that estimated volumes of erosion within an area 3.2 km (2 mi) south of the existing seawall in one year, two years, and 10 years; the 95 percent confidence limits are shown along with the average erosion volumes. The values shown in Table 26 are not gross or net sediment transport rates, rather they represent the amount of sediment eroded, or lost, within the geographic region modeled (between the existing southern end of the seawall on Wallops Island and 3.2 km [2 mi] south of the southern end of the seawall).

<table>
<thead>
<tr>
<th></th>
<th>Minimum¹</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>55,000 m³ (72,000 yd³)</td>
<td>73,000 m³ (96,000 yd³)</td>
<td>92,000 m³ (120,000 yd³)</td>
</tr>
<tr>
<td>2 years</td>
<td>116,000 m³ (152,000 yd³)</td>
<td>143,000 m³ (187,000 yd³)</td>
<td>170,000 m³ (223,000 yd³)</td>
</tr>
<tr>
<td>10 years</td>
<td>617,000 m³ (807,000 yd³)</td>
<td>680,000 m³ (889,000 yd³)</td>
<td>742,000 m³ (970,000 yd³)</td>
</tr>
</tbody>
</table>

¹The minimum and maximum values represent the 95 percent confidence interval

Continual loss of the shoreline south of the seawall would result in critical infrastructure on Wallops Island remaining at-risk from storm damages. Because the central portion of Wallops Island does not currently contain a beach, the no further erosion would occur but the seawall would be exposed to on-going storms and would need periodic maintenance and repair. The northern part of Assawoman would continue to experience erosion.
Existing and previous structures, such as groins and the seawall, have been implemented to reduce shoreline retreat on Wallops Island and have disturbed the natural sediment transport processes. These structures limited shoreline retreat, but have also resulted in the complete erosion of the beach seaward of the seawall and prevented long-term natural maintenance of the gently sloping nearshore and beach systems that would have existed under natural conditions. These structures have also prevented overwash processes from occurring, which serve to maintain beach and dune systems. Continuing to prevent the beach and dune system from responding to changing conditions would likely result in the loss of surface area on the landward side of Wallops Island, resulting in island narrowing as the sea level rises, although the timescale over which this would occur is uncertain.

As discussed in the existing conditions of Chapter 3, the shoreline in the vicinity of Wallops Island is not in a state of static equilibrium, and based on past trends of sediment transport and erosion in the region, it is reasonable to assume that substantial changes will continue to occur. The changes that would occur under the No Action Alternative would be the same as those described for the existing conditions in Section 3.1.5.3

Effects of Sea-Level Rise

For coastal engineering projects, including the SRIPP, prediction of sea-level rise is a necessary component of the project design. The anticipated sea-level rise at Wallops Island and surrounding areas was calculated using USACE guidelines (USACE, 2009e). The guidelines direct that projects take into account three different methods to include the possibility of sea-level rise: 1) adaptive management, which allows for future modifications to the project after the effects of sea-level rise can be confirmed; 2) facilitating future modifications, which means that projects will be designed for the current sea level, but are still adaptable to future rises; and 3) design for the future, which means that the current project is also designed based on an estimate of future sea levels (NRC, 1987).

Available data on global and relative MSL trends, the effect of existing infrastructure, LiDAR-mapped topography, and computer modeling were all examined. This data was used to calculate the range of water level rise in the SRIPP project area, which is estimated to be between 0.25 m (0.84 ft) and 0.78 m (2.53 ft) during the 50-year life span of the SRIPP (USACE, 2010a). This range of sea-level rise values determined by USACE is attributed to the low and high scenarios from the three plausible variations in eustatic sea level to the year 2100 (NRC, 1987). See Appendix A for more detailed information on the methodology the USACE used to calculate sea-level rise values.

Sea-level rise will likely reduce the rate of southwesterly growth of Fishing Point and the accretion on the north end of Wallops Island (USACE, 2010a). It may cause any shoreline breaches in the Tom’s Cove area to be more likely and more frequent. As sea level rises, it is anticipated that the natural shoreline on Wallops Island (at the north and south ends) would retreat, although the amount of retreat and impacts are uncertain. The shoreline that is “fixed” by the seawall would become increasingly underwater due to rising sea levels; however, the impacts to the seawall over the 50-year lifetime of the SRIPP would likely be negligible.
**Environmental Consequences**

**Alternative One**

**Sand Placement and Seawall Extension**

Implementation of the beach fill component would result in significant changes to the Wallops Island shoreline. The initial beach fill would extend the existing shoreline a total distance of 73 m (240 ft) (Figure 15) to the underwater seaward extent of the fill, 21 m (70 ft) of which would be the aboveground beach. The initial beach fill would create a beach profile with a 1.8-m-high (6-ft-high) berm and a 4.3-m-high (14-ft-high) dune at the seawall (Figure 15). Because there is no beach along the 6.0-km (3.7-mi) fill area proposed under the SRIPP, the Proposed Action would result in elevating the sediments along the Wallops Island shoreline between the northern end of the rock seawall and the southern end of the existing geotextile tubes. The renourishment fills would restore the shoreline to the same position that would exist after the initial fill is completed.

Beach nourishment would be done so that the beach is restored to a comparable sediment type (a similar percentage of sand, silt, and clay), grain size, and color as the existing beach material. Between renourishment cycles, beach fill sand would erode as part of the dynamic nature of the ocean environment. The frequency of beach renourishment cycles may vary depending on the severity and frequency of storm events.

Because of the height of the dune and seawall, the beach fill and seawall extension would continue to prevent overwash processes from occurring on Wallops Island, which would likely result in the loss of surface area on the landward side of Wallops Island and island narrowing as the sea level rises, although the timescale over which this would occur is uncertain.

Construction activities related to the seawall extension would disturb surface sediments on the beach. Construction activities would cause erosion in the short-term in the areas where heavy equipment is operating on the beach. Other adverse impacts on sediments include potential spills or leaks of pollutants from vehicles. BMPs including vehicle and equipment fueling and spill prevention and control would be implemented to reduce potential impacts on soils and sediments during excavation, construction, and beach fill work.

The seawall extension would serve as a last line of defense to protect critical infrastructure if the fill placed seaward of the seawall were to be eroded. The existing seawall and proposed extension would result in a “fixed” shoreline if the sand seaward of it were to completely erode.

**Impacts on the Shoreline from Seawall Extension**

The fact that sand behind the seawall extension would be retained instead of eroded (erosion in the area of the seawall extension would occur under No Action Alternative) would lead to the potential to exacerbate the erosion on the adjacent shoreline south of the extension. The USACE conducted modeling (methodology discussed under the No Action Alternative of this section) to estimate the potential effects of the seawall extension on the 3.2 km (2 mi) stretch of shoreline south of the existing seawall during the period of time after the extension is constructed and before the beach fill occurs (i.e., SRIPP Years 1 and 2). The USACE also modeled the erosion of this area 10 years after construction of the extension assuming no beach fill were to occur, to estimate potential impacts from a worst-case scenario.

NASA is committed to the implementation schedule shown in Table 8 with the seawall construction occurring in Year 1 and the initial beach fill starting in Year 2. However, the
modeling also looked at the effect of delays in implementation of the beach fill after a seawall extension was constructed. While any delay is unlikely, if one were to occur, it would most likely mean that there was a 2-year time period between seawall extension construction and beach fill placement. Longer delays, which would be a worst-case scenario, were lumped into a 10-year period between seawall construction and beach fill placement. Therefore, the modeling looked at 1-year, 2-year, and 10-year shoreline impacts.

The USACE modeling predicted that after construction of the 1,400-m (4,600-ft) seawall extension, between 3.0 m (9.7 ft) and 4.2 m (13.7 ft) per year of the shoreline at Assawoman Inlet would be eroded over a 10-year period assuming no beach fill were to occur (Appendix A). Table 27 shows that the average shoreline change rate (negative values indicate erosion) at Assawoman Inlet attributed to construction of the seawall would be less than the variability in the change rate caused by yearly changes in the wave climate; stormy years are expected to cause greater shoreline change than the seawall extension in years of normal waves. It is expected that any negative impacts would be mitigated following beach fill placement.

Table 27: Average Shoreline Change Rate at Assawoman Inlet

<table>
<thead>
<tr>
<th></th>
<th>Total Shoreline Change Rate</th>
<th>Shoreline Change Rate Attributed to Seawall Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Average</td>
</tr>
<tr>
<td>No Seawall Extension</td>
<td>-2.8 (-9.3)</td>
<td>-3.1 (-10.3)</td>
</tr>
<tr>
<td>(No Action Alternative)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seawall Extension</td>
<td>-3.0 (-9.7)</td>
<td>-3.6 (-11.7)</td>
</tr>
</tbody>
</table>

Table 28 shows results of USACE GENESIS modeling that estimated volumes of erosion within an area 3.2 km (2 mi) south of the existing seawall in one year, two years, and 10 years after construction of the seawall extension; the 95 percent confidence limits are shown along with the average erosion volumes. The values shown in Table 28 are not gross or net sediment transport rates, rather they represent the amount of sediment eroded, or lost, within the geographic region modeled (between the existing southern end of the seawall on Wallops Island and 3.2 km [2 mi] south of the southern end of the seawall). The No Action Alternative is provided in Table 28 for comparison.
Table 28: Erosion Volumes South of Existing Seawall

<table>
<thead>
<tr>
<th>Proposed Action Alternatives</th>
<th>No Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minimum</strong></td>
<td>50,000 m$^3$ (66,000 yd$^3$)</td>
</tr>
<tr>
<td>Average</td>
<td>68,000 m$^3$ (89,000 yd$^3$)</td>
</tr>
<tr>
<td>Maximum</td>
<td>86,000 m$^3$ (113,000 yd$^3$)</td>
</tr>
</tbody>
</table>

| **Minimum** | 102,000 m$^3$ (134,000 yd$^3$) | 116,000 m$^3$ (152,000 yd$^3$) |
| Average | 126,000 m$^3$ (165,000 yd$^3$) | 143,000 m$^3$ (187,000 yd$^3$) |
| Maximum | 151,000 m$^3$ (197,000 yd$^3$) | 170,000 m$^3$ (223,000 yd$^3$) |

| **Minimum** | 452,000 m$^3$ (591,000 yd$^3$) | 617,000 m$^3$ (807,000 yd$^3$) |
| Average | 493,000 m$^3$ (645,000 yd$^3$) | 680,000 m$^3$ (889,000 yd$^3$) |
| Maximum | 534,000 m$^3$ (699,000 yd$^3$) | 742,000 m$^3$ (970,000 yd$^3$) |

1The minimum and maximum values represent the 95 percent confidence interval
2Assumes no beach fill would occur to estimate potential impacts of a worst-case scenario

Figure 36 shows model predictions of shoreline positions for the portion of the GENESIS grid that is south of the existing seawall, a distance of about 2 miles. Each shoreline is an average of the results of 20 model runs that were driven with the 20 different four-year wave blocks discussed in Chapter 3. To minimize clutter, the 95 percent confidence interval shorelines are not included in these figures.
During this interim period before the beach fill is completed (SRIPP Year 1 and part of Year 2), direct short-term adverse impacts on the Wallops Island and Assawoman Island shorelines would occur from construction of the seawall extension. However, as shown in Table 28, construction of the extension would result in lower erosion volumes compared to existing conditions (No Action Alternative); the seawall extension alone would therefore result in direct beneficial impacts within the 1.8-km (1.12-mi) stretch of shoreline to its south (effects south of that were not modeled). However, once the beach fill is completed, the short-term adverse impacts during Year 1 would be mitigated in the long-term and beneficial impacts on Wallops Island, Assawoman Island, and potentially other islands to the south would occur from the addition of sand to the longshore sediment transport system.

**Impacts on the Shoreline from Beach Fill**

Figure 37 shows the estimated shoreline positions from at Year 2 to Year 14. Though it is intended that renourishment should occur at the end of Year 5, the USACE analysis was carried out to Year 14 without renourishment to help determine if adverse impacts occur to adjacent beaches if renourishment intervals are postponed or cancelled. Figure 37 shows that by Year 4, in many places the shoreline has retreated to near the minimum shoreline for storm damage protection, and thus, this is intended to be shortly before renourishment. By Year 12, the entire initial fill has been removed from the south end of the project; however, by Year 14, there is still fill in front of the seawall.
In summary, under Alternative One, the rate of erosion on the southern end of Wallops Island and the northern end of Assawoman Island would be reduced due to additional sand available for transport after beach fill is completed. Because the nodal zone of longshore sediment transport is located in the vicinity of the southern end of Wallops Island, in any given year, sediment that is placed on the beach would be dislodged and transported south, potentially being deposited on Assawoman Island and other barrier islands to the south. However, due to the uncertainty of the nodal zone, the sediment that is placed on the beach could also be transported primarily north in any given year.

Over the lifetime of the SRIPP, the seawall extension and beach fill would have long-term direct beneficial impacts on geology and the Wallops Island shoreline by mitigating the current rate of shoreline retreat. Continued beach nourishment would add to this benefit by providing ongoing mitigation of shoreline retreat.

**Growth of the Southern Tip of Fishing Point**

The SRIPP would not affect the sediment transport processes that will continue to cause changes at Fishing Point. The influx of sediment supply from beach fill operations may affect inlet dynamics, which in turn may affect sediment transport processes along the westward tip of Fishing Point. The growth of the southern tip of Fishing Point would be the same as predicted for existing conditions (discussed under Section 3.1.5.3).
Narrowing of the Tom’s Cove Isthmus

The SRIPP would not affect the sediment transport processes that will continue to create the changes at Tom’s Cove Isthmus. The changes and impacts on Tom’s Cove Isthmus would be the same as those predicted for the existing conditions (discussed under Section 3.1.5.3).

Changes in Wallops Island Shoreline Orientation and Chincoteague Inlet Migration

The northern end of Wallops Island is currently accreting rapidly due to sediment being delivered there from two directions: 1) north along the Wallops Island shoreline, and 2) by the westward drift of Chincoteague Inlet ebb shoals. Over the short term, sediment may be stored in swash bars, the ebb tidal delta, or the ebb/flood tidal ramp. Over the long term, it is probable that the sediment will be carried into Chincoteague Inlet by tidal currents and sequestered in flood shoals. This mechanism will act to slow down the rate of sediment accumulation that would otherwise occur on northern Wallops Island. The influx of sediment supply from beach fill operations may affect inlet dynamics, which in turn may affect sediment transport processes along the westward tip of Fishing Point.

With implementation of the SRIPP, the northern end of Wallops Island would continue to accrete, and would likely accrete at a faster rate than under existing conditions due to the presence of additional sand in the longshore sediment transport system from the beach fill.

The sediment accumulation on north Wallops Island may tend to push Chincoteague Inlet to the east, which appears to already be occurring as documented on recent aerial photographs of the western tip of Assateague Island. However, future Chincoteague Inlet locations can be strongly affected by USACE dredging decisions, and whether attempts are made to maintain the inlet channel in a fixed location or to dredge whatever is found to be the current channel location. The sediment accumulation on north Wallops Island is changing the current north-south shoreline orientation to one that is much more east-west.

Effects of Sea-Level Rise

Impacts on Fishing Point and the accretion on the north end of Wallops Island and the Tom’s Cove area due to sea-level rise would be the same as those described under the No Action Alternative. The SRIPP would help to protect Wallops Island infrastructure from the effects of sea-level rise by providing additional shoreline and a newly constructed 4.3-m-high (14-ft-high) dune along the proposed beach fill. As sea level rises, it is anticipated that the beach on Wallops Island would be exposed to increasing rates of sediment transport, and therefore would erode at increasing rates over time; however, the USACE accounted for sea-level rise in this project by including an additional amount of material at each renourishment event that would raise the entire fill profile by an amount equal to the projected amount of sea-level rise (USACE, 2010a). This additional volume is shown on Figure 15 in blue. See the discussion under the No Action Alternative within this section [Section 4.2.2.1] for more information on the methodology and predicted rates used by USACE for the characterization of sea-level rise.

Dredging Offshore Borrow Sites

Impacts on the Proposed Shoals

Impacts on Unnamed Shoal A and Unnamed Shoal B are discussed in Section 4.2.2.2, Offshore Sand Shoals, below.
Environmental Consequences

Impacts on Assateague Island

As material is removed from a shoal and the water depth changes, the resulting change in wave refraction can significantly affect the longshore sediment transport on adjacent beaches. The USACE followed MMS (2001) guidelines to model the potential impacts on the Assateague Island shoreline through the use of STWAVE (STeady-state spectral WAVE model) and the CERC (Coastal Engineering Research Center) sediment transport formula (USACE, 2010a). STWAVE is a wave refraction model used to transform representative offshore waves to a near-breaking depth. The refracted wave data were then used in the CERC formula to calculate sediment transport rates along the shoreline (within individual grid points). Bathymetry data used in the STWAVE model were obtained from the National Ocean Survey hydrographic surveys that are available in electronic format from the Geophysical Data System (version 4.0) developed by the National Geophysical Data Center. Bathymetric surveys collected in the 1960's through the 1990's were used where available, with earlier survey data used to fill gaps in the more recent bathymetry coverage.

The results of the modeling effort were used to compare existing conditions to post-dredging conditions and determine if a significant change in longshore sediment transport rates, and thus potential impacts on the Assateague Island shoreline, would occur. A summary of the USACE modeling effort and results are discussed below.

The borrow sites would be dredged several times to supply material for the initial beach nourishment and each of the renourishment cycles. The greatest potential for change in wave refraction would occur once the entire volume was removed; therefore, wave refraction using the existing bathymetry was modeled and then wave refraction with the entire volume removed from the shoal was modeled.

Material can be removed from the borrow site in variety of ways. For STWAVE modeling, two material removal techniques were chosen:

1. The “Plane Method” involving removal of the highest points within a borrow site down to an elevation that provided an adequate volume of material. This method would have the effect of turning a rounded mound of sediment into one or more flat areas.
2. The “Contour Method,” in which the same depth of material would be removed from all points within the borrow site. This would have the effect of dropping the contour everywhere within the borrow site by a constant amount.

The Plane Method is assumed to be the one that would have the greatest shoreline impacts, and the Contour Method is assumed to be moderately close to what might reasonably be used by a dredging contractor. The modeling was done for removal of the entire 50-year SRIPP lifespan dredge volume (i.e., 9,990,000 m³ [13,066,250 yd³] for Alternative One) from the 5.2 km² (2 mi²) study area. The effects of these two methods on Unnamed Shoal A and Unnamed Shoal B are shown on Figures 38 and 39.
Environmental Consequences

Source: USACE, 2010a

Figure 38: Unnamed Shoal A: Plane and Contour Dredge Method Profiles

Source: USACE, 2010a

Figure 39: Unnamed Shoal B: Plane and Contour Dredge Method Profiles
The USACE modeling was based on site-specific wave characteristics by considering temporal (inter-annual) and spatial variability in wave conditions. According to MMS (2001), “the methodology used to evaluate borrow site impacts provides a reliable quantitative technique for developing acceptable site-specific limits associated with changes in sediment transport potential.”

The results of the USACE modeling effort are presented as numerical values that correspond to the change in sediment transport potential in response to dredging (see Appendix A [USACE, 2010a] for modeling results). The results are compared with a pre-determined threshold value to determine whether or not the difference in longshore sediment transport along the Assateague shoreline would be directly attributable to dredging. If model results are larger than the pre-determined threshold value, then shoreline change directly attributable to the SRIPP would likely occur, and would therefore be considered a significant impact (MMS, 2001). Values less than the threshold only indicate that dredging for the SRIPP cannot be distinguished from naturally occurring longshore sediment transport, and therefore the SRIPP would not result in significant impacts on the Assateague Island shoreline.

The results of the sediment transport modeling under the Plane Methods and Contour Methods for dredging of both Unnamed Shoal A and Unnamed Shoal B showed that the pre-determined threshold value is not crossed anywhere along the Assateague shoreline. Therefore, the proposed excavation depths (which correlate with sediment volumes) under both dredging scenarios would be acceptable.

Because the natural variability in shoreline changes along the coast, certain portions of the Assateague Island shoreline will be more tolerant of alterations to the wave climate and associated sediment transport patterns. Because the Tom’s Cove Isthmus is a naturally vulnerable area to changes in longshore sediment transport (as described under shoreline change of the No Action Alternative), if any minor shoreline changes were to occur, they would likely be seen in this area of Assateague Island. Because Chincoteague Shoal is large and shallow, it greatly modifies the nearshore wave climate, and helps to reduce the shoreline impacts of dredging activities that would occur farther seaward of Chincoteague Shoal on either of the two shoals proposed as SRIPP borrow sites. The modeling results showed that when comparing Unnamed Shoal A with Unnamed Shoal B, no significant difference in the shoreline impacts from the dredging of either site exist.

**Use of North Wallops Island as Borrow Site**

The removal of sand from the north end of Wallops Island would lower topography within the footprint of the excavated areas. Because the accretion area on the north end of Wallops Island is expected to grow in response to the initial and renourishment beach fills, the impacts from sediment removal at the north end of Wallops Island would be mitigated by the re-deposition of sediment that would come from the addition of new sand on the beach. Therefore, while the use of the north Wallops Island beach as a sand source would result in direct, short-term adverse impacts on the shoreline in the period of a few months to years after excavation activities, in the long-term (i.e., lifetime of the SRIPP), use of this area is not anticipated to result in significant changes to the shoreline. Disturbance to surface sediments outside of the excavation areas would also result from activities associated with the movement and transfer of excavated sediments from the north end of Wallops Island to the areas designated for sand placement.
**Alternative Two**

Under Alternative Two, seawall construction, initial beach fill, and renourishment activities would be the same as Alternative One; however, a slightly smaller volume of fill would be placed on the beach during both initial fill and renourishment cycles (see Table 6). The USACE accounted for sea-level rise under Alternative Two by including an additional amount of material at each renourishment event that would raise the entire fill profile by an amount equal to the projected amount of sea-level rise (USACE, 2010a). The effects of sea-level rise on Wallops Island would be the same as described under Alternative One.

Approximately 2/3 of the proposed groin structure (80 m [265 ft]) would be installed within the beach once the fill has been placed. There would be an accumulation of sediment on the updrift side of the groin, and it is possible that groin would function as a “shadow,” causing an increase in erosion downdrift of the area within the groin shadow. If the nodal zone is on Wallops Island, the groin could result in erosion within a 300-m (1,000-ft) “shadow” area south of the structure. Renourishing the beach would reduce the potential for downdrift erosion by providing continual sand on the Wallops Island shoreline, some of which would be available to the longshore sediment transport system.

Activities related to groin construction would disturb surface sediments on the beach, but these impacts would be temporary and minor. In the long-term, the groin would help to retain sand on the Wallops Island shoreline so that erosion and sediment transport from Wallops Island would be reduced and the beach created by the SRIPP would stay in place longer than under Alternative One. NASA would implement the same types of mitigation measures as described for seawall construction under Alternative One.

Figure 40 shows the estimated shoreline positions from Year 2 to Year 14. Though it is intended that renourishment should occur at the end of Year 5, the USACE analysis was carried out to Year 14 without renourishment to help determine if adverse impacts occur to adjacent beaches if the renourishment intervals are postponed or cancelled. Figure 40 shows that by Year 4, in many places the shoreline has retreated to near the minimum shoreline for storm damage protection, and thus, this is intended to be shortly before renourishment. By Year 12, the entire initial fill has been removed from the south end of the project; however, by Year 14, there is still sediment in front of the seawall.
Alternative Three

Under Alternative Three, seawall construction, initial beach fill and renourishment activities would be the same as Alternative One; however, a slightly smaller volume of fill would be placed on the beach during both initial fill and the renourishment cycles (see Table 6). The USACE accounted for sea-level rise under Alternative Two by including an additional amount of material at each renourishment event that would raise the entire fill profile by an amount equal to the projected amount of sea-level rise (USACE, 2010a). The effects of sea-level rise on Wallops Island would be the same as described under Alternative One.

The construction of a nearshore breakwater structure would result in a build-up of sediment along the shoreline opposite of the breakwater. The breakwater structure would result in additional long-term direct benefits to sediments by reducing shoreline sediment transport and therefore retaining more sediment on the beach. Temporary and minor adverse effects to sediments are anticipated in the immediate vicinity of the breakwater during the construction period.

If the nodal zone is on Wallops Island, the breakwater could result in erosion of the shoreline south of the structure. The extent of the erosion would depend on the rate of longshore sediment transport in the breakwater area, but based on the results of the USACE modeling (presented on Figure 41), the direct effects would not likely occur more than 2.5 km (1.5 mi) downdrift of the breakwater. Renourishing the beach would reduce the potential for downdrift erosion by
providing continual sand on the Wallops Island shoreline, some of which would be available to the longshore sediment transport system. In the long-term, the breakwater would help to retain sand on the Wallops Island, and the beach created by the SRIPP would stay in place longer than under Alternative One.

Source: USACE, 2010a

**Figure 41: Shoreline Positions over Time for Alternative Three**

### 4.2.2.2 Offshore Sand Shoals

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented. Maintenance and emergency repairs to structures and the seawall would continue as necessary, but those activities would not involve work in open water. Therefore, no impacts on the geology or sediments of the offshore sand shoals would occur.

**Alternative One**

Under Alternative One, dredging activities would result in changes to the volume, shape, and elevation of the sediments at the proposed borrow sites.
NASA estimates that the proposed 5.2 km² (2 mi²) borrow area would cover approximately 70 percent of the total surface area of Unnamed Shoal A. The proposed 5.2 km² (2 mi²) borrow area would cover approximately 33 percent of Shoal B. Shoal volumes are shown in Table 29.

Roughly 30 percent of the Shoal A’s total volume would be removed if only Shoal A was used to obtain fill material over the lifetime of the SRIPP. Because Unnamed Shoal A would be used for the initial fill, Unnamed Shoal B would have less total volume removed over the SRIPP lifetime. Therefore, roughly 15 percent of Shoal B’s volume could be removed if it was used to obtain the entire SRIPP renourishment volumes. Therefore, the SRIPP would result in direct, long-term adverse impacts on the volumes of sand at either of the proposed shoals. Removal of shoal sediments would result in long-term adverse impacts on site-specific and regional geology.

Table 29: Offshore Borrow Site Impacts

<table>
<thead>
<tr>
<th>Borrow Area</th>
<th>Area Impacted by SRI PP¹</th>
<th>Estimated Total Shoal Volume</th>
<th>Maximum Volume That Could Be Removed Over SRIPP Lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Shoal A</td>
<td>520 hectares (1,280 acres)</td>
<td>31 million m³ (40 million yd³)</td>
<td>9,990,000 m³ (13,066,250 yd³)</td>
</tr>
<tr>
<td>Unnamed Shoal B²</td>
<td>520 hectares (1,280 acres)</td>
<td>57 million m³ (70 million yd³)</td>
<td>6,933,000 m³ (9,067,500 yd³)</td>
</tr>
</tbody>
</table>

¹The total area that is proposed to be dredged. Assuming a trailer suction hopper dredge would remove approximately 0.3 m (1 ft) of sediment during a single pass, the dredge would make approximately 2.3 passes over the entire 520 hectare (1,280 area) on each shoal to obtain the required volume of sediment.

²Because Unnamed Shoal A would be used for the initial fill (dredge volume is 3,057,500 m³ [3,998,750 yd³]), the maximum volume represents the amount of sand required for the nine renourishment cycles.

In addition, the bottom substrate at and near either of the borrow sites may be modified in several ways. A change in the hydrological regime as a consequence of altered bathymetry may result in a change of depositional patterns at the site, and therefore a change in sediment grain size. Exposure of the underlying sedimentary units may also change the depositional patterns by exposing material that has different textural and compositional properties than the existing bottom substrate.

Bottom substrate at a distance from the borrow site may also be modified by the deposition of fine-grained sediments in benthic and surface plumes generated by dredging activities. Sediments contained within plumes produced from the disturbance and resuspension of bottom sediments (benthic plume), and from discharges of the dredging vessel and equipment (surface plume), would settle out from the water column and be deposited at a distance from the dredge site. The deposition of resuspended sediments may result in a layer of sediment that differs from the existing substrate.

**Alternative Two**

For the seawall construction, initial sand placement, and renourishment activities, impacts would be the same as those described under Alternative One. However, the volume of sand needed for renourishment activities would be less, because construction of a groin would reduce shoreline erosion rates locally. Construction of a groin would result in site-specific changes to the geology of the nearshore environment immediately east of Wallops Island due to the potential changes in the shoreline and longshore sediment transport (discussed in Sections 4.2.2.1 and 4.2.3.4 respectively). The changes would be long-term, although they could be reversed if the groin was later removed.
Alternative Three

For the seawall construction, initial sand placement, and renourishment activities, impacts would be the same as those described under Alternative One. However, the volume of sand needed for renourishment activities would be less, because construction of a nearshore breakwater would reduce shoreline erosion rates locally. Construction of a breakwater would result in site-specific changes to the geology of the nearshore environment immediately east of Wallops Island due to the potential changes in the shoreline and longshore sediment transport (discussed in Sections 4.2.2.1 and 4.2.3.4 respectively). The changes would be long-term, although they could be reversed if the breakwater was later removed.

4.2.3 Physical Oceanography and Coastal Processes

4.2.3.1 Tides

No Action Alternative

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance activities and emergency repairs would occur at unknown locations on Wallops Island as necessary. The No Action Alternative would not result in any changes to tides in the project area.

Proposed Action Alternatives

The range of the tides would not be altered by SRIPP activities under any of the Proposed Action Alternatives.

4.2.3.2 Waves

No Action Alternative

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance activities and emergency repairs would occur at unknown locations on Wallops Island as necessary. Without the construction of the seawall extension and the placement of beach fill, the zone of breaking waves will encroach further inland and closer to WFF infrastructure and assets over time.

Alternative One

As waves move shoreward from deeper water and propagate over the offshore dredged area, the height, direction, and other characteristics of the waves would change. A reduction in wave height due to deeper water depths within the borrow area is expected, especially with larger, longer period waves. The changes in wave characteristics due to dredging can significantly increase or decrease the transport of sand along the shoreline, resulting in localized erosion and accretion. Because wave conditions and shoreline change are intricately linked, Section 4.2.2.1 describes the potential effects on the shorelines as a result of changing the wave conditions by dredging the entire volume of sand from either of the shoals. Modeling results showed that when comparing Unnamed Shoal A with Unnamed Shoal B, there would be no significant difference in the wave climatology from the dredging of either site.

Alternative Two

The types of impacts on waves from offshore dredging as discussed under Alternative One would be the same for Alternative Two. The construction of a groin would have localized
impacts on the wave climate in the project area by slowing wave energy on the opposite side of where the waves strike the groin. The groin would trap sand being transported along the shoreline as shown in Figure 7.

**Alternative Three**

The types of impacts on waves from offshore dredging as discussed under Alternative One would be the same for Alternative Three. The construction of an offshore detached breakwater would slow wave energy in the area between the breakwater and the shoreline resulting in sediment deposition on the beach as shown in Figure 8.

**4.2.3.3 Currents**

**No Action Alternative**

Under the No Action Alternative the SRIPP would not be implemented; however, maintenance activities and emergency repairs would occur at unknown locations on Wallops Island as necessary. With the absence of in-water activity, there would be no impact on currents in the project area.

**Alternative One**

Increasing the shoal depth with dredging would lead to decreased current velocity, sediment convergence, and infilling at the shoal. Although local current velocities immediately downstream of dredged areas may temporarily change, the magnitude of change and the size of the footprint are expected to be relatively small. Alterations of near-bed currents may result in local and short-lived changes in sediment transport pathways in the immediate vicinity of the borrow areas, but the pathways are expected to return to pre-dredging conditions following infilling (Byrnes et al., 2003). Infilling rates and sediment deposited in borrow depressions are expected to reflect natural variations, including storm characteristics and source material.

**Alternative Two**

The types of impacts on currents from offshore dredging as discussed under Alternative One would be the same for Alternative Two.

**Alternative Three**

The types of impacts on currents from offshore dredging as discussed under Alternative One would be the same for Alternative Three.

**4.2.3.4 Longshore Sediment Transport**

**No Action Alternative**

Under the No Action Alternative the SRIPP would not be implemented; however, maintenance activities and emergency repairs would occur at unknown locations on Wallops Island as necessary. With the absence of in-water activity, there would be no project related impacts to longshore sediment transport in the project area.

Nevertheless, as USACE (2010a) reported, the shoreline in the vicinity of Wallops Island is not in a state of static equilibrium, and it is not unreasonable to assume that substantial changes will continue to occur on decadal time scales, as compared with the slower time scales of more typical beaches. Fishing Point at the southern tip of Assateague Island is continuing to grow to
the southwest at a rate of approximately 50 m (150 ft) per year. If this trend continues over the next 50 years, the tip will grow to the southwest by about 2.3 km (1.5 mi). This will more strongly shelter the Wallops Island shoreline from ocean waves approaching from the northeast, and will shift the transport divergent nodal zone which is currently on the north end of Assawoman Island to the south by roughly the same distance.

Longshore gross and net sediment transport rates for existing conditions are shown on Figures 24 and 25 in Section 3.1.6.4.

**Alternative One**

**Sand Placement and Seawall Extension**

Placement of fill on the beach would add additional sand to the nearshore system. In comparing the net sediment transport rates modeled by the USACE (Appendix A) just prior to renourishment under Alternative One (Year 4 on Figure 42) to the No Action Alternative (existing conditions—see Figure 25), it is seen that the nodal point is shifted approximately 1.5 km (1 mi) to the north of its present estimated location and that maximum transport rates substantially exceed present conditions.

![Figure 42: Net Sediment Transport Rates over Time for Alternative One](image)

Source: USACE, 2010a

Figure 42 shows how net transport rates vary from SRIPP Year 2 (partial beach fill) through Year 14. Though it is intended that renourishment should occur at the end of Year 5, the USACE
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analysis was carried out to Year 14 without renourishment to help determine if adverse impacts would occur on adjacent beaches if renourishment intervals are postponed or cancelled. Figure 42 shows that substantial accretion would occur adjacent to both the north and south ends of the project through Year 2. At the south end of the project, over time, the transport rate approaches a constant rate that is in excess of the current conditions. Accretion would occur at the north end of the project though the rate of accretion (without renourishment) decreases over time. Gross sediment transport rates were higher than for existing conditions but after beach fill, varied little year to year (USACE, 2010a).

With implementation of the SRIPP, long-term beneficial direct impacts would occur on the longshore sediment transport system in the vicinity of Wallops Island due to the addition of sand from the beach fill.

**Dredging Offshore Shoals**

Longshore sediment transport within the project area is largely controlled by coastal geomorphology such as the current location and growth of Fishing Point and the overall wave climate of the region. As discussed in Section 4.2.2.1, no significant changes to the longshore sediment transport system are anticipated from dredging either of the two proposed SRIPP borrow sites; therefore, adverse impacts on Assateague Island are not anticipated. As indicated in Section 4.2.2.1, the results USACE (2009a) modeling showed that when comparing Unnamed Shoal A with Unnamed Shoal B, no significant difference in longshore sediment transport and shoreline impacts from the dredging exist between the two shoals. The SRIPP would not affect the sediment transport processes that will continue to create the changes at Fishing Point. In addition, the SRIPP would not affect the sediment transport processes that will continue to create the changes at Tom’s Cove Isthmus.

**Alternative Two**

The types of impacts on longshore sediment transport from offshore dredging as discussed under Alternative One would be the same for Alternative Two. When comparing the net sediment transport rates just prior to renourishment under Alternative Two (Year 4 on Figure 43) to the No Action Alternative (existing conditions—see Figure 25), it is seen that the nodal point is shifted approximately 1.5 km (1 mile) to the north of its present estimated location and that maximum transport rates substantially exceed present conditions.

Figure 43 shows how net transport rates vary from SRIPP Year 2 (partial beach fill) through Year 14 with implementation of beach fill, seawall extension and a groin. Though it is intended that renourishment should occur at the end of Year 5, the USACE analysis was carried out to Year 14 without renourishment to help determine if adverse impacts would occur on adjacent beaches if renourishment intervals are postponed or cancelled. Figure 43 shows that substantial accretion would occur adjacent to both the north and south ends of the project through Year 2. At the south end of the project, over time, the transport rate approaches a constant rate that is in excess of the current conditions. Accretion would occur at the north end of the project though the rate of accretion (without renourishment) decreases over time.

While the transport rates would not be identical between Alternatives One and Two, and the groin would likely result in slightly lower rates of sediment transport within the local area around the groin, the modeling did not show a significant difference in the net sediment transport rates when comparing Alternative Two (groin) with Alternative One (no sand retention structure).
With implementation of the SRIPP, long-term beneficial direct impacts would occur on the longshore sediment transport system in the vicinity of Wallops Island due to the addition of sand from the beach fill and construction of a groin to help retain sediment on the Wallops Island shoreline.

![Figure 43: Net Sediment Transport Rates over Time for Alternative Two](image)

**Approximate location of nodal point for existing conditions**

**Approximate location of nodal point for Alternative Two**

**Assawoman Inlet (closed)**

**North end of existing seawall**

**South end of existing seawall**

**Source:** USACE, 2010a

**Figure 43:** Net Sediment Transport Rates over Time for Alternative Two

**Alternative Three**

The types of impacts on currents from offshore dredging as discussed under Alternative One would be the same for Alternative Three. As for Alternative One, when comparing the net sediment transport rates just prior to renourishment under Alternative Three (Year 4 on Figure 44) to the No Action Alternative (existing conditions—see Figure 25), it is seen that the nodal point is shifted approximately 1.5 km (1 mi) to the north of its present estimated location and that maximum transport rates substantially exceed present conditions.

Figure 44 shows how net transport rates vary from SRIPP Year 2 (partial beach fill) through Year 8 with implementation of beach fill, seawall extension and a nearshore breakwater. Though it is intended that renourishment should occur at the end of Year 5, the USACE analysis was carried out to Year 8 without renourishment to help determine if adverse impacts would occur on adjacent beaches if renourishment intervals are postponed or cancelled. Figure 44 shows that substantial accretion would occur adjacent to both the north and south ends of the project through Year 2. At the south end of the project, over time, the transport rate approaches a
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A constant rate that is in excess of the current conditions. Accretion would occur at the north end of the project though the rate of accretion (without renourishment) decreases over time.

While the transport rates would not be identical between Alternatives One and Three, and the breakwater would likely result in slightly lower rates of sediment transport within the local area around the breakwater, the modeling did not show a significant difference in the net sediment transport rates when comparing Alternative Three (breakwater) with Alternative One (no sand retention structure). Net sediment transport rates with installation of a breakwater are very similar to the rates anticipated for construction of a groin under Alternative Two.

With implementation of the SRIPP, long-term beneficial direct impacts would occur on the longshore sediment transport system in the vicinity of Wallops Island due to the addition of sand from the beach fill and construction of a breakwater to help retain sediment on the Wallops Island shoreline.

**Figure 44: Net Sediment Transport Rates over Time for Alternative Three**

### 4.2.4 Water Resources

#### 4.2.4.1 Surface Water and Water Quality on Wallops Island

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance activities and emergency repairs would occur. It is anticipated that the No Action Alternative
would have temporary impacts on surface water resources from the use of construction vehicles and heavy machinery on the beach if a spill or leak occurred. The heavy equipment and construction activities may result in the introduction of petroleum products, heavy metals, or other contaminants to nearshore waters. Construction-related impacts would be temporary, and would not likely be adverse because any accidental release of contaminants or liquid fuels would be addressed in accordance with the existing WFF ICP emergency response and clean-up measures. Implementation of BMPs for vehicle and equipment fueling and maintenance, and spill prevention and control measures would reduce potential impacts on surface water during construction.

Saltwater intrusion into the marshes on Wallops Island resulting from storm surges may increase due to sea-level rise and climate change. Saltwater intrusion would result in effects on surface water quality on the northern and southern end of Wallops Island more immediately and directly than the more developed central portion of Wallops Island where there are fewer marshes and a seawall. Because saltwater intrusion is a natural process, it is difficult to classify the affects as beneficial or adverse; however, if storm surges become more frequent and larger, the effects of during- and post-storm saltwater intrusion may create long-term impacts on the marsh environment.

**Alternative One**

No work would be done within surface waters on Wallops Island. However, Alternative One could have temporary impacts on the nearshore environment and surface water resources due to the presence of construction vehicles on existing roads and also during the use of heavy machinery on the beach or at the north end of Wallops Island. These construction activities may result in the introduction of petroleum products, heavy metals, or other contaminants to nearshore waters. Construction-related impacts would be temporary, and would not likely be adverse because any accidental release of contaminants or liquid fuels would be addressed in accordance with the existing WFF ICP emergency response and clean-up measures. Implementation of BMPs for vehicle and equipment fueling and maintenance and spill prevention and control measures would reduce potential impacts on surface water during construction.

**Alternative Two**

The types of impacts on surface waters and the mitigation measures discussed under Alternative One would be the same for Alternative Two.

**Alternative Three**

The types of impacts on surface waters and the mitigation measures discussed under Alternative One would be the same for Alternative Three.

**4.2.4.2 Wetlands**

**No Action Alternative**

Under the No Action Alternative the SRIPP would not be implemented; however, maintenance activities and emergency repairs would occur at unknown locations on Wallops Island as necessary. Emergency repairs may result in adverse impacts on wetlands or Virginia-owned subaqueous bottom lands in the nearshore environment depending on the location and scope of
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the emergency action. If work is done within either of these areas, State and Federal permits would be required. The permit process for work proposed within wetlands or subaqueous bottom land requires the submission of a JPA to the VMRC under regulation authority contained in §§28.2-103 and 28.2-1307 of the Code of Virginia. The review process takes into account various local, State and Federal statues governing the disturbance or alteration of environmental resources. The VMRC acts as an information clearinghouse and provides the application to local wetland boards, VDEQ, and the USACE for independent yet concurrent reviews. Based on the comments received from the concurrent reviews, the VMRC determines the type of permit(s) required to proceed with the project. In cases where a permit for emergency actions is required, the VMRC can issue a general wetlands permit to address catastrophic erosion situations that are attributable to specific storm events or natural calamity and thus streamline the permit process. Any necessary permits required for work involving maintenance, repair, or emergency actions in wetlands or subaqueous bottom land would be obtained by NASA prior to implementation.

Alternative One

Under Alternative One, there would be no impacts on wetlands because no wetlands are located within the construction footprint for any project activities, including the northern part of Wallops Island.

Alternative Two

Under Alternative Two, there would be no impacts on wetlands because no wetlands are located within the construction footprint for any project activities, including the northern part of Wallops Island.

Alternative Three

Under Alternative Three, there would be no impacts on wetlands because no wetlands are located within the construction footprint for any project activities, including the northern part of Wallops Island.

4.2.4.3  Marine Waters

No Action Alternative

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance activities and emergency repairs would occur. It is anticipated that the No Action Alternative could have temporary impacts on nearshore marine water resources from the use of construction vehicles and heavy machinery on the beach if a spill or leak occurred. The heavy equipment and construction activities may result in the introduction of petroleum products, heavy metals, or other contaminants to nearshore waters. Construction-related impacts would be temporary, and would not likely be adverse because any accidental release of contaminants or liquid fuels would be addressed in accordance with the existing WFF ICP emergency response and clean-up measures. Implementation of BMPs for vehicle and equipment fueling and maintenance, and spill prevention and control measures would reduce potential impacts on surface water during construction. Therefore, the No Action Alternative is not anticipated to significantly impact marine water quality.
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**Alternative One**

**Sand Placement**

There would be increased, localized turbidity associated with the beach nourishment operations in the nearshore environment from placement of the fill and from anchoring of the dredge and pump-out station. Nearshore turbidity impacts from fill placement are directly related to the quantity of fines (silt and clay) in the nourishment material.

The medium sized sand grains of the offshore borrow sites should allow for a short suspension time and containment of sediment during and after placement activities. The beach fill consists of beach quality sand of similar grain size and composition as indigenous beach sands. Turbidity impacts would be short-term and spatially-limited to the vicinity of the dredge outfall pipe, the pump-out station, and dredge anchor points. No other water quality parameters are anticipated to be substantially impacted during beach fill operations. NASA would obtain all necessary permits for sediment placement in the nearshore environment, which may include a VMRC permit, a Virginia Water Protection Permit/401 certification from the VDEQ, and USACE Section 404 permit. An evaluation report based on Section 404(b)(1) of the CWA, Guidelines for Specification of Disposal Sites for Dredged or Fill Material, has been prepared to address impacts associated with Alternative One (Appendix F). Under these guidelines, dredged or fill materials should not be discharged into the aquatic ecosystem unless it can be demonstrated that the discharge will not have an unacceptable impact from either individual or in combination with known and/or probable impacts from other activities affecting the ecosystem.

The contractor would be responsible for proper storage and disposal of any hazardous material such as oils and fuels used during the dredging and beach nourishment operations. The EPA and USCG regulations require the treatment of waste (e.g., sewage, graywater) from dredge plants and tender/service vessels and prohibit the disposal of debris into the marine environment. The dredge contractor would be required to implement a marine pollution control plan to minimize any direct impacts to water quality from construction activity. No accidental spills of diesel fuel from the dredge plant or tender vessels are expected. Personnel would implement USCG-approved safety response plans or procedures outlined in WFF’s ICP to prevent and minimize any impacts associated with a spill.

**Offshore Borrow Sites**

Temporary impacts on marine waters would occur at the borrow site. Dredging in the borrow area would result in short-term adverse effects on marine water quality, including localized increases in turbidity and slight decreases in dissolved oxygen at the location of the drag head and in the surrounding sediment plume. Suspended sediment concentrations would be elevated during and for a period (several hours) after dredging operations.

Another source of suspended sediment is the hopper overflow. As dredged sediment settles onboard, water is released back to the ocean so that transported sediment contains less water. Suspended sediment at the drag head is generally localized and close to the bottom; however, the hopper overflow usually produces a “dynamic” plume (where highly turbid water forms a turbidity plume or current through the water column), a passive phase, and sometimes a near-bottom “pancaking” or laterally spreading turbidity current phase (W.F. Baird and Associates, 2004). Dredges are often equipped with under-hull release of overflow sediment and anti-
turbidity valves, which reduce the extent of suspended sediment plumes generated by the overflow process.

Operations using hopper dredges tend to be discontinuous and associated plumes would be dispersed over a larger area. Hopper dredges trigger a small plume at the seabed from the draghead and a larger surface plume from the discharge of overspill of water with suspended sediment from the hopper (MMS, 1999). The length and shape of the surface plume generated by the overspill depends on the hydrodynamics of the water and the sediment grain size.

Although the volume of discharged material is much higher, findings about the plume dynamics of suspended sediments are much the same as plumes from trailing hopper dredges during construction aggregate mining (MMS, 1999). Detailed investigation of these types of operations off the coast of the United Kingdom found that most sediments in the plume settle out within 300 to 500 m (984 to 1,640 ft) from the dredge over a period of roughly 20 to 30 minutes and that suspended sediment concentrations returned to concentrations close to background level within an hour after completion of dredging (Hitchcock et al., 1998, cited in MMS, 1999). The distance and time increased with decreasing sediment size. In a study off the French coast, particles larger than 0.40 mm (0.02 in) settled within 1.5 km (0.9 mi) from the site. Considering that the average grain size of the potential borrow sites is estimated to range from 0.34 to 0.42 mm (0.01 to 0.02 in), it can be assumed that surface plumes from the hopper dredge should last for no more than a few hours and be no larger than 5 km (3.1 mi).

Since the dominant substrate at the borrow site is sand, it is expected to settle rapidly and cause less turbidity and oxygen demand than finer-grained sediments. No appreciable effects on dissolved oxygen, pH, or temperature are anticipated because the dredged material (sand) has low levels of organics and low biological oxygen demand. Additionally, dredging activities would occur within the open ocean where the hydrodynamics of the water column are subject to mixing and exchange with oxygen rich surface waters. Ripple marks seen on the surface of both Unnamed Shoals A and B during the 2009 benthic video survey are evidence that wave energy reaches the seafloor and mixing of the water column occurs there. It is anticipated that Alternative One would have minor, short-term impacts on marine waters at either offshore borrow site.

**North Wallops Island Borrow Site**

Although no work would be done within surface waters during excavation activities at the north Wallops Island borrow site, the nearshore marine environment could be affected if a spill or leak from construction vehicles or heavy machinery occurred. Construction-related impacts would be temporary, and would not likely be adverse because any accidental release of contaminants or liquid fuels would be addressed in accordance with the existing WFF ICP emergency response and clean-up measures. Implementation of BMPs for vehicle and equipment fueling and maintenance, and spill prevention and control measures would reduce potential impacts on surface water during construction. Therefore, excavation activities are not anticipated to significantly impact marine water quality.

**Alternative Two**

The types of impacts on marine waters and the mitigation measures discussed under Alternative One for dredging of either offshore shoal, or for use of the north Wallops Island borrow site, would be the same for Alternative Two. In addition, there is potential for short-term adverse
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water quality impacts in the nearshore and beach environment during construction of the groin if a vessel or construction equipment were to spill its fuels or other substances that could contaminate the ocean environment. The WFF ICP emergency response and clean-up measures would be implemented in the event of a spill. Toxic concentrations would be localized and temporary due to the mixing and dilution associated with wave movement. Short-term increases in turbidity during construction of the groin would occur.

**Alternative Three**

The types of impacts on marine waters and the mitigation measures discussed under Alternative One for dredging of either offshore shoal, or for use of the north Wallops Island borrow site, would be the same for Alternative Three. In addition, there is potential for short-term adverse water quality impacts in the nearshore environment during construction of the breakwater if a vessel were to spill its fuels or other substances that could contaminate the ocean environment. The WFF ICP emergency response and clean-up measures would be implemented in the event of a spill. Toxic concentrations would be localized and temporary due to the mixing and dilution associated with wave movement. Short-term increases in turbidity during construction of the breakwater would occur.

4.2.5 Floodplains

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance and emergency repair activities would occur. Because the entire island is within the 100-year floodplain, there are no practicable alternatives to conducting maintenance and repair activities within the floodplain. It is anticipated that the No Action Alternative would have no impact on floodplains.

**Alternative One**

Wallops Island is located entirely within the floodplain; therefore, all SRIPP activities on land would take place within the 100-year and 500-year floodplains. No practicable alternatives to work in the floodplain exist. The functionality of the floodplain on Wallops Island, provided both by the wetlands on the island and the area of the island itself, would not be reduced by the SRIPP. NASA would ensure that its actions comply with EO 11988, *Floodplain Management*, and 14 CFR 1216.2 (NASA Regulations on Floodplain and Wetland Management) to the maximum extent possible. Since the Proposed Action would involve federally funded and authorized construction in the 100-year floodplain, this PEIS also serves as NASA’s means for facilitating public review as required by EO 11988.

The 1.8-m-high (6-ft-high) berm, the 4.3-m-high (14-ft-high) dune at the seawall (shown conceptually on Figure 15), the seawall extension, and the new beach itself would provide some flooding reduction from ocean waters for Wallops Island facilities (USACE, 2010a). The approach of the SRIPP design is that the beach fill alone would provide storm damage reduction against smaller, more frequent storms, leaving the seawall intact to protect against the largest storms expected over the lifetime of the project. The SRIPP would not include storm damage reduction as a result of flooding from the back bays and waterways on the north, west, and south sides of Wallops Island. Substantial, long-term direct impacts on the floodplain as a result of the beach fill and seawall extension would occur under Alternative One.
Alternative Two
Under Alternative Two, the impacts on floodplains would be the same as those described for Alternative One.

Alternative Three
Under Alternative Three, the impacts on floodplains would be the same as those described for Alternative One.

4.2.6 Coastal Zone Management

No Action Alternative
Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance and emergency repair activities would occur. Maintenance activities may require a permit from VMRC for work within the coastal zone. Wallops Island is exempt from CBRA. It is anticipated that the No Action Alternative would have no impact on the coastal zone because NASA would ensure that any project activities comply with the enforceable policies of the Virginia’s Coastal Resources Management Program.

Proposed Action Alternatives
SRIPP activities within the coastal zone would have reasonably foreseeable effects on coastal resources. Based upon the information and analysis in this PEIS and the Federal Consistency Determination (Appendix G), NASA determined that the proposed SRIPP activities are consistent to the maximum extent practicable with the enforceable policies of the Virginia Coastal Resources Management Program (Table 30).

Table 30: Federal Consistency Determination

<table>
<thead>
<tr>
<th>Virginia Policy</th>
<th>Consistent?</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisheries Management</td>
<td>Yes</td>
<td>There would be short-term site-specific adverse effects on fish habitat within the fill placement area due to temporary burial of existing benthic habitat and increased levels of turbidity during and immediately after sand placement. Benthic habitats would recover post-project. No impacts on commercial or recreational fishing are anticipated. The proposed action would not violate the provisions outlined in Code of Virginia § 28.2-200 through 28.2-713 and Code of Virginia § 29.1-100 through 29.1-570.</td>
</tr>
<tr>
<td>Subaqueous Lands Management</td>
<td>Yes</td>
<td>The creation of a beach along Wallops Island would affect existing subaqueous areas in the nearshore ocean environment. Elevated turbidity in marine waters would occur during and immediately after beach fill. The newly created beach profile would extend approximately 21 meters (70 feet) above water from the existing shoreline and continue for a maximum of 52 meters (170 feet) underwater, resulting in a new bathymetric profile in the subaqueous lands immediately east of Wallops Island. Permits would be obtained from VMRC to ensure compliance with CZMP policies.</td>
</tr>
</tbody>
</table>
### Environmental Consequences

<table>
<thead>
<tr>
<th>Virginia Policy</th>
<th>Consistent?</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetlands Management</td>
<td>Yes</td>
<td>Project activities would not impact wetlands.</td>
</tr>
<tr>
<td>Dunes Management</td>
<td>Yes</td>
<td>Project activities would involve the creation of a beach and dunes along 6 kilometers (3 miles) of the Wallops Island shoreline over the top of the existing seawall. No destruction of existing dunes would occur. Permits would be obtained from VMRC to ensure compliance with CZMP policies.</td>
</tr>
<tr>
<td>Non-point Source Pollution Control</td>
<td>Yes</td>
<td>Construction activities could temporarily increase non-point source runoff to the Atlantic Ocean during the duration of the project. NASA would implement appropriate best management practices to minimize the impact. All land-disturbing activities would be conducted on the existing beach (seawall construction and use of north Wallops Island for beach renourishment) and newly created beach.</td>
</tr>
<tr>
<td>Point Source Pollution Control</td>
<td>Yes</td>
<td>The project would not involve a new point source discharge to Virginia waters.</td>
</tr>
<tr>
<td>Shoreline Sanitation</td>
<td>Yes</td>
<td>The project would not involve the construction of septic tanks.</td>
</tr>
<tr>
<td>Air Pollution Control</td>
<td>Yes</td>
<td>Use of equipment for construction of the seawall extension, movement of sand placed on the newly created beach, and excavation of sand at the north end of Wallops Island along with barge operations for dredging and transport of sand would result in emissions. NASA would minimize adverse impacts to air quality by implementing best management practices. The project would not violate Federal or Virginia air quality standards.</td>
</tr>
<tr>
<td>Coastal Lands Management</td>
<td>Yes</td>
<td>The proposed project would not include land development activities that would impact the Chesapeake Bay or its tributaries.</td>
</tr>
</tbody>
</table>

#### 4.2.7 Air Quality and Climate Change

All of the activities associated with the Proposed Action Alternatives would occur in an attainment area for all criteria pollutants; therefore, there is no requirement to perform a General Conformity evaluation, which is applicable only to areas designated as non-attainment or maintenance areas. Additionally, it is not necessary to conduct a PSD Applicability Analysis, as there are no stationary emission sources associated with any of the Proposed Action Alternatives. Subsequently, the WFF State operating permit would not be affected or need to be modified.

**No Action Alternative**

Under the No Action Alternative, activities would remain at present levels as described in Section 3.1.10 (calendar year 2008 WFF GHG emissions tables) and there would be no additional impacts to air quality and no increase in GHG emissions.
Alternative One

Seawall Extension

Prior to the construction of the seawall extension, the rock material would need to be brought onto WFF, transported from a specified location (i.e., the New Church, VA, train station, as the material would initially be transported by electric train) and stockpiled on the beach near the barge loading area. Emission calculations include those associated with the transport of rock by heavy-duty diesel trucks to an unloading site on the beach. Depending on weather conditions and road conditions/type, these trucks may generate fugitive particulates (i.e., dust) while traveling on WFF roads. However, these emissions would be minimized by implementing BMPs such as lower speed limits for construction-related equipment and the implementation of dust suppression procedures (e.g., application of water) when necessary.

During the construction phase of this additional seawall, diesel emissions would be generated mostly from large construction equipment (i.e., heavy lifting equipment such as a crane and dozer) and a marine vessel (i.e., barge). In addition, it was assumed that the construction crew would drive to the work site every day in their personally-owned vehicles (POVs, e.g., light-duty trucks), conservatively assuming that each person would drive their own vehicle.

Calculations were performed using approved emission factors and conservative assumptions. To help minimize emissions under this alternative, vehicles and equipment used for all of the proposed construction would be maintained in good working order. Additionally, the non-road diesel engines are required by law to utilize low-sulfur diesel, which must meet a 500 ppm sulfur maximum. Idling of construction equipment would be prohibited where feasible, except for certain equipment (i.e., barge, crane, and loaders) for which idling is necessary and would be unavoidable. Virginia regulations do not impose any idling restrictions on this type of construction equipment. Based on the quantification of criteria emissions (Table 31) and the short duration of time (approximately 3 months) of operating fossil-fuel burning equipment, it is unlikely that these emissions would have an impact on the area’s compliance with the NAAQS.

Table 31: Emissions from Construction Activities Associated with Seawall Extension

<table>
<thead>
<tr>
<th>Emission Sources</th>
<th>Emissions in tons per year</th>
<th>Emissions in metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOₓ</td>
</tr>
<tr>
<td>Personal Vehicles</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>(Light-Duty Diesel Trucks)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy-Duty Diesel Trucks</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Tugboat/Barge</td>
<td>5.3</td>
<td>27.7</td>
</tr>
<tr>
<td>Construction Equipment</td>
<td>1.4</td>
<td>4.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6.9</td>
<td>32.5</td>
</tr>
</tbody>
</table>

Beach Fill – Sand Placement and Dredging Operations

Initial Beach Fill

During the initial beach fill, air emissions would result from propulsion of the barge when in transit between the borrow site and the mooring buoy, dredging, pumping of sand to the beach,
placement and relocation of mooring buoys, and the placement of beach fill material. It is assumed that two hopper dredges would operate simultaneously. Each vessel would be equipped with propulsion engines totaling 8,000 horsepower (hp) and pumping/jetting engines totaling 5,000 hp, and would carry an average of 2,300 m³ (3,000 yd³) per trip. Allowance was made for 10 percent downtime for equipment operation due to refueling, weather, or mechanical problems. For Unnamed Shoal A, the one-way travel distance from the shoal site to the mooring buoy would be 27 km (17 mi), and the barge would make an average of 3.1 round trips per day. For Unnamed Shoal B, the travel distance would be 35 km (22 mi) and the barge would make an average of 2.6 round trips per day. The duration of dredging would be 216 days for Shoal A and 257 days for Shoal B.

The initial placement and relocations of the mooring buoys would be accomplished using a 5,000-hp derrick barge, two 2,000-hp work barges, and two 1,000-hp tender tugs. Placement and removal would take a total of 12 hours per buoy. It was assumed that there would be 10 separate placements and removals over the duration of the project. Beach fill activities would require four 215-hp bulldozers operating 24 hours per day at each of two sites where sand would be pumped to shore. In addition, a light all terrain vehicle (ATV) or light truck would be needed.

Emissions for barge propulsion and tug boats were based on the EPA report entitled *Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories* (EPA, 2009c). Emissions from the pumps and generators were based on AP-42 (EPA, 2009b). The total estimated emissions are presented in Table 32. To help minimize emissions under this alternative, vehicles and equipment used for all of the proposed activities would be maintained in good working order. Additionally, the ATV would be subject to the non-road diesel engines requirements to utilize low-sulfur diesel, which must meet a 500-ppm sulfur maximum. Idling of equipment would be prohibited where feasible, except for the barge, for which idling is necessary and would be unavoidable. The Commonwealth of Virginia regulations do not impose any idling restrictions on this type of equipment. There would be temporary, localized increases in the concentration of these pollutants in the ambient air. Most of the area affected would be over water. Based on the quantification of criteria emissions (see Table 32) and the short duration of time (approximately 7 months) of operating fossil-fuel-burning equipment, it is unlikely that these emissions would have an impact on the area’s compliance with the NAAQS.
Environmental Consequences

Table 32: Alternative One Emissions from Dredging and Initial Beach Fill

<table>
<thead>
<tr>
<th>Unnamed Shoal A</th>
<th>Tons per year</th>
<th>Metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOₓ</td>
</tr>
<tr>
<td>Dredging and Transport</td>
<td>76.2</td>
<td>602.9</td>
</tr>
<tr>
<td>Relocate Mooring Buoys</td>
<td>0.8</td>
<td>6.9</td>
</tr>
<tr>
<td>Beach Fill Placement</td>
<td>13.5</td>
<td>46.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>90.4</td>
<td>656.4</td>
</tr>
</tbody>
</table>

Unnamed Shoal B

|                | CO | NOₓ | VOC | PM | SOₓ | CO₂ | N₂O | CH₄ | CO₂e |
| Dredging and Transport | 86.7 | 712.8 | 24.9 | 21.8 | 10.5 | 33,057 | 1.1 | 0.6 | 33,416 |
| Relocate Mooring Buoys   | 0.8 | 6.9 | 0.3 | 0.2 | 0.1 | 339 | 1.5E-02 | 2.0E-03 | 334.12 |
| Beach Fill Placement   | 16.0 | 55.4 | 4.2 | 3.9 | 8.7 | 35 | 1.0E-03 | 3.0E-03 | 35.38 |
| TOTAL                  | 103.5 | 775.1 | 29.3 | 25.9 | 19.3 | 33,432 | 1.1 | 0.6 | 33,796 |

Renourishment from Offshore Borrow Sites

In each of the nine renourishment cycles, a total of 616,000 m³ (806,000 yd³) of sand would be placed on the beach. With dredging operations occurring at both shoals, the duration of the project would be 56 days for Shoal A, and 65 days for Shoal B. The total emissions are provided in Table 33. Air quality impacts would be the same as for the initial beach fill, but would occur over a shorter duration. To minimize downtime due to weather, NASA would conduct renourishment activities in the more favorable summer season when possible.

Table 33: Alternative One Emissions from Dredging and Renourishment Fill

<table>
<thead>
<tr>
<th>Unnamed Shoal A</th>
<th>Tons per year</th>
<th>Metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOₓ</td>
</tr>
<tr>
<td>Dredging and Transport</td>
<td>19.2</td>
<td>151.9</td>
</tr>
<tr>
<td>Relocate Mooring Buoys</td>
<td>0.8</td>
<td>6.9</td>
</tr>
<tr>
<td>Beach Fill Placement</td>
<td>3.4</td>
<td>11.7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>23.4</td>
<td>170.6</td>
</tr>
</tbody>
</table>

Unnamed Shoal B

|                | CO | NOₓ | VOC | PM | SOₓ | CO₂ | N₂O | CH₄ | CO₂e |
| Dredging and Transport | 21.9 | 179.6 | 6.3 | 5.5 | 2.6 | 8,327 | 0.3 | 0.1 | 8,417.46 |
| Relocate Mooring Buoys   | 0.8 | 6.9 | 0.3 | 0.2 | 0.1 | 339 | 1.5E-02 | 2.0E-03 | 344.04 |
| Beach Fill Placement   | 4.0 | 14.0 | 1.1 | 1.0 | 2.2 | 9 | 2.6E-04 | 7.5E-04 | 8.91 |
| TOTAL                  | 26.7 | 200.5 | 7.6 | 6.7 | 4.9 | 8,675 | 0.3 | 0.1 | 8,770 |
North Wallops Island Borrow Site

The collection of accumulated sand from the northern end of Wallops Island every 5 years for renourishment of the Wallops Island shoreline would result in emissions from construction crew POVs traveling to and from the work site. In addition, emissions from non-road construction equipment (e.g., excavators, bulldozers) used to collect, transport, and distribute the sand on the beach would occur. It is anticipated that the equipment used for the borrow site activity would include excavators, bulldozers, loaders, and specialized beach-going dump trucks. The excavator would transport the sand to a stockpile, assumed to be at the southern point of the borrow site. At the stockpile, the loaders would move the sand into the bed of each dump truck. Thus, the loaders would need to be stationary and idling continuously during this operation. The internal combustion engines powering all of the construction equipment and vehicles would burn diesel fuel.

Borrow-site-related impacts are expected to be limited to the renourishment activity duration (6 months) and area of the activity. Calculations were performed using approved emission factors and conservative assumptions. Based on the quantification of criteria emissions (Table 34), it is unlikely that these emissions would have an impact on the area’s compliance with the NAAQS.

<table>
<thead>
<tr>
<th>Emission Sources</th>
<th>Emissions in tons per year</th>
<th>Emissions in metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>Pan Excavator</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Bulldozer</td>
<td>1.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Dump Truck</td>
<td>1.3</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Light Duty Trucks (POVs)</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Loader</td>
<td>1.9</td>
<td>4.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4.5</td>
<td>9.1</td>
</tr>
</tbody>
</table>

Summary of Alternative One Emissions

The No Action Alternative is the baseline for comparison of air quality impacts. Depending on which borrow sites would be utilized for the renourishment cycles, the emissions from each element within this alternative (seawall construction and beach fill) are combined into different scenarios to help demonstrate the estimated emissions (Table 35 and Table 36). Based on the quantification of criteria pollutants for all elements of Alternative One, it is reasonable to conclude that these activities would not have a long-term adverse impact on air quality in the project area.
Table 35: Alternative One Emissions Summary for Initial Beach Fill

<table>
<thead>
<tr>
<th>Shoal</th>
<th>CO</th>
<th>NOx</th>
<th>VOC</th>
<th>PM</th>
<th>SOx</th>
<th>CO2</th>
<th>N2O</th>
<th>CH4</th>
<th>CO2e</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>106.6</td>
<td>751.4</td>
<td>28.2</td>
<td>24.5</td>
<td>18.4</td>
<td>36,929.5</td>
<td>1.0</td>
<td>&lt;1</td>
<td>37,257.3</td>
</tr>
<tr>
<td>B2</td>
<td>121.0</td>
<td>882.3</td>
<td>33.4</td>
<td>29.3</td>
<td>21.8</td>
<td>43,637.5</td>
<td>1.3</td>
<td>&lt;1</td>
<td>41,077.5</td>
</tr>
</tbody>
</table>

1 Assuming seawall construction and initial beach fill utilizing Shoal A only.
2 Assuming seawall construction and initial beach fill utilizing Shoal B only.

Table 36: Alternative One Emissions Summary for Renourishment Beach Fill

<table>
<thead>
<tr>
<th>Borrow Site</th>
<th>Emissions in tons per year</th>
<th>Emissions in metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>A1</td>
<td>25.8</td>
<td>188.1</td>
</tr>
<tr>
<td>B2</td>
<td>29.4</td>
<td>221.0</td>
</tr>
<tr>
<td>A-W.I.3</td>
<td>20.5</td>
<td>132.1</td>
</tr>
<tr>
<td>B-W.I.4</td>
<td>22.9</td>
<td>154.1</td>
</tr>
</tbody>
</table>

1 Assuming renourishment utilizing Shoal A only.
2 Assuming renourishment utilizing Shoal B only.
3 Assuming half of renourishment is obtained from Shoal A and half from the north Wallops Island borrow site.
4 Assuming half of renourishment is obtained from Shoal B and half from the north Wallops Island borrow site.

Although there are no formally adopted NEPA thresholds of significance for GHG emissions, there are a multitude of State and regional regulatory programs requiring GHG emissions reductions. The Governor of Virginia issued Executive Order 59 in 2007, which established the “Governor’s Commission on Climate Change” (Bryant, 2008). However, due to the absence of such thresholds, it is challenging to determine the level of proposed emissions that would substantially contribute to global climate change.

Given the absence of science-based or adopted NEPA significance thresholds for GHGs, the CO2e emissions from Alternative One are compared to the EPA GHG baseline inventory of 2007 to determine the relative increase in proposed GHG emissions.

Table 37 summaries the annual GHG emissions from Alternative One and the most recent U.S. annual baseline GHG emissions. This data shows the ratio of CO2e emissions resulting from Alternative 1 to all sources in the United States is approximately 0.047/7,150 million metric tonnes. CO2e emissions from this alternative would amount to approximately 6.62x10^-4 percent of the total GHG emissions generated by the United States. GHG emissions from Alternative One are the highest of all proposed alternatives, therefore it can be assumed that under any of the alternatives, the cumulative impacts of global climate change would not be substantial.

Table 37: Alternative One Construction Emissions for Wallops Mainland/Island

<table>
<thead>
<tr>
<th>Scenario/Activity</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative One1 (metric tonnes per year)</td>
<td>47,325</td>
</tr>
<tr>
<td>U.S. 2007 Baseline Emissions2 (10^6 metric tonnes per year)</td>
<td>7,150</td>
</tr>
<tr>
<td>Proposed Emissions as a % of U.S. Emissions</td>
<td>6.62x10^-4</td>
</tr>
</tbody>
</table>

Source: EPA, 2009b
1 Total emissions for Alternative One assume of use of Shoal A only for initial and renourishment fills, and Wallops Island construction emissions
2 Baseline emissions include all rocket launches from WFF during 2007
Environmental Consequences

Alternative Two

Seawall Extension

The construction activities and emissions associated with the seawall extension would be the same as outlined under Alternative One.

Groin

Similar to construction of the seawall extension, the groin construction would require similar-sized rocks, which would also be transported by heavy-duty trucks from the same train depot location. However, the number of vehicle trips would be less due to the smaller size of the groin compared to the seawall extension.

Similar to Alternative One, calculations were performed using approved emission factors and conservative assumptions. Construction activities for this alternative include those associated with the seawall extension and groin. Mitigation of emissions would be similar to Alternative One. Based on the quantification of criteria (Table 38) and the short duration (approximately 1 month) of operating fossil-fuel burning equipment for the groin construction, it is unlikely that these emissions would have an impact on the area’s compliance with the NAAQS.

Table 38: Emissions from Groin Construction Activities

<table>
<thead>
<tr>
<th>Emission Sources</th>
<th>Emissions in tons per year</th>
<th>Emissions in metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOₓ</td>
</tr>
<tr>
<td>Personal Vehicles (Light-Duty Diesel Trucks)</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Heavy-Duty Diesel Trucks</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Tugboat/Barge</td>
<td>7.2</td>
<td>29.0</td>
</tr>
<tr>
<td>Construction Vehicles</td>
<td>1.9</td>
<td>6.3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>9.5</td>
<td>35.8</td>
</tr>
</tbody>
</table>

Beach Fill

Initial Beach Fill

With dredging operations occurring at both shoals, the duration of the project would be 197 days for Shoal A and 234 days for Shoal B. The total emissions are provided in Table 39. Air quality impacts would be the same as for the Alternative One initial beach fill.
Environmental Consequences

Table 39: Alternative Two Emissions from Dredging and Initial Beach Fill

<table>
<thead>
<tr>
<th>Unnamed Shoal A</th>
<th>Tons per year</th>
<th>Metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>Dredging and Transport</td>
<td>69.5</td>
<td>549.6</td>
</tr>
<tr>
<td>Relocate Mooring Buoys</td>
<td>0.8</td>
<td>6.9</td>
</tr>
<tr>
<td>Beach Fill Placement</td>
<td>12.3</td>
<td>42.4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>82.5</td>
<td>598.9</td>
</tr>
</tbody>
</table>

Unnamed Shoal B

| CO | NOx | VOC | PM | SOx | CO2 | N2O | CH4 | CO2e |
|-----------------|---------------|------------------------|
| Dredging and Transport | 79.1 | 649.7 | 22.7 | 19.9 | 9.5 | 30,126 | 1.0 | 0.5 | 30,453.26 |
| Relocate Mooring Buoys | 0.8 | 6.9 | 0.3 | 0.2 | 0.1 | 339 | 1.5E-02 | 2.0E-03 | 344.04 |
| Beach Fill Placement | 14.6 | 50.5 | 3.8 | 3.5 | 7.9 | 32 | 9.3E-04 | 2.7E-03 | 32.24 |
| TOTAL | 94.4 | 707.1 | 26.8 | 23.7 | 17.6 | 30,498 | 1.0 | 0.5 | 30,830 |

Renourishment from Offshore Borrow Sites

With dredging operations occurring at both shoals, the duration of the project would be 49 days for Shoal A and 58 days for Shoal B. The total emissions are given in Table 40. The air quality impacts would be the same as for the initial beach fill, but would occur over a shorter duration. Renourishment activities would be carried out in the more favorable summer season when possible, thus avoiding downtime due to weather.

Table 40: Alternative Two Emissions from Dredging and Renourishment Fill

<table>
<thead>
<tr>
<th>Unnamed Shoal A</th>
<th>Tons per year</th>
<th>Metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>Dredging and Transport</td>
<td>17.2</td>
<td>136.1</td>
</tr>
<tr>
<td>Relocate Mooring Buoys</td>
<td>0.8</td>
<td>6.9</td>
</tr>
<tr>
<td>Beach Fill Placement</td>
<td>3.0</td>
<td>10.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>21.0</td>
<td>153.5</td>
</tr>
</tbody>
</table>

Unnamed Shoal B

| CO | NOx | VOC | PM | SOx | CO2 | N2O | CH4 | CO2e |
|-----------------|---------------|------------------------|
| Dredging and Transport | 19.6 | 160.9 | 5.6 | 4.9 | 2.4 | 7,459 | 0.3 | 0.1 | 7,540.21 |
| Relocate Mooring Buoys | 0.8 | 6.9 | 0.3 | 0.2 | 0.1 | 339 | 1.5E-02 | 2.0E-03 | 344.04 |
| Beach Fill Placement | 3.6 | 12.5 | 0.9 | 0.9 | 2.0 | 7.9 | 2.3E-04 | 6.8E-04 | 7.98 |
| TOTAL | 24.0 | 180.3 | 6.8 | 6.0 | 4.4 | 7,806 | 0.3 | 0.1 | 7,892 |
North Wallops Island Borrow Site

Impacts from borrow site activities associated with sand removal from north Wallops Island would be slightly less than those described under Alternative One.

Summary of Alternative Two Emissions

The No Action Alternative is the baseline for comparison of air quality impacts. Depending on what sources would be utilized for one of the renourishment activities, the emissions from each element within this alternative are combined into different scenarios to help demonstrate the estimated emissions (Table 41 and Table 42). Based on the quantification of criteria pollutants for all elements of Alternative Two, it is reasonable to conclude that these activities would not have a long-term adverse impact on air quality in the project area. It is not possible to address the significance of potential impacts from GHG emissions, and therefore no significance conclusion or mitigation can be made or adopted due to the lack of regulatory guidance for that determination to be sound (Jones and Stokes, 2007).

<table>
<thead>
<tr>
<th>Shoal</th>
<th>Emissions in tons per year</th>
<th>Emissions in metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>A1</td>
<td>100.4</td>
<td>696.1</td>
</tr>
<tr>
<td>B2</td>
<td>113.6</td>
<td>815.4</td>
</tr>
</tbody>
</table>

1Assuming groin, seawall extension, and initial beach fill utilizing Shoal A only.
2Assuming groin, seawall extension, and initial beach fill utilizing Shoal B only.

<table>
<thead>
<tr>
<th>Borrow Site</th>
<th>Emissions in tons per year</th>
<th>Emissions in metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>A1</td>
<td>23.2</td>
<td>169.2</td>
</tr>
<tr>
<td>B2</td>
<td>26.5</td>
<td>198.8</td>
</tr>
<tr>
<td>A-W.I.3</td>
<td>18.3</td>
<td>118.7</td>
</tr>
<tr>
<td>B-W.I.4</td>
<td>20.5</td>
<td>138.4</td>
</tr>
</tbody>
</table>

1Assuming renourishment utilizing Shoal A only.
2Assuming renourishment utilizing Shoal B only.
3Assuming half of renourishment is obtained from Shoal A and half from the north Wallops Island borrow site.
4Assuming half of renourishment is obtained from Shoal B and half from the north Wallops Island borrow site.

Alternative Three

Seawall Extension

The construction activities, and subsequent emissions, associated with the seawall extension would be the same as outlined under Alternative One.
Environmental Consequences

Breakwater

Similar to construction of the seawall extension, the breakwater construction would require similar-sized rocks, which would also be transported by heavy-duty trucks from the same train depot location. However, the number of vehicle trips would be less due to the smaller size of the breakwater compared to the seawall extension. Although the breakwater could be constructed entirely from land or from barges in the ocean, the ocean-construction scenario was used in the emissions analysis. Equipment that would likely be used for the breakwater construction from the ocean is anticipated to include dump trucks, a tugboat and barge, and a crane. The internal combustion engines powering the construction equipment and vehicles would burn diesel fuel.

Similar to Alternative One, calculations were performed using approved emission factors and conservative assumptions. The construction activities for this alternative include those associated with the seawall extension and breakwater. The mitigation of emissions would be similar to Alternative One. Based on the quantification of criteria emissions (Table 43) and the short duration (approximately 1 month) of operating fossil-fuel burning equipment for this construction, it is unlikely that these emissions would have an impact on the area’s compliance with the NAAQS.

<table>
<thead>
<tr>
<th>Emission Sources</th>
<th>Emissions in tons per year</th>
<th>Emissions in metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NO&lt;sub&gt;x&lt;/sub&gt;</td>
</tr>
<tr>
<td>Personal Vehicles (Light-Duty Diesel Trucks)</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Heavy-Duty Diesel Trucks</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Tugboat/Barge</td>
<td>6.6</td>
<td>28.8</td>
</tr>
<tr>
<td>Construction Vehicles</td>
<td>1.7</td>
<td>5.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>8.5</td>
<td>34.4</td>
</tr>
</tbody>
</table>

Beach Fill

Initial Beach Fill

With dredging operations at both shoals, the duration of the project would be 192 days for Shoal A and 228 days for Shoal B. The total emissions are given in Table 44. The air quality impacts and mitigation strategies would be the same as for the Alternative One beach fill.
Table 44: Alternative Three Emissions from Dredging and Initial Beach Fill

<table>
<thead>
<tr>
<th>Unnamed Shoal A</th>
<th>Tons per year</th>
<th>Metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>Dredging and Transport</td>
<td>67.6</td>
<td>535.1</td>
</tr>
<tr>
<td>Relocate Mooring Buoys</td>
<td>0.8</td>
<td>6.9</td>
</tr>
<tr>
<td>Beach Fill Placement</td>
<td>11.9</td>
<td>41.3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>80.3</strong></td>
<td><strong>583.3</strong></td>
</tr>
</tbody>
</table>

Table 45: Alternative Three Emissions from Dredging and Renourishment Fill

<table>
<thead>
<tr>
<th>Unnamed Shoal A</th>
<th>Tons per year</th>
<th>Metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>Dredging and Transport</td>
<td>16.7</td>
<td>132.5</td>
</tr>
<tr>
<td>Relocate Mooring Buoys</td>
<td>0.8</td>
<td>6.9</td>
</tr>
<tr>
<td>Beach Fill Placement</td>
<td>3.0</td>
<td>10.2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>20.5</strong></td>
<td><strong>149.7</strong></td>
</tr>
</tbody>
</table>

Renourishment from Offshore Borrow Sites

With dredging operations occurring at both shoals, the duration of the project would be 47 days for Shoal A and 57 days for Shoal B. The total emissions are given in Table 45. The air quality impacts would be the same as for the initial beach fill, but would occur over a shorter duration. The renourishment activities would be carried out in the more favorable summer season when possible, thus avoiding downtime due to weather.

Table 45: Alternative Three Emissions from Dredging and Renourishment Fill

<table>
<thead>
<tr>
<th>Unnamed Shoal A</th>
<th>Tons per year</th>
<th>Metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>Dredging and Transport</td>
<td>19.1</td>
<td>156.6</td>
</tr>
<tr>
<td>Relocate Mooring Buoys</td>
<td>0.8</td>
<td>6.9</td>
</tr>
<tr>
<td>Beach Fill Placement</td>
<td>3.5</td>
<td>12.2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>23.3</strong></td>
<td><strong>175.7</strong></td>
</tr>
</tbody>
</table>

North Wallops Island Borrow Site

The impacts from borrow-site activities associated with sand removal from north Wallops Island would be slightly less than those described under Alternative One.
Summary of Alternative Three Emissions

The No Action Alternative is the baseline for comparison of air quality impacts. Depending on what sources would be utilized for one of the renourishment activities, the emissions from each element within this alternative are combined into different scenarios to help demonstrate the estimated emissions (see Table 46 and Table 47). Based on the quantification of criteria pollutants for all elements of Alternative Three, it is reasonable to conclude that these activities would not have a long-term adverse impact on air quality in the project area. It is not possible to address the significance of potential impacts from GHG emissions, and therefore no significance conclusion or mitigation can be made or adopted due to the lack of regulatory guidance for that determination to be sound (Jones and Stokes, 2007).

Table 46: Alternative Three Emissions Summary for Initial Beach Fill

<table>
<thead>
<tr>
<th>Shoal</th>
<th>Emissions in tons per year</th>
<th>Emissions in metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>A1</td>
<td>97.0</td>
<td>677.5</td>
</tr>
<tr>
<td>B2</td>
<td>109.9</td>
<td>793.6</td>
</tr>
</tbody>
</table>

1Assuming groin, seawall extension, and initial beach fill utilizing Shoal A only.
2Assuming groin, seawall extension, and initial beach fill utilizing Shoal B only.

Table 47: Alternative Three Emissions Summary for Renourishment Beach Fill

<table>
<thead>
<tr>
<th>Borrow Site</th>
<th>Emissions in tons per year</th>
<th>Emissions in metric tonnes per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>NOx</td>
</tr>
<tr>
<td>A1</td>
<td>22.6</td>
<td>165.1</td>
</tr>
<tr>
<td>B2</td>
<td>25.7</td>
<td>193.7</td>
</tr>
<tr>
<td>A-W.I.3</td>
<td>18.0</td>
<td>116.1</td>
</tr>
<tr>
<td>B-W.I.4</td>
<td>20.1</td>
<td>135.2</td>
</tr>
</tbody>
</table>

1Assuming renourishment utilizing Shoal A only.
2Assuming renourishment utilizing Shoal B only.
3Assuming half of renourishment is obtained from Shoal A and half from the north Wallops Island borrow site.
4Assuming half of renourishment is obtained from Shoal B and half from the north Wallops Island borrow site.

4.2.8 Noise

The following text describes potential impacts on the airborne noise environment. Potential underwater noise impacts on marine mammals are described in Section 4.3.2.8.

No Action Alternative

Under the No Action Alternative, project-specific short-term impacts on noise would occur during maintenance and emergency repair activities. Impacts on noise would be dependent on the type, length, and frequency of the activities, but are not anticipated to be significant.

Alternative One

There are no adjacent communities or sensitive noise receptors close enough to Wallops Island to be affected by noise generated from SRIPP activities.

Under Alternative One, there would be temporary increases in noise levels from the operation of heavy equipment on Wallops Island, especially in the beach area during construction of the
seawall, moving the beach fill into place, or during sediment removal at the north Wallops Island borrow site. However, none of the project activities would occur near occupied facilities, so noise impacts on WFF employees and tenants would be minimal. Additionally, SRIPP activities, including haul trucks traveling on Wallops Island roads, are not anticipated to be outside the range of existing noise levels from vehicles, airplanes, and barges at WFF. NASA would comply with local noise ordinances and State and Federal standards and guidelines for potential impacts on humans caused by construction activities in order to mitigate potential impacts on NASA personnel.

OSHA limits noise exposure for workers to 115 dB for a period of no longer than 15 minutes in an 8-hour work shift, and to 90 dB for an entire 8-hour shift. Workers near activities producing unsafe noise levels, both on land and water, would be required to wear hearing protection equipment. Therefore, impacts on the occupational health of construction workers as a result of construction noise are not expected.

Ambient underwater sound levels at the offshore borrow sites would increase during dredge operations. Much of the sound produced during filling of the hopper is associated with propeller and engine noise with additional sounds emitted by pumps and generators.

**Alternative Two**

Under Alternative Two, the types of impacts and mitigation measures would be the same as described under Alternative One; however increased noise levels at the south end of Wallops Island would continue for a longer period of time compared to Alternative One due to construction of the groin in that area.

**Alternative Three**

Under Alternative Three, the types of impacts and mitigation measures would be the same as described under Alternative One; however, increased noise levels at the south end of Wallops Island would continue for a longer period of time compared to Alternative One due to construction of the breakwater in that area.

**4.2.9 Hazardous Materials and Hazardous Waste Management**

**No Action Alternative**

Under the No Action Alternative, impacts from hazardous materials and hazardous waste are possible because existing infrastructure containing storage areas or accumulation points would continually be at risk from wave overtopping and flooding (especially during severe storm events), as well as continued shoreline retreat. NASA would likely remove hazardous materials and hazardous wastes from Wallops Island more frequently and prior to threatening weather to lessen potential impacts from hazardous materials and hazardous waste.

Maintenance or emergency repair activities may include the use of hazardous materials and hazardous waste generation (i.e., solvents, hydraulic fluid, oil, and antifreeze). With implementation of safety measures and proper procedures for the handling, storage, and disposal of hazardous materials and wastes during construction activities, no adverse impacts are anticipated during construction.
Environmental Consequences

**Alternative One**

Construction activities would include the use of hazardous materials and hazardous waste generation (i.e., solvents, hydraulic fluid, oil, and antifreeze). With implementation of safety measures and proper procedures for the handling, storage, and disposal of hazardous materials and wastes during construction activities, no adverse impacts are anticipated during construction.

The short- and long-term effects of an accident on the environment would vary greatly depending upon the type of accident and the substances involved. NASA has implemented various controls to prevent or minimize the effects of an accident involving hazardous materials on NASA property, including the following:

- Preparation of an ICP
- Preparation of emergency plans and procedures designed to minimize the effect an accident has on the environment
- Maintenance of an online database (MSDSPro) of hazardous materials and the associated buildings where they are stored or used, which would be updated to include the new facilities
- Annual training for all users of hazardous materials

Implementation of Alternative One would have a beneficial impact by restoring the shoreline and increasing the distance between breaking waves and hazardous materials critical storage areas and accumulation points. No impacts on ASTs or USTs are anticipated under Alternative One because the tanks are not located within the project area. In the event of a petroleum or chemical release during construction activities, or the disturbance or movement of an AST or UST, NASA would notify VDEQ. Section 62.1-44.34:19.1 of the Code of Virginia requires an operator of a facility with a total aboveground storage capacity of more than 4,997 liters (1,320 gallons) of oil, or an operator of an individual AST with a storage capacity of more than 2,498 liters (660 gallons) of oil to register the facility or AST. ASTs with a storage capacity of 2,498 liters (660 gallons) of oil or less are exempt from registration. NASA would ensure that contractors providing ASTs to the work site have registered the ASTs as necessary to comply with Section 62.1-44.34:19.1 of the Code of Virginia.

When barge operators and any SRIPP contractors are operating vessels that are carrying hazardous waste materials, NASA would ensure that the contractors are in compliance with 49 CFR Part 176 – Carriage by Vessel. This regulation defines the general operating requirements such as certificates, cargo manifest, special permits, emergency situations, required reporting, and repairs involving welding, burning, and power-activated tools and appliances when hazardous waste materials are on board the vessel.

**Alternative Two**

The types of hazardous materials and hazardous waste management impacts, minimization and mitigation measures, and regulations for Alternative Two are the same types as those described under Alternative One.
**Alternative Three**

The types of hazardous materials and hazardous waste management impacts, minimization and mitigation measures, and regulations for Alternative Three are the same types as those described under Alternative One.

**4.2.10 Munitions and Explosives of Concern**

**No Action Alternative**

Under the No Action Alternative the SRIPP would not be implemented but emergency measures may still be implemented to protect at-risk infrastructure. It is not anticipated that MEC would constitute a safety hazard in the areas near the shoreline where maintenance or emergency repair activities would occur. However, MEC (both UXO and DMM) from the former National Advisory Committee for Aeronautics (NACA)/NASA EOD Area (Figure 29) may migrate to the Atlantic Ocean if further beach erosion occurs in the project area (USACE, 2007). Therefore, the No Action Alternative would result in potentially adverse impacts as it relates to MEC.

**Alternative One**

MEC are not anticipated to be encountered on the Wallops Island shoreline in the area of seawall construction or beach fill. It is anticipated that shoreline erosion would increase to the south of the seawall extension, which includes the area known as the former NACA/NASA EOD Area. MEC (both UXO and DMM) may migrate to the ocean if further beach erosion occurs in this area (USACE, 2007). The SRIPP beach fill would reduce the potential of MEC migration into the ocean.

During offshore dredging activities, MEC are not anticipated to be encountered on Unnamed Shoal A or B. If MEC is inadvertently encountered during dredging and accidentally placed on the Wallops Island shoreline, NASA personnel would notify the WFF Security office, who would arrange to have them properly removed. To minimize the chance that MEC would be transported to the beach, a screen would be placed over the drag head to prevent UXO from entering the hopper.

There is a potential that MEC would be encountered during excavation of the north Wallops Island borrow site. As described in Chapter 3, historic military activities in that area have resulted in a high probability of encountering MEC in the nearshore environment and on the northern end of Wallops Island. As seen on Figure 29, the sea target impact and the small arms range safety fan overlap the accreting shoreline of north Wallops Island.

To minimize the risk of adverse impacts from UXO in this area, an MEC Avoidance Plan that addresses the potential hazards would be prepared. A visual and magnetic survey of the area to locate MEC would be completed and potential hazards removed prior to excavation.

**Alternative Two**

Impacts related to MEC would be the same as described under Alternative One. No MEC is anticipated to be encountered in the area of the groin. Construction of a groin would reduce the rate of shoreline erosion, minimizing the possibility of MEC migration into the ocean via beach erosion.
**Alternative Three**

Impacts related to MEC would be the same as described under Alternative One. No MEC is anticipated to be encountered in the area of the breakwater. Construction of a breakwater would reduce the rate of shoreline erosion, minimizing the possibility of MEC migration into the ocean via beach erosion.

### 4.3 BIOLOGICAL ENVIRONMENT

#### 4.3.1 Terrestrial Environment

##### 4.3.1.1 Vegetation

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance and emergency repair activities would occur. Vegetation associated with the dune and swale zones and the shrub, thicket, and maritime forest areas located at the southern end of the island would continue to be at-risk as the shoreline continues to retreat. The ongoing accretion at the northern end of Wallops Island would continue to provide substrate for the establishment and development of vegetative communities.

Increased overwash events would impact coastal vegetation on Wallops Island. Apart from the physical destruction of plants by overwash processes, fluctuations in the elevation of the water table and variations in groundwater salinity, both spatially and temporally, would have an adverse impact on vegetation patterns. Overwash events would erode and strip vegetation in some areas and deposit sediment on other areas, burying vegetation.

The No Action Alternative could result in temporary adverse impacts on vegetation due to disturbance and removal for emergency repairs and maintenance activities. Impacts would be minimized by avoiding naturally vegetated areas and re-vegetating after construction. Over time, because this alternative would not prevent shoreline retreat, vegetation in the dune and shore environments may be adversely affected.

**Alternative One**

Alternative One would reduce the factors currently contributing to the loss of vegetative beach habitat on Wallops Island: inundation from storms, wave energy, and loss of sand. The high energy environment of the beach and surf zone cannot be tolerated by the majority of vegetation, except for a few plants which exist in the subtidal zone, phytoplankton, macro algae, and some algae attached to substructure. Therefore, addition of sand to the shoreline would result in beneficial impacts on existing vegetation. The presence of a beach is an important buffer for other vegetative zones on Wallops Island. The SRIPP would create beach and dune habitat along approximately 6.0 km (3.7 mi) of shoreline where none currently exists, allowing grasses to repopulate the upper dune areas. Vegetative species associated with dune and swale systems would also benefit from the expanded beach habitat that would be created under Alternative One. Additionally, shrub, thicket, and marine forest systems on the island would have additional storm damage reduction from erosion and wave action.

It is anticipated that under Alternative One there would be some temporary impacts on vegetation during the construction of the seawall. The movement of dump trucks carrying the
Environmental Consequences

Seawall components would likely disturb some vegetation in the upper beach zone. During renourishment cycles from the northern part of Wallops Island, vegetation is not expected to be disturbed because the pan excavator and other equipment would travel along the unvegetated beach to reach the upland borrow site. Overall, it is anticipated that Alternative One would result in beneficial impacts on Wallops Island vegetation.

**Alternative Two**

Under Alternative Two, the types of impacts on vegetation would be the same as those discussed under Alternative One; however, less beach fill volume (initial and renourishment volumes) would be required compared to Alternative One. Although there would be a slightly smaller amount of vegetative beach habitat created initially, the groin would further reduce the amount of wave energy reaching the beach and would slow longshore sediment transfer from Wallops Island shoreline. This would help maintain the beach as both a vegetative habitat for beach grasses and a buffer for other vegetative zones present on Wallops Island.

The groin would be constructed partially on land, partially in the ocean. It is anticipated that there would be temporary impacts on vegetation during the portion of the construction on land. The movement of dump trucks carrying the groin components would likely tread on vegetation in the upper beach zone; however, adverse effects are anticipated to be temporary and minor.

**Alternative Three**

Under Alternative Three, the types of impacts on vegetation would be the same as those discussed under Alternative One; however, less beach fill volume (initial and renourishment volumes) would be required compared to Alternative One. Although there would be a slightly smaller amount of vegetative beach habitat created initially, the breakwater would further reduce the amount of wave energy reaching the beach and would slow longshore sediment transfer from Wallops Island shoreline. This would help maintain the beach as both a vegetative habitat for beach grasses and a buffer for other vegetative zones present on Wallops Island. The breakwater would be constructed entirely in the ocean, so there would be no construction impacts on vegetation.

4.3.1.2 Terrestrial Wildlife

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance and emergency repair activities would occur. Based on past trends of sediment transport and erosion in the region, it is reasonable to assume that under the No Action Alternative substantial changes to Wallops Island shoreline will continue to occur. This may adversely affect migratory birds by decreasing the amount of beach habitat available for breeding, nesting, and foraging activities. Over time, this could alter the type and magnitude of terrestrial wildlife and migratory bird habitats present on Wallops Island.

**Alternative One**

The majority of terrestrial wildlife is found in the northern dune and swale zone and the western freshwater and brackish marshes of Wallops Island. Reptiles and amphibians are found among the vegetation of the dune and swale zone, so it is unlikely that they would be adversely affected by beach fill and seawall construction activities since these would not occur in the dune and
swale environment. Mammals inhabit the dune and swale zone, as well as the maritime forest in the center of the island. It is unlikely that there would be any concentration of mammals in either the seawall construction area, or in the beach nourishment area of the Wallops Island shoreline. Although they may occasionally venture into the upper beach zone, they would become startled by SRIPP-related noises and activity, and would quickly vacate the area.

Temporary minor adverse impacts on upper beach invertebrates, such as ghost crabs, on existing portions of the beach may occur during implementation of Alternative One. During beach nourishment activities, the large amount of sand placed on the beach would smother some of these organisms; however, the adverse impacts would be short term. These invertebrates would also experience adverse impacts during future renourishment cycles using sand borrowed from the unvegetated beach of north Wallops Island. Bulldozing to shape the beach has been shown to reduce the populations of ghost crabs by over 50 percent up to three months after construction activities have ended (Peterson et al., 2000). However, these adverse impacts would be temporary and highly localized. Terrestrial species found inland in vegetated areas may become startled by construction-related noises, but this would be temporary and would only last the duration of the construction.

Impacts on migratory birds are anticipated during construction of the seawall extension due to temporary noise disturbances, especially during spring and fall migrations; however, noise disturbances would be similar to existing noise from daily operations, including airplane and launch operations on Wallops Island. Impacts to threatened and endangered bird species are addressed in Section 4.3.3.

Birds in the immediate area would be startled by construction and dredge noise during beach nourishment, and are likely to leave the immediate area. This may temporarily disrupt foraging and nesting activities. However, the continued presence of migratory birds at WFF, even with the noise from flight and launch operations over the past few decades, suggests that short-term noises have not significantly disturbed birds on the island. During dredging operations at Unnamed Shoals A and B, noise disturbances from the hopper dredge are expected. These noises may cause migratory seabirds to vacate the shoal area, where they sometimes feed on schooling fish, but the adverse effects would be temporary and localized.

In addition, seabirds may experience indirect impacts at the dredge site from local changes in the fish populations during and after dredging operations.

**Alternative Two**

The types of impacts on terrestrial wildlife and migratory birds and the mitigation measures discussed under Alternative One would be the same for Alternative Two. However, because less beach fill volume (initial and renourishment volumes) would be required compared to Alternative One, there would be fewer barge trips and less potential for disturbance of migratory bird breeding, nesting, and feeding activities. Less beach fill would also decrease the amount of invertebrates lost through smothering.

The groin would provide benefits to bird populations by introducing habitat for fish that would be attracted to the inwater structure. In addition, the above water portion of the groin would provide potential roosting and resting area for birds.


**Alternative Three**

The types of impacts on terrestrial wildlife and migratory birds and the mitigation measures discussed under Alternative One would be the same for Alternative Three. However, because less beach fill volume (initial and renourishment volumes) would be required compared to Alternative One, there would be fewer barge trips and, therefore, less potential for disturbance of migratory bird breeding, nesting, and feeding activities. Less beach fill would also decrease the amount of invertebrates lost through smothering.

The breakwater would provide benefits to bird populations by introducing habitat for fish that would be attracted to the inwater structure. In addition, the above water portion of the breakwater would provide potential roosting and resting area for birds.

**4.3.2 Marine Environment**

**4.3.2.1 Submerged Aquatic Vegetation**

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance and emergency repair activities would occur. Maintenance and repair activities may result in very localized and minor increases in turbidity. These increases in turbidity would not impact SAV beds the nearest of which are located the nearest SAV bed to the SRIPP project area is in New Virginia Cove, approximately 11 km (7 mi) from the northernmost point of proposed beach fill on Wallops Island shoreline and approximately 8 km (5 mi) from the mouth of Chincoteague Inlet.

**Alternative One**

As discussed in Chapter 3, SAV is present in small amounts in the coastal bays of Wallops, Assawoman, and Chincoteague Islands. SAV is known to be sensitive to changes in water quality. Although localized increases in turbidity are anticipated during implementation of Alternative One in the nearshore area of Wallops Island, it is not expected to adversely impact SAV beds, the nearest of which is in New Virginia Cove, approximately 11 km (7 mi) from the northernmost point of proposed beach fill on Wallops Island shoreline, and approximately 8 km (5 mi) from the mouth of Chincoteague Inlet.

**Alternative Two**

The types of impacts on SAV discussed under Alternative One would be the same for Alternative Two. The minor additional turbidity associated with the construction of a groin in the southern portion of the project area would not adversely impact SAV beds located in the coastal bays of the region.

**Alternative Three**

The types of impacts on SAV discussed under Alternative One would be the same for Alternative Three. The minor additional turbidity associated with the construction of a breakwater in the southern portion of the project area would not adversely impact SAV beds in the coastal bays of the region.
No Action Alternative
Under the No Action Alternative, there would be no dredging or in-water construction activities, therefore, there would be no impacts on plankton.

Alternative One
Sand Placement Site
Placement of sand in the surf zone would result in only minor temporary impacts on phytoplankton or zooplankton because this area is already subject to dynamic wave activity and mixing of the water column. Sand placement would result in an increase in turbidity from the resuspension of sediment at the discharge pipe along the beach. This turbidity would be carried along the shoreline and seaward. The resuspended sediment may temporarily reduce sunlight penetration that would adversely impact phytoplankton productivity. The resuspended sediment may also release organic matter that zooplankton can feed up. Burlas et al. (2001) conducted biological monitoring of a beach restoration project on the New Jersey coast and concluded that there was no obvious difference in the surf zone ichthyoplankton at the nourished beaches and nearby natural beaches.

Offshore Borrow Sites
Plankton are widely dispersed throughout the project area. Because phytoplankton and zooplankton distributions are concentrated in the upper portions of the water column and dredging would occur at the sediment surface, there should be only minor entrainment of plankton in the dredge. In addition, water release and water quality changes, such as increased turbidity and localized decreases in DO, may result in localized adverse impacts to plankton communities. Although ichthyoplankton may be entrained in the suction dredge during dredging operations, ichthyoplankton are not concentrated on sand shoals; therefore, no significant impacts on ichthyoplankton are expected under Alternative One on the two offshore sand shoals.

Alternative Two
The impacts on the plankton from dredging of offshore shoals and placement of the sand under Alternative Two would be the same as those under Alternative One. The groin would occupy a portion of the water column in the surf zone and nearshore but would not cause a negative impact to the plankton.

Alternative Three
The impacts on the plankton from dredging of offshore shoals and placement of the sand under Alternative Three would be the same as those under Alternative One. The breakwater would occupy a portion of the water column but would not cause a negative impact to the plankton.

4.3.2.3 Benthos
No Action Alternative
Under the No Action Alternative, beach habitat for benthos will continue to erode along the southern portion of Wallops Island and accrete on the northern portion. Benthic communities would continue to exist within the shifting beach landscape.
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Alternative One

Offshore Borrow Sites

Based on an initial beach fill target of approximately 2.4 million m$^3$ (3.2 million yd$^3$) and assuming a loss of 25 percent of the material during dredge and sand placement operations, a total of approximately 3.1 million m$^3$ (4 million yd$^3$) of sand would be dredged from Shoal A. It is assumed that the entire 5.2 km$^2$ (2 mi$^2$) borrow site area would be dredged for the initial beach fill requirements at a uniform dredging depth of approximately 0.6 m (2 ft). Shoal A covers approximately 700 hectares (1,800 acres), and Shoal B covers approximately 1,600 hectares (3,900 acres). Therefore, during the dredging for the initial beach placement approximately 70 percent of the surface area of Shoal A would be affected. For renourishment cycles, either Shoal A or Shoal B would be used. Under Alternative One, each renourishment cycle would require the dredging of approximately 770,000 m$^3$ (1,007,500 yd$^3$) of sand. Assuming a uniform dredging depth of 0.6 m (2 ft), approximately 140 hectares (347 acres) or approximately 19 percent of the total area of Shoal A or 9 percent of the total area of Shoal B would be dredged.

Dredging sand from either offshore shoal would have a significant and immediate adverse impact on the local benthic community of the shoal. The primary direct effect would be the removal of sand and entrainment of the infauna and epifauna that reside within and on the sediment. Because the majority of the benthos live in the upper 15 cm (6 in) of sediment, a single pass of the dredge would remove approximately 0.3 m (1 ft) of sediment and results in a significant decrease in the abundance, biomass, and number of species of benthic organisms in the immediate area of the dredge cut. However, it is expected that there would be a negligible impact on the regional benthic ecosystem because: (1) the benthic assemblages on the sand shoals are not unique and similar to assemblages in adjacent areas and (2) the spatial extent of the dredged area is small compared to the broad area of the nearshore continental shelf. Diaz et al. (2006) reported on the results of biological monitoring on Sandbridge Shoal located off the southern Virginia coast that has been dredged four times from 1996 to 2003. Their results showed no negative impacts on macrobenthos.

In addition to the direct impacts on the benthos from the dredging operations, there may be indirect impacts as a result of changes to the sedimentary environment. Dredging causes the suspension of sediment, which increases turbidity over the bottom as a benthic plume. The deposition of this suspended sediment in adjacent areas can indirectly affect the benthos by covering the sediment surface and changing the physical characteristics of the sediment. However, benthos living on the nearshore continental shelf are adapted to sediment movements as a result of storm activity. As is evident from the ripple marks and bedforms in the video survey of the proposed SRIPP shoals, surficial sediment is frequently moved around on the shoals to create these features. Most macrobenthic organisms can burrow and move through a few centimeters of deposited sediment. Changes to the grain size of the sediment surface may affect larval settlement patterns as benthic larvae preferentially settle on particular sized sediment.

Dredging also changes the local sediment topography by creating furrows and depressions and lowering the overall topography of the shoal. The changes in bottom topography result in changes to local hydrodynamics which in turn may affect the distribution of both larval and adult benthic organisms. Changes in the local hydrodynamics may also affect the distribution of food resources for the benthos.
Environmental Consequences

Through the physical removal of the surficial sediment, dredging exposes sediment that has different physical and geochemical properties that the pre-dredged sediment. The changes to the surficial sediment characteristics may change its suitability for burrowing, feeding, and larval settlement for the benthos. Dredging exposes anaerobic sediment that may affect the benthic recolonization of the dredged area and changes the rate of nutrient exchange between the sediment and water column.

Because of the dynamic nature of benthic communities on the nearshore continental shelf and their variability over time, the recolonization and recovery of the dredged area can proceed at various rates. Depending on the time of year, benthos can recolonize the dredged area in varying degrees via larval recruitment as well as from immigration of adults from adjacent, undisturbed areas. Benthic abundances and total species numbers may reach pre-dredge amounts relatively quickly dependent upon the time of year dredging occurs (e.g., within a year) (Burlas et al., 2001; Posey and Alphin, 2002; Byrnes et al., 2004). However, it may take several years before the benthic community recovers to its pre-dredge levels of community composition and biomass (Wilber and Stern 1992; Newell et al., 1998).

In the early stages of recovery of the benthic community, there may be shifts in the dominant species in the dredged areas. There are several benthic species in this region of the Mid-Atlantic such as oligochaetes, the bivalve *Tellina* spp. and polychaete worm *Asabellides* that would likely recruit into the dredged area in any season (Diaz et al., 2004). There are species with life history characteristics, such as multiple reproductive events per year, which allow them to rapidly recolonize unoccupied space. These opportunistic species are adapted to exploit suitable habitat when it becomes available.

The timing of dredging will be an important factor in determining the eventual recovery of the dredged area because many benthic species have distinct reproductive and recruitment periods (Diaz et al., 2004). Recovery would be primarily from larval recruitment and adult immigration. As a result, recovery should be most rapid if dredging is completed before seasonal increases in larval abundance and adult activity in the spring and early summer (Herbich, 2000).

**Pump-Out Station**

As described in Section 2.6.5, a pump-out station may be located offshore. It would be used to deliver the sand and water slurry contained in the hopper dredge to the beach. It would be anchored temporarily offshore of the beach and would likely have multiple anchor sites. The placement of the anchors and anchor sweeps would impact benthic habitat. However, the impact would be temporary and last approximately seven months during the placement of the beach fill. In addition, the anchors for the pump-out station would rest on and periodically move along the sediment surface. There would be a negligible impact on the regional benthic ecosystem because; (1) the benthic assemblages on the relatively uniformly flat bottom offshore of the beach are not unique and are similar to assemblages in adjacent areas and (2) the spatial extent of the disturbed area is small compared to the broad area of the nearshore continental shelf.

**Placement Site**

Unlike many beach restoration projects, the initial sand placement would occur to a large extent in an area where a beach does not currently exist. Of the approximate 6.0-km (3.7-mi) length of the project, there is no beach for a length of approximately 4,250 m (14,000 ft). Placement of the
dredged sand along the Wallops shoreline would bury existing subtidal benthic organisms seaward of the seawall as well as intertidal organisms living on and within the interstitial areas of the rock seawall. Placement of the initial fill would bury existing intertidal benthic community along an approximate 4,300-m (14,000-ft) length of the seawall. The mean tidal range is approximately 1.1 m (3.6 ft); therefore approximately 0.5 hectare (1.2 acres) of hard-bottom, intertidal habitat would be permanently buried. In addition, approximately 91 hectares (225 acres) the subtidal benthic community along the existing seawall would be buried during the initial fill placement.

A new beach would be formed in front the seawall and a beach benthic community would become established. With the placement of fill and restoration of the beach, the composition of the benthic community along the seawall would fundamentally change. The community would change from one characterized by; (1) sessile and mobile epifaunal organisms present throughout an intertidal zone on the hard substrate of the seawall and (2) an adjacent subtidal sand bottom, to an exposed beach with a swash and surf zone. The presence of the seawall, and the hard habitat it currently provides to intertidal organisms, is an artificial condition that has developed from the erosion of the pre-existing beach.

Due to the handling and pumping activities, the dredged sand itself would also be devoid of live benthos. As a result, the recovery of benthos at the placement area would rely on immigration of adult organisms from adjacent undisturbed areas as well as larval colonization from the water column. Recovery time of the benthos within the seaward surf zone is expected to be relatively rapid, even more rapid than the offshore borrow sites given the dynamic conditions within the nearshore and surf zones.

Because of the absence of a beach seaward of the existing seawall, the placement of sand in this location would have a beneficial effect on benthic organisms by restoring beach habitat that does not currently exist. It is expected that the beach would repopulate with benthic organisms relatively quickly. Burlas et al. (2001) estimated that the recovery time for benthos in their New Jersey study ranged from approximately 2 to 6 months when there is a good match between the fill material and the natural beach sediment.

Several environmental studies of beach nourishment indicate that there are no detrimental long-term changes in the beach fauna as a result of beach nourishment (USACE, 1992; Burlas et al., 2001). The greatest influencing factor on beach fauna populations appears to be the composition of the placed material not the introduction of additional material onto the beach. The deposited sediments, when similar in composition (grain size and other physical characteristics) to existing beach material (whether indigenous or introduced by an earlier nourishment or construction event), do not appear to have the potential to result in long term impacts on the numbers of species or community composition of beach infauna (USACE, 1994; Burlas et al., 2001).

During placement of sand on the existing beach during renourishment cycles, there would be impacts to the established beach and nearshore benthos. In the subtidal area that would be filled, impacts would tend to be most severe to small, relatively immobile species such as oligochaetes and polychaetes that are unable to burrow through the overburden of new sand. Larger, more mobile taxa such as mole crabs (Emerita) which can burrow through the placed sediment or other species that avoid the disturbance by migrating out of the area are generally less impacted by the sediment deposition (Burlas et al., 2001). Peterson et al. (2000) reported that Emerita and Donax densities were lower by 86 - 99 percent on nourished beaches 5 – 10 weeks after
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construction in North Carolina. The slow recovery rates may have been a consequence of a poor match in grain size and a high shell content.

Grain size compatibility is important to the establishment of a healthy native beach benthic community. Peterson et al. (2006) reported that cold-season filling using much coarser sand than native caused dramatic suppression of the beach community and degrading the habitat value and benthic prey base for foraging shorebirds on a beach in North Carolina. Alternatively, sediment that is too fine may have a negative effect on the establishment of beach benthos. For example, mole crab feeding may be affected negatively by turbidity as a result of fine grained sediment.

**Alternative Two**

The impacts on the benthos from dredging the offshore shoals and the placement of the sand under Alternative Two would be very similar to those under Alternative One. However, because the amount of dredged material required under Alternative Two is less than Alternative One, the impacts on benthic habitat would be less. Based on an initial beach fill target of approximately 2.30 million m³ (2.92 million yd³) and assuming a loss of 25 percent of the material during dredge and placement operations, a total of approximately 2.8 million m³ (3.65 million yd³) of sand would be dredged from Shoal A.

It is assumed that the entire 5.2 km² (2 mi²) borrow site area would be dredged for the initial beach fill requirements at a uniform dredging depth of approximately 0.6 m (2 ft). Shoal A covers approximately 700 hectares (1,800 acres), and Shoal B covers approximately 1,600 hectares (3,900 acres). Therefore, during the dredging for the initial beach placement approximately 70 percent of Shoal A would be affected. For renourishment cycles, either Shoal A or Shoal B would be used. Under Alternative Two, each renourishment cycle would require the dredging of approximately 690,000 m³ (915,000 yd³) of sand. Assuming a uniform dredging depth of 0.6 m (2 ft), approximately 116 hectares (287 acres) or approximately 16 percent of the total area of Shoal A or 7 percent of the total area of Shoal B would be dredged.

Construction and placement of a groin would result in a direct and permanent adverse impact on the local benthic community within the immediate footprint of the groin. The construction of the groin would bury 0.08 hectare (0.19 acre) of sandy, subtidal benthic habitat and replace it with hard substrate. The benthos within the construction limits of the groin would be covered with rock. However, the groin would not have a minor impact on the benthic community within the region as the footprint of the structure is small compared to the overall available area of similar unconsolidated sediment throughout the nearshore shelf. Alternatively, a groin would provide approximately hard substrate and habitat heterogeneity in an otherwise featureless area. It would provide approximately 0.02 hectare (0.05 acre) of hard, intertidal benthic habitat. The hard surface of the rock would offer attachment surface for a variety of sessile organisms and the spaces between the rocks would provide habitat for mobile species such as crabs.

**Alternative Three**

The impacts on the benthos from dredging the offshore shoals and the placement of the sand under Alternative Three would be very similar to those under Alternative One. Because the amount of dredged material required under Alternative Three is less than Alternatives One or Two, the impacts on benthic habitat would be less. Based on an initial beach fill target of approximately 2.17 million m³ (2.84 million yd³) and assuming a loss of 25 percent of the
material during dredge and placement operations, a total of approximately 2.71 million m$^3$ (3.55 million yd$^3$) of sand would be dredged from Shoal A.

It is assumed that the entire 5.2 km$^2$ (2 mi$^2$) borrow site area would be dredged for the initial beach fill requirements at a uniform dredging depth of approximately 0.6 m (2 ft). Shoal A covers approximately 700 hectares (1,800 acres) and Shoal B covers approximately 1,600 hectares (3,900 acres). Therefore, during the dredging for the initial beach placement approximately 70 percent of Shoal A would be affected. For renourishment cycles, either Shoal A or Shoal B would be used. Under Alternative Two, each renourishment cycle would require the dredging of approximately 671,250 m$^3$ (878,750 yd$^3$) of sand. Assuming a uniform dredging depth of 0.6 m (2 ft), approximately 111 hectares (275 acres) or approximately 15 percent of the total area of Shoal A or 7 percent of the total area of Shoal B would be dredged.

Construction and placement of a breakwater would result in a direct and permanent adverse impact on the local benthic community within the immediate footprint of the breakwater. The construction of the breakwater would bury 0.31 hectare (0.76 acre) of sandy, subtidal benthic habitat and replace it with hard substrate. The benthos within the construction limits of the breakwater would be covered with rock. However, the breakwater would have a minor impact on the benthic community within the region as the footprint of the structure is small compared to the overall available area of similar unconsolidated sediment throughout the nearshore shelf. Alternatively, a breakwater would provide hard substrate and habitat heterogeneity on an otherwise featureless bottom. It would function similar to an artificial reef, only in relatively shallow water compared to deeper water where artificial reefs typically are created, and having a portion exposed above the water. It would provide approximately 0.11 hectare (0.28 acre) of hard, subtidal benthic habitat as well as 0.04 hectare (0.11 acre) of hard, intertidal benthic habitat. The hard surface of the rock would offer attachment surface for a variety of sessile organisms and the spaces between the rocks would provide habitat for mobile species such as crabs.

4.3.2.4 Invertebrate Nekton

No Action Alternative

Under the No Action Alternative, there would be no in-water activity for emergency repairs and maintenance to protect at-risk infrastructure; therefore, there would be no impacts on invertebrate nekton.

Alternative One

Borrow Sites

No significant impacts on invertebrate nekton such as squid, ctenophores (comb jellies), and jellyfish would occur under Alternative One. Pelagic invertebrates are widely dispersed throughout the inner continental shelf offshore of the MAB and not concentrated on shoal features (Slacum et al., 2006). In addition, water quality changes resulting from the hopper dredges should not result in a significant impact to pelagic invertebrates. Individuals may be entrained in the suction dredge during dredging operations, but this level of mortality would not be significant to the regional population of pelagic invertebrates.
Placement Site

Placement of sand in the surf zone is not expected to result in significant impacts on invertebrate nekton because this area is already exposed to dynamic wave activity and mixing of the water column. Burlas et al. (2001) conducted biological monitoring of a beach restoration project on the New Jersey coast and concluded that there were no obvious differences in the surf zone invertebrate nekton at the nourished beaches compared to the nearby natural beaches.

Alternative Two

The impacts on invertebrate nekton from dredging the offshore shoals and from placement of the sand under Alternative Two would be the same as those under Alternative One. The groin would occupy a portion of the water column in the surf zone and nearshore but would not cause an adverse impact on these pelagic invertebrates.

Alternative Three

The impacts on invertebrate nekton from dredging the offshore shoals and from placement of the sand under Alternative Three would be the same as those under Alternative One. The breakwater would occupy a small portion of the water column but would not cause an adverse impact on these pelagic invertebrates.

4.3.2.5 Finfish

No Action Alternative

Under the No Action Alternative, there would be no in-water activity for emergency repairs and maintenance to protect at-risk infrastructure; therefore, there would be no impacts on finfish.

Alternative One

Offshore Borrow Sites

Dredging the offshore shoals for beach fill material may affect finfish in a number of ways. Short-term impacts would consist of changes in water chemistry, habitat quality, or organism behavior as a result of the mechanical disturbance of the seafloor during dredging. Typically, these impacts are localized and dissipate rapidly once the dredging activity ceases. Long-term impacts typically consist of more permanent changes in the bottom substrate and local hydrodynamics or disruptions of vulnerable life history stages of fish. For example, as described in Section 3.2.2, several fish species in the project area, such as sand eel and winter flounder, have eggs that rest on the bottom. These species would be adversely impacted by dredging.

Fish are regularly entrained in dredges although in relatively low numbers (Reine et al., 1998). Larval and juvenile fish are often at greatest risk of entrainment due to their limited mobility and swimming strength. The distribution of individual fish species in the project area is largely determined by water depth, temperature, and salinity with most species ranging widely throughout the project area. Entrainment during offshore sand dredging, even if associated mortality is high, is likely to have minimal population level impacts for most taxa (Zarillo et al., 2008). Entrainment should be a localized, short-term concern for only a few families of demersal (bottom-dwelling) fish such as sea robins and flounder.
Fish use underwater sound pressure waves as well as sight to locate food and detect the presence of predators. While behavioral alterations of fish from manmade noise sources including dredging are poorly studied, it is possible that foraging, spawning, and recruitment success of fish would be impacted in the immediate vicinity of dredging operations, causing some organisms to relocate. In addition, the physical presence of the dredge and light produced during nighttime operations may attract other species to the vicinity. Behavioral alterations from sound, light, and structure would be localized and would end once dredging is completed. Dredging may also attract fish due to the suspension of benthic prey species in the water column along with the suspended sediment.

Dredging results in increased turbidity at the site of sediment excavation and as slurry overflow or dewatering from the hopper dredge. Wind, waves, and strong directional currents can also resuspend fine particles that accumulate in dredged areas. Turbidity may alter the trophic dynamics of an area by reducing the feeding efficiency of plankton-eating fish (Benfield and Minello, 1996) and reduce benthic prey species. Turbidity can also directly impact fish by irritating or clogging gill membranes and sediment deposition can impact demersal eggs, hindering egg respiration and increasing mortality.

The direct impact of turbidity on mortality, growth, and spawning behavior for continental shelf fish is largely unstudied but is likely a minimal concern since most fish are mobile enough to escape of avoid areas of highest turbidity. Furthermore, many shelf fish species are likely adapted to relatively high ambient turbidity levels.

Dredging would physically remove sediment from the shoals which, as described in Section 4.3.2.3, would result in an immediate reduction in the biomass, density, and diversity of benthic infauna and epifauna. These organisms serve as essential prey for many demersal fish. Loss of this forage base during dredging would have an adverse impact on the survival and growth rates of demersal fish in the immediate vicinity of the dredge operations. In addition, the borrow sites would be recolonized by different benthic communities until full recovery is realized which may result in a short-term change in the demersal fish population of the area.

**Placement Site**

Direct impacts of beach nourishment projects on surf zone fish are not well documented and largely inferred from changes to benthic prey resources (Burlas et al., 2001; Hackney et al., 1996). Given the highly dynamic nature of the surf zone, impacts to surf zone fish are not anticipated to be significant. Potential impacts to the fish community from the beach nourishment project could occur through several processes. The placement of sand on the beach buries, at least temporarily, existing benthic habitat, which may reduce the availability of infauna to benthic feeders. Additionally, the physical disturbance caused by dredging and the pumping of sand onto the beach may also affect fish distribution patterns. As described in the above Offshore Dredging subsection, elevated turbidity can negatively affect the physiology and feeding behavior of some fishes and presumably could make areas of shoreline that are being nourished unsuitable for some surf zone inhabitants.

Wilber et al. (2003) conducted a study of surf zone fish in response to beach nourishment in northern New Jersey. They reported that beach nourishment impacts on surf zone fish were restricted to localized attraction (northern kingfish) and avoidance (bluefish) responses to the beach nourishment operation. It is expected that beach fill operations at Wallops Island would
result in a similar response; therefore, short-term and localized adverse impact on the surf zone fish population are anticipated.

**Alternative Two**

The impacts on finfish from dredging the offshore shoals and from placement of the sand under Alternative Two would be similar to those under Alternative One.

The construction of a groin would be a beneficial impact to local fish communities. A groin would function as fish habitat similar to the breakwater but to a lesser degree because it would be located in shallower water and have less submerged surface area and less of a submerged footprint. The groin would function as an artificial reef and provided structure and habitat in the otherwise featureless sand bottom that is characteristic of the nearshore environment offshore of Wallops.

**Alternative Three**

The impacts on finfish from dredging the offshore shoals and from placement of the sand under Alternative Three would be similar to those under Alternative One.

The construction of an offshore breakwater would be a beneficial impact to local fish communities. The breakwater would function as an artificial reef and provide structure and habitat in the otherwise featureless sand bottom that is characteristic of the nearshore environment offshore of Wallops. It is anticipated that the structure would attract a variety of fish species not regularly found on the sand bottom.

**4.3.2.6 Essential Fish Habitat**

An EFH Assessment has been prepared for the project and is provided in Appendix H.

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance activities and emergency repairs would occur. Temporary impacts on nearshore EFH from the use of construction vehicles and heavy machinery on the beach may occur through the introduction of petroleum products, heavy metals, or other contaminants due to a leak or spill. Construction-related impacts would be temporary, and would not likely impact EFH because any accidental release of contaminants or liquid fuels would be addressed in accordance with the existing WFF ICP emergency response and clean-up measures. Implementation of BMPs for vehicle and equipment fueling and maintenance, and spill prevention and control measures would reduce potential impacts on EFH during construction. Therefore, the No Action Alternative would not impact EFH.

**Alternative One**

**Wallop Island Nearshore Environment**

The placement of sand on the Wallops Island beach would result in temporary adverse impacts on EFH due to turbidity and suspended solids concentrations that would be elevated above normal background levels in the surf zone in the immediate area of beach nourishment. Additionally, the beach nourishment would cause a smothering effect to benthos in the areas where sand is placed along the shoreline, likely resulting in the loss of immobile benthic species in the area. However, the population would have the ability to recolonize from adjacent
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undisturbed areas, and the overall population would not be adversely affected in the long-term. Therefore, beach nourishment on Wallops Island would result in a temporary, localized adverse impact to EFH in the nearshore area.

EFH may also be temporarily affected from the use of construction vehicles and heavy machinery on the beach for the movement of beach sand, construction of the seawall extension and excavation activities at the north Wallops Island borrow site. The heavy equipment and construction activities may result in the introduction of petroleum products, heavy metals, or other contaminants to nearshore waters due to a leak or spill. Construction-related impacts would be temporary, and would not likely be adverse because any accidental release of contaminants or liquid fuels would be addressed in accordance with the existing WFF ICP emergency response and clean-up measures. Implementation of BMPs for vehicle and equipment fueling and maintenance, and spill prevention and control measures would reduce potential impacts on nearshore waters and EFH during construction. Therefore, construction of the seawall may temporarily impact nearshore EFH.

Offshore Borrow Sites

Under Alternative One, the dredging of either offshore shoal is expected to cause temporary adverse effects to the benthos and temporary degradation of water quality due to an increase in suspended sediment concentrations.

Non-motile benthic species which inhabit the offshore shoals, including the surf clam, would be adversely affected under Alternative One due to entrainment in the dredger. However, the adverse effects to the overall population are anticipated to be temporary as they would have the ability to recolonize from adjacent undisturbed areas. Studies conducted from 2002 to 2005 by the VIMS examined the effects of dredging to the benthic community in offshore sand shoals. The study found that benthic invertebrate communities destroyed by the dredger are able to rebound within a period of a few years (Diaz et al., 2004). Mitigation techniques such as maintaining the morphology of the shoals would be evaluated to preserve areas of benthic habitat and allow for quicker recruitment of benthic species to the dredged areas.

The loss of benthic organisms would create a loss of prey for local wildlife, including some managed fish species, but the effect would be localized and temporary. The hopper dredge would also cause an increase in turbidity that could temporarily disturb the ability of fish, surf clams, and other mollusks to feed; however, this adverse effect would be temporary.

The mitigation techniques suggested by NMFS in a memorandum dated June 18, 2009, would be evaluated and utilized to the fullest extent possible. The measures suggested include the following:

- Minimize the total amount of borrow removed from the offshore shoals over the 50-year life of the project.
- Control the methods used for hopper dredging borrow from the shoals to preserve geomorphic integrity (use the Contour Method).

With implementation of mitigation measures and BMPs, Alternative One would result in localized and temporary adverse impacts on EFH. In the EFH assessment dated November 2009, NASA determined that there would be “site-specific adverse effects on EFH” but the impacts
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would not be significant in a regional context (Appendix H). No response has been received to date.

**Pump-out Station**

A pump-out station may be temporarily anchored in the nearshore environment to deliver the sand and water slurry contained in the hopper dredge to the beach. Benthic habitat would be adversely impacted by the placement of the anchors and anchor sweeps. Benthic organisms would be displaced within the footprint of the anchor and as the anchor chain moves along the bottom sediment. However, the impact would be temporary and last as long as the beach fill placement operations. There would be a negligible impact on the regional benthic ecosystem because; (1) the benthic assemblages on the relatively uniformly flat bottom offshore of the beach are not unique and are similar to assemblages in adjacent areas and (2) the spatial extent of the disturbed area is small compared to the broad area of the nearshore continental shelf.

**Alternative Two**

The types of impacts on EFH and the mitigation measures discussed under Alternative One would be similar to those for Alternative Two. As presented in Table 5, approximately ten percent less fill volume would be required during the project lifetime for Alternative Two when compared to Alternative One. Therefore, less turbidity and loss of benthic species by entrainment would occur compared to Alternative One. Also, less sand would be placed on the beach; therefore, there would be fewer impacts on nearshore and beach benthic communities from turbidity and burial.

During groin construction, adverse effects to surf clam EFH would occur. A number of the non-motile clams would be lost due to crushing during the groin placement. However, this adverse impact would be highly localized and the long-term effects of the groin would be beneficial to several federally-managed species because it would provide additional habitat for fish and sessile benthos such as sponges that attach to hard substrates. The groin would permanently cover approximately 0.08 ha (0.19 ac) of benthic habitat.

**Alternative Three**

The types of impacts on EFH and the mitigation measures discussed under Alternative One would be similar to those for Alternative Three. As presented in Table 5, approximately twelve percent and three percent less fill volume would be required during the project lifetime for Alternative Three when compared to Alternatives One and Two, respectively. Therefore, less turbidity and loss of benthic species by entrainment would occur compared to Alternatives One and Two. Also, less sand would be placed on the beach; therefore, there would be fewer impacts on benthic communities and EFH would result from turbidity and burial.

During breakwater construction, adverse effects to surf clam EFH would occur. Construction barge anchoring would impact EHF and clams would be crushed during the breakwater placement. However, this adverse impact would be highly localized. The breakwater would permanently cover approximately 0.31 ha (0.76 ac) of benthic habitat and EFH. The long-term effects of the breakwater would be beneficial to EFH species because it would provide additional habitat for fish and sessile benthos that attach to hard substrates. The breakwater would provide approximately 0.04 ha (0.11 ac) of hard, intertidal benthic habitat as well as approximately 0.11 ha (0.28 ac) of hard, subtidal benthic habitat.
4.3.2.7 **Marine Birds**

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance and emergency repair activities would occur. Based on past trends of sediment transport and erosion in the region, it is reasonable to assume that under the No Action Alternative substantial changes to Wallops Island shoreline will continue to occur. This would adversely affect sea birds by decreasing the amount of beach habitat.

**Alternative One**

As discussed in Chapter 3, sea bird species are known to breed, nest, and forage along the shoreline of Wallops Island. Temporary noise disturbances from both the construction machinery used for seawall extension, movement of beach sand, excavation of the north Wallops Island borrow site, and the dredges are expected to adversely affect sea birds; however, these noise levels would be similar to existing noise from daily operations, including occasional flights and rocket launches on Wallops Island. Birds which are startled by construction and dredge noise are likely to temporarily leave the immediate area, which could disrupt foraging and nesting activities. Due to the short duration of the noise disturbances, impacts on birds are considered minimal (NASA, 1997). The continued presence of migratory, sea, and shore birds at WFF suggests that occasional loud noises over the past few decades have not significantly disturbed birds on the island.

Another potential adverse impact to sea birds is the disturbance of beach habitat during the placement of sand on Wallops Island shoreline. The placement of sediment on the shoreline may temporarily disturb the breeding, nesting, and feeding activities of sea birds. During beach nourishment, the large amount of sand placed on the beach is anticipated to smother some sea bird prey species such as crabs and worms, which inhabit the surface layer of sand. However, studies by Nelson (1985, 1993) and Hackney et al., (1996) report an infaunal recovery time ranging from 2 to 7 months following beach nourishment. Therefore, no long-term adverse affects to sea bird foraging capabilities are anticipated.

Studies of the effects of beach nourishment on shorebird populations have reported variable results. For example, Peterson et al. (2006) reported that shorebird (primarily sanderling) use of a filled beach at Bogue Banks, North Carolina was reduced by 70 percent on filled beaches for several months after project completion. They postulated that reduction in shorebird use was in response to a decrease in prey (primarily coquina clam, *Donax* spp.) abundance and possibly much coarser than native sediment that was placed on the beach. Grippo et al. (2007) examined the effects of beach renourishment projects over a two-year study on waterbird and shorebird communities in Brunswick County, North Carolina. No significant effect on total waterbird and shorebird abundance were found, and waterbirds actually increased in number due to the creation of additional beach habitat. Although less food resources were present while the benthic communities recovered, no significant differences in feeding activity were observed, although this could have been due to the highly transient nature of the birds.

Currently there is little or no beach present along the existing seawall. As such, there is no beach habitat for birds. Initial placement of beach fill would have little or no impact on birds within the areas where beach does not exist at the present time. There would be potential impacts on birds
during the renourishment phases of the project after the initial beach fill has been placed and habitat and benthic prey populations have had time to develop.

**Offshore Borrow Sites**

Sea birds sometimes target offshore shoals as a source of prey because some species of fish tend to school around shoals. Sea birds use their sight to locate fish over the shoals, and the increased turbidity caused by dredging may temporarily impair their feeding ability. However, the sediment is expected to quickly settle from the water column. During dredging operations at the shoals, noise disturbances from the hopper dredge are expected. This noise may cause sea birds to vacate the area for the duration of dredging. Adverse impacts on sea birds at the offshore borrow sites are anticipated to be temporary and localized and therefore would not be significant.

Removal of sand from the shoal(s) would lower the topography of the shoal and, as described in Section 4.3.2.5 (Finfish), may adversely affect fish populations in the area. As a result, dredging may indirectly affect sea bird populations that prey on fish present at the shoal by altering fish distribution and populations.

**Alternative Two**

The types of impacts on sea birds and the mitigation measures discussed under Alternative One would be similar to those for Alternative Two. However, because less beach fill volume (initial and renourishment volumes) would be required compared to Alternative One, there would be fewer barge trips, and therefore a reduced potential for disturbance of sea bird breeding, nesting, and feeding activities.

**Alternative Three**

The types of impacts on sea birds and the mitigation measures discussed under Alternative One would be similar to those for Alternative Three. However, because less beach fill volume (initial and renourishment volumes) would be required compared to Alternative One, there would be fewer barge trips, and therefore a reduced potential for disturbance of sea bird breeding, nesting, and feeding activities.

**4.3.2.8 Marine Mammals**

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented but emergency measures and maintenance would still take place as necessary. Because none of these measures would take place in marine waters, no impacts on marine mammals are anticipated under the No Action Alternative.

**Alternative One**

The potential impacts associated with activities under Alternative One include physical disturbance to habitats (benthic or aquatic) during dredging and fill, vessel strike, and increased noise from vessel activities (dredging). No impacts are anticipated to marine mammals from the placement of sand on the beach, as all activities would occur from the beach.
Environmental Consequences

**Disturbance to Habitat**

Dredging for sand can indirectly affect marine mammals by reducing the ability to obtain food in several ways. The most evident impact is a substantial initial reduction in the benthic invertebrate fauna in the dredged area (discussed in more detail in Section 4.3.2). Dredging operations can cause marine mammals to avoid particular feeding areas due to noise or vibrations. Decreased feeding success and prey availability may occur in areas of increased activity-related turbidity. Turbidity plumes caused by offshore dredging can lead to decreased visibility, which in turn can affect foraging ability by those species that use sight as a primary means to locate prey.

These effects can also be expected outside the immediate vicinity of the dredging activity. The associated plumes would be dispersed over a larger area. However, because the concentration of the suspended particles in the plume diminishes rapidly with time and distance from the source, the effects on fauna further away from the activity are reduced. In general, the effects of turbidity on phytoplankton due to light reduction, or on pelagic fish and invertebrates due to gill irritation and reduction of light levels for visual feeders, are considered small (MMS, 1999).

**Vessel Strike**

Vessel collisions are more likely to affect certain species that have surface feeding or resting habits, such as right and humpback whales. Threatened and endangered marine mammals are discussed in more detail in Section 4.3.3. According to the September 25, 2007, NMFS BO on the SRIPP, the potential of marine mammal strikes would be mitigated by operating the dredge at speeds below 14 knots. Since the issuance of the 2007 NMFS BO, a Final Rule has been issued regarding vessel speeds along the east coast of the Atlantic seaboard; this rule restricts speeds to no more than 10 knots for all vessels 65 feet or greater (50 CFR 224.105, issued October 10, 2008). Compliance with this rule is expected, as the speed of the dredge is not anticipated to be greater than 3 knots while dredging and 10 knots while empty. Therefore, the risk of vessel strike to marine mammals is insignificant. At this low speed, operators would be able to avoid humpback whales by maneuvering the dredge vessel to avoid a whale strike. In addition, there is currently no available information to suggest that dredge vessels have ever collided with humpback whales while operating in Atlantic waters.

**Noise**

There are three metrics commonly used in the evaluation of underwater sound impacts to marine mammals: peak pressure, root-mean-square (rms) or sound pressure level, and sound exposure level (SEL). Under the MMPA, the rms levels are used to determine harassment, and all underwater sound levels throughout the remainder of this PEIS will be reported in rms. The rms amplitude is a type of average that is determined by squaring all of the amplitudes over the period of interest, determining the mean of the squared values, and then taking the square root of the mean of the squared values.

Transmission loss (TL) underwater is the decrease in acoustic intensity as an acoustic pressure wave propagates out from a source. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water chemistry, and bottom composition and topography. Because the temperature, sea conditions, water chemistry, and bottom composition are unknown, conservative estimates of TL for the underwater sources were performed based
only on water depth. Because the project activities occur in waters with depths less than 30 m, TL was calculated using “cylindrical spreading.” Cylindrical spreading occurs when sound energy spreads outward in a cylindrical fashion bounded by the bottom sediment and water surface, such as shallow water, resulting in a 3-dB reduction per doubling of distance, using the formula:

\[ TL = 10 \times \log(R), \]

Where \( R \) = distance relative to the source to the received level of interest

Under the MMPA, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as “…any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild.” Level B harassment is defined as “…any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.”

Since 1997, NMFS has been using generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (NMFS, 2005). NMFS is developing new science-based thresholds to improve and replace the current generic exposure level thresholds, but the criteria have not been finalized (Southall et al., 2007). The current Level A (injury) threshold for impulse noise (e.g., impact pile driving) is 180 dB rms for cetaceans (whales, dolphins, and porpoises) and 190 dB rms for pinnipeds (seals, sea lions). The current Level B (disturbance) threshold for impulse noise is 160 dB rms for cetaceans and pinnipeds.

Marine mammals use hearing and sound transmission for all aspects of their life, including reproduction, feeding, predator and hazard avoidance, communication, and navigation. The introduction of sound into the marine environment from anthropogenic sources has the potential to cause long-term or short-term effects. Short-term effects can include behavioral disruption or temporary habitat displacement; and long-term effects can include extended habitat displacement, physical injury to the auditory system, or in some cases mortality (Richardson et al., 1995). The behavioral responses of marine mammals to noise are highly variable and may depend upon individual hearing sensitivity (animals respond only to sounds they can directly detect), past exposure and habituation to noises, and demographic factors such as the age and sex of the animal. Other factors include the duration of the sound, whether the sound is moving, and environmental factors that affect the sound, including habitat characteristics (National Research Council [NRC], 2003).

To understand how anthropogenic noise may affect marine mammals, it is important to understand the hearing abilities of the marine mammals. A summary of the hearing sensitivities of marine mammals likely to occur within the project area are shown in Table 48. Southall et al. (2007) categorized cetaceans into three general hearing groups: low-frequency (7 Hz to 22 kHz), mid-frequency (150 Hz to 160 kHz), and high-frequency (200 Hz to 180 kHz). The majority of cetaceans, including beaked whales, toothed whales, pilot whales, and dolphins, fall into the mid-frequency hearing group. Baleen whales are in the low-frequency hearing group, and the dwarf sperm whale is in the high-frequency hearing group. All pinnipeds in the water are categorized into the same hearing group (75 Hz to 75 kHz). The Florida manatee has a hearing bandwidth of 400 Hz to 46 KHz (Gerstein, 2002).
### Table 48: Marine Mammals Hearing Groups

<table>
<thead>
<tr>
<th>Hearing Group</th>
<th>Estimated Auditory Bandwidth</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-frequency cetaceans</td>
<td>7 Hz to 22 kHz</td>
<td>Right whale, Humpback whale, Fin whale</td>
</tr>
<tr>
<td>Mid-frequency cetaceans</td>
<td>150 Hz to 160 kHz</td>
<td>True’s Beaked Whale, Blainville’s Beaked Whale, Sowerby’s Beaked Whale, Cuvier’s Beaked Whale, Melon-Headed Whale, Short-Finned Pilot Whale, Long-Finned Pilot Whale, Rough-Toothed Dolphin, Bottlenose Dolphin, Atlantic Spotted Dolphin, Common Dolphin, Atlantic White-Sided Dolphin, Risso’s Dolphin, Striped Dolphin, Spinner Dolphin, Clymene Dolphin</td>
</tr>
<tr>
<td>High-frequency cetaceans</td>
<td>200 Hz to 180 kHz</td>
<td>Dwarf Sperm Whale</td>
</tr>
<tr>
<td>Pinnipeds in Water</td>
<td>75 Hz to 75 kHz</td>
<td>Harbor Seal</td>
</tr>
<tr>
<td>Manatees</td>
<td>400 Hz to 46 kHz</td>
<td>Florida Manatee</td>
</tr>
</tbody>
</table>

*Source: Southall et al., 2007; Gerstein, 2002*

A detailed description of marine mammal species is in Section 3.2.2.8. The marine mammals of primary concern for noise impacts are those that are likely to occur within the action area. These are bottlenose dolphins and possibly, right whales and humpback whales. The coastal morphotype of bottlenose dolphins may occur in the shallow waters off Wallops Island all year round, comprising either the northern or southern migratory stocks, though they are more likely to occur during summer months. The offshore morphotype is unlikely to occur within the project area, as they are primarily found along the outer continental shelf and continental slope. Right whales may occur in the area on occasion, especially when transiting between southeastern U.S. waters and New England. This is likely to occur between November and April. Humpback whales may occur in deeper water offshore of Wallops Island in fall, winter, and spring, as they
migrate to feeding grounds off the New England coast. Although harbor seals may occur in the area, there are no known haulout sites in the project vicinity, so impacts to harbor seals are not addressed further. Although manatees are reported, it is highly unlikely they would be found in the project vicinity, and are not addressed further.

Under this alternative, underwater noise would be generated through the use of a hopper dredge. The primary noise from hopper dredging is created by the suction pipes used to remove the fill from the seabed. The noise generated by dredgers depends on their operational status: seabed removal, transit, and dumping. In general the noisiest activity is associated with the seabed removal. Dredge noise is strongest at low frequencies (below 1,000 Hz). Greene (1987) reported received levels of 142 dB at 0.93 km (0.58 mi) for loading operations, 127 dB at 2.4 km (1.5 mi) while underway, and 117 dB at 13.3 km (8.3 mi) while pumping (at frequencies below 1,000 Hz).

As discussed in Section 3.1.11, calculations were performed with these source levels assuming a transmission loss of 10 log (cylindrical spreading) to the NMFS Level A and Level B thresholds (190 dB and 160 dB, respectively). Based on these assumptions, underwater noise from the hopper dredge would not reach the Level A threshold and would, therefore, not result in any injury or mortality. Dredge noise may exceed the Level B threshold at a distance of approximately 15 m (50 ft) from the dredge during loading, and at a distance of approximately 1 m (3.3 ft) from the dredge while underway or pumping. Noise from dredging would be audible to the species known to occur in the area, and may result in some masking of vocal behavior of right whales, humpback whales, and non-echolocation calls of bottlenose dolphins. Right whales have shown some evidence of tolerance to this type of noise along the southeast coast (Richardson et al., 1995). As summarized in Richardson et al. (1995), there are few studies documenting the responses of humpback whales to dredging, and other studies indicate the responses of humpbacks to a vessel depends heavily on their behavior (e.g., feeding humpbacks are less likely to react when actively feeding than when resting). Also summarized in Richardson et al. (1995), dolphins often tolerate or approach vessels, but the reactions are typically related to the behavioral activity similar to humpbacks (resting dolphins avoid, feeding dolphins ignore, and socializing dolphins approach). Because dredging has occurred in this area previously and vessels are common, noise impacts are not expected to be significant. A NMFS-approved observer would be present on board the dredging vessel for any dredging occurring between April 1 and November 30.

**Alternative Two**

The potential impacts from activities under this alternative are the same as those identified under Alternative One. In particular, a discussion of potential impacts from dredging would be the same. However, under this alternative, one third of the groin (approximately 43 m [140 ft]) would be constructed in the water using a barge with heavy lifting equipment. The rock placement and barge operation would generate some underwater noise. As summarized in Nedwell and Edwards (2004), measurements of rock placement are scarce, and the one available study indicated that rock placement did not contribute to the overall noise level. Richardson et al. (1995) report barge noise levels ranging from 145 to 170 dB at 1 m (3.3 ft) at frequencies below 5 kHz.

As discussed in Section 3.1.11, calculations were performed with a maximum source level of 170 dB at 1 m (3.3 ft) assuming a transmission loss of 10 log (cylindrical spreading) to the
NMFS Level A and Level B thresholds (190 dB and 160 dB, respectively). Based on these assumptions, underwater noise from the barge would not reach the Level A threshold and would, therefore, not result in any injury or mortality. Barge noise may exceed the Level B threshold at a distance of approximately 13 m (8.1 mi) from the barge. The response of marine mammals to vessel noise is discussed for Alternative One and would be the same under this alternative.

**Alternative Three**

The potential impacts to marine mammals from dredging would be the same as those discussed under Alternative One. The potential impacts from rock placement and barging would be the same as those identified under Alternative Two.

### 4.3.3 Threatened and Endangered Species

The species listed in Table 49 are not likely to be affected by SRIPP actions due to lack of habitat or presence within the SRIPP action areas.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Reason for No Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Cicindela dorsalis dorsalis</em></td>
<td>Northeastern beach tiger beetle</td>
<td>Highly unlikely to occur in the project area</td>
</tr>
<tr>
<td><em>Sciurus niger cinereus</em></td>
<td>Delmarva peninsula fox squirrel</td>
<td>Project area not suitable habitat</td>
</tr>
<tr>
<td><em>Acipenser brevirostrum</em></td>
<td>Shortnose sturgeon</td>
<td>Project area not suitable habitat</td>
</tr>
<tr>
<td><em>Physeter macrocephalus</em></td>
<td>Sperm Whale</td>
<td>Project area not suitable habitat</td>
</tr>
<tr>
<td><em>Balaenoptera borealis</em></td>
<td>Sei Whale</td>
<td>Project area not suitable habitat</td>
</tr>
<tr>
<td><em>Balaenoptera musculus</em></td>
<td>Blue Whale</td>
<td>Project area not suitable habitat</td>
</tr>
<tr>
<td><em>Trichechus manatus latirostrus</em></td>
<td>Florida Manatee</td>
<td>Project area not suitable habitat</td>
</tr>
<tr>
<td><em>Eretmochelys imbricate</em></td>
<td>Hawksbill Sea Turtle</td>
<td>Highly unlikely to occur in the project area</td>
</tr>
</tbody>
</table>

The species discussed in further detail below have been documented in the SRIPP action area or have been identified by regulatory agencies as being potentially impacted by SRIPP activities.

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented and beach habitat loss will continue due to shoreline erosion. Repairs and maintenance of the existing seawall and geotubes are likely to slow the rate of erosion over the central part of Wallops Island. However, erosion south of the seawall would continue. The dune and swale, shrub, thicket and maritime forest areas located at the northern and southern ends of Wallops Island would be at continued risk of loss. Under the No Action Alternative, negative impacts are anticipated to threatened and endangered bird species that rely on the beach for their habitat such as the piping plover, Wilson’s plover, gull-billed terns, roseate tern, and red knot; as well as species such as upland sandpipers, which use the early successional habitat found in the dune and swale areas. The leatherback, hawksbill, Kemp’s ridley, loggerhead, and Atlantic green sea turtles are known to
migrate along East Coast beaches, but rarely nest in the area. It is not likely that repairs and maintenance activities would adversely affect sea turtles.

Under the No Action Alternative, no activities would occur in open water and, therefore, no impacts on marine threatened or endangered species would occur.

**Alternative One**

**Vegetation**

Neither seabeach amaranth nor Virginia least trillium have been documented on Wallops Island or have designated protected populations or designated habitat in the SRIPP action areas. However, since there is potentially suitable habitat for these species on north Wallops Island, NASA has determined that the proposed action may result in adverse impacts on Virginia least trillium and may affect, but is not likely to adversely affect seabeach amaranth. Offshore activities would not affect these species.

**Protected Marine Mammals**

No impacts on marine mammals from the construction of the seawall or the placement of sand on the beach are anticipated because the activities would occur in water depths too shallow for marine mammals to occur. Offshore dredging of the either proposed shoal is not anticipated to directly impact marine mammals; however, indirect adverse impacts are anticipated.

The potential impacts of offshore dredging activities are generally similar for all of the species of marine mammals that are described in Section 3.2.3.6. Potential impacts include disturbance to benthic and aquatic habitats and disruption of the prey base, interference with filter feeding, noise disruption, and potential collisions with equipment or transport vessels. Certain types of impacts, such as vessel collisions, are more likely to affect species that have surface feeding or resting habits, such as right, fin and humpback whales.

A potential direct adverse effect on protected marine mammals is the noise associated with dredging operations. Noise from the dredge may have an effect on whale species that are sensitive to low frequency sound. The noise emitted by a dredge depends on the local environment, especially the sea-bed type. Variability in noise levels is also associated with the different parts of the dredging operations, such as the dredger dragging against the sea floor; the sound of the pump driving the suction through the pipe; noise from deposition of sand into the hopper; and the noise associated with the dredging ship itself. Meteorological conditions will also influence the noise emitted by the dredging operations (MALSF, 2009).

As discussed in Section 3.1.11, conservative calculations were performed with these source levels assuming a transmission loss of 10 log (cylindrical spreading) to the NMFS Level A and Level B thresholds (190 dB and 160 dB, respectively). These conservative calculations do not take into account water temperature, chemistry, bottom composition, sea conditions, current conditions, or topography.

Marine mammals use hearing and sound transmission for all aspects of their life including reproduction, feeding, predator and hazard avoidance, communication and navigation. The introduction of sound into the marine environment from anthropogenic sources has the potential to cause long term or short term effects. Short term effects can include behavioral disruption or temporary habitat displacement; and long-term effects can include extended habitat
Environmental Consequences

displacement, physical injury to the auditory system, or in some cases mortality (Richardson et al., 1995). The behavioral responses of marine mammals to noise are highly variable and may depend upon individual hearing sensitivity (animals respond only to sounds they can directly detect), past exposure and habituation to noises, and demographic factors such as the age and sex of the animal. Other factors include the duration of the sound, whether the sound is moving, and environmental factors that affect the sound including habitat characteristics (National Research Council [NRC], 2003).

Under the MMPA, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as “…any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild.” Level B harassment is defined as “…any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.”

Since 1997, NMFS has been using generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (NMFS, 2005). NMFS is developing new science-based thresholds to improve and replace the current generic exposure level thresholds, but the criteria have not been finalized (Southall et al., 2007). The current Level A (injury) threshold for impulse noise (e.g., impact pile driving) is 180 dB rms for cetaceans. The current Level B (disturbance) threshold for impulse noise is 160 dB rms for cetaceans.

Under the Proposed Action, underwater noise would be generated through the use of a hopper dredge. The primary noise from hopper dredging is created by the suction pipes used to remove the fill from the seabed. The noise generated by dredgers depends on their operational status, seabed removal, transit and dumping. In general the noisiest activity is associated with the seabed removal. Dredge noise is strongest at low frequencies (below 1000 Hz). Greene (1987) reported received levels of 142 dB at 0.93 km (0.58 mi) for loading operations, 127 dB at 2.4 km (1.5 mi) while underway, and 117 dB at 13.3 km (8.3 mi) while pumping (at frequencies below 1000 Hz).

Based on these assumptions, underwater noise from the hopper dredge would not reach the Level A threshold and would, therefore, not result in any injury or mortality. Dredge noise may exceed the Level B threshold at a distance of approximately 15 m (50 ft) from the dredge during loading and at a distance of approximately 1 m (3.3 ft) from the dredge while underway or pumping. Noise from dredging would be audible to the species known to occur in the area and may result in some masking of vocal behavior of the right, fin and humpback whale.

As summarized in Richardson et al. (1995), there are few studies documenting responses of right, fin and humpback whales to dredging; other studies indicate responses of humpbacks to vessel depends heavily on their behavior (e.g., feeding humpbacks are less likely to react when actively feeding than when resting). Because dredging has occurred in this area previously and vessels are common, noise impacts are not expected to be significant.

Dredging for sand can indirectly affect marine mammals by reducing their ability to obtain food in several ways. The most direct impact is a substantial initial reduction in the benthic invertebrate fauna in the dredged area (discussed in more detail in section 4.3.2). Decreased feeding success and prey availability may occur in areas of increased turbidity. Turbidity plumes caused by offshore dredging can lead to decreased visibility, which in turn can affect foraging
Environmental Consequences

ability by those species that use sight as a primary means to locate prey. These effects can also be expected outside the immediate vicinity of the dredging activity.

Operations using hopper dredges tend to be discontinuous and associated plumes would be dispersed over a larger area. Hopper dredges trigger a small plume at the seabed from the draghead and a larger surface plume from the discharge of overspill of water with suspended sediment from the hopper (MMS, 1999). The length and shape of the surface plume generated by the overspill depends on the hydrodynamics of the water and the sediment grain size.

Although the volume of discharged material is much higher, findings about the plume dynamics of suspended sediments are much the same as plumes from trailing hopper dredges during construction aggregate mining (MMS, 1999). Detailed investigation of these types of operations off the coast of the United Kingdom found that most sediments in the plume settle out within 300 to 500 m (984 to 1,640 ft) from the dredge over a period of roughly 20 to 30 minutes and that suspended sediment concentrations returned to concentrations close to background level within an hour after completion of dredging (Hitchcock et al., 1998, cited in MMS, 1999). The distance and time increased with decreasing sediment size. In a study off the French coast, particles larger than 0.40 mm (0.02 in) settled within 1.5 km (0.9 mi) from the site. Considering that the average grain size of the potential borrow sites is estimated to range from 0.34 to 0.42 mm (0.01 to 0.02 in), it can be assumed that surface plumes from the hopper dredge should last for no more than a few hours and be no larger than 5 km (3.1 mi).

Because the concentration of the suspended particles in the plume diminishes rapidly with time and distance from the source, the effects on fauna further away from the activity are reduced.

In general, the effects of turbidity on phytoplankton due to light reduction or on pelagic fish and invertebrates, due to gill irritation and reduction of light levels for visual feeders, are considered small (MMS, 1999). A suction hopper dredge is usually on-site for 3 to 4 hours during a 24-hour period, with the remaining time spent in travelling and unloading sand. This discontinuous method of offshore dredging allows suspended sediments to dilute, dissipate, and settle. The SRIPP project area could be avoided by whales, which could easily feed in adjacent areas until the disturbance ceased.

No impacts on humpback whales from the construction of the seawall or the placement of sand on the beach are anticipated because the activities would occur in water depths too shallow for these whales to occur.

Therefore, the operations under the Proposed Action of the SRIPP are not anticipated to cause long-term adverse impacts on the habitat, calving areas, or the food resources of the humpback whale. A Biological Assessment (BA) has been prepared by NASA for submission to the USFWS and NMFS to address any potential impacts from project activities (Appendix I).

Sea Turtles

Impacts to the four Federally listed sea turtle species (leatherback, Kemp’s ridley, loggerhead, and Atlantic green) likely to occur in the SRIPP action areas were assessed. Except for an occasional loggerhead nest, these turtles are not known to successfully nest on Wallops Island beaches; therefore, Alternative One would not affect sea turtle nesting. Entrainment in drag heads is the primary risk regarding incidental take of sea turtles, although for the larger leatherback this is not a concern. Turtle deflectors, although not 100 percent effective, have been
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successfully used on drag heads to reduce the risk of sea turtles being captured and killed. The ranges and migratory movements of sea turtles are largely correlated with water temperature. Sea turtles are likely to be found in the action area between April and November of each year. Leatherback turtles are less affected by cold water temperatures and may stay in northern regions throughout the year. Therefore, NASA has determined that Alternative One may affect, and is likely to adversely affect the loggerhead sea turtle, and may affect, but is not likely to adversely affect the leatherback, Kemp’s ridley, or Atlantic green sea turtles.

To estimate the amount of sea turtle takes for the current SRIPP PEIS Proposed Action, which will be determined later by NMFS through the ongoing Section 7 consultation process for this PEIS, NASA used the information presented by NMFS in their BO issued for the SRIPP Programmatic EA Proposed Action (NMFS, 2007).

Based on the distribution of sea turtles in the action area and the historic interactions between sea turtles and dredging and relocation trawling operations, NMFS stated in their 2007 BO for the SRIPP that it was reasonable to expect that no more than one sea turtle is likely to be injured or killed for approximately every 1,529,110 m³ (2,000,000 yd³) of material removed from proposed borrow areas in State waters. Because the current SRIPP Proposed Action is for borrow sites in Federal waters (opposed to State waters in the SRIPP Programmatic EA), there is less likelihood for incidental takes and the actual takes would probably be lower than the NMFS estimate stated above. However, to use a conservative approach, NASA applied NMFS’ determination of 1 take per 1,529,110 m³ (2,000,000 yd³) of dredged material to Alternative One of this PEIS. Because Alternative One proposes to remove 9,990,000 m³ (13,066,250 yd³) over the 50-year lifetime of the project, NASA estimated that the SRIPP may result in a total of 7 sea turtles takes over the lifetime of the SRIPP. Approximately two sea turtles takes may occur during dredging operations for the initial beach fill operations and five sea turtles takes may occur during dredging for the nine renourishment events. Given the NMFS estimate that at least 90 percent of the injured/killed turtles would be loggerheads (NMFS, 2007), 6 of the turtle takes for the SRIPP Alternative One of this PEIS would likely be loggerheads.

Birds

No impacts on the bald eagle, peregrine falcon, or upland sandpiper are anticipated under Alternative One primarily because their habitats would not be disrupted by SRIPP activities. Dredging of the offshore borrow sites may indirectly affect the Gull-billed tern and Roseate Tern by disturbing potential feeding grounds, but these activities are not anticipated to result in significant impacts on these species.

In the long term, the expansion of the beach would likely provide additional suitable habitat for shorebirds such as the Red Knot and Piping Plover. Construction, excavation of the north Wallops Island area for renourishment fill, and beach fill placement activities would temporarily negatively impact shorebirds with construction noise levels and the movement of construction equipment on areas with existing beach habitat. For activities related to use of the north Wallops Island area for beach renourishment, NASA would work with USFWS on specifying and implementing mitigation measures to ensure adequate protection for Piping Plovers. Since the Red Knot only uses the action area as a stop over for migration, NASA has determined that project may affect but is not likely to adversely affect the Red Knot. Because the action area serves as a breeding and nesting area for the Piping Plover, NASA has determined that the project may affect and is likely to adversely affect these species.
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**Alternative Two**

**Vegetation**

Impacts on threatened and endangered vegetative species from Alternative Two would be similar to those described under Alternative One.

**Marine Mammals**

No impacts on threatened and endangered marine mammals from the construction of the seawall or the placement of sand on the beach are anticipated. Construction of a groin would temporarily disturb foraging habitat, but this disruption is not anticipated to significantly impact marine mammals. Impacts on threatened and endangered marine mammals from dredging activities would be similar to those discussed under Alternative One.

**Sea Turtles**

Impacts on sea turtles from seawall extension, beach fill placement, and dredging activities would be similar to those discussed under Alternative One. Construction of a groin would temporarily disturb foraging habitat and may lead to some habitat loss due to erosion within a groin “shadow” approximately 300 m (100 ft) downdrift of the structure (see Section 4.2.2.1 for details); however, renourishing the beach would reduce the potential for downdrift erosion by providing continual sand on the Wallops Island shoreline. Alternative Two is not anticipated to significantly impact sea turtles.

**Birds**

Impacts on threatened and endangered birds under Alternative Two would be similar to those described under Alternative One. Construction of a groin may lead to some habitat loss due to erosion within a groin “shadow” approximately 300 m (100 ft) downdrift of the structure (see Section 4.2.2.1 for details); however, renourishing the beach would reduce the potential for downdrift erosion by providing continual sand on the Wallops Island shoreline.

**Alternative Three**

**Vegetation**

Impacts on threatened and endangered vegetative species from Alternative Three would be similar to those described under Alternative One.

**Marine Mammals**

No impacts on threatened and endangered marine mammals from the construction of the seawall or the placement of sand on the beach are anticipated. Construction of a breakwater would temporarily disturb foraging habitat, but this disruption is not anticipated to significantly impact marine mammals. Impacts on threatened and endangered marine mammals from dredging activities would be similar to those discussed under Alternative One.
Sea Turtles

Impacts on sea turtles from seawall extension, beach fill placement, and dredging activities would be similar to those discussed under Alternative One. Construction of a breakwater would temporarily disturb foraging habitat and may lead to some habitat loss due to erosion within a 2.5-km (1.5-mi) area downdrift of the structure (see Section 4.2.2.1 for details); however, renourishing the beach would reduce the potential for downdrift erosion by providing continual sand on the Wallops Island shoreline. Alternative Three is not anticipated to significantly impact sea turtles.

Birds

Impacts on threatened and endangered birds under Alternative Three would be similar to those described under Alternative One. Construction of a breakwater may lead to some habitat loss within a 2.5-km (1.5-mi) area downdrift of the structure (see Section 4.2.2.1 for details); however, renourishing the beach would reduce the potential for downdrift erosion by providing continual sand on the Wallops Island shoreline.

4.3.3.1 Agency Consultation

A BA is currently being prepared as a component of the formal consultation process provided under Section 7 of the ESA. More detailed procedures for this formal consultation process are defined in 50 CFR 402.14(c). Early consultation is conducted when the action agency is planning a project or program that may affect protected species; however, not every project detail may be known. During previous consultations for the SRIPP, the specific borrow area(s) off the coast of Wallops Island had not been identified. However, NASA completed early consultation for potential dredging within a broad area of State waters east of Wallops Island for the SRIPP by submitting a BA in May 2007. NASA received a BO for proposed dredging in State waters from NMFS on September 25, 2007. In a letter to USFWS dated March 1, 2007, NASA transmitted a BA addressing potential impacts of the SRIPP on the Piping Plover. In a letter dated April 24, 2007, USFWS stated that the SRIPP (as defined in 2007) would not adversely affect threatened or endangered species under their jurisdiction.

With the preparation of the current BA for the SRIPP, NASA, in conjunction with MMS and USACE, is continuing the Section 7 consultation process by submitting additional project information to NMFS and USFWS. Once NMFS and USFWS issue a BO, NASA will finalize the consultation process by obtaining any required incidental take permits from NMFS and USFWS.

Binding clauses may be built in to a BO resulting from the BA requiring NASA to consult again for future dredging activities; however, this document, the March 2007 BA and the September 2007 BO lay the groundwork for the consultation process and allow all three agencies to efficiently finalize future consultations for this project. The BA was prepared under the assumption that the dredging would continue at varying degrees of intensity for the next 50 years, with renourishment cycles approximately every 5 years.

Determination of Effects to State and Federally Protected Species

Table 50 includes NASA’s determination of effects to State and federally protected species under the ESA.
Table 50: Determination of Effects to Federally Protected Species

<table>
<thead>
<tr>
<th>Species</th>
<th>NASA’s Determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seabeach amaranth</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Humpback Whale</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Fin Whale</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Right Whale</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Leatherback Sea Turtle</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Kemp’s Ridley Sea Turtle</td>
<td>May affect, likely to adversely affect</td>
</tr>
<tr>
<td>Loggerhead Sea Turtle</td>
<td>May affect, likely to adversely affect</td>
</tr>
<tr>
<td>Atlantic Green Sea Turtle</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Red Knot</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Piping Plover</td>
<td>May affect, likely to adversely affect</td>
</tr>
</tbody>
</table>

4.4 SOCIAL AND ECONOMIC ENVIRONMENT

4.4.1 Land Use

No Action Alternative

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance and emergency repair activities would maintain the use of existing facilities; therefore, these activities would not result in changes to land use. However, maintenance of existing conditions may not adequately protect existing and planned infrastructure and facilities closest to the beach on Wallops Island. If significant beach loss did occur (i.e., during a large storm event), currently at-risk infrastructure on Wallops Island could be damaged, resulting in loss of these facilities and changes to land use if they cannot be repaired or reconstructed in their original location.

Alternative One

Implementation of the SRIPP would result in ongoing use of existing and planned facilities on Wallops Island; therefore no changes to land use would occur.

Alternative Two

Implementation of the SRIPP would result in ongoing use of existing and planned facilities on Wallops Island; therefore no changes to land use would occur.

Alternative Three

Implementation of the SRIPP would result in ongoing use of existing and planned facilities on Wallops Island; therefore no changes to land use would occur.

4.4.2 Infrastructure and Facilities

No Action Alternative

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance and emergency repair activities would maintain the use of existing facilities. However, maintenance of existing conditions may not adequately protect existing and planned infrastructure and facilities closest to the beach on Wallops Island. Beach erosion, especially
during storm events, could result in damage to or loss of $1 billion in infrastructure and facilities, and loss of the capabilities of WFF and tenant’s operations.

**Alternative One**

Under Alternative One, SRIPP activities would maintain the use of existing and planned facilities on Wallops Island. The SRIPP would protect from damage to or loss of $1 billion in infrastructure and facilities, and from the loss of the capabilities of WFF and tenant’s operations.

**Alternative Two**

Alternative Two would provide an equal level of storm damage reduction to infrastructure and facilities on Wallops Island as Alternative One.

**Alternative Three**

Alternative Three would provide an equal level of storm damage reduction to infrastructure and facilities on Wallops Island as Alternative One.

### 4.4.3 Recreation

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance and emergency repair activities would occur. The Wallops Island beach would not be re-established where it is completely eroded; therefore, recreational use of the beach including fishing from the shore would continue to be limited.

**Alternative One**

Use of sections of the Wallops Island beach would be restricted during SRIPP activities. However, because other beaches in the area and other parts of Wallops Island could be used as alternate locations for recreational purposes, no adverse impacts are anticipated.

While some recreational boaters and divers may utilize the marine waters within the SRIPP project area, they have considerable discretion in their choice of recreation locations. As a result, temporary clearances for safety purposes that would be implemented under the SRIPP would have little or no effect on the numbers of vessels or people involved in recreational activities, the success of their activities, or the satisfaction of participants in their recreational experience. When a safety clearance of the project area would be required, a Notice to Mariners would be provided in advance. This notification would continue to allow boaters to select an alternate destination without substantially affecting their activities. Barge trips to and from the offshore borrow sites and Wallops Island would result in increased traffic on the ocean, but because boaters can avoid the barges with ease, no severe disruptions to recreational boating or diving are anticipated.

**Alternative Two**

The types of impacts described under Alternative One would be the same for Alternative Two. However, a slight increase in the disruption to local shore fisherman and recreational boaters would occur during the groin construction period. Because recreational boaters could avoid the groin area during construction, no serious disruptions to recreational boating are anticipated.
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Alternative Three

The types of impacts described under Alternative One would be the same for Alternative Three. However, a slight increase in the disruption to local shore fisherman and recreational boaters would occur during the breakwater construction period. Because recreational boaters could avoid the breakwater area during construction, no serious disruptions to recreational boating are anticipated.

4.4.4 Commercial and Recreational Fisheries

No Action Alternative

Under the No Action Alternative, the SRIPP would not be implemented; however, maintenance and emergency repair activities would occur. Because these activities would take place on Wallops Island or in the nearshore area, it is anticipated that the No Action Alternative would result in only temporary impacts on any commercial or recreational fishing taking place from the Wallops Island beach or immediately offshore.

Alternative One

Under Alternative One, there could be temporary impacts on commercial and recreational fishing resources during the placement of beach fill material on Wallops Island due to elevated turbidity levels in the nearshore environment and disruption of the benthos, which would cause fish to avoid the disturbed areas. No impacts to commercial and recreational fishing are anticipated from construction of the seawall or use of the north Wallops Island borrow site for renourishment. There would be temporary adverse impacts on commercial and recreational fishing at the offshore borrow sites during dredging. As described in Section 3.2.2.3 (Benthos), benthic habitat would be temporarily disturbed and it is anticipated that fish would migrate short distances to avoid the dredging operations.

Fishermen who participated in the spring 2009 SRIPP survey mostly had permits for bluefish, black sea bass, scup, squid/mackerel/butterfish, and summer flounder. Fishing for these species at Unnamed Shoals A and B would be temporarily adversely impacted by the presence of the dredge in the area and the increase in turbidity during dredging, which may interfere with fish feeding (Gordon et al., 1972), and consequently the fishing quality in the area. However, Unnamed Shoals A and B are only two of many shoals in the project vicinity and have not achieved nearly the same level of popularity with commercial and recreational fishermen as other nearby areas, such as Blackfish Bank Shoal. Thirty-six of the survey respondents (55 percent) reported fishing within 8 km (5 mi) of either Blackfish Bank or the Wallops Island shoreline. Of those 36 respondents, 24 said they fished at Blackfish Bank (NASA, 2009d). Fishermen could easily avoid fishing at Unnamed Shoals A and B during dredging operations.

Only one local vessel that had a permit for surf clams responded to the SRIPP survey, but vessels registered in other cities may also fish the area. Surf clams are present in the project area from the beach zone to a depth of about 45 m (150 ft), and would be the most adversely impacted of the commercially and recreationally fished species. Because the offshore shoals are within the surf clam habitat area, they could be entrained in the dredges, smothered from the placement of dredged sediments on the beach, or have difficulty feeding on plankton due to increased turbidity in the nearshore environment and at the offshore borrow sites. Surf clams are a common prey item for many pelagic fish. Studies conducted from 2002 to 2005 by VIMS examined the effects
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of dredging to the benthic community in offshore sand shoals (Diaz et al., 2006). The study suggests that benthic invertebrate communities destroyed by the dredger are able to rebound within a few years (Diaz et al., 2006). Impacts on surf clam populations would be mitigated by maintaining the morphology of the shoals and leaving undisturbed areas of benthic habitat in between passes of the dredger. These techniques would allow for quicker repopulation of the benthic layer. The loss of surf clams in the dredged areas on Unnamed Shoals A and B could reduce the numbers of fish present in the project area; however, these impacts are anticipated to be temporary and highly localized, and are not expected to significantly affect commercial or recreational fishing. In addition, according to Mr. Tom Hoff of the Mid-Atlantic Fishery Management Council (personal comm.), approximately 80 percent of the vessels fishing for surf clams of the Atlantic coast landed their catches in New Jersey, 5 to 10 percent in Ocean City, Maryland, 10 percent off the Delmarva Peninsula, and 5 to 10 percent off New England. The NMFS 2008 commercial fishery landings ranked by U.S. port also indicate that the majority of commercial fishing on the East coast is done north of the project area in States like New Jersey, Massachusetts, and Maine. The ports closest to the project area are lower ranked ports, with Ocean City, Maryland ranked 52, and Chincoteague, Virginia ranked 77 out of 90 ranked U.S. ports (NMFS, 2009).

NASA’s SRIPP activities would not impact daily commercial fishing routes, including ingress and egress from Chincoteague Inlet.

**Alternative Two**

Under Alternative Two, the types of impacts on commercial and recreational fisheries would be similar to those discussed under Alternative One; however, because less beach fill volume (initial and renourishment volumes) would be required compared to Alternative One, the beach nourishment would require less time to execute and fewer trips to the shoals, resulting in fewer disruptions to fishermen. Elevated turbidity is expected during the construction of the new groin, but it would also provide additional habitat for fish as well as benthic organisms that attached to hard substrates such as sponges and crab that would live on and in the crevices of the rocks.

**Alternative Three**

Under Alternative Three, the types of impacts on commercial and recreational fisheries would be the same as those discussed under Alternative One; however, because less beach fill volume (initial and renourishment volumes) would be required compared to Alternative One, the beach nourishment would require less time to execute and fewer trips to the shoals, resulting fewer disruptions to fishermen. Elevated turbidity is expected during the construction of the new breakwater, but it would also provide additional habitat for fish as well as benthic organisms that attached to hard substrates such as sponges and crab that would live on and in the crevices of the rocks.

**4.4.5 Population, Employment and Income**

**No Action Alternative**

Under the No Action Alternative, the SRIPP would not be implemented; however, minor maintenance and emergency repair activities would occur. Under this alternative, damage and/or loss of WFF assets could occur; these losses would delay Wallops Island mission assignments and could eliminate technological capabilities as well as employment opportunities.
Alternative One

Construction activities would result in beneficial economic impacts to the overall economy. In addition to a temporary increase in the number of workers at WFF, economic impacts from the Proposed Action would result from construction material purchases in the region generating local sales, construction payroll expenditures for labor on-and off-site, and related spending by supplying firms and laborers or “multiplier effects” created by the project investment. These economic benefits would occur for a relatively limited time during actual construction.

Direct effects would involve generation of employment and spending by workers within Accomack County. Construction activities would also result in indirect economic activity by supplying industries that furnish requisite input materials and services to the industries directly involved in construction. These indirect impacts reflect the intermediate production or increased economic activity to supply services, materials, and machinery necessary to support the construction program. In turn, the labor force would re-spend a portion of their salary and wage earnings on various consumer expenditures, producing an “induced” effect. The induced impact is the effect of increased consumer spending by salary and wage earners. Some non-local construction workers and vessel operators and crew are anticipated to require lodging in local motels and hotels.

The SRIPP would reduce the potential losses of work days and jobs that could result from storm damages, and therefore delays to Wallops Island missions, or the loss of the infrastructure resulting in elimination of WFF’s and tenant’s technological capabilities. Additionally, launches from the Wallops Island Launch Complex 0 provide benefits to the local economy. Per launch event, the local economy typically benefits approximately $1,000,000 from the launch team alone (e.g., hotel, per diem rates for meals and incidentals, rental car), $2,000,000 for services and commodities support, and $3,000,000 to $5,000,000 from tourism (Reed, pers. comm.). Alternative One of the SRIPP would reduce the potential storm-related damages resulting from shoreline retreat to the launch pads within Launch Complex 0.

Alternative Two

The types of impacts and benefits would be similar to those described under Alternative One. However, there would be a slight increase in benefits to the local economy compared to Alternative One due to the construction of a groin, which would result in additional employment opportunities for local construction workers and increased numbers of people in Accomack County.

Alternative Three

The types of impacts and benefits would be similar to those described under Alternative One. However, there would be a slight increase in benefits to the local economy compared to Alternative One due to the construction of a breakwater, which would result in additional employment opportunities for local construction workers and increased numbers of people in Accomack County.
4.4.6 Health and Safety

No Action Alternative

Under the No Action Alternative, the SRIPP would not be implemented; however, minor maintenance and emergency repair activities would occur. Maintenance and emergency repair activities could result in short-term impacts on human health and safety and the increased usage of local fire, police, and medical services. Construction safety procedures and appropriate training implemented at WFF and NASA would ensure that construction and dredging contractors perform all work in accordance with OSHA standards. Therefore, it is anticipated that the No Action Alternative would not impact health and safety.

Alternative One

Construction activities could result in short-term impacts on human health and safety and the increased usage of local fire, police, and medical services. Construction safety procedures and appropriate training would be implemented at WFF and NASA would ensure that construction and dredging contractors perform all work in accordance with OSHA standards. Therefore, it is anticipated that Alternative One would not impact health and safety.

Alternative Two

Health and safety impacts and mitigation would be the same as described under Alternative One.

Alternative Three

Health and safety impacts and mitigation would be the same as described under Alternative One.

4.4.7 Environmental Justice

No Action Alternative

Under the No Action Alternative, maintenance and emergency repair activities be similar to activities already conducted at WFF; therefore, since the EJIP found that current WFF actions do not disproportionately affect low-income or minority populations (NASA, 1996), no impacts on low-income or minority populations would occur.

Alternative One

Construction activities associated with Alternative One are not expected to occur close to any residential and commercial land uses. SRIPP-related activities are expected to occur at least 3.1 km (1.9 mi) away from the nearest community, which is Mount Wharton subdivision located northwest of Wallops Island. Typically, construction activities result in noise and/or construction related traffic that can potentially affect minority and low-income persons. Under Alternative One, noise impacts during construction would be within acceptable limits and are not expected to cause any disproportionate impacts to minority and low-income persons. Construction activities are also not expected to result in any traffic-related impacts on roads and streets within communities near WFF. Implementation of the SRIPP would not result in displacement of residences or businesses. Therefore, no impacts on environmental justice are anticipated under Alternative One.
**Environmental Consequences**

**Alternative Two**
Under Alternative Two, no impacts on environmental justice are anticipated. Although the specific actions under Alternative Two would differ from Alternative One, the nature of impacts would be similar.

**Alternative Three**
Under Alternative Three, no impacts on environmental justice are anticipated. Although the specific actions under Alternative Three would differ from Alternative One and Two, the nature of impacts would be similar.

**4.4.8 Cultural Resources**
The geographical area within which an undertaking may affect historic properties is the APE. As stipulated in Section 106, Federal agencies must identify historic properties within the APE and consider the effects of the undertaking on these properties. The *Historic Resources Survey and Eligibility Report for Wallops Flight Facility* (NASA, 2004) referenced earlier in this report serves as the baseline for the identification of the above-ground historic properties at WFF, while the archaeological sensitivity model presented in the *Cultural Resources Assessment, NASA Wallops Flight Facility* (NASA, 2003b) serves as the baseline for identifying potential archaeological resources. Together these studies, addressed in the Cultural Resources Management Plan for WFF, likely account for many of the historic properties that are present at WFF and as such allow for a general assessment of the potential for an undertaking to affect historic properties.

Underwater actions, which include dredging within Unnamed Shoal A or Unnamed Shoal B, pump-out operations in the nearshore environment east of Wallops Island, and the construction of a groin or breakwater, would only affect archaeological resources. These actions have no potential to affect above-ground resources. The location(s) of the pump-out station(s) has not been identified by WFF. Additional Section 106 consultation would be required for the area(s) around the pump-out station(s) once the location(s) has been identified.

For any identified cultural resources that may be affected by NASA activities under the SRIPP, NASA would be responsible for complying with Section 106 and Section 110 of the NHPA. NASA would consult with the VDHR and any other interested parties for actions that would potentially impact NRHP-listed or eligible resources to identify the area of potential effects, the effects the action would have on cultural resources, and the appropriate measures to avoid or mitigate impacts on cultural resources.

**No Action Alternative**
*Above-Ground Resources*: Under the No Action Alternative, shoreline retreat would continue. Maintenance and emergency repairs to existing structures would likely be necessary as a result of future storm events. As needed, maintenance and emergency repairs to damaged structures would need to be completed in accordance with Section 106 and Section 110 of the NHPA. This would include the review of any newer buildings or structures that have reached the NHPA 50-year threshold for their National Register eligibility after the *Historic Resources Survey and Eligibility Report for Wallops Flight Facility* was approved by VDHR. Therefore, it is anticipated that the No Action Alternative could have adverse effects on above-ground resources.
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_**Archaeological Resources:**_ The only potential impacts on archaeological resources would be the use of heavy equipment disturbing unknown archaeological sites along the beach. However, based on the Reconnaissance Level Archaeological Survey conducted in September 2006, there is little potential for archaeological sites to occur along the beachfront. Therefore, it is anticipated that the No Action Alternative would have no adverse effect on archaeological resources.

**Alternative One**

**Seawall and Beach Fill**

**Above-Ground Resources:** NASA has determined that the Proposed Action does not have the potential to directly affect above-ground historic properties within the APE. Additionally, NASA has determined that the project may have indirect (visual) effects on above-ground historic properties should they be present in the APE, but that these would not be adverse.

**Archaeological Resources:** Terrestrial archaeology would likely not be affected for beach fill activities because there would be only surface disturbance on the beachfront; in addition, no archaeological material or features were found during the Phase I Archaeological Survey conducted in September 2006. Because there were no historic properties identified within the APE on Wallops Island and because the archaeological review of recent ground disturbance in the area found no archaeological resources, NASA has determined that no archaeological historic properties would be affected by the Proposed Action.

**Section 106 Consultation:** On December 9, 2009, NASA submitted a letter to VDHR with NASA’s determinations of effects for cultural resources as stated above. In a letter dated January 5, 2009, VDHR concurred with NASA’s determination “that there are no historic properties location within the project area and that no further work is needed within the area studied,” and that Alternatives One, Two, and Three of the SRIPP “will not adversely affect any historic properties” (Appendix C). In the event that previously unrecorded historic properties are discovered during project activities, NASA would stop work in the area and contact VDHR immediately.

**Offshore Borrow Sites**

Analysis of the data from the 2009 remote sensing survey coupled with the frequent fishing that takes place at or near Unnamed Shoal A, indicated that none of the anomalies detected during the survey have potential to represent significant submerged cultural resources.

**Section 106 Consultation:** In October 2009, NASA submitted a cultural resources report to MMS stating that “No further avoidance or work is recommended for the isolated anomalies or five target clusters identified [at Unnamed Shoal A and Unnamed Shoal B].” In an email dated December 15, 2009, MMS agreed with NASA’s determination and no archaeological mitigation is required (Appendix C).

**North Wallops Island Borrow Site**

Because there were no historic properties identified within the APE on Wallops Island and because the archaeological review of recent ground disturbance in the proposed north Wallops
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Island borrow site area found no archaeological resources, NASA has determined that no archaeological historic properties would be affected by the Proposed Action.

Section 106 Consultation: On December 9, 2009, NASA submitted a letter to VDHR with NASA’s determinations of effects for cultural resources as stated above. In a letter dated January 5, 2009, VDHR concurred with NASA’s determination “that there are no historic properties location within the project area and that no further work is needed within the area studied,” and that Alternatives One, Two, and Three of the SRIPP “will not adversely affect any historic properties” (Appendix C). In the event that previously unrecorded historic properties are discovered during project activities, NASA would stop work in the area and contact VDHR immediately.

Alternative Two

Seawall and Beach Fill

The impacts and consultation discussed under Alternative One for seawall and beach fill components of the SRIPP would be the same for the seawall and beach fill components of Alternative Two.

Groin

Results from the 2009 cultural resources wading survey of the proposed groin location and Wallops Island shoreline survey did not identify any significant cultural resources. The final 70 m (200 ft) of the survey area were not surveyed due to safety concerns regarding impalement and entanglement of divers on rebar left from the dumping of construction debris. Moreover, based on the ground disturbance that has occurred at this site including construction of the original groin, disposal of concrete construction waste throughout the area, and the general erosion and sediment transport that routinely takes place along the Wallops Island shoreline, this section has a very low potential to contain significant historic resources. Because there were no historic properties identified within the APE on Wallops Island and because the archaeological review of recent ground disturbance in the area found no archaeological resources, NASA has determined that no archaeological historic properties would be affected by construction of the proposed groin.

Section 106 Consultation: On December 9, 2009, NASA submitted a letter to VDHR with NASA’s determinations of effects for cultural resources as stated above. In a letter dated January 5, 2009, VDHR concurred with NASA’s determination “that there are no historic properties location within the project area and that no further work is needed within the area studied,” and that Alternatives One, Two, and Three of the SRIPP “will not adversely affect any historic properties” (Appendix C). In the event that previously unrecorded historic properties are discovered during project activities, NASA would stop work in the area and contact VDHR immediately.

Offshore Borrow Sites

The impacts and consultation discussed under Alternative One for dredging Unnamed Shoal A or B would be the same for Alternative Two.
North Wallops Island Borrow Site

The impacts and consultation discussed under Alternative One for use of the north Wallops Island area as a borrow site would be the same for Alternative Two.

Alternative Three

Seawall and Beach Fill

The impacts and consultation discussed under Alternative One for seawall and beach fill components of the SRIPP would be the same for the seawall and beach fill components of Alternative Three.

Breakwater

Results from the 2009 remote sensing survey indicated that no significant submerged cultural resources exist in the proposed breakwater location. Because there were no historic properties identified within the APE of the breakwater and because the archaeological review in the area found no archaeological resources, NASA has determined that no archaeological historic properties would be affected by construction of the proposed breakwater.

Section 106 Consultation: On December 9, 2009, NASA submitted a letter to VDHR with NASA’s determinations of effects for cultural resources as stated above. In a letter dated January 5, 2009, VDHR concurred with NASA’s determination “that there are no historic properties location within the project area and that no further work is needed within the area studied,” and that Alternatives One, Two, and Three of the SRIPP “will not adversely affect any historic properties” (Appendix C). In the event that previously unrecorded historic properties are discovered during project activities, NASA would stop work in the area and contact VDHR immediately.

Offshore Borrow Sites

The impacts and consultation discussed under Alternative One for dredging Unnamed Shoal A or B would be the same for Alternative Three.

North Wallops Island Borrow Site

The impacts and consultation discussed under Alternative One for use of the north Wallops Island area as a borrow site would be the same for Alternative Two.

4.4.9 Transportation

4.4.9.1 Upland

No Action Alternative

Under the No Action Alternative, SRIPP would not be implemented; however, maintenance activities and emergency repairs would occur. These activities would cause recurring traffic to and from and on Wallops Island, the nature and magnitude of which would depend upon the types of maintenance and repairs needed.
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**Alternative One**

Temporary impacts on traffic flow would occur during construction activities due to an increase in the volume of construction-related traffic at roads in the immediate vicinity of Wallops Island. Construction traffic would include bulldozers, excavators, and cranes, brought in via truck, haul/dump trucks, worker vehicles, and others. Traffic lanes may be temporarily closed or rerouted during construction, and construction equipment and staging could interfere with typical vehicle flow. NASA would coordinate all transportation activities, including closures, traffic control, safety issues, etc. with Accomack County and the Virginia Department of Transportation Accomack Residency Office. To mitigate potential delays, NASA would:

- Provide adequate advance notification of upcoming activities for all areas that would be affected by construction-related traffic, temporary closures, or re-routing
- Coordinate any traffic lane or pedestrian corridor closures with all appropriate officials
- Place construction equipment and vehicle staging so as to not hinder traffic and pedestrian flow

All project-related transportation vehicles would consist of legal Department of Transportation loads, although if a crane in transported over land, it may be characterized as oversize and would require a permit from the Virginia Department of Motor Vehicles for transportation.

During renourishment cycles, sediment may be obtained from north Wallops Island. Heavy equipment including pan excavators, dump trucks, excavators, and bulldozers would travel along the existing roads and along the beach to access the north Wallops Island borrow sites; no new permanent or temporary roads would be constructed to access the borrow site.

**Unnamed Shoal A and Unnamed Shoal B Borrow Sites**

Minor construction traffic is anticipated to be associated with the Unnamed Shoal A and Unnamed Shoal B borrow sites. Employees would drive to the docked dredging barges to load them with any needed equipment. However, this amount of traffic would not be a significant increase from the usual daily landside traffic on Wallops Island.

**Alternative Two**

The types of landside transportation impacts and mitigation measures would be the same as those described under Alternative One, except there would be an increase in traffic during the construction of the groin.

**Alternative Three**

The types of landside transportation impacts and mitigation measures would be the same as those described under Alternative One; however there would be slightly more construction traffic for installation of the breakwater.

4.4.9.2 **Maritime**

**No Action Alternative**

Under the No Action Alternative, SRIPP would not be implemented; however, maintenance activities and emergency repairs would occur. It is unlikely that maintenance and repairs would
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occur in or from the water. If boats or barges were required, a slight increase in maritime traffic could occur which would depend upon the types of the repairs that were needed; however, any increase in maritime traffic would be insignificant.

Alternative One

No maritime traffic would occur for construction of the seawall, sediment re-working on the beach after the dredge material is placed, or for use of the north Wallops Island borrow site.

Dredging of either offshore shoal would be accomplished using hopper dredges, which are ships capable of dredging material, storing it onboard, transporting it to the disposal area, and pumping it on-shore. Two hopper dredges would likely run at the same time, as one ship is dredging at either Unnamed Shoal A or B, the second ship would be offloading sediment on the beach. After filling its hoppers with sand, the dredge would then travel the approximately 15 km (10 mi) toward Wallops Island. The pathway from Unnamed Shoals A and B to the pump out site is not a straight line, but a dogleg shape, for the purpose of avoiding Chincoteague Shoal and Blackfish Bank. The dredge would travel from Unnamed Shoal A or B to the turning point approximately 15 or 23 km (9 or 14 mi) away respectively, then on to moor to the pump out buoy located 10,000 feet from shore (5 km [8 mi] from the turning point). Booster pumps may be needed to aid the offloading of sand from this pump out station to the shoreline.

Navigational accidents, such as vessel collisions, would be avoided by following proper safety protocols as outlined in 72 Collision Regulations (COLREGS), The International Navigational Rules Act of 1977, and the Inland Navigation Rules Act of 1980 (USCG, 2009a). The barge route would extend directly from Unnamed Shoals A and B to the Wallops Island shoreline.

A Private Aid to Navigation (PATON) permit would need to be obtained from the USCG to place temporary buoys for dredging activities. The management of the PATON can be deferred to State or local authorities, or to agencies such as the USACE or MMS. The USCG will usually only become involved in PATON management if there is not a designated mooring area and a buoy needs to be placed on the chart or in situations when a large commercial mooring buoy needs to be lit or charted, however, only after the selected local authority has approved the placement (USCG, 2009b).

Temporary increases in the volume of maritime traffic would occur for approximately seven months during initial beach nourishment activities and approximately six months during each renourishment cycle. Potential impacts on the three general types of maritime traffic in the project area, military and government, commercial, and recreational, are discussed below.

Military and Government Traffic

Due to the presence of regular military and government traffic in the project area, and the overlap of the U.S. Navy Virginia Capes Range Complex operating area, it is likely that the dredges would encounter these vessels during travel between the offshore shoals and the beach. NASA would coordinate all transportation activities, marine traffic control, safety issues, etc. with USCG and the U.S. Navy. To mitigate potential delays and ship strikes, NASA would:

- Select the dates, times, and routes that the dredges would take with efforts to avoid the majority of existing military traffic.
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- Provide adequate advance notification of upcoming activities to all agencies that would be affected by dredging-related traffic or re-routing.

With implementation of mitigation and notification measures, impacts on maritime government and military traffic would be temporary and minor.

Commercial Traffic

Although commercial vessels may pass by the dredging sites on their way to Port of Baltimore, MD, and the Port of Virginia, in Norfolk, there are no TSS lanes designated in the project area. Therefore, it is unlikely that the dredges would interfere with commercial traffic. Additionally, the dredges would comply with Federal navigational regulations (72 COLREGS) which specify requirements for any seagoing vessel operating in U.S. waters outside inland demarcation lines, which is the area enclosed by the shoreline. In the project area it is the line drawn from Assateague Beach Tower Light to the tower charted at latitude 37°52.6’ N, longitude 75°26.7’ W. The COLREGS include requirements such as having the proper day signals and navigational lights. Therefore, no significant impacts on commercial maritime traffic are anticipated.

Recreational Traffic

Fishing and recreational boating traffic occurs in the project area primarily offshore of Wallops and Assateague Islands and at offshore shoals. Although recreational traffic may be present in the project areas concurrently with dredging and beach nourishment operations, the dredges would be outfitted with the proper lights and signals under 72 COLREGS, so they can easily be seen and avoided. Although recreational fishing and boating routes would be unavailable for use in the areas immediately surrounding the offshore dredging sites and the Wallops Island beach during SRIPP operations, the majority of the project area would still be available for travel. Therefore, no significant impacts on recreational maritime traffic are anticipated.

Alternative Two

Maritime transportation impacts and mitigation measures under Alternative Two would be similar to those described under Alternative One; however, there would be an increase in traffic in the nearshore environment off Wallops Island during the one month period for construction of the groin.

Alternative Three

Maritime transportation impacts and mitigation measures under Alternative Three would be similar to those described under Alternative One; however, there would be an increase in traffic in the nearshore environment off Wallops Island during the one month period for construction of the breakwater.

4.5 RELATIONSHIP BETWEEN SHORT-TERM USE OF MAN’S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

NEPA requires analysis of the relationship between a project’s short-term impacts on the environment and the effects those impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This means that choosing one option may
reduce future flexibility in pursuing other options, or that committing a resource to a certain use may often eliminate the possibility for other uses of that resource.

Short-term refers to the total duration of shoreline restoration activities, whereas long-term refers to an indefinite period beyond 50-year life of the SRIPP activities. Initial activities, such as dredging and sea wall construction, result in short-term, localized impacts (primarily to the natural environment) that would be reduced by the mitigation measures described under each resource area.

The Proposed Action would result in short- and long-term environmental effects. However, the Proposed Action would not likely be expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety, or the general welfare of the public.

The SRIPP would also result in beneficial effects. As described in Chapter 5, NASA would monitor the Wallops Island shoreline to gain a better understanding of physical oceanographic processes and longshore sediment transport during the lifetime of the SRIPP. This information would be available to the public and would benefit the scientific community, as well as NASA, in understanding the effects of shoreline restoration and offshore dredging. In addition, the SRIPP would restore a substantial area of the Wallops Island beach where no beach currently exists. The restoration of the beach would provide new habitat to terrestrial species, including federally protected species such as the Piping Plover and loggerhead turtle.

By reducing the level of storm damages to the launch pads and other infrastructure on Wallops Island, the SRIPP is enabling continued scientific research. The SRIPP would allow the continuation of critical NASA missions such as suborbital research from NASA’s sounding rocket program and re-supply of the International Space Station.

4.6 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

NEPA requires that environmental analysis include identification of “…any irreversible and irreplaceable commitments of resources which would be involved in the Proposed Action should it be implemented.” Irreversible and irreplaceable resource commitments are related to the use of non-renewable resources and the effects that the uses of those resources would have on future generations. Irreversible effects primarily result from the use or destruction of a specific resource (e.g., energy or minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action (e.g., the disturbance of a cultural site).

Energy typically associated with construction activities would be expended and irretrievably lost under all of the SRIPP alternatives including the No Action Alternative. Fuels used during transportation of construction materials (i.e., rock and mobilization of equipment to the site) and the operation of equipment and barges would constitute an irreplaceable commitment of fuel resources.

Sediment removed from the offshore shoals would be an irreversible use of the mineral resource there. If it is found that the northern end of Wallops Island could be mined for larger volumes beyond what is proposed in this PEIS, then the rate and volume of consumption of the offshore borrow areas used to maintain the Wallops Island shoreline could be reduced. This could serve to prolong the integrity of the offshore shoals and their benthic communities that are more valuable
as commercial and recreational fisheries and that are otherwise being irreversibly consumed for beach renourishment.

### 4.7 Cumulative Effects

The CEQ defines cumulative effects as the “impact on the environment which results from the incremental impact of the action(s) when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions” (40 CFR 1500). Past, present, and reasonably foreseeable projects that may result in cumulative impacts when combined with the SRIPP are described below. For the purposes of this PEIS, projects that may occur within the 50-year life span of the SRIPP are considered.

There are several ongoing and planned projects at WFF, particularly on Wallops Island. Only those with potential to contribute to cumulative impacts to the physical, biological, and socioeconomic environment, when combined with the SRIPP, are considered. In addition, there are other projects and activities outside of the WFF boundaries that may result in cumulative impacts in the area. These projects include; dredging of offshore shoals, beach nourishment projects, commercial fishing, and submarine infrastructure projects such as construction of pipelines or cables.

The cumulative effects take into consideration relevant past, present, and reasonably foreseeable onshore and offshore project and activities that may affect resources within of the project area. The area for the cumulative effects analysis covered the nearshore areas from approximately Ocean City, MD to Sandbridge, VA. Below is a brief description of the projects considered in the cumulative effects analyses.

#### 4.7.1 WFF Launch Range Activities

NASA can currently launch up to approximately 102 rockets a year from the launch areas on Wallops Island. These include a maximum of 60 from the Sounding Rocket Program, 12 from orbital rocket missions at Pad 0-B, and 30 from Navy missiles and drones (NASA, 2005). Debris from various WFF launch operations (i.e., spent rockets, payloads, drones, and rocket-boosted projectiles) lands in the Atlantic Ocean. This debris may consist of a variety of components including metals, batteries, electrical components, and propellants.

#### 4.7.2 Onshore Projects

Currently, NASA is planning three projects on Wallops Island that may result in impacts to environmental resources within the SRIPP project area. These projects are described briefly below.

**North Unmanned Aerial Systems Airstrip at Wallops Island**

NASA is currently considering the construction of an UAS airstrip on north Wallops Island. The purpose of the North UAS Airstrip would be to provide a venue and infrastructure to support launch and recovery operations for UASs. UASs are small aircraft that serve as platforms for small science instruments. They are controlled remotely by a pilot on the ground and are powered by batteries or small model aircraft gasoline engines. The east-west orientation of this airstrip would provide an alternative to the north-south positioning of the current UAS airstrip on
south Wallops Island. An EA is currently being prepared. The implementation date of the UAS airstrip would occur no earlier than mid-2011.

**Expansion of the Wallops Flight Facility Launch Range**

NASA and MARS facilities will be upgraded to support up to and including medium large class suborbital and orbital expendable launch vehicle (ELV) launch activities from WFF. Components of the project include site improvements required to support launch operations (such as facility construction and infrastructure improvements); testing, fueling, and processing operations; up to two static fire tests per year; and launching of up to six ELVs and associated spacecraft per year from Pad 0-A. Implementation of the project would result in a maximum of 18 orbital-class launches from MARS Launch Complex 0 per year (12 existing launches from Pad 0-B, and 6 additional launches from Pad 0-A). The first orbital launch from Pad 0-A is currently planned for 2011.

**Wallops Flight Facility Alternative Energy Project**

The purpose of WFF’s Alternative Energy Project is to generate clean, renewable energy from a technologically proven source that will be used by WFF in order to meet Federal renewable energy requirements. WFF is proposing to implement the use of wind turbines and solar panels in order to reduce the fossil fuels needed to create electricity while also reducing WFF’s annual operation costs. NASA is currently preparing an EA for the project; implementation of this project is planned for mid-2010.

4.7.3 **Offshore Projects and Actions**

There are ongoing and reasonably foreseeable offshore projects that have been considered in evaluating the cumulative effects from the SRIPP. These projects occur within a broader nearshore and inner continental shelf region of the SRIPP project area.

4.7.3.1 **Virginia Capes Operating Area**

The Virginia Capes Operating Area (VACAPES OPAREA) is a surface and subsurface operating area off the Virginia and North Carolina coasts within the VACAPES Range Complex (Figure 45). The mission of the VACAPES Range Complex is to provide sustainable and modernized ocean operating areas, airspace, ranges, range infrastructure, training facilities, and resources to fully support U.S. Navy training requirements. The VACAPES OPAREA is used by the U.S. Navy Atlantic Fleet training for research, development, testing, and evaluation activities, and associated range capabilities enhancements, including infrastructure improvements.
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The VACAPES OPAREA includes the nearshore area from just off the mouth of Delaware Bay south to Cape Hatteras. The western boundary is roughly the 3-nautical-mile State territorial limit and the eastern boundary extends 287 km (178 mi) into waters more than 4,000 m (13,120 ft) deep.

4.7.3.2 Offshore Dredging

Offshore dredging projects in both Maryland and Virginia have been included in the evaluation of cumulative effects. Although the shoals identified as potential sand sources for the SRIPP are located in northern Virginia, they are at the southern end of the Assateague Ridge field that extends offshore of Maryland (Swift and Field, 1981). Therefore, projects utilizing sand from this offshore shoal complex are considered in the evaluation of the cumulative effects.

Maryland

Atlantic Coast of Maryland Shoreline Protection Project

To help remedy the sand loss in Ocean City, MD (located approximately 80 km [50 mi] north of WFF) from beach erosion because of storms, the USACE began a beach renourishment effort for Ocean City in the late 1980s. Ocean City’s Beach Renourishment Project is an ongoing effort. In general, the dredging is on a 4-year cycle and is planned to continue for another 40 years. The last renourishment cycle was completed in 2006, with the next renourishment cycle planned for 2010. For this upcoming renourishment cycle, the USACE is considering four offshore shoals in Federal waters east of Ocean City Inlet (the southernmost proposed shoal is approximately 16 km [10 mi] southeast of the inlet) to provide some or all of the volume for the project duration. Currently, the USACE plans to provide approximately 535,000 m$^3$ (700,000 yd$^3$) of material to the beach in each renourishment cycle.

Assateague Island Beach Restoration

Beginning in 2003, the NPS undertook a beach restoration effort at Assateague Island to mitigate the effects of the Ocean City Inlet jetty system built in the 1930s. The objective of the NPS project is not traditional beach nourishment to protect the shoreline from storm damage or to halt erosion, but rather to restore Assateague Island’s sand budget and ensure that natural coastal processes continue to dictate the evolution of the island (NPS, 2003). Approximately 1 million m$^3$ (1.4 million yd$^3$) of sand was taken from Great Gull Bank for initial nourishment, a shoal approximately 8 km (5 mi) east of northern Assateague Island. For renourishment, sediment has been dredged approximately twice yearly from an ebb shoal immediately offshore of Ocean City Inlet. This ebb shoal will be continue to be used for renourishment activities for the project duration of 40 years.

Virginia

To date, there has been no sand dredged from Federal waters offshore of Virginia north of the mouth of the Chesapeake Bay. However, sand has been dredged from offshore Federal waters south of the Chesapeake Bay. These projects are described below.

Sandbridge Beach Erosion Control and Hurricane Protection Project

The City of Virginia Beach has utilized sand from Sandbridge Shoal since 1998 to renourish Sandbridge Beach. Sandbridge Shoal is located approximately 4.5 to 6.6 km (2.8 to 4.1 mi) offshore. In 1998, the city dredged 4.4 million m$^3$ (5.7 million yd$^3$) of sand. In 2002, the city
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dredged an additional 1.53 million m³ (2.0 million yd³). The Navy’s Dam Neck facility has also utilized Sandbridge Shoal, dredging 619,000 m³ (809,000 yd³) of sand in 1996 and 535,000 m³ (700,000 yd³) in 2003.

An EA for the Sandbridge Beach Erosion Control and Hurricane Protection Project was prepared in June 2009 by the USACE Norfolk District in cooperation with the MMS. The EA indicates that approximately 1.1 to 1.5 million m³ (1.5 to 2 million yd³) of sand would be placed on the beach approximately every 3 years. The cycle may occur less often, but probably no less than once every 5 years for the 50-year project life.

**Virginia Beach Hurricane Protection Project**

The City of Virginia Beach and the USACE maintain a hurricane protection project that includes beach nourishment. The Virginia Beach project includes a seawall and maintenance of the beach from Rudee Inlet to 89th Street, including a larger dune system from 58th to 89th streets. The initial and renourishment sand source is material dredged from Thimble Shoal and the Atlantic Ocean channels. In the future, material may be obtained from an area off Cape Henry.

**Future Offshore Dredging**

Communities and facilities along the Eastern Shore may require sand sources for beach nourishment. The sand to support these projects will come from a variety of sources including inlets, the Chesapeake Bay, nearshore ebb shoals, and potentially offshore shoals. Although no other specific offshore dredging projects have been identified at this time, in addition to the projects listed above, it is possible that within the 50-year life span of the SRIPP, other offshore areas will be dredged.

**4.7.3.3 Other Offshore Projects and Actions**

**Submarine Infrastructure Projects – Cables, Pipelines**

Although no submarine infrastructure projects are proposed at this time for the SRIPP project area and vicinity, it is possible that within the 50-year life span of the SRIPP a cable, pipeline, or other submarine infrastructure project would occur. It is likely that a project of this nature would result in disturbance of the seafloor and benthic communities. Submarine infrastructure may be placed on the sediment surface or buried within the sediment. All projects of this nature would require review and permits from MMS and other Federal agencies as required for projects in Federal waters, and State and Federal agencies as necessary for work done in State waters. The potential environmental impacts would be considered and documented through the NEPA process for federally funded projects.

**Offshore Renewable Energy Projects**

There has been some preliminary interest in developing potential wind farms off the coast of Virginia and Maryland. The Commonwealth of Virginia and MMS held an offshore renewable energy task force meeting on December 8, 2009, to discuss renewable energy development on the OCS. Maryland issued a Request for Interest and Information with regard to potential offshore wind energy development, with a deadline for responses on January 31, 2010. Offshore wind projects may look to site their turbine foundations in the shallower waters available on shoal crests. Offshore alternative energy projects would require review and approvals from MMS and other Federal agencies as well as the adjacent coastal States. The potential environmental
impacts would be considered and documented through the NEPA process for federally funded or permitted projects.

**Offshore Oil and Gas Exploration**

The MMS has initiated the first step for a potential lease sale (Sale 220) offshore Virginia under the current Outer Continental Shelf Leasing Program 2007-2012 (Figure 46). The sale will be held no earlier than 2011. The area covered is about 1.17 million hectares (2.9 million acres) and is over 80 km (50 mi) offshore. The MMS estimates that this area may contain 130 million barrels of oil and 1.14 trillion cubic feet of natural gas.

No other oil and gas projects in the Mid-Atlantic region offshore of Virginia are known at this time; however, it is possible that offshore sand and gravel may be mined for oil and gas resources. All projects of this nature would require review and permits from MMS and their potential environmental impacts considered and documented through the NEPA process. Potential oil and gas exploration and production in this area would result in potential impacts not only to the offshore environment, but also to the onshore environment where supporting infrastructure would be constructed.

**Commercial Fishing**

As described in Chapter 3, there is commercial fishing activity within the project area. Trawl scars and lost trawl gear on the seafloor were observed during the remote sensing study conducted for the underwater archeological work on the shoals. Churchill (1989) determined that as much as approximately one-third of the seafloor off the Maryland coast out to about 48 km (30 mi) offshore was disturbed by commercial trawling activity in a single year. Assuming this 1985 estimate applies to the Virginia coast, approximately 2,590 km\(^2\) (1,000 mi\(^2\)) of the
approximate 7,900 km\(^2\) (3,050 mi\(^2\)) within the waters 48 km (30 mi) offshore of Virginia would be disturbed in a single year by trawling. Trawling disturbs only the sediment surface. Conversely, sand dredging operations, which can extend several feet into the substrate, depending on the sediment characteristics and dredge specifications.

### 4.7.4 Potential Cumulative Effects

The following section addresses only those resources that have been identified as having the potential to be affected from the incremental effects of the SRIPP in combination with the projects and activities described in Sections 4.7.1, 4.7.2, and 4.7.3 above.

#### 4.7.4.1 Physical Environment

As noted previously, the evaluation of cumulative effects considered projects in the nearshore area from offshore Ocean City, MD to Sandbridge, VA.

**Bathymetry**

Proposed SRIPP dredging would contribute cumulatively to changes in offshore bathymetry when combined with other offshore dredging projects on the inner continental shelf of Virginia and Maryland by lowering the elevation of the seafloor in the dredged areas. The cumulative impact to bathymetry is not anticipated to be significant, because dredging operations along the northern Virginia coastline have been, and are anticipated to be, limited primarily to inlets and inshore navigational channels in the near future. There are dredging operations on shoals located in Federal waters offshore of Ocean City and Assateague Island, MD, to the north of the SRIPP project area, and Sandbridge Shoal, VA, located to the south, but these are located tens of kilometers away from the SRIPP project site. Changes to bathymetry also contribute indirectly to changes in marine life, and these impacts are discussed in the sections below.

The USACE (2008) assumed that the maximum thickness of material that would be removed for future Ocean City beach fill requirements could be up to 3 m (10 ft). It is assumed that the maximum thickness of material removed from offshore shoals for the SRIPP would be approximately 1.5 m (5 ft).

**Offshore Sand Shoals**

The proposed SRIPP dredging operations would contribute incrementally to the overall removal of sand resources from the inner continental shelf in the Mid-Atlantic region offshore of Maryland and Virginia. According to the USACE (2008), dredging conducted for Ocean City and Assateague Island, MD, has removed 10 million m\(^3\) (14.3 million yd\(^3\)) of sand from detached nearshore and offshore shoals. The USACE (2008) estimates that an additional 11.4 million m\(^3\) (15 million yd\(^3\)) could be required for the Atlantic Coast of Maryland Project through 2044. Total cumulative volume for the project would exceed 22 million m\(^3\) (29,000,000 yd\(^3\)).

The Maryland Geologic Survey estimates that the total volume of potential sand resources suitable for beach restoration projects contained within the shoals offshore of Maryland exceeds 1.2 trillion yd\(^3\) (Conkwright and Gast, 1994a,b; Conkwright and Gast, 1995; Conkwright and Williams, 1996; Table 51). The cumulative total of sand that may be dredged from offshore Maryland represents approximately 2 percent of the total amount of potential sand resources available.
Unlike Maryland (e.g., Conkwright and Gast, 1994a, 1994b, and 1995), there has been no comprehensive inventory and estimate of the total volume of potential sand resources contained within sand shoals offshore of Virginia. Potential volumes of sand resources that were estimated for the two unnamed shoals identified for this project are approximately 31 million m$^3$ (40 million yd$^3$) for Unnamed Shoal A and 57 million m$^3$ (70 million yd$^3$) for Unnamed Shoal B. In addition, Blackfish Bank has approximately 19 million m$^3$ (25 million yd$^3$) of sand. Under the Preferred Alternative, assuming that Unnamed Shoal A would be used for initial and all renourishment cycles, the SRIPP would remove approximately 33 percent of the total volume available on Unnamed Shoal A through 2050 (Table 51).

Sandbridge Shoal is the only other shoal in Federal waters offshore of Virginia that has been dredged and will likely be dredged in the foreseeable future. The total potential volume of sand available on Sandbridge Shoal offshore of south Virginia is estimated to be 31 million m$^3$ (40 million yd$^3$) by Hardaway et al. (1998). Cumulative dredging impacts on Sandbridge Shoal through 2050 are estimated to be over 15 million m$^3$ (20 million yd$^3$), or over 50 percent of the total volume present.

### Table 51: Volume of Potential Suitable Sand Resources for Shoreline Restoration in Maryland and Virginia

<table>
<thead>
<tr>
<th>Area</th>
<th>Total Potential Suitable Sand Resources Present m$^3$ (yd$^3$)</th>
<th>Sand Dredged 1988–2009 m$^3$ (yd$^3$)</th>
<th>Potential Sand to be Dredged 2010–2050 m$^3$ (yd$^3$)</th>
<th>Cumulative Total Through 2050 m$^3$ (yd$^3$)</th>
<th>Percent of Volume Present</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maryland</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total$^a$</td>
<td>900,000,000 (1,200,000,000)$^a$</td>
<td>10,900,000 (14,306,000)$^a$</td>
<td>11,000,000 (15,000,000)$^d$</td>
<td>22,406,000 (29,306,000)</td>
<td>2</td>
</tr>
<tr>
<td><strong>Virginia (partial list)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blackfish Bank Shoal$^b$</td>
<td>19,000,000 (25,000,000)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unnamed Shoal A</td>
<td>31,000,000 (40,000,000)$^b$</td>
<td>0</td>
<td>9,990,000 (13,066,250)</td>
<td>9,990,000 (13,066,250)</td>
<td>33</td>
</tr>
<tr>
<td>Unnamed Shoal B$^f$</td>
<td>57,000,000 (70,000,000)$^b$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sandbridge Shoal</td>
<td>31,000,000 (40,000,000)$^c$</td>
<td>3,524,000 (4,610,000)</td>
<td>12,200,000 (16,000,000)$^e$</td>
<td>15,760,000 (20,610,000)</td>
<td>52</td>
</tr>
</tbody>
</table>

$^a$ = Maryland Geologic Survey (Conkwright and Gast 1994a,b and 1995; Conkwright and Williams, 1996)
$^b$ = USACE, 2010a
$^c$ = Hardaway et al., 1998
$^d$ = USACE, 2008 (SEIS estimated maximum volume)
$^e$ = USACE, 2009c ([Sandbridge EA] assumes eight renourishment cycles from 2010 – 2050 at 1.5 million m$^3$ [2 million yd$^3$] per cycle)
$^f$ = Volumes shown for both Unnamed Shoal A and Unnamed Shoal B assume that only one shoal (A or B) would be for all renourishment cycles
The offshore dredging projects described above have removed and will remove substantial amounts of sand from individual offshore shoals. However, the cumulative amount of sand removed for these projects combined is small compared to the overall quantity of sand remaining and left intact along the continental shelf off the coasts of Maryland and Virginia.

Depending on the strength and frequency of future storms, additional sand may be needed for both the proposed SRIPP and other offshore dredging projects, which would increase the potential cumulative impact of the actions. It is not anticipated that SRIPP dredging activities when combined with the dredging activities of other offshore shoals in the region would result in significant cumulative impacts, because the impacted areas are small compared to the total amount of undisturbed offshore shoals.

It is possible that future demand for beach renourishment sand, submarine infrastructure projects, oil and gas exploration, or offshore renewable energy projects would result in additional disturbance of shoals, which may lead to adverse impacts on the geomorphic integrity of the offshore sand shoal environment.

**Shoreline Change**

Within the area from Ocean City MD to Sandbridge, VA, there are several beach nourishment projects that are ongoing and proposed in the future. As described above, these projects include; the Atlantic Coast of Maryland Shoreline Protection Project, Assateague Island Beach Restoration Project, Sandbridge Beach Erosion Control and Hurricane Protection Project, and the Virginia Beach Hurricane Protection Project. The SRIPP would contribute incrementally to the overall beneficial impacts of shoreline restoration efforts within the region. Each of these projects is designed to restore and maintain shorelines within their respective project limits. From a regional perspective, they would not affect shoreline changes outside of their project boundaries.

**Marine Water Quality**

The SRIPP would have minor and temporary localized adverse impacts on marine water quality due to elevated levels of turbidity during dredging and sand placement operations. Other projects occurring in regional marine waters (offshore dredging in MD and VA waters, submarine infrastructure, renewable energy, and oil and gas exploration projects) would also result in temporary elevated levels of turbidity from disturbances on the seafloor.

Debris and materials (metals, batteries, electrical components, and propellants) from spent rockets, payloads, drones, rocket-boosted projectiles, and other objects enter the Atlantic Ocean waters within the region of the SRIPP project area from existing WFF Launch Range operations, future WFF projects (Expansion of the Wallops Island Launch Range), and U.S. Navy activities within the VACAPES OPAREA. The VACAPES Range Complex operations would also introduce small amounts of potentially hazardous chemicals into the marine environment (U.S. Department of Navy, 2009). The water quality analysis of all current and proposed VACAPES operations indicated that concentrations of constituents of concern would be well below the water quality criteria established to protect aquatic life. The combined effects of these materials entering the marine environment could result in cumulative impacts to water quality and aquatic life.
Environmental Consequences

Other non-hazardous expended material, defined as all parts of a device made of nonreactive materials, including parts made of metals such as steel or aluminum; polymers such as nylon, rubber, vinyl, and plastics; glass; fiber; and concrete would accumulative in the SRIPP project area over time from a variety of sources. While these items represent persistent seabed litter, their strong resistance to degradation and their chemical composition mean that they do not chemically contaminate the surrounding environment by leaching heavy metals or organic compounds. Expended material that sinks to the sea floor would gradually degrade, be overgrown by marine life, and/or be incorporated into the sediments. Floating non-hazardous expended material may be lost from target boats and would either degrade over time or wash ashore as flotsam.

The project activities listed above would occur within the open ocean where the hydrodynamics of the water column are subject to mixing and exchange due to currents and wave movement. Toxic concentrations and elevated levels of turbidity would be localized and temporary due to mixing and dilution. Therefore, the incremental contribution to cumulative water resource impacts from the SRIPP combined with other operations and projects in marine waters would not be substantial.

Air Quality

Construction-related and operational activities that would occur under the Proposed Action for the SRIPP and the other projects that are reasonable and foreseeable at WFF would occur at different locations and at different times over a period of several years. Tables 50 and 51 show the estimated emissions from the preferred alternatives of current and planned WFF projects using conservative assumptions to create worst-case scenarios.

Site preparation (i.e., earth moving and soil disturbance) and wind erosion for the projects would result in various amounts of fugitive particulate (i.e., dust) emissions (PM$_{10}$ and PM$_{2.5}$). The amount of fugitive dust emissions would depend on numerous factors, such as the degree of vehicular traffic, amount of exposed soil, soil moisture content, and wind speed. Construction activities would create combustion product (tailpipe) emissions (mostly PM, NO$_X$, and CO) from vehicles (e.g., contractor POVs, delivery trucks, and heavy construction equipment), and temporary non-road equipment powered by internal combustion engines.

BMPs (e.g., dust suppression, establishment of lower speed limits in construction areas) and legal requirements (i.e., use of low-sulfur fuel, anti-idling regulations) would be implemented during each project to minimize and mitigate those emissions to the maximum extent practicable. Criteria pollutant emissions from mobile sources associated with the WFF projects listed in Table 52 would be short-term, negligible, and localized.

The operational phases of these projects would produce similar criteria pollutant emissions on an annual basis, although only the first year of operational emissions was estimated. BMPs (e.g., use of alternative fueled vehicles at WFF) and installation of the two wind turbines proposed for the Alternative Energy Project would help minimize criteria pollutant emissions locally. In addition, a positive impact in a regional reduction in criteria pollutant emissions could result from the decreased use of fossil fuels during the production of electricity at the electric power generation plant that currently supplies WFF.
Cumulative emissions from the Alternative Energy Project, Expansion of the WFF Launch Range, and the SRIPP are unlikely to lead to a violation of the NAAQS, as regional concentrations are already in attainment, with no indication that a re-designation for any criteria pollutant is imminent. Therefore, minimal and short-term cumulative impacts from construction-related and operational activities are anticipated without significant effects on local or regional air quality.

Although cumulative impacts from all construction-related and operational activities are anticipated to be minimal, WFF is in the process of decentralizing the Central Boiler Plant/steam system with individual propane-fired boilers. Table 53 provides the estimated emissions reduction resulting from this action.

**Table 53: Emissions Reduction Resulting from Central Boiler Plant Decentralization in Tons**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>2007 Emissions</th>
<th>Proposed Emissions After Decentralization</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>1.86</td>
<td>2.6</td>
<td>39% increase</td>
</tr>
<tr>
<td>NOx</td>
<td>17.8</td>
<td>4.55</td>
<td>74% reduction</td>
</tr>
<tr>
<td>PM</td>
<td>1.2</td>
<td>0.25</td>
<td>79% reduction</td>
</tr>
<tr>
<td>SO2</td>
<td>27</td>
<td>&lt;1</td>
<td>99% reduction</td>
</tr>
</tbody>
</table>

**Climate Change**

The potential effects of proposed GHG emissions are by nature global and cumulative, since individual sources are not large enough alone to have an appreciable effect on the climate. Such an impact on global climate change would only occur when GHG emissions from anthropogenic sources and sinks combine with proposed GHG emissions on a global scale.
Environmental Consequences

Overall, construction vehicles, equipment, and non-road vehicle sources would emit minimal GHG emissions during the site preparation and construction phases of the projects shown in Table 54. However, dredging operations for the SRIPP would produce considerably more GHG emissions compared to the other WFF projects. The operational phases of the WFF projects would also create GHG emissions on an annual basis, although only the first year of operational emissions was estimated.

<table>
<thead>
<tr>
<th>Project</th>
<th>CO₂e Emissions¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wallops Research Park</td>
<td>Data Unavailable²</td>
</tr>
<tr>
<td>UAS Airstrip</td>
<td>17,390</td>
</tr>
<tr>
<td>Alternative Energy Project</td>
<td>210</td>
</tr>
<tr>
<td>SRIPP</td>
<td>37,250</td>
</tr>
<tr>
<td>Expansion of WFF Launch Range – Alternative One</td>
<td>445</td>
</tr>
<tr>
<td>WWF Launch Range Activities³</td>
<td>1,400</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>56,695</strong></td>
</tr>
</tbody>
</table>

¹ Only CO₂e emissions are included, as this is a representation of all GHG emissions.
² Quantitative air analysis not performed for this project.
³ Based on 2008 WFF baseline emissions.

Given the absence of science-based or adopted NEPA significance thresholds for GHGs, all of the CO₂e emissions presented in Table 54 from the year with the highest (worst) emissions are compared to the EPA 2007 GHG baseline inventory to determine the relative increase in proposed GHG emissions from WFF.

Although the SRIPP and other proposed projects would not cause substantial cumulative impacts associated with global climate change, there are several measures currently in place at WFF, as well as initiatives to be implemented in the near future, that would reduce energy consumption and thereby reduce GHG emissions. For example, the installation of two 2.0-MW wind turbines and/or solar panels (with an equivalent amount of energy generated by two 2.0-MW wind turbines) proposed on Wallops Island under the Alternative Energy Project would reduce the use of fossil fuels to generate electricity, both locally and regionally. This would result in a beneficial impact to the cumulative effects of planned and ongoing projects in the area, since it has been documented that the three largest GHG emission sources in Virginia are transportation, non-utility uses of fuel in commercial industrial and residential facilities, and electricity generation (Bryant, 2008).

In addition to the Alternative Energy Project, WFF has replaced almost 50 percent of its entire light-duty, government-owned fleet (30 out of 70 vehicles) with newer, more fuel-efficient vehicles, as well as switched all of its diesel vehicles to using 20-percent biodiesel. In addition, the aforementioned decentralization of the Central Boiler Plant/steam system with individual propane-fired boilers would result in an estimated emissions reduction of approximately 4,400 metric tonnes per year of CO₂.
4.7.4.2 Biological Environment

Benthos

The proposed SRIPP offshore dredging would contribute incrementally to the cumulative impacts on the benthos at two scales: the larger context of the inner continental shelf offshore of Virginia and Maryland, as well as the individual shoal(s). The SRIPP dredging would contribute incrementally to the cumulative impacts on benthos living on the shoals within the overall Assateague Ridge complex.

The USACE (2008) estimates that the total seafloor area that would be affected over the life of the Atlantic Coast of Maryland Shoreline Protection Project through 2044 would be approximately 1,860 hectares (4,600 acres). For the SRIPP, assuming the entire 5.2 km² (2 mi²) borrow area will be dredged during the initial sand placement, a total of approximately 518 ha (1,280 ac) of benthic habitat would be adversely impacted. In addition, cumulative dredging impacts for the nine renourishment events would total approximately 1,260 ha (3,120 ac) of benthic habitat. As a result, over the 50-year life cycle of the SRIPP, approximately 1,800 ha (4,400 ac) of benthic habitat would be adversely impacted. Cumulatively over the lifetime of the projects, the SRIPP with the Atlantic Coast of Maryland Shoreline Protection Project would impact nearly 3,700 ha (9,000 ac) of benthic habitat.

There are over 777,000 hectares (1,920,000 acres) of seafloor within 48 km (30 mi) of the Virginia shoreline, and approximately 233,000 hectares (576,000 acres) of seafloor within 48 km (30 mi) of the Maryland coastline (USACE, 2008). Combined, there is nearly 1,036,000 hectares (2,560,000 acres) of seafloor offshore of Maryland and Virginia. Cumulatively, the reasonably foreseeable future dredging projects offshore will affect less than 0.4 percent of the nearshore seafloor in the region.

The sand on the shoal may be dredged repeatedly for the renourishment cycles. If dredging is conducted within short periods of time (i.e., 3 years or less), benthic communities may not have sufficient time to recover. Other offshore dredging projects that could affect the potential adult recruitment to the SRIPP dredged area may further lengthen recovery time of the proposed SRIPP shoals. Commercial fishing activities such as trawling would also contribute to the cumulative impacts on benthic organisms, and in turn other marine species, by widespread benthic habitat disturbance.

The cumulative reduction in benthic invertebrate fauna from the SRIPP when combined with other proposed and potential dredging activities would negatively affect fish that forage on these benthic species. However, nearby shoals such as Blackfish Bank, which would not be used for SRIPP renourishment activities, and Unnamed Shoal B, which may not be used for SRIPP renourishment activities, would provide alternate foraging grounds for marine species and, therefore, mitigate the anticipated adverse cumulative impacts.

As described in Section 4.3.2.3, benthic communities within the dredged area should recover to pre-dredge levels of community composition and biomass a few years after dredging. Therefore, communities should have recovered prior to the next dredging event so that only the area most recently dredged is affected.
Environmental Consequences

**Fish**

Cumulative impacts to fish fauna are expected to be minimal. Dredging operations would most adversely affect demersal fish through entrainment or removal of their benthic forage base. However, given the planktonic dispersal of most OCS fishes and the relatively high adult mobility of even small species, fish utilization of shoals that are dredged will occur after each dredge operation. This utilization should proceed rapidly because the species assemblage outside the borrow sites is similar to the assemblage on the shoal. Most of the fish species found within the dredge sites are common and widespread throughout the nearshore continental shelf in the MAB.

**Marine Mammals**

If multiple dredging operations occur at the same time on shoals on the Assateague Ridge shoal complex, the noise associated with the operations may contribute to cumulative impacts on marine mammals in the area. As described in Section 4.3.2.8, since dredging operations are generally of relatively short duration, significant cumulative effects from associated noise are not anticipated. However, NASA would consult with NMFS on appropriate mitigation measures should multiple dredging operations overlap.

Dredging may impact marine mammals through noise generated during sand removal, changes to benthic habitats, and vessel collisions during transport of the material to a pump-out station offshore of the shoreline. It is assumed that noise would cause avoidance responses in species. Because the dredging operations will be limited to one or two shoals, it is not expected that multiple dredging operations would result in significant cumulative impacts to the prey base of threatened and endangered marine mammals.

MMS (2004) reported on dredging and marine mammal collisions. Vessel collisions with endangered whales are one of the major factors limiting their recovery. There has never been a report of a whale strike or mortality by a hopper dredge in the United States (NMFS, 2004), although there is one report of a right whale calf mortality resulting from a strike by a dredging vessel in South Africa (MMS, 2004). It is generally thought that hopper dredges move slow enough to minimize the risk of a strike with a marine mammal.

The SRIPP vessel and dredging noises, when combined with other underwater noise levels in the region, particularly from U.S. Navy operations in the VACAPES Range Complex, may result in temporary adverse impacts on marine mammals traveling through the area. In addition to natural airborne and underwater noise (breaking waves, wind), other manmade sources of noise include military, general aviation, and commercial aircraft; shipping and fishing vessels; dredging; nearshore construction activities; military explosive use; oil and gas exploration and extraction; mineral exploration and extraction; and geophysical surveys.

Airborne noise attributable to military activities in the VACAPES Range Complex emanates from multiple sources including naval ship power plants, military aircraft, targets, bombs, missiles, small arms, and water-based demolitions. Sound from military sources in the VACAPES Range Complex is virtually all transitory, and can be widely dispersed or concentrated in small areas for varying periods. Sound levels from naval ships are analogous to the sound levels of commercial shipping. There are no underwater explosive ordnance areas in the VACAPES Range Complex that overlap with the SRIPP project area (Figure 45). An EIS completed in 2009 to address potential impacts from activities within the VACAPES Range Complex.
Environmental Consequences

Complex (U.S. Department of the Navy, 2009) stated that although it is possible a single animal may be significantly affected when considering all the events in the training complex, no significant effects are predicted and no significant impacts to populations of marine mammals are anticipated when the potential impacts due to sonar activities are included with the potential impacts due to range complex activities. Because the amount of additional noise attributable to SRIPP activities would be negligible compared to the VACAPES activities, there would be no significant impact to marine mammals in territorial waters.

**Threatened and Endangered Species and Migratory Birds**

The SRIPP may contribute incrementally to the cumulative impacts on threatened and endangered species in the project area. Cumulative impacts may result from; (1) the offshore dredging operation and the vessel transport of fill material, and (2) the placement of the sand on the shoreline. NASA’s determinations of effects from the Proposed Actions for the Expansion of the WFF Launch Range, the Alternative Energy Project, and the SRIPP are shown in Table 55. No evaluations of effects to federally listed species have been made for the North UAS Airstrip project yet.

<table>
<thead>
<tr>
<th>Species</th>
<th>Expansion of WFF Launch Range</th>
<th>Alternative Energy Project</th>
<th>SRIPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seabeach amaranth</td>
<td>May affect, not likely to adversely affect</td>
<td>No effect</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Whales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humpback, Fin, and Right Whales</td>
<td>May affect, not likely to adversely affect</td>
<td>ND</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Sperm, Sei, Blue Whales</td>
<td>May affect, not likely to adversely affect</td>
<td>ND</td>
<td>No effect</td>
</tr>
<tr>
<td>Mammals – Terrestrial and Marine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Florida Manatee</td>
<td>ND</td>
<td>ND</td>
<td>No effect</td>
</tr>
<tr>
<td>Delmarva Peninsula fox squirrel</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Insects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeastern Beach Tiger Beetle</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Sea Turtles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leatherback Sea Turtle</td>
<td>May affect, not likely to adversely affect</td>
<td>No effect</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Kemp’s Ridley Sea Turtle</td>
<td>May affect, not likely to adversely affect</td>
<td>No effect</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Loggerhead Sea Turtle</td>
<td>May affect, likely to adversely affect</td>
<td>No effect</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Hawksbill Sea Turtle</td>
<td>May affect, not likely to adversely affect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Atlantic Green Sea Turtle</td>
<td>May affect, likely to adversely affect</td>
<td>No effect</td>
<td>May affect, not likely to adversely affect</td>
</tr>
</tbody>
</table>
Environmental Consequences

<table>
<thead>
<tr>
<th>Species</th>
<th>Expansion of WFF Launch Range</th>
<th>Alternative Energy Project</th>
<th>SRIPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Knot</td>
<td>May affect, not likely to adversely affect</td>
<td>Likely to adversely affect</td>
<td>May affect, not likely to adversely affect</td>
</tr>
<tr>
<td>Piping Plover</td>
<td>May affect, likely to adversely affect</td>
<td>Likely to adversely affect</td>
<td>May affect, likely to adversely affect</td>
</tr>
</tbody>
</table>

1ND = no determination made because no suitable habitat present within project area, documented absence of the species within the project area, or project would result in no effect to the species.

**Impacts from Offshore Activities**

The potential impacts to federally-listed threatened and endangered marine mammals are the same as those described above and are not expected to be significant.

Cumulative effects to sea turtles may occur due to the multiple dredging operations planned in the offshore areas of Maryland and Virginia. Turtles are more likely to be directly affected by dredging than other threatened and endangered species in the area. As described in Section 4.3.3, the primary direct effect to sea turtles is entrainment in the drag heads. Indirect effects to turtles are the same as those described for marine life above and are not anticipated to be significant.

Table 56 summarizes the number of sea turtle takes, by month, from projects conducted in the USACE Norfolk District from 1980 to 2009. For the 30-year reporting period, a total of 63 sea turtle takes were recorded. Of the 63 total takes, 53 were loggerhead sea turtles. From 2000 to 2009, there have been no recorded takes of sea turtles for projects within the USACE Norfolk District (USACE, 2009d).

Table 56: Cumulative Sea Turtle Takes by Month and Species between 1980 and 2009, USACE Norfolk District

<table>
<thead>
<tr>
<th>Month</th>
<th>Atlantic Green</th>
<th>Hawksbill</th>
<th>Kemp's Ridley</th>
<th>Leatherback</th>
<th>Loggerhead</th>
<th>Unidentified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Feb</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Apr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>May</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Jun</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Jul</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Aug</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Sep</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>10</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Oct</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Nov</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Dec</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>53</td>
<td>4</td>
<td>63</td>
</tr>
</tbody>
</table>

Source: USACE, 2009d

NASA estimated that the SRIPP may result in 7 sea turtles takes over the lifetime of the current SRIPP EIS Alternative One (see Section 4.3.3). Given the NMFS estimate (from their 2007 BO for the SRIPP Proposed Action of dredging in State waters) that at least 90 percent of the
Environmental Consequences

injured/killed turtles for the SRIPP would be loggerheads (NMFS, 2007), 6 of the turtle takes for
the SRIPP Alternative One of this EIS would likely be loggerheads. Based on Table 56, there is
an average of 3 sea turtle takes per year from dredging operations in the USACE Norfolk
District. The SRIPP would average approximately 0.13 sea turtle takes per year over the 50 year
lifetime of the project, or less than 5 percent of the current yearly takes. Approximately two sea
turtles takes may occur during dredging operations for the initial beach fill operations and five
sea turtles takes may occur during dredging for the nine renourishment events.

Impacts from Onshore Activities

The proposed SRIPP would create a beach where one currently does not exist and augment the
existing beach at the northern and southern ends of Wallops Island. As described in Section 4.3,
the new beach would provide additional potential habitat for shorebird nesting and foraging, as
well as sea turtle nesting. It is reasonable to assume these species may nest and utilize this
additional habitat at some point after sand placement. However, it is not possible to predict at
this time the potential number or locations of Piping Plover nests or sea turtle nests that may
occur on the newly created beach. As described in Chapter 5, future monitoring activities would
include biological resources such as Piping Plover and sea turtle nesting activity.

Long-term adverse impacts on birds (including Federally-listed species) and bats from the
Alternative Energy Project are anticipated. Potential avoidance or minimization BMPs, such as
modified operation of the turbines, ultrasonic deterrent devices, and post-construction fatality
monitoring would be implemented to reduce the potential long-term (direct and indirect)
impacts.

Temporary interruption of foraging and nesting activities for shore birds may occur as a result of
launch and static fire testing activities proposed for the Expansion of the WFF Launch Range
project. The nesting area designated on the northern end of Wallops Island is not expected to be
affected by emissions or noise. The northernmost point of the designated plover habitat on the
southern end of the island would be closer to the launch pads; however, noise generated from
rocket launches is generally low-frequency, of short duration, and occurs infrequently. Naturally
occurring background noises in the nesting area, such as wave action and thunderstorms, are
more frequent and of longer duration than noise from a rocket launch.

Construction of the proposed UAS Airstrip would result in the loss of approximately 40 hectares
(100 acres) of forest and shrub/thicket vegetation at the north end of Wallops Island west of the
proposed SRIPP renourishment area and the Piping Plover habitat. The UAS would also result in
noise impacts and startle effects on species within the immediate vicinity of the airstrip.

Impacts on migratory birds would be greatest during spring and fall migrations; however, noise
disturbances would be similar to existing noise from daily operations, including airplane and
launch operations on Wallops Island, so cumulative impacts from noise are not expected to be
significant when compared to current WFF activities. Birds in the immediate area of any activity
for all projects at Wallops Island and within the SRIPP project area (including other dredging
operations) are likely to be startled and leave the immediate area. This may temporarily disrupt
foraging and nesting activities. The continued presence of migratory birds at WFF, even with the
noise from flight and launch operations over the past few decades, suggests that short-term
noises have not significantly disturbed birds on the island. During dredging operations at
Unnamed Shoals A and B, noise disturbances from the hopper dredge are expected. These noises
may cause migratory seabirds to vacate the shoal area, where they sometimes feed on schooling fish, but the adverse effects would be temporary and localized.

When added to the potential impacts from the SRIPP, the Expansion of the WFF Launch Range, the UAS Airstrip project, and the Alternative Energy Project and existing sounding, rocket launches may result in cumulative impacts on bird species (including non-federally listed migratory birds and bats, along with federally listed species such as the Piping Plover) due to loss of habitat, noise impacts, and injury/deaths from operation of the wind turbines proposed for the Alternative Energy Project. It is not possible to predict the number of individuals or the number of Piping Plover nests that may be affected by these future activities. The SRIPP along with other WFF projects would contribute to long-term adverse impacts on habitat loss in the overall region, although not to an extent considered significant when considered in conjunction with the amount of habitat available at Wallops Island, WFF, and along the Eastern Shore.

4.7.4.3 Socioeconomic Environment

Economic

Jobs and tax revenue from WFF’s existing activities, proposed projects, and the other regional projects described in Section 4.7.2 and 4.7.3 would result in beneficial cumulative economic impacts on the local economy of the Eastern Shore and the Maryland and Virginia coastal areas. The SRIPP would support the continuation of activities on Wallops Island by reducing potential losses of work days and jobs that could result from the loss of the infrastructure, resulting in elimination of WFF’s and tenant’s technological capabilities.

Educational systems in the surrounding areas, such as CNWR, benefit from WFF’s expertise. WFF offers educational tours for schools and other organizations, as well as WFF personnel lecturing at schools and judging school science fairs. The expansion of launch range operations is anticipated to introduce additional educational and recreational experiences for both local residents and tourists.

Commercial and Recreational Fisheries

Dredging for the SRIPP would have a minor incremental cumulative effect on commercial and recreational fisheries in the area. The proposed SRIPP dredge area on either Unnamed Shoal A or Unnamed Shoal B is 520 hectares (1,280 acres). The potential future dredge areas for the Atlantic Coast of Maryland Shoreline Protection Project total over 2,000 hectares (4,590 acres) (USACE, 2008). The potential future dredge area of Sandbridge Shoal is approximately 1,620 hectares (4,000 acres) throughout eight planned renourishment cycles (USACE, 2009c). Cumulatively, these projects comprise approximately 3,900 hectares (9,600 acres).

There are over 777,000 hectares (1,920,000 acres) of seafloor within 48 km (30 mi) of the Virginia shoreline, and approximately 233,000 hectares (576,000 acres) of seafloor within 48 km (30 mi) of the Maryland coastline (USACE, 2008). Combined, there is nearly 1,036,000 hectares (2,560,000 acres) of seafloor offshore of Maryland and Virginia. Cumulatively, the reasonably foreseeable future dredging projects offshore will affect less than 0.4 percent of the seafloor potentially utilized by fishermen.

In addition, the SRIPP dredging operations would last approximately 7 months during the initial construction phase and approximately 2 months during each renourishment phase. The other
planned dredging operations offshore of Virginia and Maryland would be expected to have a similar duration. As a result, the potential conflicts between commercial and recreational fishermen and the dredging operations would be temporary and localized.

4.8 PERMITS, LICENSES, AND APPROVALS

The following list of potential permits, licenses, and approvals are likely to be required for the Proposed Action. The agency responsible for each is included after the identified permit, license, or required consultation. Any required permits, licenses, or approvals would be obtained prior to construction.

- CWA Section 404 Dredge and Fill Permit, USACE
- Rivers and Harbors Act Section 10 Permit, USACE
- CWA Section 401 Water Quality Certification/Virginia Water Protection Permit, VDEQ
- Virginia Stormwater Management Program Permits, Virginia DCR
- VMRC Permits
- Federal Consistency Determination, VDEQ
- Biological Opinion, USFWS and NMFS
- Magnuson-Stevens Act, Essential Fish Habitat consultation, NOAA
- VDHR Section 106 Consultation
- MMS Memorandum of Agreement for use of Federal offshore sand resources
CHAPTER FIVE: MITIGATION AND MONITORING

Because the SRIPP Proposed Action would take place in a complex and dynamic environment over a significant time period, mitigation measures would be implemented and evaluated continuously to ensure they are effective and appropriate. To accomplish this, NASA would implement an adaptive management strategy for the SRIPP comprised of the following 3 elements:

- First, the Proposed Action is planned based on existing and adequate knowledge of the project area, well-defined project goals, and current technology.
- Second, the Proposed Action would be implemented with the initially planned mitigation measures described below.
- Third, results would be monitored and evaluated. The cycle would then reinitiate, driven by the monitoring results and project performance. Results could validate existing practices or reveal the need for alterations in project implementation or mitigation techniques.

The adaptive management approach is based on the recognition and acceptance of a certain degree of uncertainty inherent in predicting how the Proposed Action activities would affect physical and biological resources in the project area. By monitoring and evaluating how measures are working, NASA would ensure that mitigation measures are optimized.

The following sections discuss NASA’s proposed mitigation measures and monitoring as they apply to the Proposed Action Alternatives and within the framework of adaptive management.

5.1 MITIGATION

CEQ regulations (40 CFR 1508.20) define mitigation to include: (1) avoiding the impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the lifetime of the action; and (5) compensating for the impact by replacing or providing substitute resources or environments.

Mitigation measures are either institutional in that they are inherent in project alternative selection, or as measures incorporated into the construction and operation and maintenance of the project.

Mitigation techniques can include operational measures or technology-based methods. They can be short- or long-term and may be designed to avoid completely, minimize, remediate, or compensate for environmental impact. The following sections describe the mitigation measures that would be implemented for the various components of the alternatives; seawall extension, offshore dredging, sand placement, groin or breakwater construction, and North Wallops Island excavation.
5.1.1 Seawall Extension

5.1.1.1 Physical Resources

The main physical effects of seawall construction activities would be soil and sediment disturbance and potential pollution releases from construction equipment.

Construction activities related to the seawall extension activities would disturb surface sediments on the beach. NASA would implement erosion and sediment control BMPs to minimize erosion. Other adverse impacts on sediments include potential spills or leaks of pollutants from vehicles. BMPs including vehicle and equipment fueling and spill prevention and control would be implemented to reduce potential impacts on soils and sediments during seawall construction.

5.1.1.2 Biological Resources

The main biological effects of seawall construction activities would be disturbance of potential beach habitat for shorebirds and sea turtles in the southern portion of the project area.

A qualified biologist would conduct surveys and monitor the project area to ensure Red Knots and Piping Plovers are not directly affected during construction activities. Piping Plover and sea turtle nesting have not been documented in this portion of the study area. Additionally, the Red Knot does not use the project area for nesting.

5.1.2 Offshore Dredging Operations

5.1.2.1 Physical Resources

The main physical effects of dredging for sand on the proposed offshore shoals would be removal of sand from the shoal, suspended sediment/turbidity, distribution of sediment outside the dredge footprint, and changes to bathymetry. The dredge contractor would be responsible for proper storage and disposal of any hazardous material such as oils and fuels used during the dredging and beach nourishment operations. The U.S. EPA and U.S. Coast Guard regulations require the treatment of waste (e.g., sewage, gray water) from dredge plants and tender/service vessels and prohibit the disposal of debris into the marine environment. The dredge contractor will be required to implement a marine pollution control plan to minimize any direct impacts to water quality from construction activity.

Dredging would remove a significant amount of sand from the shoal and shoal complex; approximately 30 percent of the total volume of Unnamed Shoal A or approximately 15 percent of the total volume of Unnamed Shoal B. In addition, the bottom substrate at and near either of the borrow sites may be modified in several ways. A change in the hydrological regime as a consequence of altered bathymetry may result in a change of depositional patterns at the site and therefore a change in sediment grain size. Exposure of underlying sedimentary units may also change the depositional patterns by exposing material that has different textural and compositional properties than the existing bottom substrate.

Dredging activities would result in changes to the bathymetry of the selected offshore borrow site. To minimize impacts to the bathymetry, dredging would be conducted in a manner to remove a relatively shallow, uniform thickness of material from the chosen borrow area. The shoal’s general profile would be maintained, though at a lower elevation than pre-project conditions.
5.1.2.2 Biological Resources

The main biological impacts from the dredging operation would occur to the benthos and potentially to commercial fisheries, marine mammals, and sea turtles.

Dredging sand from either offshore shoal would have a significant and immediate adverse impact on the local benthic community of the shoal. The primary direct effect would be the removal of sand and entrainment of the infauna and epifauna that reside within and on the sediment. However, it is expected that there would be a negligible impact on the regional benthic ecosystem because: (1) the benthic assemblages on the sand shoals are not unique and similar to assemblages in adjacent areas and (2) the spatial extent of the dredged area is small compared to the broad area of the nearshore continental shelf.

The loss of benthic organisms would create a loss of prey for local wildlife, including some managed fish species, but the effect would be localized and temporary. The hopper dredge would also cause an increase in turbidity which could temporarily disturb the ability of fish, surf clams, and other mollusks to feed; however, this effect would be temporary.

The mitigation techniques suggested by NMFS in a memorandum dated June 18, 2009 to NASA would be evaluated and utilized to the fullest extent possible. The measures suggested include the following:

1. Minimize the total amount of borrow removed from the offshore shoals over the 50-year life of the project.
2. Control the methods used for hopper dredging borrow from the shoals to preserve geomorphic integrity (use the Contour Method).

NASA would minimize the potential of marine mammal strikes by operating the dredge at speeds below 14 knots. At this low speed, operators would be able to avoid marine mammals by maneuvering the dredge vessel to avoid a strike (NMFS, 2007).

The greatest danger to animals during dredging operations is referred to as “entrainment” or drawing into the hopper dredge. Sea turtles are at the greatest risk (Magnuson et al., 1990). The centrifugal force of the pump, located behind the intake pipe of the drag head, draws the animal into the pipe. The animal may be killed by the pump and then pulled into the hopper. It is believed that entrainment primarily takes place when the drag head is operating on bottom sediments. Affected animals are usually feeding or resting near the bottom at the time the drag head moves along the bottom. In some rare instances, suction may be created when currents flow around the drag head as it is placed or moved.

The USACE has enacted contractual specifications for deflectors on all hopper dredges. They are as follows:

“Hopper dredge drag heads shall be equipped with sea turtle deflectors that are rigidly attached. No dredging shall be performed without a turtle deflector device that has been approved by the Contracting Officer.

The leading V-shaped portion of the deflector shall have an included angle of less than 90 degrees. Internal reinforcement shall be designed to have a plowing effect of at least 6 inches in depth when the drag head is being operated. Appropriate instrumentation or indicator shall be used and kept in proper calibration to ensure the critical ‘approach angle,’ which refers to the lower drag pipe relative to the plane of the sediment. If the
lower drag head pipe angle varies significantly from the design approach angle, the 6-inch plowing effect does not occur and the deflector does not function to repel the sea turtles. When the deflector is in operation during dredging, operators need to make every effort to maintain the design approach angle and to ensure that the dredge is disengaged before it is lifted from the floor of the ocean.”

In a USACE field test experiment, the rigid deflector, properly installed and operated, blocked 95 percent of mock turtles from entrainment in the dredge. This rate is probably lower than what would actually occur, given that live turtles have the ability to flee from danger (USACE, 1997). Turtle deflectors would be installed on the drag heads during dredging to reduce the risk of entrainment. In addition and as directed by the 2007 BO, NASA would implement the following measures to minimize impacts of incidental take of sea turtles:

1. NASA would ensure that during times of the year when sea turtles are known to be present in the action area, hopper dredges are outfitted with state-of-the-art sea turtle deflectors on the drag head and operated in a manner that will reduce the risk of interactions with sea turtles which may be present in the action area.
2. A NMFS-approved observer would be present on board the vessel for any dredging occurring in the April 1 – November 30 time frame.
3. NASA would ensure that dredges are equipped and operated in a manner that provides endangered/threatened species observers with a reasonable opportunity for detecting interactions with listed species and that provides for handling, collection, and resuscitation of turtles injured during project activity.
4. NASA would ensure that all measures are taken to protect any turtles that survive entrainment in the dredge.
5. NMFS would be contacted before dredging commences and again upon completion of the dredging activity.

All interactions with listed species would be properly documented and promptly reported to NMFS.

5.1.3 Sand Placement Activities

5.1.3.1 Physical Resources

The main physical effects from sand placement activities would be sediment disturbance and potential pollution from construction equipment.

To minimize impacts on sediments, beach nourishment would be done so that the beach is restored to a comparable sediment type (a similar percentage of sand, silt and clay), grain size and color as the existing beach material.

5.1.3.2 Biological Resources

Sand placement activities would affect beach benthic organisms and shorebird habitat. As described in Section 4.3.2.3 (Benthos), the initial placement of sand would bury existing intertidal organisms along the seawall and the subtidal benthic adjacent to the seawall. There is very little existing beach within the proposed placement area. Placement of sand on the existing
beach at the northern and southern ends of the project may disturb potential habitat for protected shorebirds.

To ensure that no Piping Plovers are adversely affected, a qualified biologist would conduct regular surveys during sand placement activities. If Piping Plovers or nests were identified, mitigation measures such as avoidance of the nesting area would be implemented to avoid potential impacts.

NASA would conduct regular monitoring of the beach for potential nesting activity using a qualified biologist during sand placement activities if these activities take place during sea turtle nesting season. If a nest is detected, buffers would be established around the nest(s) where no sand placement activities would occur.

Beach fill placement activities would temporarily negatively impact shorebirds with construction noise levels and the movement of construction equipment on areas with existing beach habitat. For activities related to use of the north Wallops Island area for beach renourishment, NASA would work with USFWS on specifying and implementing mitigation measures to ensure adequate protection for Piping Plovers.

Turtle nesting issues associated with beach fill include grain size, color, radiance and compaction. In order to minimize impacts on nesting sea turtles, renourishment sand should complement natural sand as closely as possible. The principal sediment types associated with the offshore shoals are generally in the category of medium-grained beach quality sand. The dredged material closely matches the existing beach material, thus sea turtles should not be affected by the type of material used for beach placement.

5.1.4 Construction of Groin or Breakwater

5.1.4.1 Physical Resources

The main physical effects of constructing a sand retention structure would be suspended sediment/turbidity, distribution of sediment outside the construction footprint and changes to bathymetry.

In the case of the groin, there would be an accumulation of sediment on the updrift side of the groin, and some shoreline erosion would occur on the downdrift side of the groin. The extent of the erosion will depend on the direction and rate of longshore sediment transport in the groin area. Renourishing the beach would reduce the potential for downdrift erosion by providing continual sand on the Wallops Island shoreline. Additionally, the groin would be located within the sediment transport nodal zone along the beach to ensure minimal potential downdrift impacts.

5.1.4.2 Biological Resources

The main biological effect of constructing a sand retention structure would be disturbance to the benthic environment. The groin or breakwater footprint would be designed to minimize impacts to benthic habitat.
5.1.5 North Wallops Island Sediment Removal

5.1.5.1 Physical Resources
The main physical effects of excavation activities on north Wallops Island for beach fill material would be sediment disturbance and potential pollution releases from construction equipment.

Construction activities related to the excavation activities would disturb surface sediments on the beach. Disturbance to surface sediments would also result from removal and transfer of sand from north Wallops Island for renourishment activities. NASA would implement erosion and sediment control BMPs to minimize erosion. Other adverse impacts on sediments include potential spills or leaks of pollutants from vehicles. BMPs including vehicle and equipment fueling and spill prevention and control would be implemented to reduce potential impacts on soils and sediments during excavation, construction, and beach fill work.

The removal of sediments during excavation activities would be mitigated by the re-deposition of sediment that would come from the addition of new sand on the beach. Therefore, a portion of the sand placed on the beach during renourishment would return to the north end of Wallops Island.

5.1.5.2 Biological Resources
The main biological effects of construction and excavation activities would be disturbance of potential habitat for protected vegetation, shorebirds and sea turtles.

A qualified biologist would conduct surveys and monitor the project area to ensure Red Knots, Piping Plovers, and seabeach amaranth are not directly affected during construction activities. If north Wallops Island is used for beach renourishment, NASA would work with USFWS to ensure adequate protection for any observed Red Knots and Piping Plovers in the area. In addition, work in the proposed north Wallops Island borrow site area would be limited to the non-nesting season for the Piping Plover (September-March). The Red Knot does not use the project area for nesting.

Use of the north Wallops Island proposed borrow site area for renourishment activities may temporarily negatively impact shorebirds with elevated construction-related noise levels and the movement of construction equipment on areas with existing beach habitat. For activities related to use of the north Wallops Island proposed borrow site area, NASA would work with USFWS on specifying and implementing mitigation measures to ensure adequate protection for Piping Plovers.

5.2 MONITORING

5.2.1 Threatened and Endangered Species Monitoring
Potential habitat areas for seabeach amaranth on the north end of Wallops Island would be surveyed immediately prior to sand removal activities to ensure that the species is not present. In the event that the seabeach amaranth is encountered during project activities, NASA will work with the USFWS to ensure appropriate measures are taken to protect the species and its habitat.

A NMFS-approved observer would be present on board the dredging vessel for any dredging occurring between April 1 and November 30.
Mitigation and Monitoring

5.2.2 Beach Profile Monitoring

5.2.2.1 Data Collection

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, from Chincoteague Inlet in the north to Gargathy Inlet in the south, a distance of approximately 13.7 km (8.5 mi). The second of the two annual survey events would be limited to the length of shoreline from Chincoteague Inlet on the north to 0.8 km (0.5 mi) south of 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 -4.5 to -6 m (-15 to -20 ft) 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 3.2 km (2 mi) 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).

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 areas adjacent to Wallops Island.

Cross-sections of the beach would be taken along new and/or previously established baselines on set stations every 152 m (500 ft) from Chincoteague Inlet to Assawoman Inlet and every 305 m (1,000 ft) from Assawoman Inlet to Gargathy Inlet. The beach survey would extend from the baseline to a depth of -1.2 m (-4 ft) MLW offshore. An offshore hydrographic survey along the previously established baseline on set stations every 152 m (500 ft) would be conducted. The offshore survey would extend from -0.9 m (-3 ft) MLW to the depth of closure, anticipated between (-15 to -20 ft MLW). If possible (weather permitting), the hydrographic survey would be conducted within 2 weeks of the beach survey. Bathymetric survey data would be processed in Computer-Assisted Design (CAD), Beach Morphology Analysis Package (BMAP), and xyz formats.

5.2.2.2 Comparison of Beach Profiles

The USACE’s BMAP within Coastal Engineering and Design Analysis System would be used for initial profile comparisons and analyses. Once the surveying data is compiled, the new survey profiles would be overlaid on previous survey profiles and the authorized template profile to observe relative differences. Using BMAP, the following shoreline position and volumetric calculations would be performed:

- Shoreline change at mean high water
- Shoreline change at the design berm elevation
- Volume change between overlapping extents of new and post-fill survey profiles
- Volume surplus/deficit between the new survey profile and the assumed authorized beach fill template
5.2.2.3 **Shoreline and Volumetric Change**

In addition to relative profile comparisons the shoreline and volumetric change based on three-dimensional surfaces of the study area within a GIS environment would be evaluated. These types of analyses expand upon the two-dimensional profile comparisons and are recommended for identifying areas of concern along the shoreline and evaluating sediment transport trends. New survey data would be incorporated in GIS to allow for mapping and further analysis of shoreline and volumetric change. This includes developing a digital terrain model from the new survey data. Shoreline positions would be extracted from the digital terrain model and plotted in GIS for comparison with historical shoreline positions. Additionally, volume change grids would be calculated to plot the morphologic changes in relative survey periods. Color-shaded grids showing areas of erosion and accretion within the nearshore study area would be developed from the three-dimensional comparisons. The LiDAR data would be processed and included as part of the analysis.

5.2.2.4 **Project Design Life Analysis**

Based on results of shoreline change and volume analyses performed, areas of concern within the study area extent would be identified. The results of the analyses would be used to evaluate project performance of the beach nourishment project and to determine maintenance areas for future renourishment.

5.2.2.5 **Monitoring Summary and Mapping**

A report summarizing the data collection, coastal engineering analyses, observed trends from the shoreline change and volumetric change analyses, project design life estimates, identified areas of concern, statement of overall quantity needed to bring the entire beach up to the template, and recommended future work would be prepared semi-annually. The following items would also be included in the summary report:

- Profile comparison plots with summarized results (e.g. shoreline change, volume change)
- Large-scale map(s) showing relative shoreline positions and corresponding shoreline change rates for the time period in question
- Large-scale map(s) showing volumetric change over the study area extent
### CHAPTER SIX: LIST OF PREPARERS

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<tr>
<td>Dirk Herkof</td>
<td>Meteorologist, M.S., B.S. Meteorology, 35 years experience</td>
<td>Air Quality Analysis for Dredging and Beach Fill</td>
</tr>
<tr>
<td><strong>USACE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>George Mears</td>
<td>USACE Project Manager, BS Geology, ME, Environmental Engineering; MBA, Management, PMP, 13 years</td>
<td>Project Manager, Resource Scheduling, Planning, Outreach, and SRIPP study/EIS reviews</td>
</tr>
<tr>
<td>David King</td>
<td>Oceanographer, Ph.D. Oceanography, 22 years experience</td>
<td>Numerical Modeling and Development of Project Alternatives</td>
</tr>
<tr>
<td>Gregg Williams</td>
<td>Project Manager/Civil Engineer, Civil Engineering Technology, B.S., 17 years experience</td>
<td>SRIPP Alternatives Planning and Design</td>
</tr>
<tr>
<td>Mark Hudgins</td>
<td>Civil Engineer, B.S. Civil Engineering, M.E. Coastal Engineering, P.E., 23 years experience</td>
<td>Coastal Engineering, SRIPP Planning and Design</td>
</tr>
<tr>
<td>Robert Huntoon</td>
<td>Geotechnical Engineer, B.S. Civil Engineering, 5 years experience</td>
<td>Geotechnical Evaluation for Rock Revetment Extension and Potential North End Sand Renourishment Site</td>
</tr>
</tbody>
</table>
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CHAPTER SEVEN: AGENCIES, ORGANIZATIONS, AND PERSONS CONSULTED

7.1 INTRODUCTION

NEPA states that “There shall be an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to the proposed action.” Stakeholders and the general public have been engaged as the SRIPP and this EIS developed. Stakeholders include Federal, State and local governments, business interests, landowners, residents, and environmental organizations.

7.2 SCOPING PROCESS

During the SRIPP planning process, NASA provided several opportunities for public and stakeholder involvement, the first of which was a stakeholder and regulatory agency meeting held at WFF on November 20, 2008. On March 24, 2009 NASA announced its intent to prepare an EIS and conduct scoping in the Federal Register. NASA sent scoping letters to 71 targeted stakeholders and agencies in April 2009 (Appendix J). NASA formally invited the two coordinating agencies (MMS and USACE) to participate in the PEIS process via letters in April, 2009 (Appendix J). The public, agencies, and NASA employees were also invited to provide comments on the SRIPP EIS website at http://sites.wff.nasa.gov/code250/shoreline_eis.html.

Responses were received and are included in Appendix J. The first public scoping meeting was held on April 21, 2009 at the WFF Visitor’s Center – the minutes of this meeting are included in Appendix J. A public information meeting was also held at the WFF Visitor’s Center on December 8, 2009.

The comments received during the initial public scoping were categorized into the topics shown in Table 57 below. A total of 146 comments were received. Multiple recommendations, discussions, or thoughts on the same theme from the same commenter were considered as one comment under that topic. NASA considered all scoping comments in preparing the Draft PEIS.
### Table 57: Responses to Scoping by Comment Topic

<table>
<thead>
<tr>
<th>Comment Topic</th>
<th>No. of Comments</th>
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<tbody>
<tr>
<td>Groin impacts on downdrift islands</td>
<td>26</td>
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<tr>
<td>Relocation of at-risk infrastructure/sea level rise</td>
<td>19</td>
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<td>Miscellaneous recommendation or comment</td>
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<tr>
<td>Alternatives</td>
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<td>Funding</td>
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<tr>
<td>More explanation in EIS</td>
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<tr>
<td>Impacts on benthos and birds at borrow sites</td>
<td>9</td>
</tr>
<tr>
<td>Evaluate baseline conditions</td>
<td>8</td>
</tr>
<tr>
<td>Monitoring of effects</td>
<td>7</td>
</tr>
<tr>
<td>Impacts on shoreline north of WFF</td>
<td>6</td>
</tr>
<tr>
<td>Threshold criteria for project success and evaluation</td>
<td>6</td>
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<tr>
<td>Commercial and recreational fishing</td>
<td>4</td>
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<tr>
<td>Positive comment</td>
<td>4</td>
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<tr>
<td>Regional sediment budget modeling</td>
<td>4</td>
</tr>
<tr>
<td>Blackfish Bank shoal</td>
<td>3</td>
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<tr>
<td>Compensation for stakeholder losses</td>
<td>3</td>
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<tr>
<td>Recommended mitigation measures</td>
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<tr>
<td>Seawall</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>146</strong></td>
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#### 7.3 WEB SITE

Throughout the duration of the SRIPP NEPA process, NASA is maintaining a Web site that provides the public with the most up to date project information. The Web site may be accessed at [http://sites.wff.nasa.gov/code250/shoreline_eis.html](http://sites.wff.nasa.gov/code250/shoreline_eis.html).

#### 7.4 DRAFT PEIS

The public was notified of the opportunity to review and comment on this Draft SRIPP PEIS by announcements in the Federal Register and local newspapers. The Draft PEIS is also available for public review at the following locations:

**NASA WFF Technical Library**

**Island Library**
Agencies, Organizations, and Persons Consulted

Building E-105
Wallops Island, VA 23337
(757) 824-1065
Hours: Mon–Fri: 8 a.m. to 4:30 p.m.

NASA Headquarters Library
300 E Street SW, Suite 1J20
Washington, DC VA 20546
(202) 358-0168
Hours: Mon–Fri: 7:30 a.m. to 5:00 p.m.

Eastern Shore Main Public Library
23610 Front Street
P.O. Box 360
Accomac, VA 23301
Phone: (757) 787-3400
Monday, Tuesday, Wednesday, Friday:
9 a.m. to 6 p.m.
Thursday: 9 a.m. to 9 p.m.
Saturday: 9 a.m. to 1 p.m.

4077 Main Street
Chincoteague, VA 23336
(757) 336-3460
Hours: Mon: 10 a.m. to 2 p.m.
Tues: 10 a.m. to 5 p.m.
Wed, Fri, Sat: 1 p.m. to 5 p.m.

Northampton Free Library
7401 Railroad Avenue
Nassawadox, Virginia, 23413
(757) 442-2839
Monday, Tuesday, Wednesday, Friday:
9 am - 6 pm
Thursday: 9 am - 9 pm
Friday: 9 am - 6 pm
Saturday: 9 am - 1 pm

NASA will hold a public comment meeting to discuss the Draft PEIS at the WFF Visitor’s Center. The time and date of this meeting will be published in the Federal Register and local newspapers. Written comments on the Draft PEIS are requested by April 15, 2010, or within 45 days of the U.S. EPA’s publication of its NOA in the Federal Register, whichever is later.

Comments submitted by mail should be addressed to:

250/NEPA Manager
WFF Shoreline Restoration and Infrastructure Protection Program
NASA Goddard Space Flight Center’s Wallops Flight Facility
Wallops Island, Virginia 23337

Comments may also be submitted via e-mail to wff_shoreline_eis@majordomo.gsfc.nasa.gov.

In summary, NASA solicited public and agency review and comment on the environmental impacts of the SRIPP through:

1. Publication of a notice of availability of this Draft PEIS in the Federal Register and local newspapers;
2. Publication of the Draft PEIS on the WFF Environmental Office Web site;
3. Consultations with local, State, and Federal agencies; and
4. Direct mailing of the Draft PEIS to interested parties.

A limited number of copies of the Draft PEIS are available by contacting:

Joshua A. Bundick
NASA Wallops Flight Facility, Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Joshua.A.Bundick@nasa.gov

Table 58 shows which agencies/stakeholders: (1) received copies of the scoping letter, (2) who provided responses to the scoping letters or Web site, and (3) who will receive copies of this Draft PEIS.

Public comments on the Draft PEIS and NASA’s responses will be included in the Final PEIS. The Final SRIPP PEIS is planned for completion in the summer of 2010. A Notice of Availability will be published in the Federal Register and local newspapers to ensure that the public is aware of the document’s progress.
### Agencies, Organizations, and Persons Consulted

Table 58: Table of Agencies, Organizations, and Individuals Consulted for the SRIPP PEIS

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Sent a Scoping Letter</th>
<th>Expressed Interest/Comment During Scoping</th>
<th>Sent a Copy of Draft PEIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Horst Greczmiel</td>
<td>CEQ, Office of NEPA Oversight</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ms. Susan Bromm</td>
<td>EPA, Office of Federal Activities</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ms. Alaina DeGeorgio</td>
<td>EPA, Region III</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ms. Renee Searfoss</td>
<td>EPA, Region III</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mr. Roger Amato</td>
<td>MMS, Leasing Division</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. James Bennett</td>
<td>MMS, Environmental Division</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Dirk Herkhof</td>
<td>MMS, Environmental Division</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Peter Colosi</td>
<td>NMFS, Protected Resources Division</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ms. Julie Crocker</td>
<td>NMFS, Protected Resources Division</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Mr. John Nichols</td>
<td>NMFS, Habitat Conservation Division</td>
<td></td>
<td>X</td>
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<tr>
<td>Mr. David O'Brien</td>
<td>NMFS, Habitat Conservation Division</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ms Trish Kicklighter</td>
<td>NPS, Assateague Island National Seashore</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ms. Courtney Schupp</td>
<td>NPS, Assateague Island National Seashore</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Doug Crawford</td>
<td>NOAA, Command and Data Acquisition Station</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Mr. Robert Cole</td>
<td>USACE, Norfolk District</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Dr. David King</td>
<td>USACE, ERDC Vicksburg</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mr. Nicholas Konchuba</td>
<td>USACE, Norfolk District</td>
<td></td>
<td></td>
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<tr>
<td>Mr. George Mears</td>
<td>USACE, Norfolk District</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Mr. John Walters</td>
<td>USCG, Waterways Management Section</td>
<td></td>
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<tr>
<td>LT Mark Merriman</td>
<td>USCG, Chincoteague Group</td>
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<tr>
<td>Dr. Marilyn Ailes</td>
<td>U.S. Navy, Surface Combat Systems Center</td>
<td></td>
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</table>
### Agencies, Organizations, and Persons Consulted

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<tr>
<th>Name</th>
<th>Organization</th>
<th>Sent a Scoping Letter</th>
<th>Expressed Interest/Comment During Scoping</th>
<th>Sent a Copy of Draft PEIS</th>
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<tbody>
<tr>
<td>Mr. Rich Bitting</td>
<td>U.S. Navy, Surface Combat Systems Center</td>
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<tr>
<td>CAPT J.M. Hinson</td>
<td>U.S. Navy, Fleet Forces Command</td>
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<tr>
<td>CDR John Keegan</td>
<td>U.S. Navy, Surface Combat Systems Center</td>
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<tr>
<td>Ms. Joelle Buffa</td>
<td>USFWS, Chincoteague National Wildlife Refuge</td>
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<tr>
<td>Ms. Amanda Daisey</td>
<td>USFWS, Chincoteague National Wildlife Refuge</td>
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<tr>
<td>Mr. Louis Hinds, III</td>
<td>USFWS, Chincoteague National Wildlife Refuge</td>
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<tr>
<td>Mr. Tony Leger</td>
<td>USFWS, Northeast Regional Office</td>
<td>X</td>
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<tr>
<td>Mr. Tylan Dean</td>
<td>USFWS, Virginia Field Office</td>
<td>X</td>
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<tr>
<td>Mr. Mike Drummond</td>
<td>USFWS, Virginia Field Office</td>
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<tr>
<td>Ms. Cindy Schulz</td>
<td>USFWS, Virginia Field Office</td>
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<tr>
<td><strong>State Agencies</strong></td>
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<tr>
<td>Ms. Catherine Harold</td>
<td>Chesapeake Bay Local Assistance Department</td>
<td>X</td>
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<tr>
<td>Mr. Richard Baldwin</td>
<td>Mid-Atlantic Regional Spaceport</td>
<td>X</td>
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<tr>
<td>Ms. Kristal McKelvey</td>
<td>VDCR, Central Office</td>
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<tr>
<td>Ms. Rene Hypes</td>
<td>VDCR, Central Office</td>
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<td>Mr. Tom Smith</td>
<td>VDCR, Central Office</td>
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<tr>
<td>Mr. Robbie Rhur</td>
<td>VDCR, Central Office</td>
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<tr>
<td>Ms. Dorothy Field</td>
<td>VDCR, Eastern Office</td>
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<tr>
<td>Mr. Frank Daniel</td>
<td>VDEQ, Tidewater Regional Office</td>
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<tr>
<td>Ms. Ellie Irons</td>
<td>VDEQ, Office of Environmental Impact Review</td>
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<td>Ms. Laura McKay</td>
<td>VDEQ, Coastal Zone Program</td>
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<td>Ms. Ruth Boettcher</td>
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<td>Ms. Amy Ewing</td>
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<td>Mr. Raymond Fernald</td>
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<td>Ms. Ethel Eaton</td>
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<td>Mr. Ron Grayson</td>
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<td>Dr. Mark Luckenbach</td>
<td>VIMS, Eastern Shore Laboratory</td>
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<tr>
<td>Mr. George Badger, III</td>
<td>VMRC, Habitat Division</td>
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<td>Mr. Robert Grabb</td>
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<td>Mr. Mike Meier</td>
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<td>Mr. Steven Miner</td>
<td>Accomack County Administration</td>
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<tr>
<td>Mr. Grayson Chesser</td>
<td>Accomack County Board of Supervisors</td>
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<td>Mr. Jack Gray</td>
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<tr>
<td>Ms. Laura Belle Gordy</td>
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<td>Ms. Sandra Hart Mears</td>
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<tr>
<td>Mr. Donald Hart, Jr.</td>
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<td>Mr. Stephen Mallette</td>
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<td>Mr. E. Philip McCaleb</td>
<td>Accomack County Board of Supervisors</td>
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<tr>
<td>Ms. Wanda Thornton</td>
<td>Accomack County Board of Supervisors</td>
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<tr>
<td>Mr. Ronald Wolff</td>
<td>Accomack County Board of Supervisors</td>
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</table>
### Agencies, Organizations, and Persons Consulted

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<tr>
<th>Name</th>
<th>Organization</th>
<th>Sent a Scoping Letter</th>
<th>Expressed Interest/Comment During Scoping</th>
<th>Sent a Copy of Draft PEIS</th>
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</thead>
<tbody>
<tr>
<td>Mr. David Fluhart</td>
<td>Accomack County Building and Zoning</td>
<td>X</td>
<td></td>
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</tr>
<tr>
<td>Ms. Elaine Meil</td>
<td>Accomack-Northampton Planning District Commission</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ms. Katherine Nunez</td>
<td>Northampton County Administration</td>
<td>X</td>
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<tr>
<td>Mayor Michael McDermott</td>
<td>Pocomoke City, Maryland</td>
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<tr>
<td>Mr. James Ring</td>
<td>Somerset County Board of Supervisors</td>
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<tr>
<td>Mr. Robert Ritter</td>
<td>Town of Chincoteague, Virginia</td>
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<td>Mayor John Tarr</td>
<td>Town of Chincoteague, Virginia</td>
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<tr>
<td>Mr. Richard Pollit</td>
<td>Wicomico County Administration</td>
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<tr>
<td>Ms. Louise Gulyas</td>
<td>Worcester County Board of Supervisors</td>
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<tr>
<td>Dr. Arthur Schwartzchild</td>
<td>Anheuser Busch Coastal Research Center</td>
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<tr>
<td>Ms. Kathy Phillips</td>
<td>Assateague Coastal Trust</td>
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<tr>
<td>Mr. Nick Olmstead</td>
<td>BaySys Technologies, Inc.</td>
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<tr>
<td>Mr. Paul Mentz</td>
<td>BMT SYNTEK Technologies, Inc.</td>
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<tr>
<td>Mr. Mike Handforth</td>
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