Wallops Assateague Chincoteague Inlet (WACI) Geologic and Coastal Management Summary Report

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October 2015
1 Introduction

The Seaside Special Area Management Plan (SAMP) has engaged many stakeholders to reduce use conflicts and enhance the productivity and resiliency of both natural systems and local water-based industries. The northern areas of the Seaside face a unique set of challenges related to established development and uses on the barrier islands of Wallops, Chincoteague, and Assateague that are not common to the remainder of the Seaside which is largely undeveloped and pristine (Figure 1-1). Wallops Island is host to the NASA-Wallops Flight Facility (WFF), the Mid-Atlantic Regional Spaceport (MARS), and a section of Chincoteague National Wildlife Refuge. Chincoteague Island hosts the Town of Chincoteague, a vibrant community with thriving tourism and seafood industries and a federally-designated Harbor of Safe Refuge. Assateague Island is host to the US Fish and Wildlife Service’s (USFWS) Chincoteague National Wildlife Refuge (CNWR) and National Park Service’s (NPS) Assateague Island National Seashore (AINS). These islands are located around Chincoteague Inlet, which provides access to inland and offshore waters which is critical for local and regional recreational and commercial economies.

These entities represent different types of ownership and management policies. WFF, USFWS, NPS are federal agencies, while the Mid-Atlantic Spaceport is owned by Commonwealth of Virginia. The Town of Chincoteague is locally managed, and The Nature Conservancy (TNC) is a private organization. The entire project area is located in Accomack County.

The purpose of this project was to give a voice to the local community and to provide the framework for interjurisdictional discussions of issues and solutions. The desired outcome of this effort is to enhance the coastal resiliency and productivity of communities, operations, economies, and environments through the centralization of the data needed for coastal processes and alternative solution development through interjurisdictional coordination. The project consist of four separate tasks: literature review and annotated bibliography, stake holder meeting, summary report, and website creation. In order to better understand the physical system, a review of existing literature was performed. These reports and articles were obtained through internet searches and their contents summarized into an annotated bibliography.

On September 29, 2015, a meeting was held at Chincoteague National Wildlife Refuge. Federal stakeholders from several agencies, TNC, and Accomack County, and the Town of Chincoteague to discuss coastal issues that are of a high priority to the local community including:

1) Relocation of public beach at Assateague Island National Seashore
2) Ongoing re-nourishment of Wallops Island and fate of sand
   a. Northward transport to Chincoteague Inlet
   b. Southward transport to Assawoman Island and washover
3) Toms Cove Isthmus Stability
   a. Breach Potential and impacts to aquaculture and Town of Chincoteague

2 Coastal Setting

2.1 Physical
The WACI shore plan area is located within a larger shore reach that extends from Cape Henlopen at the mouth of Delaware Bay to Cape Charles which is at the mouth of Chesapeake Bay (Figure 2-1). However, the WACI shore is only one of three subreaches set within the larger coastal setting from southern Virginia to New York’s Long Island. These subreaches are defined morphodynamically and by the sediment transport within the reach. The first subreach (Cape Charles to Cape Henlopen) occurs along the Virginia, Maryland and Delaware coasts. The second subreach is along the New Jersey coast from Delaware Bay north to Raritan Bay. The third subreach is along New York’s Long Island. Each of these subreaches have similar sediment transport patterns. Sediment is transported north on the northernmost end of the reach; there is an area of reversal south of which, the sediment is transported south (Figure 2-1). The VA-MD-DE shore is slightly different in that there is an area of reversal at Wallops Island which is at the boundary of sediment zone 1 and 2 where sediment is transported north.

The Virginia Eastern Shore has migrated south over the past 500,000 years (Colman, 1990) forcing the Chesapeake Bay mouth southward (Figure 2-2). With each lowering of sea level during ice ages, the Susquehanna River channel would carry water and sediment far out onto the continental shelf to the ocean that existed at that time. During the last glacial age, the Cape Charles Channel was formed just north of where the modern day shipping channel occurs. From a geologic perspective, 15,000 years ago the ocean of the Mid-Atlantic coast was about 60 miles to the East and sea level was about 300 feet lower, the last glacial age, the Wisconsin, Late Holocene (Coleman et al., 1988; Field, 1980; Tascano & York, 1992). Since that time, sea level has been rising at about 1 foot/100 years which is a simplification of the trend. The effect nonetheless is a transgressive sea flooding the coastal landscape which itself is a result of numerous episodes of the sea coming going in response to glacial and interglacial climate processes. Early research by Shattuck (1901, 1902, 1906) characterized mid-Atlantic coastal morphology as the “terrace-formation” hypothesis. Later investigators included stratigraphic relationships in interpreting the coastal landscape. Jordan (1962) shows how fluvial systems interface with ocean during the Pleistocene (Figure 2-3). Kraft (1971) detailed the stratigraphic relationship of the Delaware coastal plain (Figure 2-4) where transgressive Holocene sediments overly pre-Wisconsin stratigraphy.

Today, the coastal landscape continues to be a function of a rising sea level, projected to increase in the near future. The shoreline is the intersection of the land, sea and air and its movement, rate of change, is a measure of the impacts of not only long-term sea-level rise but the impinging wave climate. Early maps, based on John Smith’s maps, positioned Mid-Atlantic coastal features as early as 1621, but it was not until 1776 that the updated Anthony Smith map was printed (Stephenson and McKee, 2000). Coastal mapping had developed with some degree of accuracy by then. However, it was not until about 1840 that National Ocean Service T-sheets were developed that a reasonably accurate depiction of the ocean shoreline was constructed (Fielding, 1840). Later survey efforts include the Survey of the Coast in 1852 and 1880, and the U.S. Coast and Geodetic Survey in 1882. In the early 1900s, topographic quadrangle maps were developed and the mean high water shoreline displayed. In 1937/1938, the first comprehensive aerial imagery was obtained, and aerial photography has been used up until the recent advent of Lidar. In 1980, the National Ocean Survey developed shoreline positions for the East Coast by topographic quadrangle from the mid-1850s through 1980. This included a varying number of
field surveys and analysis of aerial imagery. For example, the Wallops Island quadrangle had 12 shoreline plotted at mean high water.

In an updated paper, Hapke et al. (2010) developed long-term shoreline change rate for the New England and Mid-Atlantic Ocean coasts (Figures 2-5 and 2-6). The long-term rates were developed along numerous coastal transects and included shoreline surveys 1800s to 1997/2000 along with short term rates from 1960s-70s to 1997/2000. Within the data are coastal features, both natural, man-made or some combination, that effect the nature of shore change. These features also support the nature of sediment transport along the coast.

Delmarva North shore change region features the Cape Henlopen to Fishing Point “Hammer Headland”. These are coastal feature that can be large or small but involve erosion of the inter drainage divides, both upland and nearshore that result in the addition of sand to the littoral system. The impinging wave climate, that is heavily influenced by nearshore bathymetry, forces the sediment either left or right along shore where there is usually a nodal point (Figure 2-1). The end points are often accretionary features, spits, like Cape Henlopen and Fishing Point. The nodal point in this case lies somewhere between Indian River Inlet and Ocean City Inlet. The jetty features and consequent sand build on one side with erosion on the other attest to this. More recently, large beach nourishment projects at Ocean City and the Delaware beaches obviously modify the sediment budget and may amplify the coastal morphology accordingly.

Delmarva South features Wallops Island to Cape Charles and is more complex as the string of barrier island extends southward with multiple inlets.

2.1.1 Assateague Island

Recently, Seminack and Mcbride (2015) described the coastal geomorphic dynamics of Assateague Island which is 58 –km long. Assateague Island is a wave dominated barrier island which are prone to breaching events and inlet formation. Both breaching and inlet formation occur during storms but breaches usually are shorter lived than actual inlets. According to McBride, Assateague Island has experienced many breaching events though out its recent history as a result of extratropical and tropical storm impacts. Eleven inlet events were identified from the late 1700s to 2011. In total, 34% of Assateague Island is estimated to contain tidal inlet fill. The inlet locations are shown in Figure 2-7 along with the inlet life span of each.

The Ocean City Inlet and Chincoteague Inlet were not described by Seminack and McBride (2015), but they are the bounding water bodies for Assateague Island. Ocean City Inlet was formed in an August 1933 hurricane and was subsequently jettied to maintain the opening. The impacts to longshore or littoral sediment transport (LST) have been obvious. With the net direction of LST being southward along Assateague, the sand has accumulated on the north side Ocean City Inlet (net accretion) with a consequent landward offset on the south (erosion). This is further evidence on the southward direction of sand transport along Assateague.

Another geomorphic feature that is evidence of the direction of LST is Fishing Point at the south end of Assateague Island. Fishing Point is a large accretionary spit feature that was non-existence in the mid-1850s. Old charts in 1690 show 5 inlets along what is now called
Assateague Island (Figure 2-7) including Breach Inlet, today’s Ocean City Inlet. From a LST perspective inlets tend to interrupt the flow of sand as the material is caught up in the ebb and flood shoals. By 1880, all of the inlets have closed except for Green Run Inlet which at the time was closing. Other inlets including Ocean City Inlet in the 20th century developed on the north end of Assateague Island. It was between 1859 and 1908 that the Fishing Point Spit began forming possibly as a result of lack of littoral “interruptions” by inlets over time as proposed in Schupp (2013). There was also shore advance several miles north along Assateague Island that may have been part of the “improved” LST system

Fishing Point has therefore evolved from a modest spit feature in 1908 to the large accretionary feature it is today. Along the way, as the spit migrated southward the area to the west, including old Assateague Inlet which was once open ocean became progressively more sheltered as a new lagoon, Tom’s Cove was created (Figure 2-8). With time Assateague Inlet and Chincoteague Inlet combined to become one broad tidal inlet. LST also occurs along the nearshore region and sand entered the ebb shoal region of Chincoteague Inlet making it a larger feature, important to the overall sediment budget. Estimates of net LST along southern Assateague Island range from 1.6 x 10^5 m^3/yr to 1.1 x 10^6 m^3/yr with a large percentage of material trapped in sediment sinks of Fishing Point and Chincoteague Inlet (Finkelstein, 1983; Headland et al. 1987; and Moffat Nichols, 1986). The average long and short term erosion rates vary along Assateague Island (Figure 2-5) with erosional spikes south of Ocean City and Tom’s Cove Isthmus as well as accretionary spike at Fishing Point.

The early spit feature became a connecting isthmus by 1908 and acted as zone of sediment bypass to the terminal end for spit, Fishing Point. Today, the Tom’s Cove isthmus connects the large vegetated Fishing Point to Assateague Island. The Tom’s Cove Isthmus is generally unvegetated at its middle and breached in the 2009 Northeaster but subsequently closed (Figure 2-9). Any breach must compete with the larger tidal prism of Chincoteague Inlet.

The offshore region of Assateague Island and much of the coast to Cape Henlopen has many northeast/southwest linear trending shoals (Figure 2-10). Field (1980) describes these a being formed by wave and current processes acting on previously deposited sediments, and these sand bodies are being formed and modified at the present. These shoals may impact the imping wave climate and along the nearshore operate with the littoral zone of sediment transport. Many are sand rich and are a good source of beach sands like the one used for the Wallop Island beach nourishment projects in 2012 and 2015.

Assateague Island and much of the surrounding coast became part of the USFWS Refuge system in 9xx and a public beach was established in 19xx. Over the past decade, constant overwash events across the parking lot require ongoing maintenance (Figure 2-11)

2.1.2 Wallops Island

The Delmarva south coast extends from Chincoteague Inlet to Cape Charles and consists of numerous barrier islands along a tidal dominated system (Figure 2-12). The long and short term shoreline change indicates a more complex island evolutionary history. This is due to the numerous tidal inlets which trap sand and control in large part the littoral processes operating
The evolution of Fishing Point impacted Wallops Island as well. Wallops Island, begins the string of smaller more tidally dominated barrier islands that extend to Cape Charles. Wallops is also the north extent of what is called the arc of erosion or the Chincoteague Bight which extends to down to Wachapreague Inlet (reference xxx,xxxx). Wallops Island is bounded on the north by Chincoteague Inlet and the south by Assawoman Island. Up until the early 2000s Assawoman Island was separated from Wallops Island by Assawoman inlet which closed by 2007 (King et al., 2011).

Wallops Island resides in the “lee” of Assateague Is as far back as 1690. The “headland” effect of Assateague Island is now exacerbated by the development of Fishing Point as well as the offshore shoals and large ebb shoal of Chino Inlet. Historically, since the mid-1800s, Wallops Island has tended to erode along the south end and accrete along the north end. When Assawoman Inlet closed, the LST was able to operate along a continuous shore reach. Shoreline change in the WACI zone is illustrated in Figure 2-13.

Wallops Island became the site of the National Aeronautics and Space Administration’s (NASA) Goddard Space Flight Center’s Wallops Flight Facility (WFF) in 1945. Rocket launch facilities and support buildings were located along the coast. Chronic shoreline erosion caused the WFF to initiate shore protection installations. A steel sheet pile wall was installed in 1956 followed by a series of wood groins in 1959 (Figure 2-14). The wall failed in the 1962 Ash Wednesday Storm resulting filling the south end of the island and in the addition of more groins by 1972. These measures were inadequate and were abandoned in lieu of using rock for a long seawall (Figure 2-15). After 10 years of constant maintenance, WFF engaged MN to perform shoreline modeling to ascertain the nature of sediment transport (Figure 2-16). The sediment budget of the WACI zone shows over 1 million cy/yr of LST southward along Assateague Island. The updated model results are shown in Figure 2-17 that illustrate the persistent nodal zone on Wallops Island where transport diverges north and south.

The beach fill project of 2012 utilized sand from the offshore shoal designated Shoal A. Hopper dredge was used to bring the sand to the nearshore where it hooked up to a SCOTS buoy and pumped ashore (Figure 2-18). Post 2012 beach fill is shown in Figure 2-19. Hurricane Sandy impact the region shortly thereafter causing loss of beach fill both along shore, off shore and as washover across the southern end of Wallops Island (Figure 2-20). Post Sandy Surveys show the dramatic sequence of events in a typical cross section about mid-project (Figure 2-21).

Assawoman Island and many of the barrier islands to the south are owned by the Nature Conservancy (TNC). These island have their own history of shoreline change and as seen in Figure 2-5 where the tidal inlets control the longshore sediment transport processes. At the nodal zone on south Wallops Island the net movement of sands is to the south.

2.1.3 Chincoteague Inlet

As seen in the previous sections Chincoteague Inlet has evolved largely in response to evolution of Fishing Point and to a lesser degree the north end of Wallops Island. The inlet
throat had narrowed to about 1,800 feet by 1994, but then it slowly has gotten wider as the terminal end of Fishing Point migrated southward not westward. The inlet throat widened to about 6,400 feet by 2013 which may account for increased concern by the Town of Chincoteague of more wave energy now allowed through the inlet.

Tidal inlet morphology (inlet cross-sections) are typically a function of the tidal prism and in the case of Chincoteague Inlet it is a function of the area of Chincoteague Bay and the tide range (Figure 2-22) in a study of Chincoteague Bay develop a model for water quality. Figure 3-23 shows the modeled water depth and tide range within the Chincoteague Bay tidal system where tide range decreases northward then increases again as a function the estuary narrowing into Sinepuxent Bay and the narrow tidal connection to Ocean City Inlet. The tidal volume and rate of turnover is shown to be between 3.9 and 4.4 tidal cycles. Tidal current running in and out of Chincoteague Inlet are reported to be significant, but no data can be found to support this.

Sediment transport processes around Chincoteague Inlet include about a 1.0 million cy of sand coming down from Assateague Island that gets caught up in the ebb shoal and eventually may bypass to the south past Wallops Island. The shoaling is clearly seen in the 1949 aerial image (Figure 2-24) and the nature of the sand bypassing may be similar to that at Ocean City inlet (Figure 2-25).

Chincoteague Inlet is a federal navigation channel and the USACE performs maintenance dredging since 1995 (Table 2-2). It is 200 feet wide with a controlling depth of 12 feet. The latest bathymetry for the inlet throat is shown in Figure 2-26 showing infilling from the Fishing Point side of the channel. Past disposal areas include an area off of Wallops Island (Figure 2-27). There is a proposal out to perform another maintenance dredging to the inlet. The final plans may include a beach nourishment component (personal comm. USACE, 2015).

2.2 Hydrographic Setting

Clearly sea level rise is the underlying force behind shoreline change and varies globally depending on the tectonic setting of the coast. For the Mid-Atlantic sea-level rise since the last low stand, 15,000 yrs ago in illustrated in Figure 2-28. Future projections are complex based on various models; therefore three levels of SLR are provided in Figure 2-29. For planning, the 50 year scenario is preferred.

The mean tide range in the WACI zone is 1.12 m (3.67 ft) measured at Wallops Island. As discussed earlier the tidal flushing in and out of Chincoteague Bay has been modelled as only a few days. Water levels are elevated during storm events. Historic storm surge elevations for Wallops Island are shown in Figure 2-29. According to NASA (2013), more recently Hurricane Irene in 2011 and Hurricane Sandy in 2012 had comparable storm surges of 5 ft. At Wachapreague, about 25 miles south, Sandy storm surge levels exceeded 8 ft MLLW (NOAA, 2012).

The wave climate along the Mid-Atlantic coast is function of the frequency, speed and duration of the local winds (Figure 2-31). This region experiences predominantly winds from
the south-southwest during the summer mostly between 5 to 10 m/s (11 to 22 mi/hr). During the winter, winds are generally from the northwest quadrant with wind speeds frequently greater than 10 m/s (22 mi/hr) (Carruthers et al., 2011). However, along with nearshore bathymetry, northeast storms and the infrequent hurricane can control, in part, the sediment transport processes operating along a given coast.

3 WACI Shoreline Management

The WACI coastal neighborhood (Figure 1-1) consists of: Accomack County, Accomack Northampton County Planning District Commission, Town of Chincoteague, The Nature Conservancy, NASA, U.S. Fish and Wildlife Service, and the National Park Service. Other entities that have regulatory oversight in the region include: Commonwealth of Virginia, US Army Corps of Engineers, and the Bureau of Ocean Energy Management. Presently, many efforts are currently underway in the WACI coastal neighborhood including but limited to:

- University of Virginia - Long-term Ecological Research Project (LTER)
- NASA Wallops – Environmental Assessments for Shore projects
- NASA Goddard Space Flight Center (GSFC); WFF and Marine Science Consortium (MSC)
- 2009- MARCO- Mid-Atlantic Council on the Ocean, Eastern Shore North coast SAMP (Special Area Management Plan)
- 2010-Eastern Shore Climate Adaptation Working Group (CAWG)
- 2014- TNC/ANPDC – Two year Grant- Hurricane Sandy Coastal Resilience Funds to enhance coastal resilience from the National Fish and Wildlife Foundation
- 2014- MACRI – Mid-Atlantic Coastal Resilience Institute
- 2015 FWS – Chincoteague and Wallops Island NWR Final Comprehensive Conservation Plan (CCP)
- 2015 USGS. Sediment collection offshore Delmarva Peninsula.

Shoreline management strategies were developed by Wallops, FWS, and TNC for inclusion in the Barrier Island-Inlet Evolution Model currently under development and funded by a NFWF grant to TNC/ANPDC (Table 3-1). More recently, USFWS concluded that the beach nourishment component option should be removed from consideration due in part to cost and maintenance as outlined in the final Comprehensive Conservation Plan (reference, 2015) (Figures 3-2 and 3-3). Wallops will continue to protect its infrastructure with beach nourishment and maintain its rocks seawall. The beach will require ongoing maintenance. TNC concluded that modeling the natural migration of barrier islands is preferred.

The following entities were represented at a meeting on September 29, 2015 at the Chincoteague NWR: Accomack County, Accomack Northampton County Planning District Commission, Town of Chincoteague, The Nature Conservancy, NASA, U.S. Fish and Wildlife Service, National Park Service, U.S. Army Corps of Engineers, U.S. Geological Survey, and the Virginia Marine Resources Commission. The purpose of the meeting was to initiate the development of a interjurisdictional framework. The stated goals of the meeting were to:

1) Provide the geological background as to how the coastal landscape has evolved; and
2) Solicit reaction so that we can better understand each stakeholder’s needs and desires.
Discussed were: Relocation of public beach at Assateague Island National Seashore

1) Ongoing re-nourishment of Wallops Island and fate of sand
   a. Northward transport to Chincoteague Inlet
   b. Southward transport to Assawoman Island and washover

2) Toms Cove Isthmus Stability
   a. Breach Potential and impacts to aquaculture and Town of Chincoteague

During the discussion period of the meeting, several concerns were raised by the local constituents. These are: 1) the recession of Fishing Point and consequent widening of Chincoteague Inlet which exposed the Town of Chincoteague to storm surge; and 2) the narrow isthmus along the ocean side of Tom’s Cove may breach under storm attack threatens Fishing Point as well as the oyster grounds and aquaculture in Tom’s Cove. Will a permanent inlet form?

A series of questions were posed about what research questions need to be addressed:

- On Assateague Island: What is the long term plan for the new beach?
- Will allowing inlets/breaches to remain open along Assateague Is reduce LST and threatened the Tom’s Cove Isthmus?
- Can a breach in Tom’s Cove Isthmus sustain itself?
- Will WFF beach fill increase shoaling in Chincoteague Inlet?
- What is the contribution (s) of LST into Chincoteague Inlet? How was Chincoteague Inlet formed?
- Can Chincoteague Inlet dredge material be put on shore either at WFF or Assateague Island?
- How can the fines be utilized? Thin layering across tidal marsh?
- What are LST impacts of WFF beach fill to Assawoman Island and backbarrier marshes?
- Can WFF beach fill be “governed” with coastal structures to increase beach fill residency?
- Is back passing WFF beach a viable option?

4  **WACI Management Structure**

4.1  **Strategic Planning (SAMP)**

The ANPDC is the likely coordinating entity to maintain a link to each of the property owners and stakeholders in the WACI coastal neighborhood. As part of this grant VIMS has developed a website that has taken links from USGS etc. that can act as a working model for information sharing.

4.2  **Chincoteague Inlet, pending dredging project**

The impending USACE maintenance dredging of Chincoteague Inlet offers an opportunity to see if a sand management approach to utilizing the sandy dredge material for beach nourishment. Many questions must be answered…
5 References


Finkelstein, K., 1983, Cape formation as a cause of erosion on adjacent shorelines; Proceedings Coastal Zone ’83, American Society of Civil Engineers, p. 620-640.


