Rural Shallow Water Dredging: Channel Assessment and Disposal Site Strategies

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Table of Contents

Cover photo: Dredge disposal area at the Virginia Institute of Marine Science Boat Basin, 21 March 2013. Photo by VIMS, Shoreline Studies Program.

1 Introduction

The shallow draft navigation channels on the Middle Peninsula, Northern Neck, and Eastern Shore of Virginia were administered and managed by the Army Corps of Engineers (Corps or USACE) Norfolk District until 2010. At that time, the Corps discontinued support for the channels effectively abandoning management responsibility to local governments should they choose to pursue it. These channels were originally established and managed for productive commercial and economic uses such as boating, fishing, and providing safe harbors for vessels during storms.

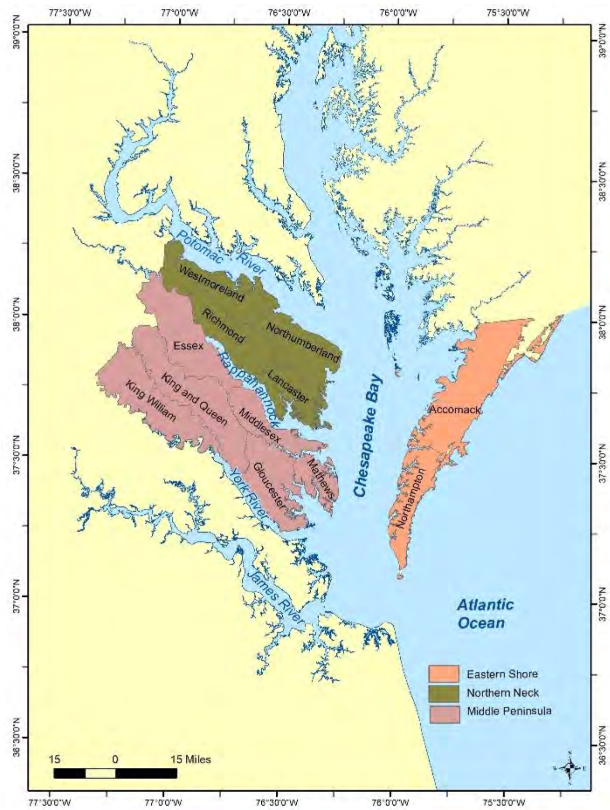


Figure 1-1. Localities considered in the report.

Though local governments support commercial use of these waterways, they may not be equipped to assume management responsibilities for activities such as dredging that are required to maintain these channels for commercial use. Dredging is an expensive endeavor particularly in regard to the disposal of the dredge material. Sandy material can be placed along the shoreline as a beneficial use; however, muddy material generally has to be placed on land necessitating the acquisition of a suitable disposal area.

The goal of this report is to provide general considerations for localities on the dredging and disposal of material from shallow draft channels, in particular for those channels on the Middle Peninsula, Northern Neck, and Eastern Shore of Virginia (Figure 1-1). This report offers background on shallow draft channels, both federally and non-federally maintained, suggests procedures for the dredging and disposal process, and applies the process to an existing channel. Existing data on the Middle Peninsula, Northern Neck, and Eastern Shore channels are provided to assist localities with management decisions. In addition to data for most of the existing federal channels, Davis Creek in Mathews County, is used as an example of what steps need to be taken and what data are necessary for maintenance dredging and disposal.

Three basic data requirements are needed for any dredging project: 1) how much material will be dredged, 2) what is the composition of the dredged material, and 3) where the proposed disposal site is located. These requirements usually will determine the most cost-effective type of dredging, mechanical or hydraulic, and whether there are opportunities for the beneficial use of materials. The USACE has guidelines and standards to which projects on federally-maintained channels must adhere. Though technically, non-federally maintained channels may not require such detailed processes, no real cost savings exists to short cut the procedures required for federal channel maintenance because a Corps permit is required. Corps permits for dredging non-federal channels require the same basic elements as federal channels do.

The Corps has a great deal of information readily available on shallow draft dredging. Several documents, in particular, are considered to provide additional information on shallow draft dredging project design. In an effort to provide a summary document that consolidates necessary material to provide an understanding of the issues while not being bogged down in details, this information is not repeated in this report. The amount and scope of information varies widely and is accessible for those who need additional data. The reports are publicly available and can be found on their originator's website. However, for expediency in referencing them, they are linked here and on the VIMS, Shoreline Studies Program website. The reports are:

- Dredging and Dredged Material Management (USACE, 2015): Includes a great deal of information for all types of dredging projects design.
- Beneficial Use Projects Using Dredged Material (EPA\USACE, 2007): Identifying, planning, and financing beneficial use projects using dredged material, beneficial use planning manual
- Guidance and Best Practices for Determining Suitability (Brandon & Price, 2007): Summary of available guidance and best practices for determining suitability of dredged material for beneficial uses
- Eastern Shore of Virginia Regional Dredging Needs Assessment (ANPDC, 2016): Data for the shallow draft channels and Appendix E, a user's guide to dredging on the Eastern Shore of Virginia which provides specific guidance for Virginia projects including permitting
- Shallow Draft Navigation and Sediment Plan for Middle Peninsula (MPPDC, 2011): Data for the shallow draft channels and probable average annual cost for maintaining all the federal navigation channels on the Middle Peninsula.

2 Shallow Draft Channels

Shallow draft navigation projects are projects maintained to depths shallower than 14 feet and have low commercial use (less than 1 million tons annually). These projects also may provide a safe harbor of refuge. The shallow draft channels on the Middle Peninsula, Northern Neck, and Eastern Shore are vital to the economies and provide recreation for its citizens. Each channel has its own unique setting and history. The federal channels, many of which were established in the 1950s to 1970s, were authorized by Congress. The channels are fixed in the shorescape, but the disposal areas may have changed over the years due to overfilling of initial sites, the development of alternate upland disposal sites, or the beneficial use of material. Beneficial uses of dredge material have taken on priority status over the past decade or so.

2.1 Federal Channels

Since Congress appropriated funds in 1884 to improve navigation in Chesapeake Bay, the Norfolk District of the USACE has been responsible for the development and maintenance of coastal waterways to provide safe and reliable channels. Those channels that have federal interest and funds are managed by the Corps. As funding became sporadic, many channels filled in and were not dredged. However, recently, the Corps, Norfolk District, has made an effort to determine the state of those federally-recognized channels. The Corps surveyed most of their shallow draft channels between 2017 and 2019 providing the opportunity to calculate conceptual maintenance dredging volumes.

The dredging and disposal data for each federal channel is shown in Appendix A. The information for each site relies on historical data, existing reports, and/or recent permit applications. Though all data found was included, the data included on the maps may not be completely accurate.

Middle Peninsula Channels

The Middle Peninsula has 17 federal navigation channels (Figure 2-1). An assessment of each channel's present condition, when appropriate, is shown in Appendix A. All the channels are maintained for ingress and egress to tidal creeks except Horn Harbor (Site 4), Mattoponi River (Site 8), Locklies Creek (Site 7), Mill Creek (Site 10) and Pamunkey River (Site 11). Horn Harbor and Locklies are channels outside the creek that make the creek channel accessible. Mill Creek has no data available. It is

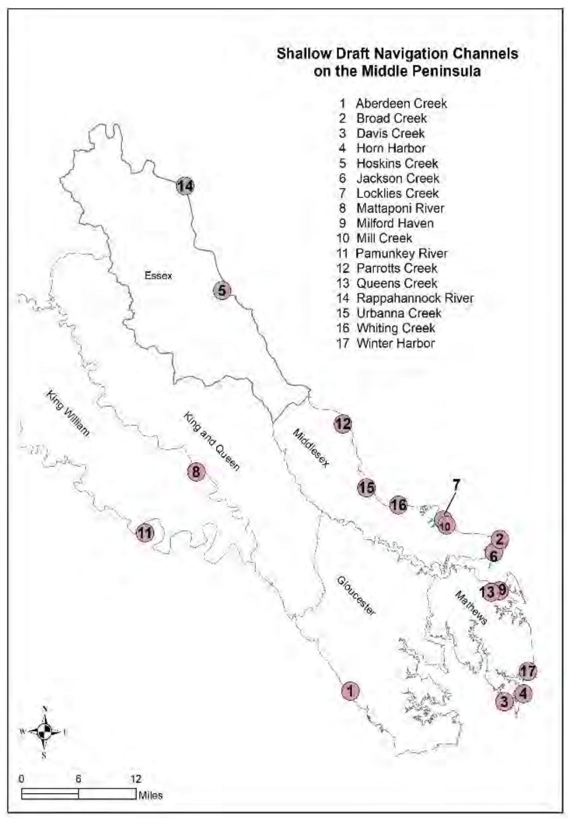


Figure 2-1. Location of federal navigation channels on the Middle Peninsula.

a small navigation channel that provided access to Mill Creek Wharf in the past. Today, the site has a boat landing maintained by the Commonwealth of Virginia, but the channel is no longer dredged. Jackson Creek (Site 6), Queens Creek (Site 13), and Winter Harbor (Site 17) are actively used channels that need regular maintenance dredging. Aberdeen Creek (Site 1) and Davis Creek (Site 3) have alternate channels in use outside the Corps channel "footprint".

Northern Neck Channels

Thirteen federal navigation channels occur on the Northern Neck (Figure 2-2). Seven sites are on the Potomac River and come under the Baltimore District of the USACE. The channel assessments are found in Appendix A and include sites located on the Rappahannock River, Chesapeake Bay, and the Potomac River. All the sites are creek channels except Site 13 which is the Rappahannock River and Site 6, which provides access to the Dymer Creek channel. Channel survey data exists for nine sites.

Eastern Shore Channels

Nine federal channels are located on the bayside of the Eastern Shore, and two occur on the back barrier bay on the ocean side (Figure 2-3). Additional federal channels empty into the Atlantic Ocean on the Eastern Shore, but those are not discussed in this report. The ANPDC (2016) report provides detailed information on the dredging needs of the Eastern Shore. Refer to that report for channel specific data. Cape Charles Harbor technically is not a shallow draft

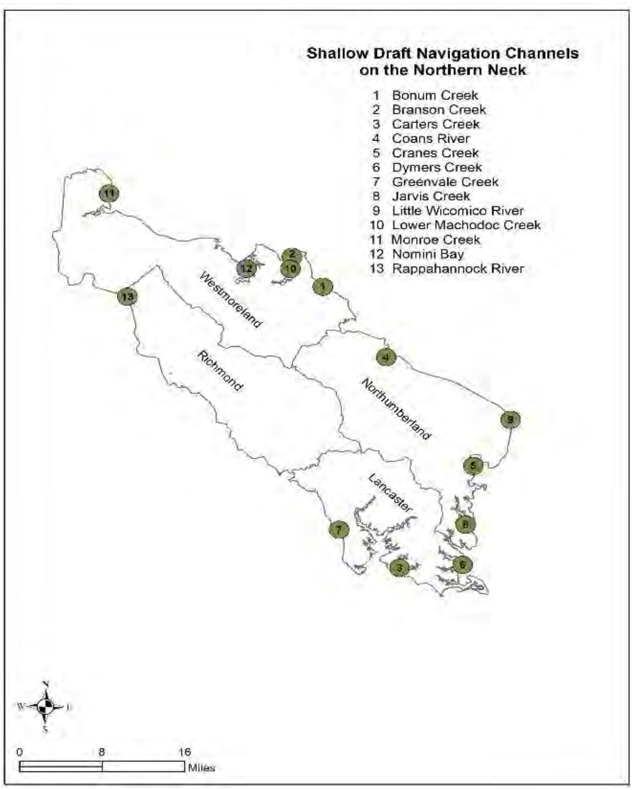


Figure 2-2. Location of federal navigation channels on the Northern Neck.

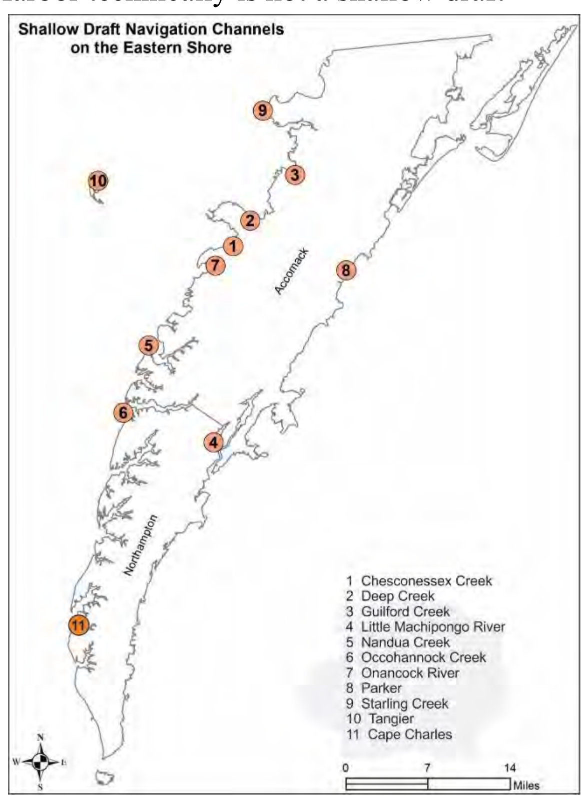


Figure 2-3. Location of federal navigation channels on the Eastern Shore.

channel because it is maintained to 18 ft and is not included in this report. However, information on this channel is included in ANPDC (2016).

2.2 Non-Federal Channels

No list of non-federal channels exists, but those found on navigation charts and on the US Coast Guard light list are shown in Table 2-1. Numerous channels in Chesapeake Bay are not maintained by the Corps but have navigation aids maintained by the U.S. Coast Guard. The light list provides condition of the navigation aids in the channel but not an assessment of channel depths. The lists in Table 2-1 may not include all non-federal creeks in the three areas.

Table 2-1. List of shallow draft non-federal channels on the Middle Peninsula, Northern Neck, and Eastern Shore. List taken from nautical charts.
The channels that are marked are noted with an asterisk.

Middle Peninsula	**Northern Neck**	**Bayside Eastern Shore**
Timberneck Creek	Totusky Creek*	Kings Creek*
Sarah's Creek*	Morrattico River*	Hungars Creek*
Perrin River	Deep Creek*	Hunting Creek*
Blackwater Creek*	Windmill Point Marina*	Nassawadox Creek*
Pepper Creek*	Carters Creek*	Pungoteague Creek*
Stutts Creek*	Antipoison Creek*	
Hole in the Wall	Tabbs Creek	
Healy Creek	Towles Creek	
Sturgeon Creek		
Bush Park Creek		
La Grange		

*Channel markers are listed in the US Coast Guard's 2019 Light List

Of the non-federal channels on the Middle Peninsula, Timberneck Creek in Gloucester County and the Hole in the Wall in Mathews are slated for assessment and dredging. The Timberneck Creek channel in Gloucester County can serve as an example of a conceptual design for a new dredging in a non-federal channel (Figure 2-4). Channel design must balance safety, economic, and sustainability requirements. Channels also must be wide and deep enough to safely accommodate vessel traffic but not so large as to require excessive dredging or habitat modification. Timberneck Creek has been approved for channel dredging and until a more formal study is performed, the channel width and depth will be assumed to be similar to the nearby federal channel, Aberdeen Creek (Appendix A). Aberdeen Creek has an 80-foot wide channel and a -6 ft controlling depth as well as turning basin by existing commercial docks. The Timberneck Creek channel had 2 day markers as aids to navigation provide guidance for the conceptual dredging plan (Figure 2-5). Following the channel markers in Timberneck Creek, the channel can extend from the -5 ft contour inside the creek, perhaps with a small turning basin, to the -5 ft contour in the York River with a foot or two over dredge. The conceptual channel center line follows the channel markers south to the farthest marker. However, an alternate channel could be dredge to the -7 ft contour which is a different route to get to "deep" water sooner thereby reducing channel dredge volumes. However, the latter crosses shallow shoal, a factor to consider for dredge volume and developing a maintenance plan.

The following steps are the minimum required to design a dredging plan for Timberneck Creek after the optimum route is selected which may be a function of these steps: survey the channel depths to determine the volume of material that needs to be dredged; take sediment cores and analyze for composition; and define the disposal site(s) based on sediment composition and proximity of potential disposal sites. Typically, fine dredge material, which will require an upland disposal, may be located inside the creek; however, suitable sand for beach nourishment may be located on the outboard end of the channel, similar to Aberdeen Creek (Hardaway et al., 2014).

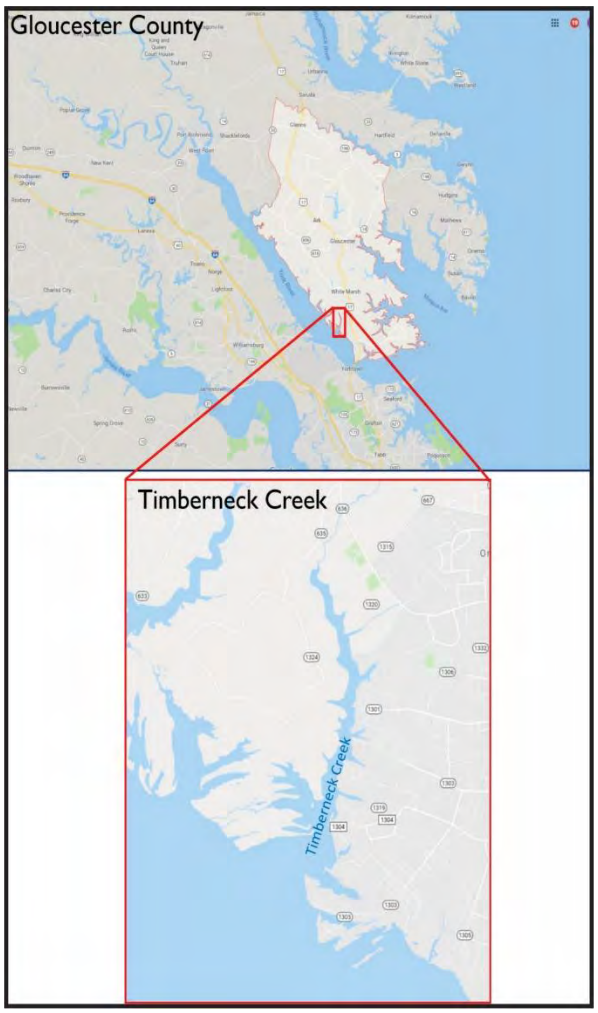


Figure 2-4. Location of Timberneck Creek in Gloucester County.

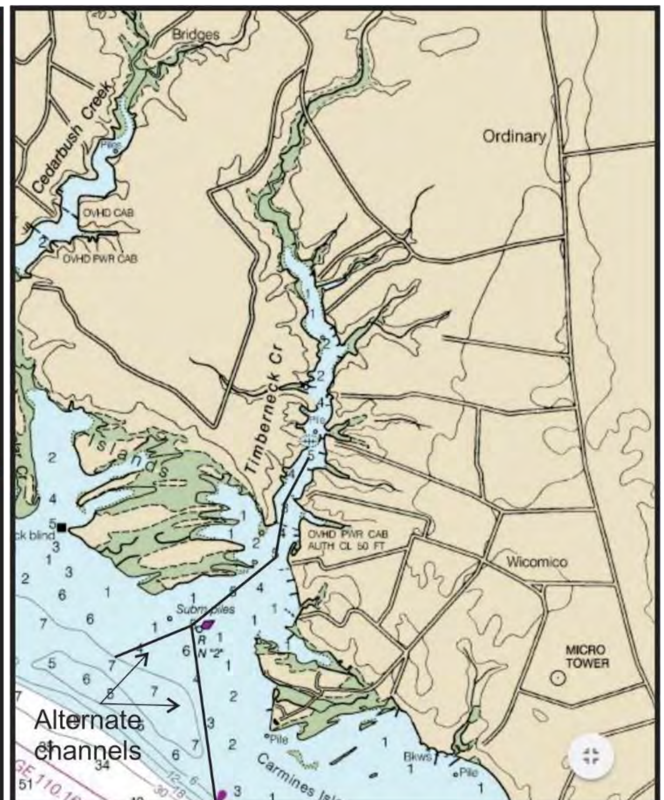


Figure 2-5. Conceptual channel plan for Timberneck Creek.

3 Dredge Disposal

For shallow draft channels in Chesapeake Bay, disposal of dredge material is both a concern and a major component of the dredge planning process. In the past, dredge material was disposed of on the upland, along the shore, or in open-water. However, many previously used upland sites have been filled to capacity, previously-leased shore sites are no longer available, and environmental concerns sometimes limit open-water disposal. As such, new sites must be considered.

For the purposes of this report, upland confined disposal and beneficial use, particularly shoreline placement, are discussed. Upland sites typically require a containment berm located nearby on property where a lease has been obtained. When material is placed alongshore, it is considered a beneficial use of dredge material and is usually restricted to sand rich dredge material.

How material is dredged has implications for dredge disposal. Dredges are usually classified as hydraulic or mechanical manner depending on how they achieve excavation and removal of material. Hydraulic dredges are characterized by the use of a centrifugal pump to dredge sediment and transport it, in a liquid slurry form, to a discharge area. These dredges are able to move a great deal of material quickly via pipeline. Mechanical dredges are characterized by the use of some form of bucket to excavate and raise the bottom material. Material is either deposited directly adjacent to the channel or it can be placed in barges for transport to the placement site (USACE, 2015).

3.1 Upland Confined Disposal

Upland dredge disposal sites require a containment berm or retaining dike to form a confined disposal facility (CDF). CDFs consist primarily of earth embankments constructed on lowland areas or nearshore islands with the principal objective of retaining solid particles within the disposal area while at the same time allowing the release of clean effluent back to natural waters (Figure 3-1). The confinement or retention dikes enclose the placement area, isolating the dredged material from adjacent waters during placement (Figure 3-2).

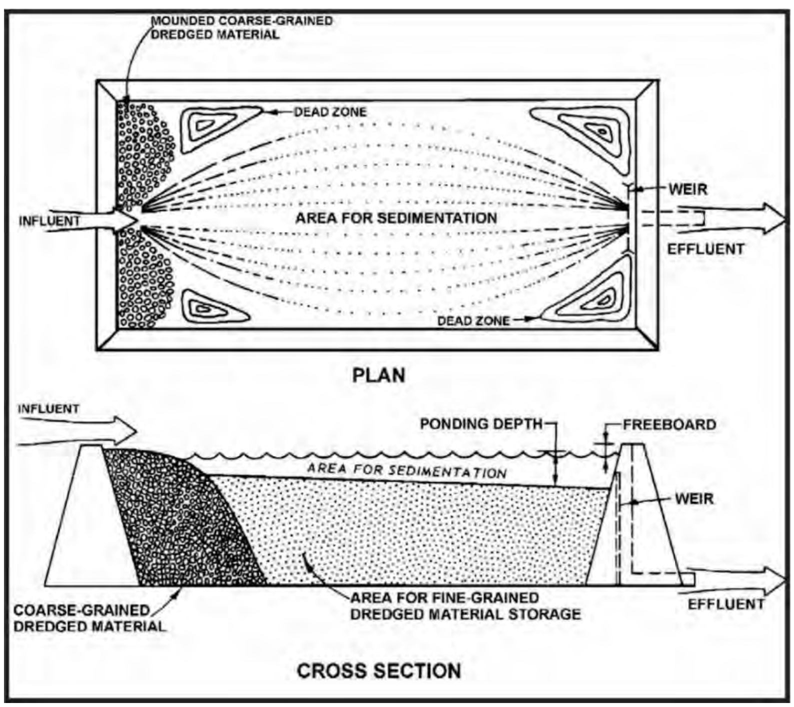


Figure 3-1. Conceptual diagram of dredged material containment area (from USACE, 2015).

Figure 3-2. Inactive confined disposal area at Winter Harbor, Mathews County, VA. Much of the site has become vegetated. The front corner berm/dike is being eroded. Photo: 7 March 2010 Shoreline Studies Program, VIMS.

The primary goal of a CDF is to provide adequate storage capacity for dredging requirements and to maximize efficiency in retaining the solids, particularly fine-grained sediment. CDFs are particularly important for contaminated dredge material because most chemical contaminants associated with sediments could be contained effectively through efficient solids containment. Many contaminants in sediment remain attached to solid particles during dredging and placement in the CDF. However, CDF design considerations are greater and require special qualifications because of the many pathways for contaminants to leak into the environment (USACE, 2015). Therefore, they are not considered in this report where it is assumed the material from the channels will not be contaminated.

Design and evaluation of CDF options differ depending on whether there is an existing CDF or if a new site is required (USACE, 2015). Evaluation of an existing CDF determines if the proposed placement operation can be accomplished at the site when considering factors such as the area available, volume to be dredged, sediment characteristics, and anticipated dredging operational parameters such as the dredge size and flowrate. Design of a new CDF involves determining the necessary site geometry such as the area and dike height (USACE, 2015). Additional considerations are site configuration and access, proximity to sensitive environments, topography to include potential changes in elevation and runoff patterns and adjacent drainage, groundwater levels, and soil properties. Many of these characteristics need to be determined by site visits to potential CDF locations.

The location of a retaining dike at a site often is established by factors other than just foundation conditions and available borrow material such as proximity to dredge, only land available, and so on. The heights and geometric configurations of retaining dikes are generally dictated by containment capacity requirements, availability of construction materials, and prevailing foundation conditions.

The site must be volumetrically large enough to meet both short-term storage capacity requirements during filling operations and long-term requirements for the anticipated life of the site (USACE, 2015). Sufficient surface area and dike height with freeboard must be available for retention of fine-grained material to maintain effluent water quality. When the dredged material is initially deposited in the CDF, it may occupy several times its original volume. The settling process is a function of time, but the sediment eventually consolidates to its in situ volume or less if desiccation occurs. Adequate volume must be provided during the dredging operation to contain the total volume of sediment to be dredged, accounting for any volume changes during placement (USACE, 2015). Hydraulic dredging can add several volumes of water for each volume of sediment removed whereas mechanical dredging typically has a water content similar to what the material is in situ. If the material is suitable, the dredge material can be used to build the berms for the CDF after dewatering.

3.2 Beneficial Use Disposal

Dredged material is a manageable, valuable soil resource with beneficial uses. As such, considering uses other than CDF or open water disposal and incorporating those uses into project plans and goals at the project's inception should occur whenever possible. Beneficial use includes a variety of options which utilize the material for productive purposes. The USACE identifies several broad categories of beneficial uses including: habitat restoration/enhancement of wetland, upland, island, and aquatic sites including use by waterfowl and other birds; beach nourishment; aquaculture; parks and recreation (commercial and noncommercial); agriculture, forestry, and horticulture; strip mine reclamation and landfill cover for solid waste management; shoreline stabilization and erosion control (living shorelines, fills, artificial reefs, submerged berms, etc.); construction and industrial use (including port development, airports, urban, and residential); and material transfer (fill, dikes, levees, parking lots, and roads).

When potential beneficial use opportunities for dredged material are being identified, it is important to evaluate the suitability of the dredged material in question for a given use (EPA/USACE, 2007). The EPA/USACE (2007) report provides detailed guidance for determining suitability of dredge material for beneficial uses. In addition, USACE has a website dedicated to beneficial uses to provide guidance and case studies (https://budm.el.erdc.dren.mil/). Beneficial use of dredge material is more likely to occur when a disposal need is part of a broad, watershed-level planning effort. The Middle Peninsula Chesapeake Bay Public Access Authority initiated a "Shallow Draft Navigation and Sediment Management Plan" (MPPAA, 2011) for the channels on the Middle Peninsula. The plan included possible beneficial use disposal for the channels reviewed.

The dredge material has to be evaluated for physical and engineering suitability for the potential beneficial use. Beach nourishment is one beneficial use for shallow water channel material in Chesapeake Bay. Beach nourishment is used to replenish eroded sand from beaches to stabilize the shoreline, moderate wave action, help with erosion control, and to feed the littoral zone (Figure 3-3). It is strongly dependent on the sand fraction of the source. This is usually in the order of 85 to 90% sand and approved by permit. For beach fill, the sand grain size should have a median (D_{50}) of 0.6mm +/-0.35mm. Site conditions may warrant using a finer grained material with the appropriate environmental controls. However, fine material will be more readily transported away from the site.

Other beneficial uses include shore protection/habitat restoration through the use of living shoreline projects. Using the dredge material as fill behind rock sills and planting with marsh grass both enhances shoreline habitats and stabilizes the shoreline. Sandy material is the preferred material, but sediments may be slightly finer than that required for beach nourishment. The difficulty with this beneficial use is timing between dredging and construction of the living shoreline.

Transport of dredged material can be a major cost item in determining the economic feasibility of a project and as such should be evaluated early in the site selection stage of the planning process. MPPAA (2015) considered sites within 1 mile of the dredge project for material placement. This was assumed to be a reasonable balance between transport cost and site availability. If a channel is dredged hydraulically, material can be pumped to a site via pipeline. If mechanical means are used, material may be moved to a placement site via truck or barge.

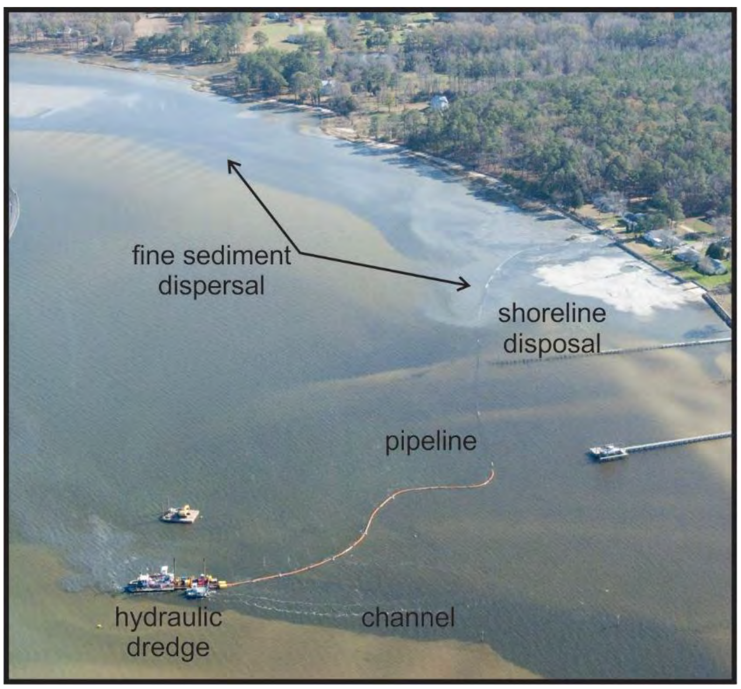


Figure 3-3. Hydraulic dredging and shoreline disposal of material at Queens Creek, Mathews County, VA. Photo 28 Nov 2009 Shoreline Studies Program, VIMS.

4 Confined Disposal Facility Design Considerations

The USACE (2015) provides a technical framework to determine management alternatives to be used in evaluating potential environmental impacts of dredge material placement (Figure 4-1).

To begin, the characteristics of all possible CDF locations should be examined and direct physical impacts determined. Design aspects related to physical site capacity, such as sizing and retention of dredged material, are evaluated first because such evaluations can be conducted quickly and inexpensively. If a given site or design option is not workable from the physical standpoint, it can be eliminated without wasting effort on more involved and expensive environmental evaluations (USACE, 2015).

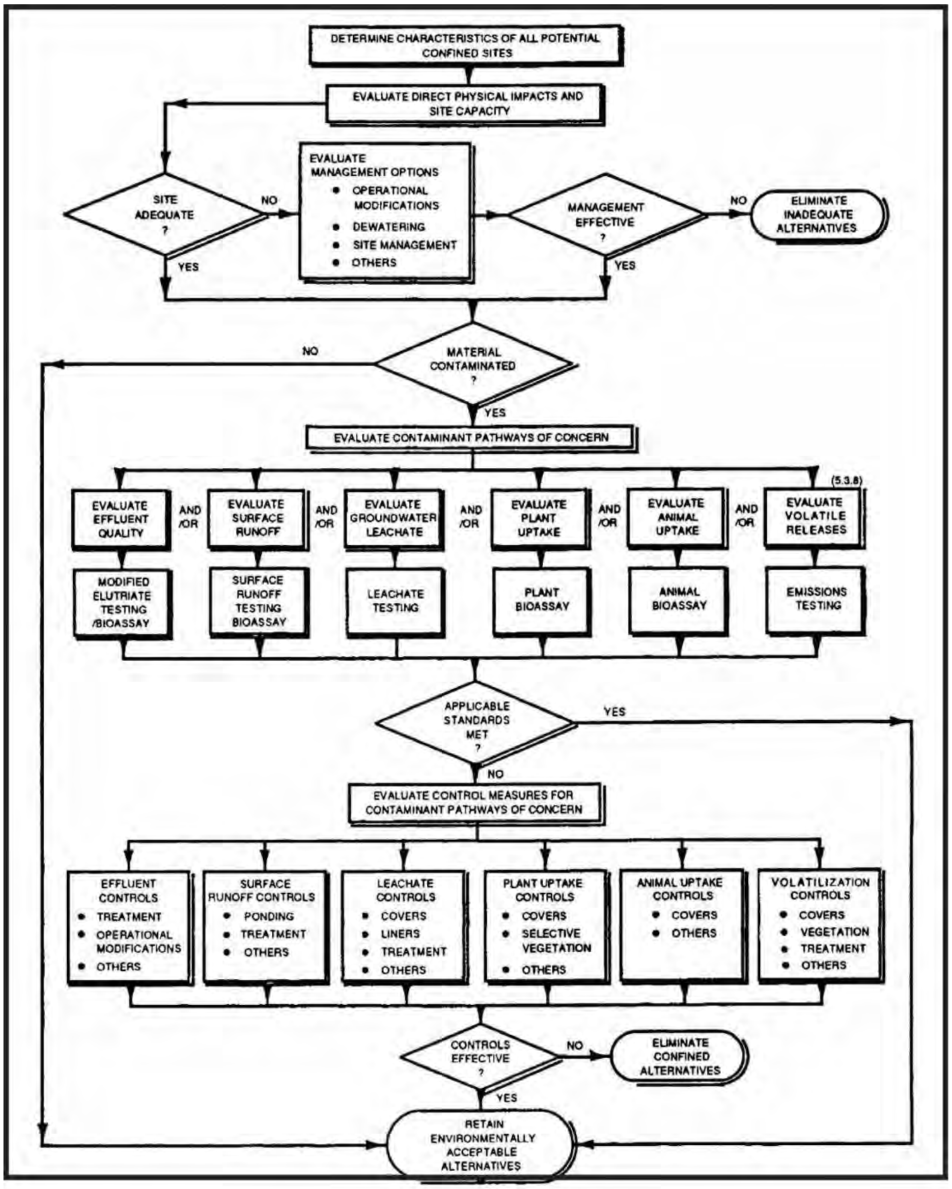


Figure 4-1. Technical framework flowchart for the evaluation of confined dredged material placement (USACE, 2015).

To determine if a site is adequate, these items should be considered:

- Is there adequate area for the disposal area and containment dike?
- Are foundation conditions adequate for estimated material loads?

- Will ground water be impacted or is the water table far enough below grade to minimize impacts?
- Is there a source for dike material? Bringing material in from upland source might be cost prohibitive, but use of the dredge material will require some form of dewatering particularly if the channel is hydraulically dredged. Excavating the adjacent upland or material would most cost effective but can be problematic when the material is not suitable or the site has a high, unconfined water table.
- Can the position of input and output pipes and weir design meet Clean Water Act permit requirements? The return flow of water (effluent) is defined as discharge by the act and must be managed accordingly.
- Additional considerations are site access, proximity to sensitive environments, topography to include potential changes in elevation and runoff patterns and adjacent drainage.

If it is determined that the site is adequate, then it must be determined whether the dredge material is contaminated. If material is contaminated, the difficulty and cost of the project is greatly increased as the CDF has to adhere to stricter design guidelines. EPA/USACE (2007) lists the chemical properties that can be tested.

When the evaluation of direct physical impacts, site capacity, or contaminant pathways indicate that the impacts will be unacceptable when conventional CDF disposal techniques are used, management actions and contaminant control measures may be considered. These may include modification to the dredging operation or site, treatment of effluent, runoff, or leachate, treatment of dredged material solids, or site controls such as surface covers or liners. Once the issues are addressed, the framework indicates the environmentally acceptable alternatives should be retained and a final decision made.

Numerous permits are required in any dredging operation. For federal channel maintenance, suitable existing disposal areas typically require an environmental assessment and/or National Environmental Policy Act (NEPA) document prepared. New, non-federal channels may or may not require these, but some elements may be prudent to include in a permit application, especially during the Corps review. More detailed information on the permitting process is presented in Appendix E of the Eastern Shore of Virginia Regional Dredging Needs Assessment (ANPDC, 2016). It provides a good explanation for permitting channel dredging on the Eastern Shore and throughout Chesapeake Bay.

5 Depth Analysis and Geotechnical Samples

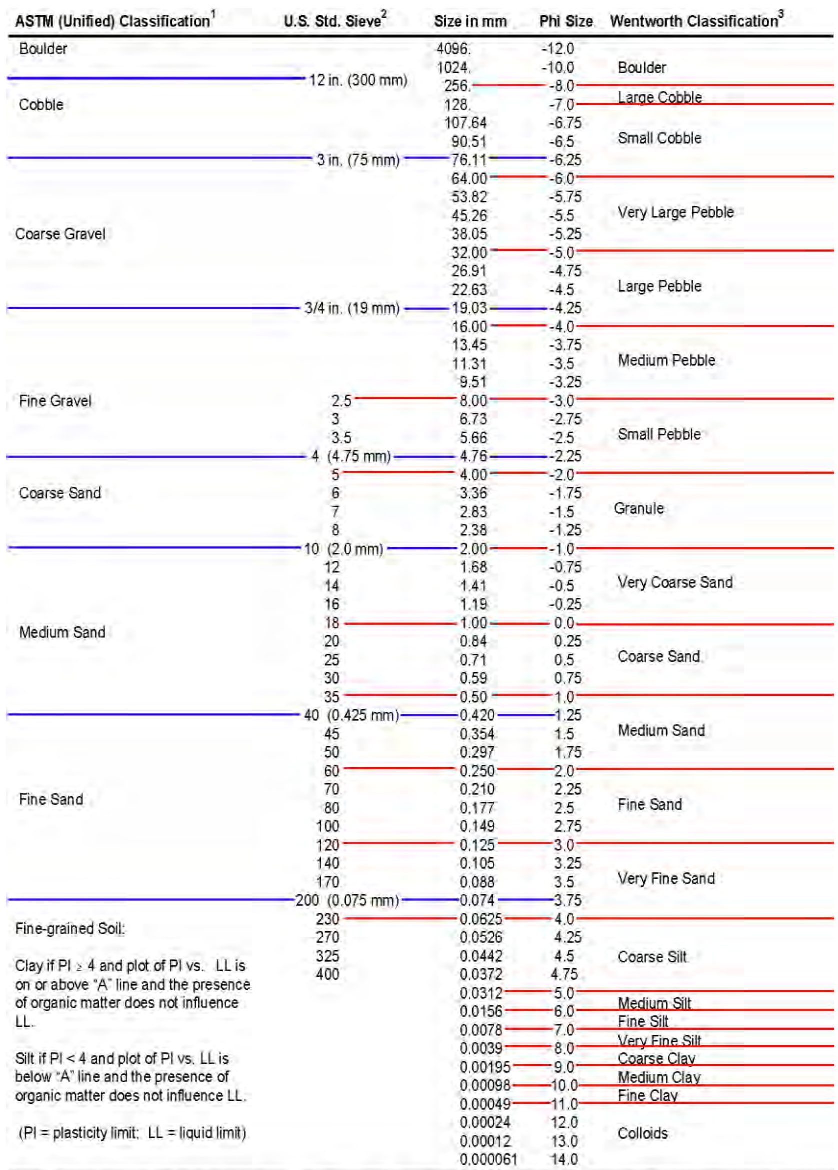
For channels that do not have recent depth survey, one must be acquired so that the amount of material that needs to be dredged can be determined. The survey also shows from where the material needs to be dredged. It is one of the most crucial steps of designing a dredge project because it informs the process that follows. The survey should determine the depth to the bottom in the projected channel both inside and outside the creek, on either side of the channel, inside the creek in the area of the turning basin, and far enough seaward to reach the channel design depth in the natural system. The survey also determines where additional sampling needs to take place because the most important element in the dredging plan is knowing what type of material will be dredged. Performing a geotechnical analysis by taking borings or cores down to and below the design dredge depth provides the data required to determine appropriate dredging technique and type of disposal, especially for new channels.

A geotechnical analysis provides a sediment profile through direct sampling and testing studies of the in-situ project material. Taking hand augers or short cores is a simple way to assess the composition of dredge material in an existing shallow draft channel requiring maintenance. It also may be sufficient for developing a conceptual plan for a new upland disposal site because all the material will be confined. However, full cores or borings down to the design depth will be needed for the final phase of planning. In addition, for CDF sites, geotechnical investigation determines the type of material at the selected disposal site. However, the in-situ material may be acceptable to build the confining dike. Also, the depth to the water table is important to know so that any impacts can be determined within the containment area, particularly in regard to estimated loadings caused by the placement of dredged material.

A review of all available existing information should be made during conceptual planning. This includes geologic literature, both published and unpublished, records of previous geotechnical studies in the project area, and soils maps in the project area. This data can provide guidance on possible concerns that may arise. For existing containment areas, the foundation conditions may have been defined by previous subsurface investigations made in connection with dike construction. When existing data is not sufficient to inform on the geotechnical data needed for the project, subbottom site investigations should occur. Taking borings or cores at selected locations in the channel down to the proposed channel design depth provides ground-truthing data for dredge material type. The subbottom material or channel fill can vary significantly along the channel particularly differing inside and outside the channel. For this reason, care should be taken to sample along the channel at various locations.

The borings or cores can be sampled to provide the types, configuration, and geotechnical character of the subbottom soils present. These samples will determine the sediment profile of the dredge material. Grain-size analysis consists of separating size classes (Figure 6-1).

Knowing the percent of gravel, sand, silt, and clay within the sample determines possibilities for beneficial use and informs CDF design. Grain sizes larger than 0.0625 mm are considered sand and gravel. Less than 0.0625 mm is silt, and clay material is defined as being smaller than 0.00195 mm. Sometimes all material less than 0.0625 is considered mud. Generally, medium sand with less than 15% finer material is needed to be placed along the shoreline as a beneficial use. Finer materials can be utilized in other beneficial uses.



[1] ASTM Standard D 2487-92. This is the ASTM version of the Unified Soil Classification System. Both systems are similar (from ASTM (1994)).
[2] Note that British Standard, French, and German DIN mesh sizes and classifications are different.
[3] Wentworth sizes (in mm) cited in Krumbein and Sloss (1963).

Figure 6-1. Grain size distribution charts showing grain size by categories (from USACE, 2015).

Statistics are used to determine specific site parameters to build the sediment profile. These statistics include: Maximum grain size; median grain size, also called the D_{50} because it corresponds to the 50% finer ordinate on the grain-size distribution curve; and sorting which is a coefficient of uniformity that measures grain-size variation of a sample. Standard deviation of grain size is the typical statistical dispersion measurement used to determine sorting. Poorly-graded (also known as well-sorted) sediments (<0.5) have mostly one size of grain within the sample, whereas well-graded (also known as poorly-sorted) material (>1) has a large variation of sediment grain size. Between 0.5 and 1, sediments are moderately sorted.

Local commercial labs for sediment analysis of the cores include: Schnabel (Newport News), McCallum (Chesapeake), and Waypoint (Richmond). Chemical analyses can be done by Envirocompliance Labs in Hampton. These are provided only for guidance on possible analysis companies. VIMS does not provide recommendations for any particular companies.

6 Davis Creek Dredging and Disposal

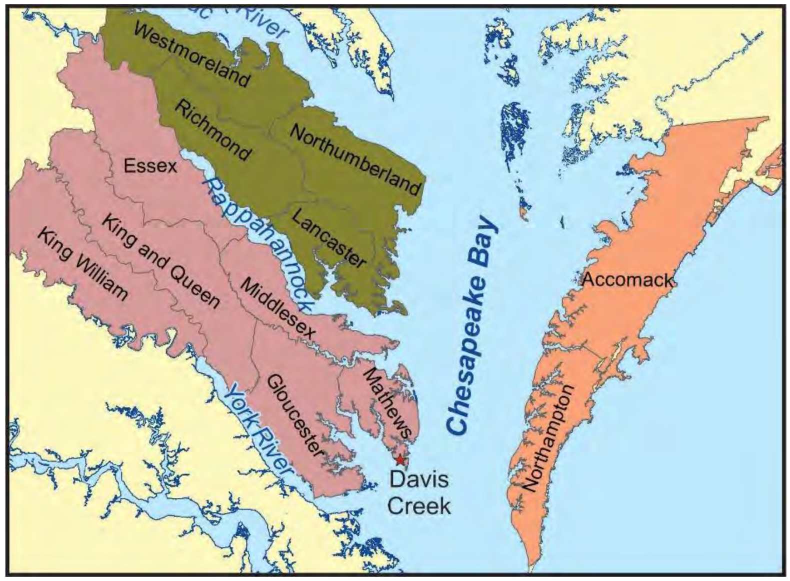


Figure 5-1. Location of Davis Creek in Mathews County, Virginia.

Davis Creek is a federally-maintained channel in Mathews, Virginia (Figure 5-1). Previous dredging cycles have used a material holding site created by the USACE in the nearshore and along the shoreline adjacent to the Creek. Being mostly sandy material, the area stabilized over time, and homes were constructed on the site. Though no longer suitable for upland disposal, this site could benefit from disposal of sandy material along the shoreline. If the material is too fine, an upland CDF site will be required. The Middle Peninsula Chesapeake Bay Public Access Authority (MPPAA) has a property near Davis Creek that could be used as a holding site for material.

A small channel naturally occurred at Davis Creek prior to the initial dredge project (Figure 5-2A). The first time the creek was dredged was in 1956, and the material was placed in the nearshore on the east side of the channel (Figure 5-2B). Approximately 244,000 cubic yards (cy) were placed to form a headland feature jutting about 1,500 feet into Mobjack Bay and about 2,700 feet alongshore. Subsequent disposal episodes occurred in 1962 (119,000 cy) (Figure 5-2C) and 1971 (53,500 cy). Since the material was placed, an upland with marshes flanking each side has developed (Figure 5-2D), and houses have been built.

The infilling rate has decreased through time. The volume removed during the second dredging in 1962 was 119,000. That indicates an infilling rate of 19,833 cy/yr over six years. Only 53,500 cy was dredged in 1971 indicating an infilling rate of 5,944 cy/yr over nine years. The Corps had planned to dredge Davis Creek in 2003 with overboard disposal in Mobjack Bay. Approximately 60,000 cy were estimated to be dredged from the channel and turning basin. This would have put the rate of infilling of 2,307 cy/yr over 26 years. However, due to significant protests about the disposal method, this project was never performed.

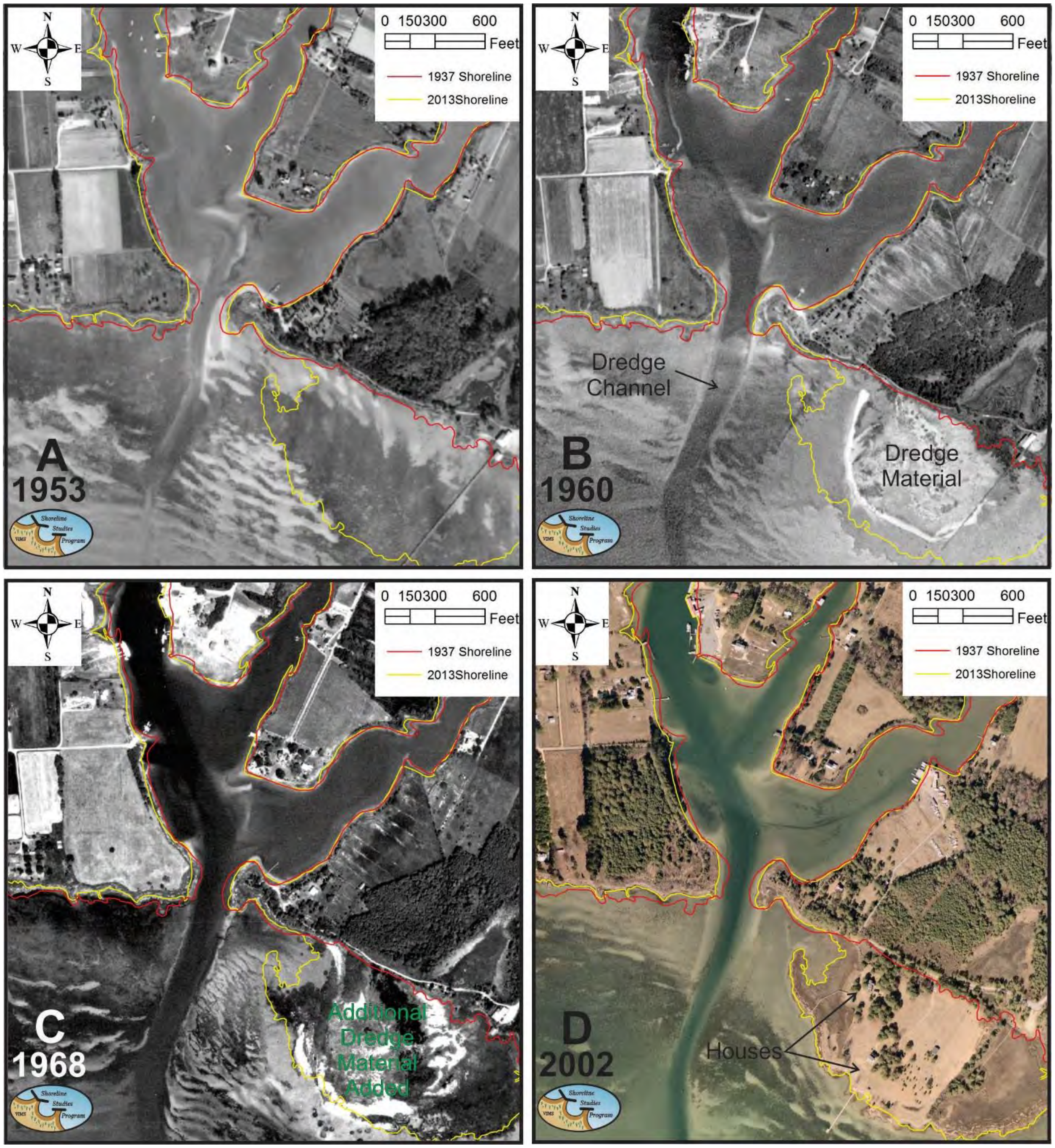


Figure 5-2. Historic photos showing channel dredging and material disposal at Davis Creek in A) 1953; B) 1960; C) 1968; D) 2002.

The basic considerations for determining how to dispose of material from a channel once a dredging need has been identified include: survey the site to determine dredge volume; take cores to determine material types; decide on a disposal type (CDF or beneficial use); and design disposal area. Corps performed a survey in 2017 to determine the amount of material needed to be dredged (Figure 5-3). The analysis of this survey indicates that much of the throat of the channel is less than 6 ft deep whereas it was designed to be at 10 ft MLW. That survey indicates significant shoaling in the access channel with depths from 0.1 to 4.0 feet. The channel sections from 23+00 to 33+00 are the most impacted. The shallowest part of the channel is along the southwest side indicating possible net infilling from the west across the existing adjacent shoal system. The Corps indicates on the survey plots that the controlling depth for the newer channel should be 8 ft with an 80 ft wide channel (Figure 5-4).

The target channel section for dredging is 13+00 to 42+00 yielding approximately 31,000 cy of material. With a 2 ft over-dredge, this will increase to over 48,000 cy. Recent auger samples taken by VIMS personnel along the shoal section of the channel sampled the channel sediment 2-3 ft below the bottom. This limited dredge material assessment shows silts and clays in the upper 2 feet inside the creek (B-1 and B-2) (Figure 5-5). Samples along the outside channel show the top foot or so with relatively clean sand but becoming finer with depth (B-3 and B-4). These samples indicate the importance of sampling to the controlling depth. The sediment profile may change considerable with depth and will need to be averaged to determine the overall characteristics of dredge material. The last auger shows relatively clean sand down 2 feet below grade. Sediment sample analysis results are shown in Appendix B.

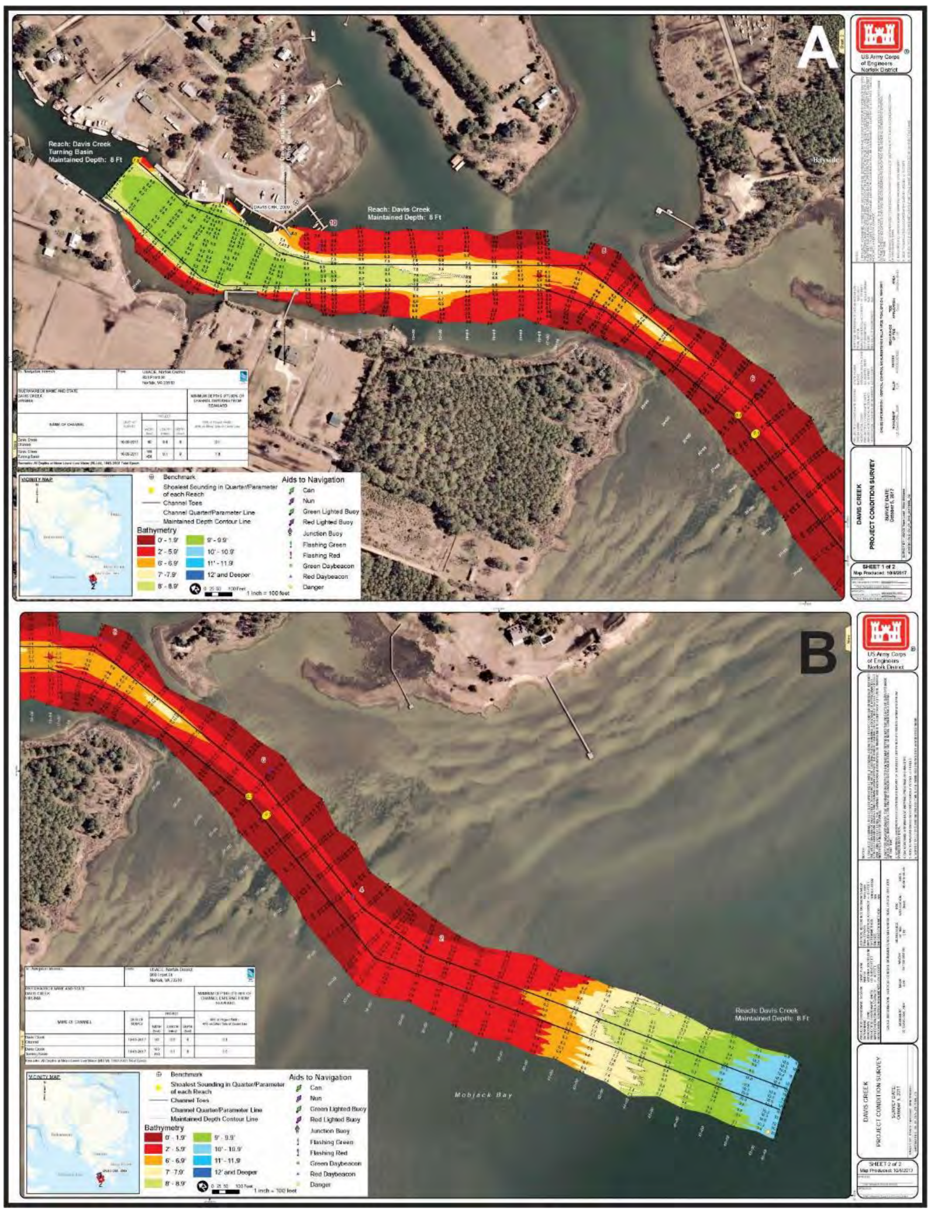


Figure 5-3. U.S. Army Corps of Engineers 2017 channel survey of Davis Creek.

The MPPAA has an upland property located about a mile north of Davis Creek at Dutchman's Point (Figure 5-6) which is being considered as a possible dredge disposal site. Maps showing publicly-owned land within the Middle Peninsula, Northern Neck, and Accomack Northampton Planning District Commissions were created to gain an understanding of the potential locations that could be evaluated/used for the general storage of dredged material and for locations to support the creation of wetlands, living shorelines, beaches and flood control projects (Appendix C). Even without federal funds involved in the dredge and disposal operation for a federally-recognized channel, any new disposal site is still required to meet federal standards as per USACE (2015). For non-federal channel design, the federal standards provide excellent guidelines that will be evaluated during the permit phase of any channel dredging and disposal project.

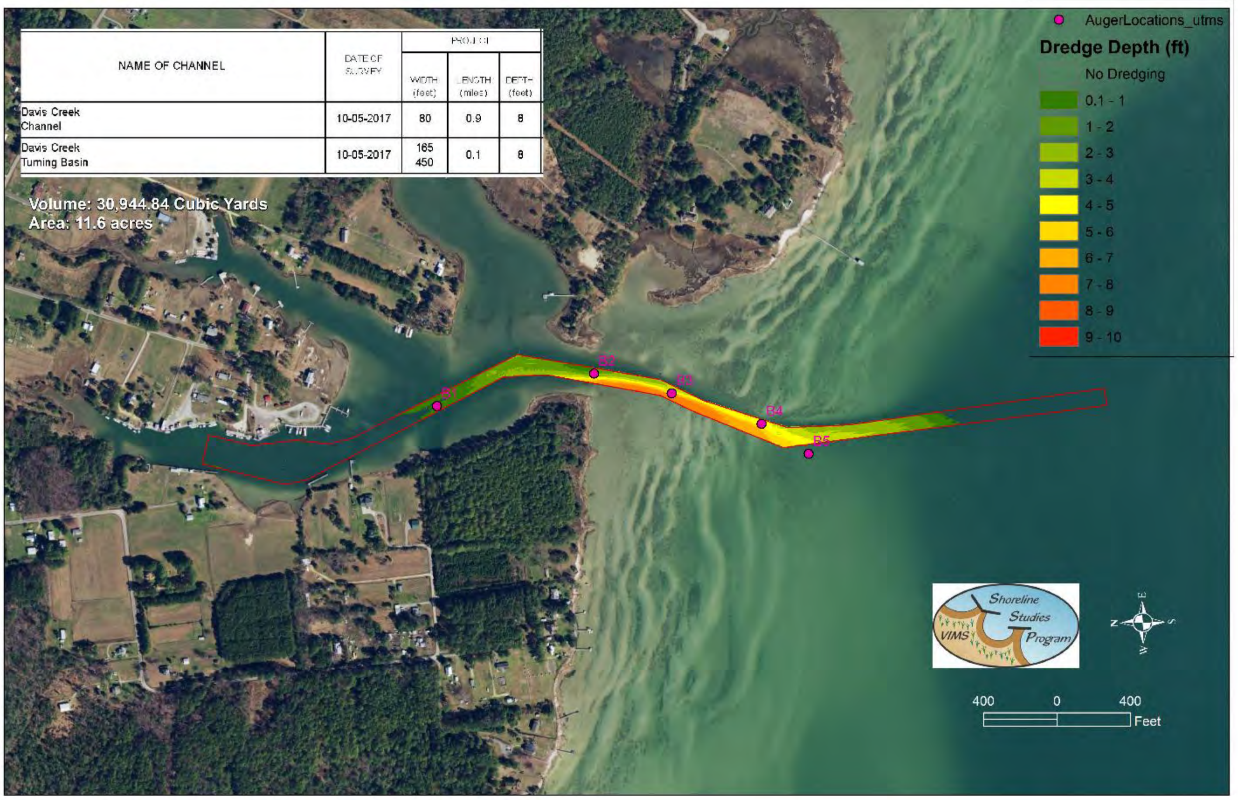


Figure 5-4. Davis Creek channel showing the amount of material that needs to be dredged and the auger sample locations.

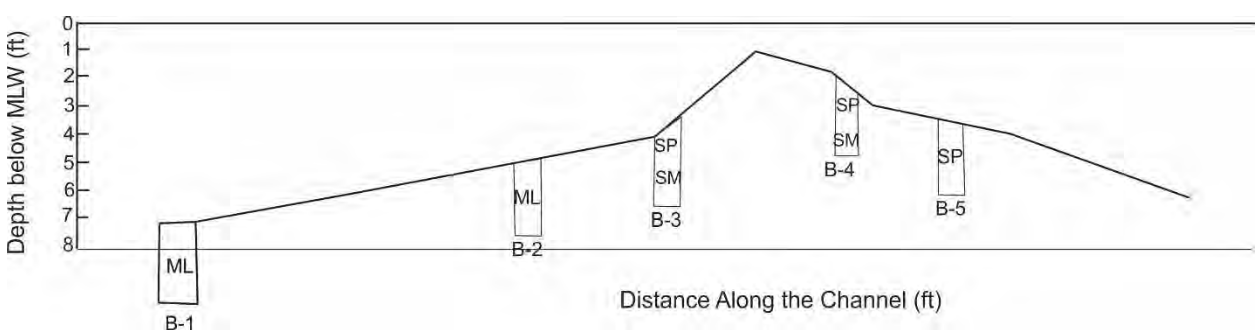


Figure 5-5. Channel cross-section showing the auger samples and their analysis. SP is poorly graded sand with gravel, SM is silty sand, and ML is inorganic silts and very fine sands.

A conceptual upland disposal site on the MPPAA property following the Corps standard flow chart without the complication of contaminated dredge material was designed. Generally, contaminated material in not expected in these shallow draft channels. The Dutchman Point property has about 5 acres adjacent to Mobjack Bay (Figure 5-6) and has about 4.5 acres of wooded upland and about 0.5 acres of tidal marsh long the Bay coast. Determining the type of dredging to be used is important in the design of an upland CDF. This conceptual plan will assume that the channel will be hydraulically dredged which has impacts for the CDF design.

Figure 5-6. Location of potential CDF disposal site at Dutchman's Point property owned by the Middle Peninsula Public Access Authority.

The area of the upland disposal site required will depend on whether the CDF is designed for one-time use or if it includes maintenance scenarios. For this conceptual plan, a one-time dredge and disposal is considered. The proposed MPPAA property is long and narrow, and the CDF can only by about 100 ft wide. The actual length and height depends on if some of the sandier dredge material is used to help build the containment dike. This would reduce the amount of material that would have to be stored in the containment facility. Further analyses are needed to determine if and where sandy material exists in the channel, but conceptually that material would be dredged first and allowed to dewater before using it for dike construction. Typically, the dredge material will need to occupy about 1,600 cy/acre foot of disposal area.

A 12 ft dike/berm is suggested using some sandy dredge material to contain the remaining amount of dredge material. This dike will take about 13 cy/foot of material to construct (Figure 5-7). The general elements of the disposal site are shown in Figure 3-1. It would take about 3.75 acres, allowing for 8 ft thick layer of dredge material, to hold 48,000 cy of material. However, the site has only about 4 acres available and it would take a 12 ft high dike or larger to contain that material. Furthermore, the dike itself may take up to 40,000 cy of material to construct. Given the sandy nature of the outboard channel material, it may be possible to use some of that for dike construction. Finding the balance will depend on the method of construction of the CDF. For instance, using geotubes around the perimeter as a preliminary containment and dewatering might be possible. The sandy material can be used to fill the geotubes which can then act as a small dike to contain additional sandy material for dewatering. This material could then be used to build a dike whose dimensions and height will depend on the final remaining volume estimates and composition (Figure 5-8). The result may be a reduced footprint for the entire operation.

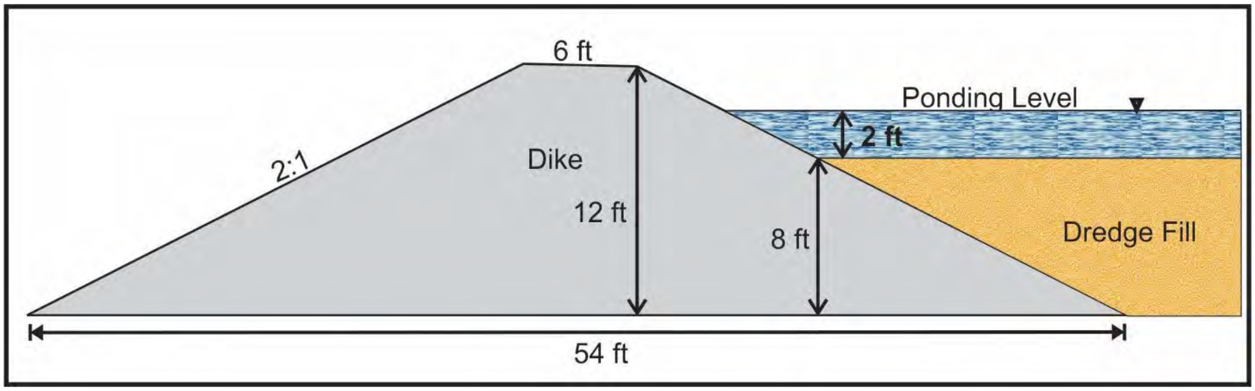


Figure 5-7. Proposed dike configuration for the CDF.

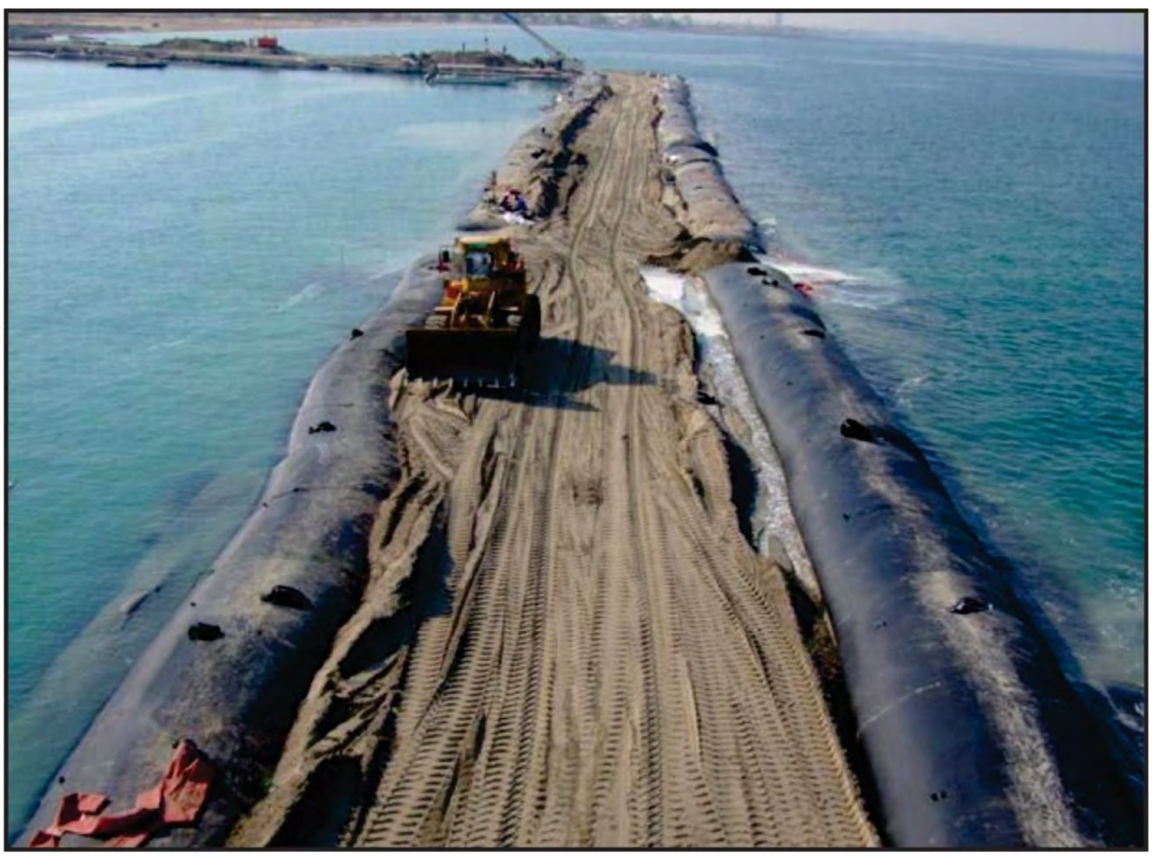


Figure 5-8. Geotextile dike example (from the TenCate Geosynthetics website). This geotextile is used for illustrative purposes only; VIMS does not provide recommendations for any particular company.

7 Summary

Shallow water dredging is an important economic consideration for local governments who answer directly to citizens concerned about recreational and commercial uses of the channels. Because the USACE no long maintains many channels, it is up to local governments to find funding, plan, and execute dredging operations for the channels within their locality. For many localities, this can be difficult. The goal of this report is to provide localities and other management agencies with general considerations on the dredging and disposal of material from shallow draft channels, in particular for those channels on the Middle Peninsula, Northern Neck, and Eastern Shore of Virginia.

Using existing guidance data and reports, the complex task is summarized to provide a useful document for localities. These guidance documents are linked in the report for those that seek additional information. Overall, these are the basic consideration for determining how to dispose of material from a channel once a dredging need has been identified: survey the site to determine dredge volume, perform geotechnical survey to determine material types; decide on a disposal type (CDF or beneficial use); and design disposal area. Maps depicting publicly-owned land within the Middle Peninsula, Northern Neck, and Accomack-Northampton Planning District Commissions can be used to determine potential locations for the general storage of dredged material and for locations to support the creation of wetlands, living shorelines, beaches and flood control projects.

If an upland disposal is chosen for dredge material, the general recommendations for its design depend on present and future use. Other factors include determining the nature of material, either sand or fines, and the disposal area proximity to channel dredging operation. Also important is how the channel is dredged (mechanically or hydraulically) and how often.

This report offers background on shallow draft channels, both federally and non-federally maintained, suggests procedures for the dredging and disposal process, and applies the process to an existing channel. Existing data on the Middle Peninsula, Northern Neck, and Eastern Shore channels and potential disposal areas are provided to assist localities with management decisions. In addition, an example is provided for the potential maintenance dredging and disposal of material at Davis Creek in Mathews County. It is hoped that this report provides the information needed for localities and other organizations to manage their shallow water draft channels efficiently and cost-effectively.

8 References

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Appendix A

Federal shallow draft channel data

for

channels within the Middle Peninsula, Northern Neck, and Accomack-Northampton Planning District Commissions

Middle Peninsula Channels

Dredge volumes were determined using ArcMap GIS 3D analyst and spatial analyst tools and data downloaded from the US Army Corps of Engineers including channel boundaries and depth survey. Some channels did not have channel boundaries and those were approximated from navigation data and survey data.

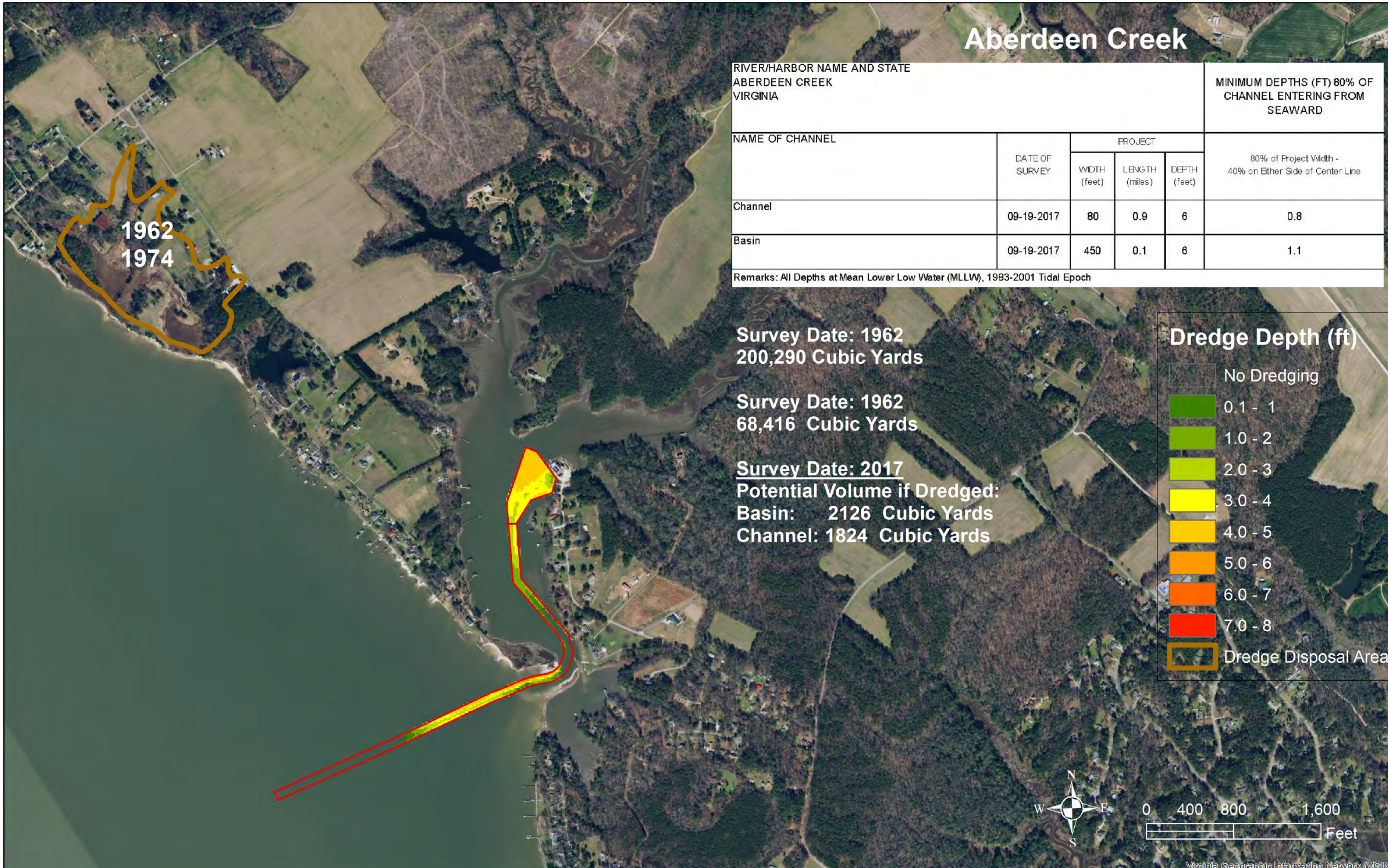
The historic dredge volume amounts and disposal areas were approximated from a 1973 hard copy report by the U.S. Army Corps of Engineers and digitized into GIS. The most recent projected dredge volume amount was determined to the controlling depth only. No over-dredge was used in the calculation.

The channel dredging data and the disposal location data may not be complete. The data was compiled from existing sources. However, it was difficult to locate information on each channel.

Aberdeen Creek

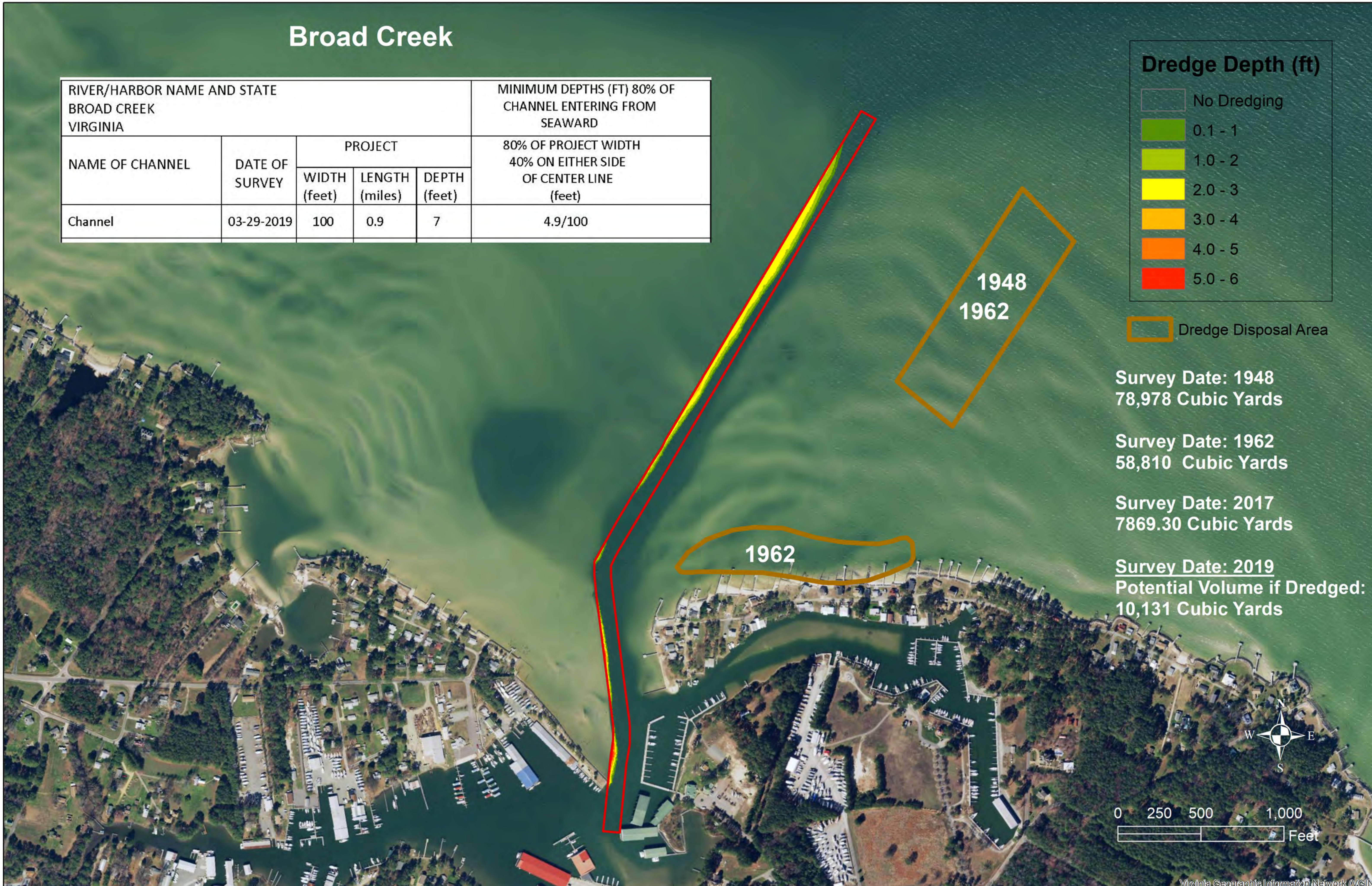
RIVER/HARBOR NAME AND STATE ABERDEEN CREEK VIRGINIA						MINIMUM DEPTHS (FT) 80% OF CHANNEL ENTERING FROM SEAWARD
NAME OF CHANNEL	DATE OF SURVEY	PROJECT				80% of Project Width - 40% on Either Side of Center Line
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)		
Channel	09-19-2017	80	0.9	6		0.8
Basin	09-19-2017	450	0.1	6		1.1

Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch

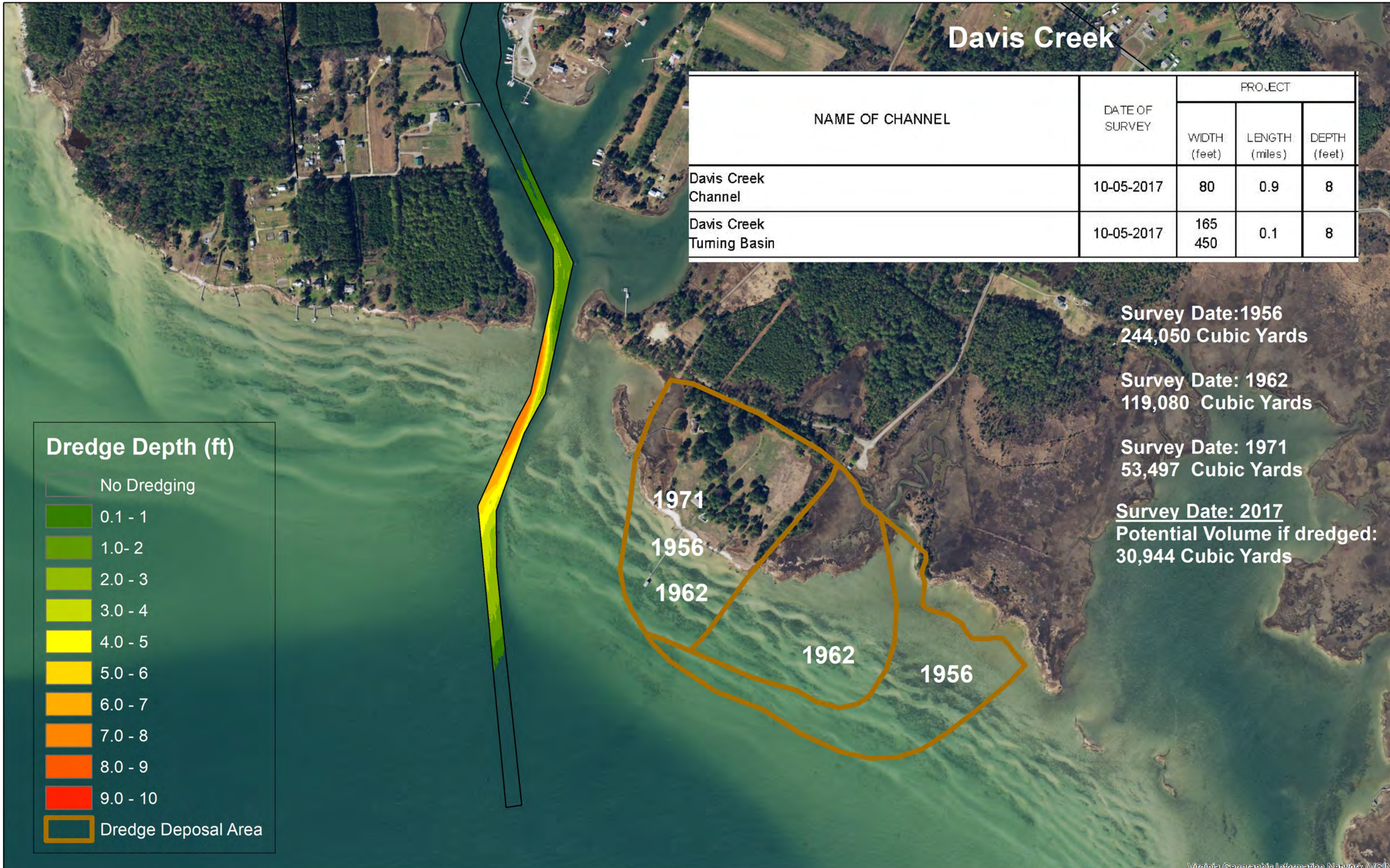


Broad Creek

RIVER/HARBOR NAME AND STATE BROAD CREEK VIRGINIA					MINIMUM DEPTHS (FT) 80% OF CHANNEL ENTERING FROM SEAWARD
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% OF PROJECT WIDTH 40% ON EITHER SIDE OF CENTER LINE (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Channel	03-29-2019	100	0.9	7	4.9/100



Davis Creek

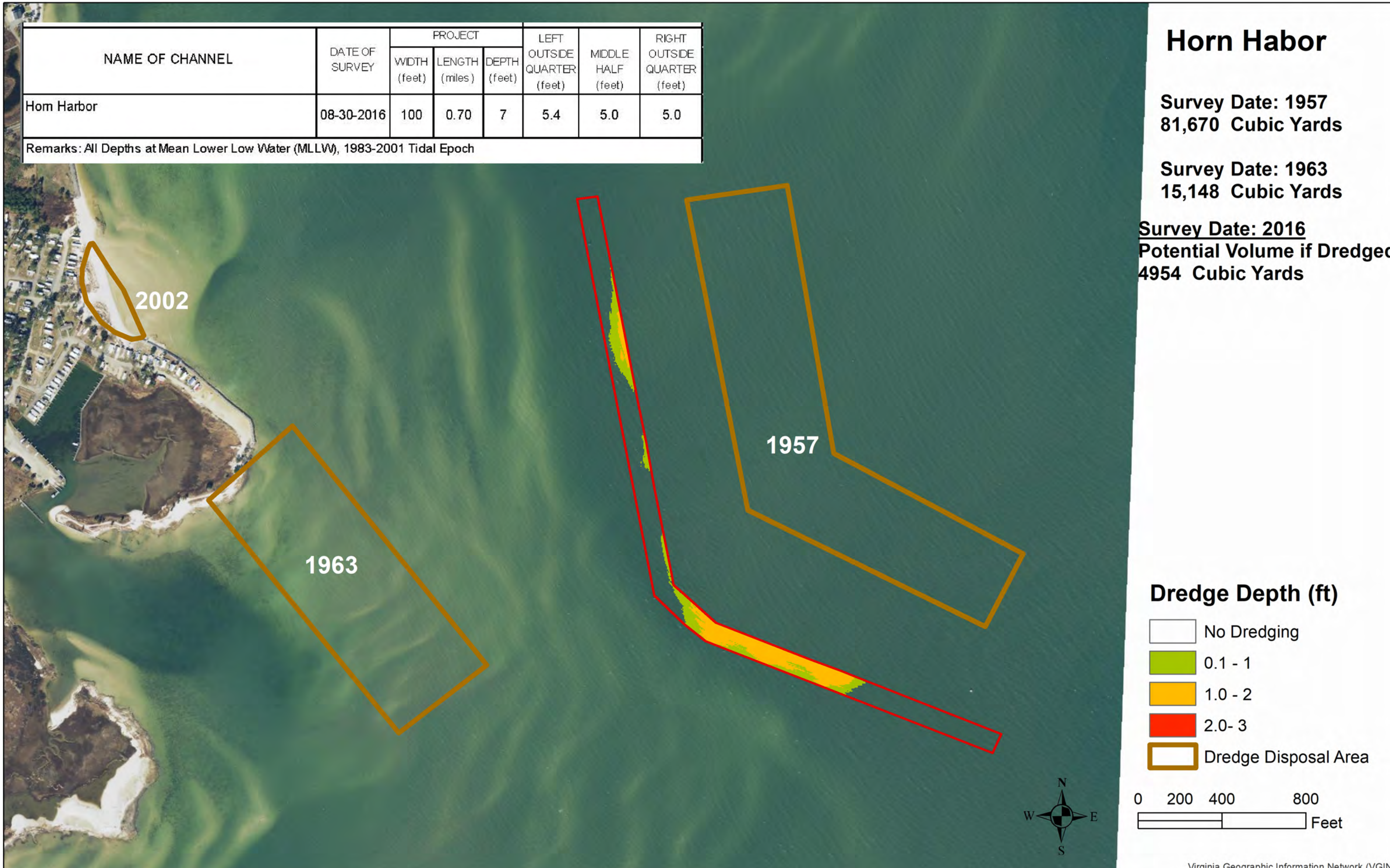


NAME OF CHANNEL	DATE OF SURVEY	PROJECT		
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)
Davis Creek Channel	10-05-2017	80	0.9	8
Davis Creek Turning Basin	10-05-2017	165 450	0.1	8

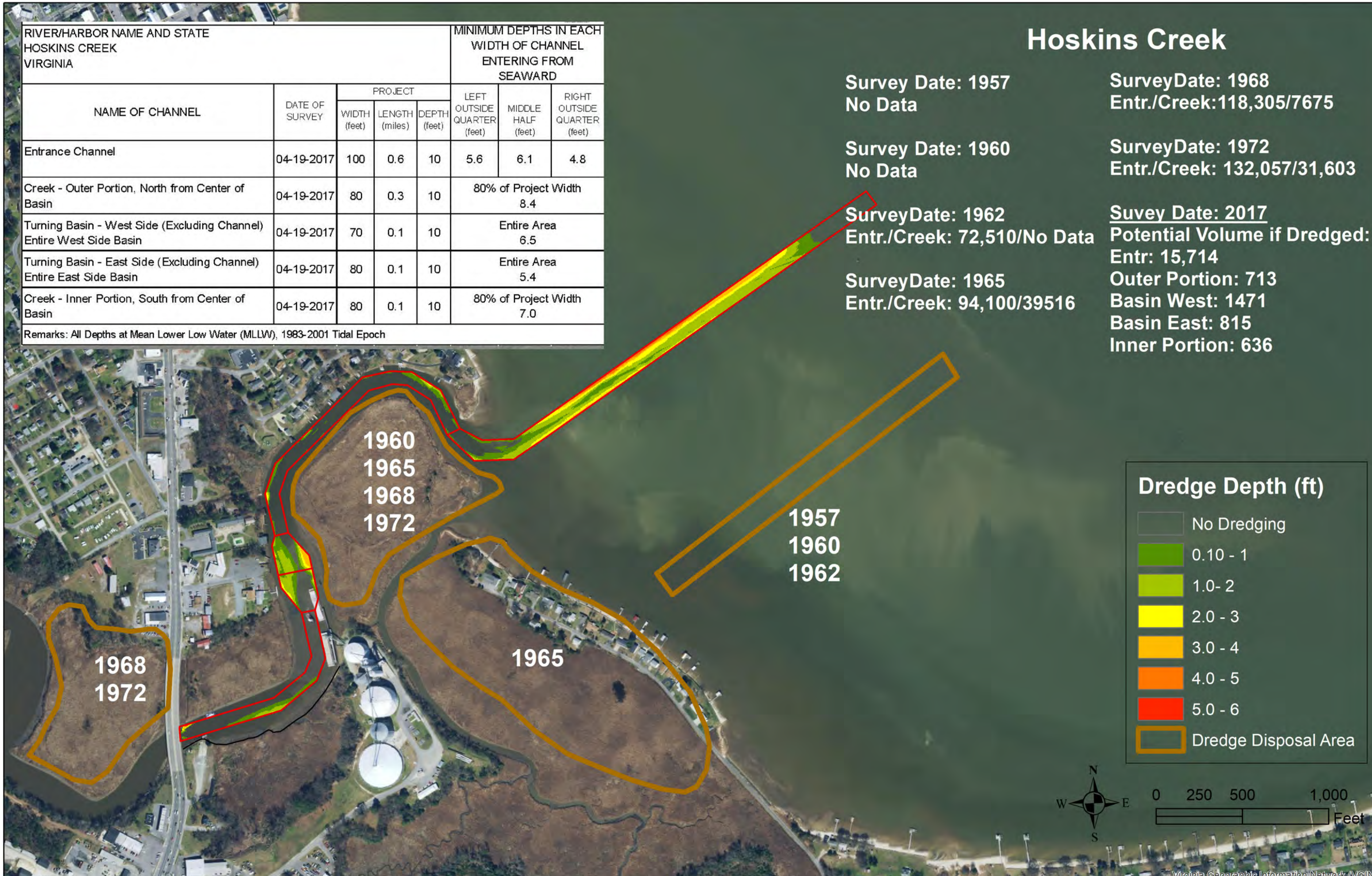
Horn Habor

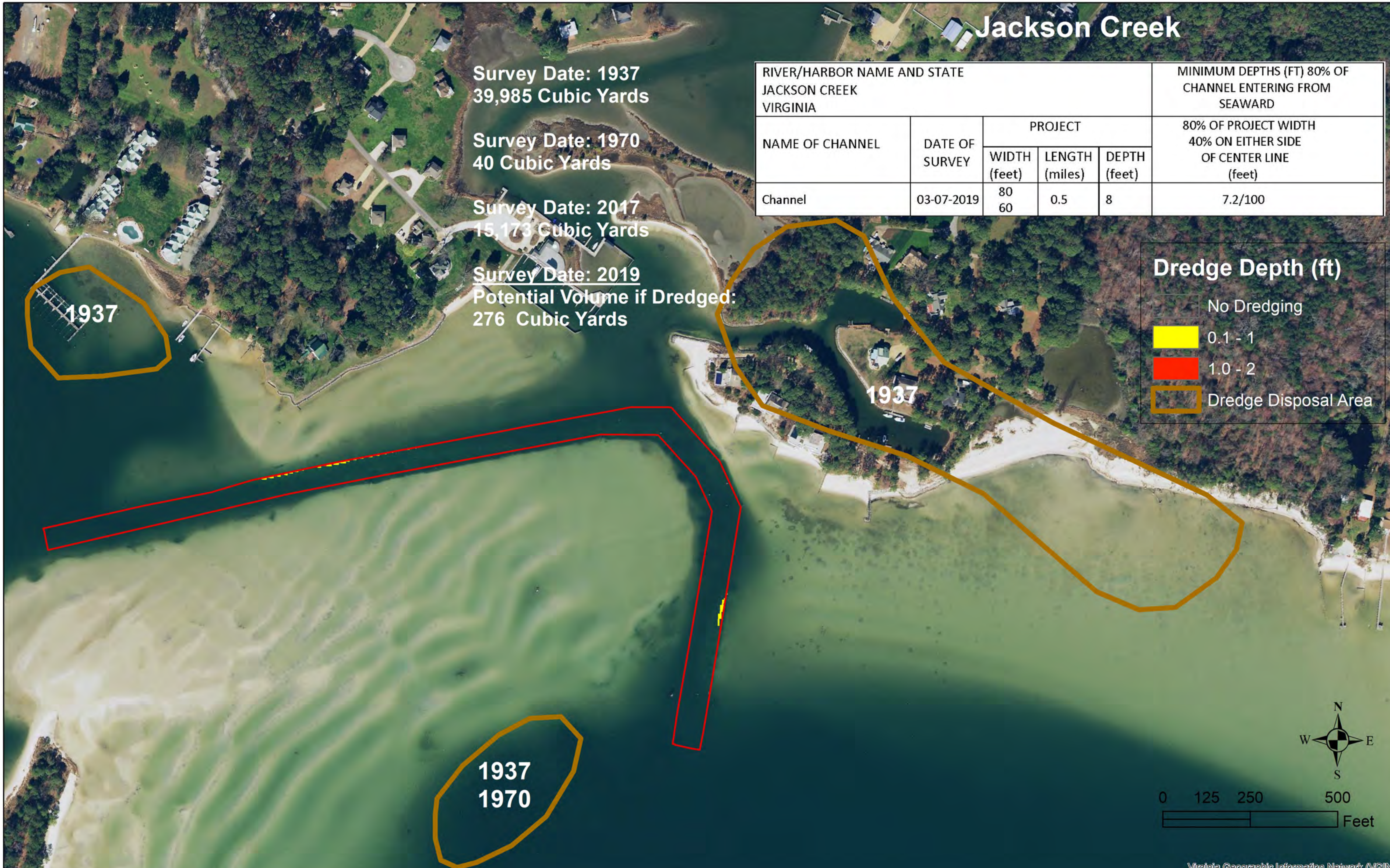
NAME OF CHANNEL	DATE OF SURVEY	PROJECT WIDTH (feet)	PROJECT LENGTH (miles)	PROJECT DEPTH (feet)	LEFT OUTSIDE QUARTER (feet)	MIDDLE HALF (feet)	RIGHT OUTSIDE QUARTER (feet)
Horn Harbor	08-30-2016	100	0.70	7	5.4	5.0	5.0

Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch



RIVER/HARBOR NAME AND STATE HOSKINS CREEK VIRGINIA					MINIMUM DEPTHS IN EACH WIDTH OF CHANNEL ENTERING FROM SEAWARD		
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			LEFT OUTSIDE QUARTER (feet)	MIDDLE HALF (feet)	RIGHT OUTSIDE QUARTER (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)			
Entrance Channel	04-19-2017	100	0.6	10	5.6	6.1	4.8
Creek - Outer Portion, North from Center of Basin	04-19-2017	80	0.3	10	80% of Project Width 8.4		
Turning Basin - West Side (Excluding Channel) Entire West Side Basin	04-19-2017	70	0.1	10	Entire Area 6.5		
Turning Basin - East Side (Excluding Channel) Entire East Side Basin	04-19-2017	80	0.1	10	Entire Area 5.4		
Creek - Inner Portion, South from Center of Basin	04-19-2017	80	0.1	10	80% of Project Width 7.0		
Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch							





RIVER/HARBOR NAME AND STATE JACKSON CREEK VIRGINIA					MINIMUM DEPTHS (FT) 80% OF CHANNEL ENTERING FROM SEAWARD
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% OF PROJECT WIDTH 40% ON EITHER SIDE OF CENTER LINE (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Channel	03-07-2019	80 60	0.5	8	7.2/100

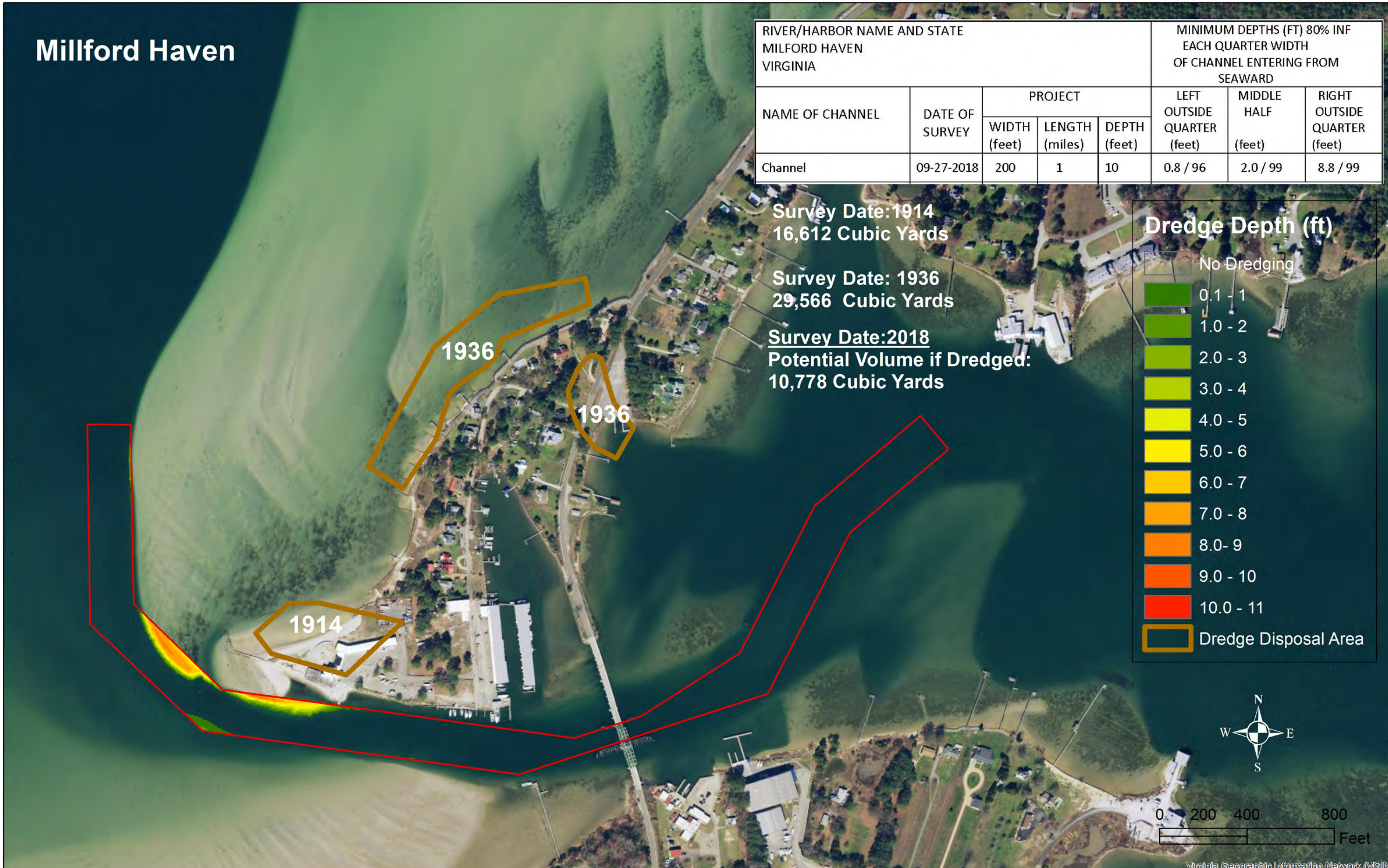
Locklies Creek

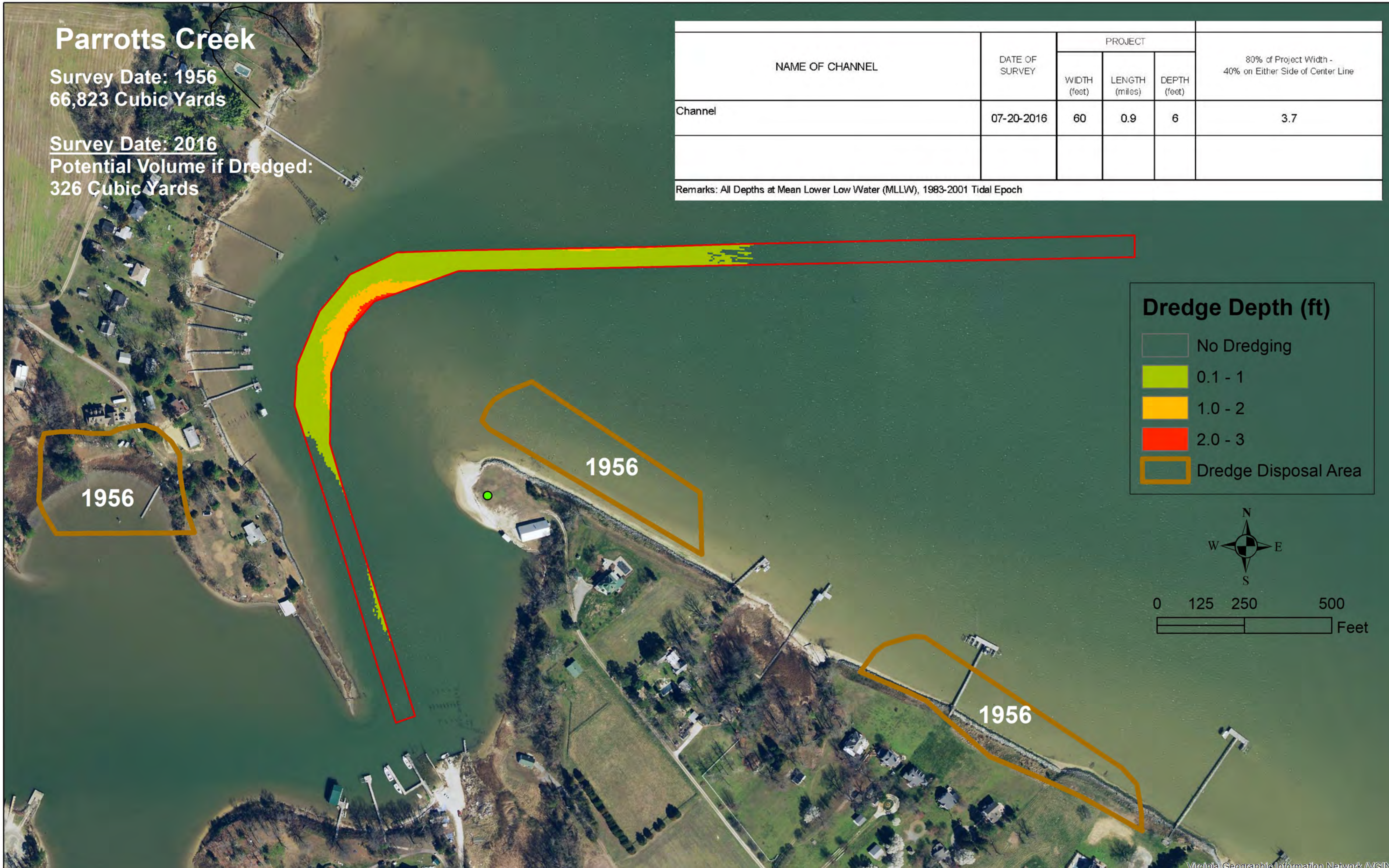
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% of Project Width - 40% on Either Side of Center Line
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Locklies Creek Channel	07-22-2016	100	0.7	4	1.7

Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch

Millford Haven

RIVER/HARBOR NAME AND STATE MILFORD HAVEN VIRGINIA					MINIMUM DEPTHS (FT) 80% INF EACH QUARTER WIDTH OF CHANNEL ENTERING FROM SEAWARD		
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			LEFT OUTSIDE QUARTER (feet)	MIDDLE HALF (feet)	RIGHT OUTSIDE QUARTER (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)			
Channel	09-27-2018	200	1	10	0.8 / 96	2.0 / 99	8.8 / 99





NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% of Project Width - 40% on Either Side of Center Line
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Channel	07-20-2016	60	0.9	6	3.7

Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch

Queens Creek

NAME OF CHANNEL	DATE OF SURVEY	PROJECT WIDTH (feet)	PROJECT LENGTH (miles)	PROJECT DEPTH (feet)	80% OF PROJECT WIDTH 40% ON EITHER SIDE OF CENTER LINE (feet)
Basin	01-29-2019	200	0.1	6	6.1/100
Channel	01-29-2019	60	0.8	6	6.9 / 99

Urbanna Creek

NAME OF CHANNEL	DATE OF SURVEY	PROJECT WIDTH (feet)	PROJECT LENGTH (miles)	PROJECT DEPTH (feet)	LEFT OUTSIDE QUARTER (feet)	MIDDLE HALF (feet)	RIGHT OUTSIDE QUARTER (feet)
Channel	07-20-2016	150 - 290	0.5	10	+2.8	+1.4	7.9
Turning Basin	07-20-2016	390	0.3	10	(Entire Area) 7.6		

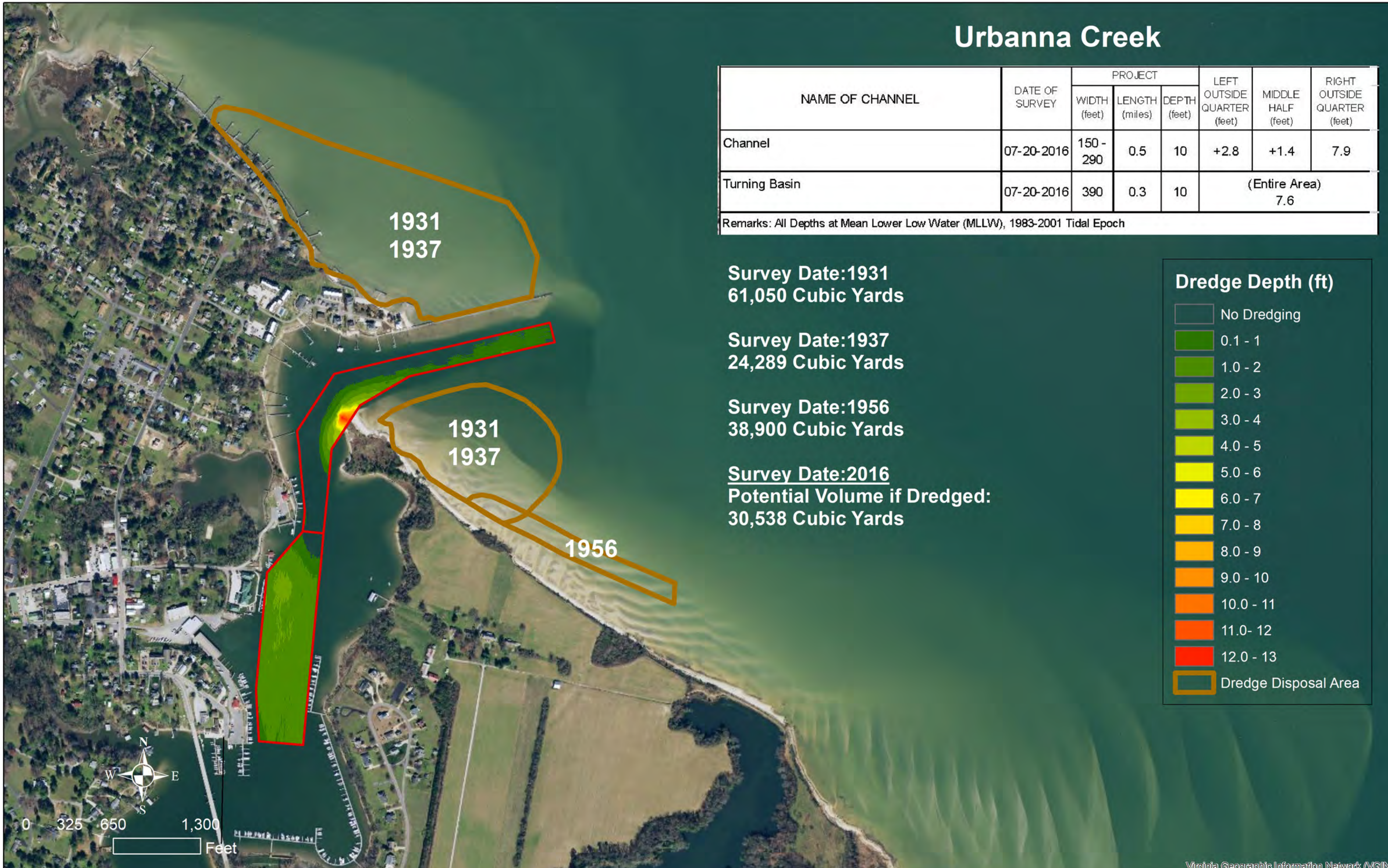
Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch

Survey Date:1931
61,050 Cubic Yards

Survey Date:1937
24,289 Cubic Yards

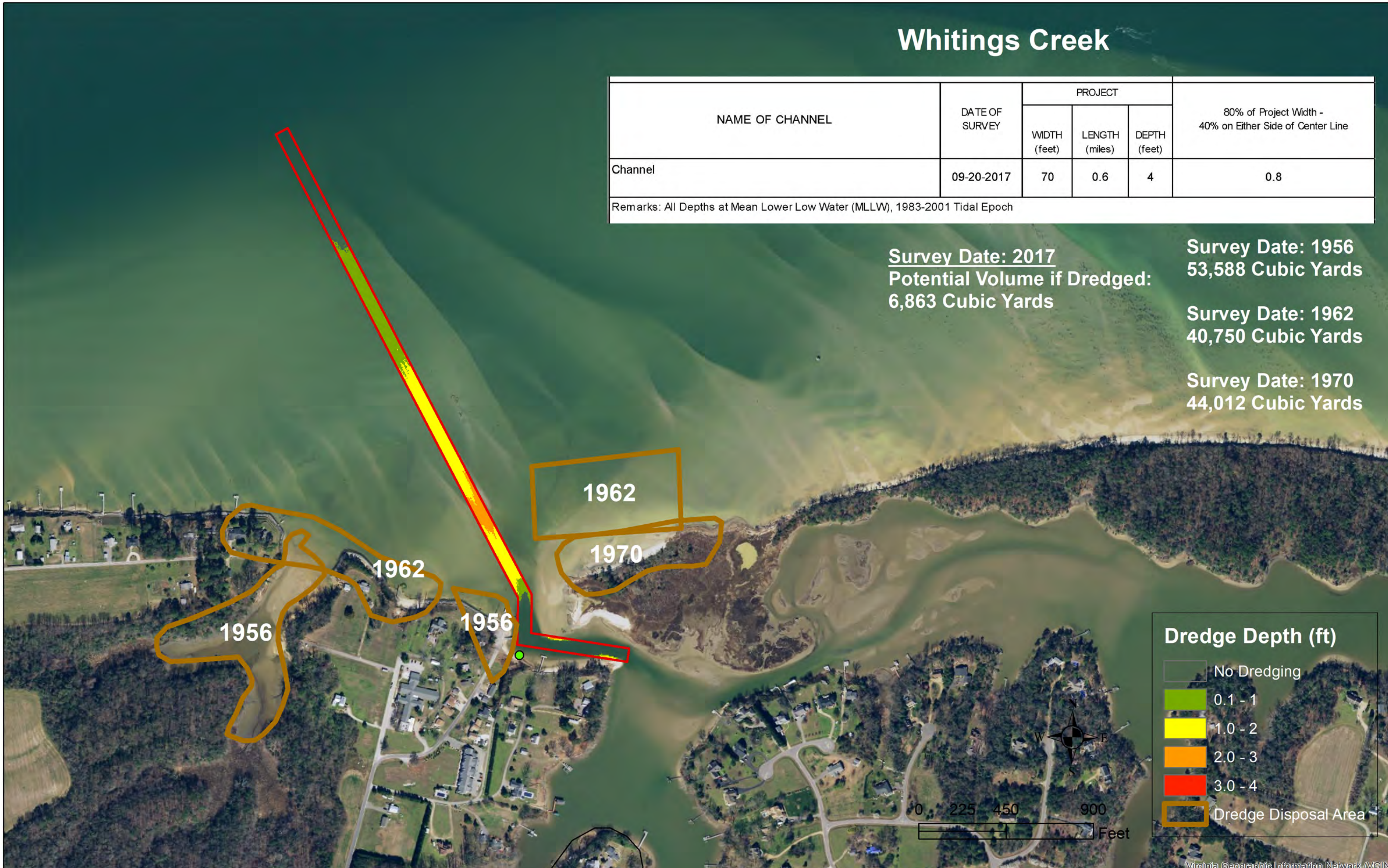
Survey Date:1956
38,900 Cubic Yards

<u>Survey Date:2016</u>
Potential Volume if Dredged:
30,538 Cubic Yards



Whitings Creek

NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% of Project Width - 40% on Either Side of Center Line
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Channel	09-20-2017	70	0.6	4	0.8
Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch					



Winter Harbor

NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% of Project Width - 40% on Either Side of Center Line
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Winter Harbor Entrance Channel	09-01-2016	100	0.70	6	1.5
Winter Harbor Creek Channel	09-01-2016	100	0.80	6	+5.2
Winter Harbor Turning Basin	09-01-2016	400 300	0.10	6	0.8
Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch					

Virginia Geographic Information Network (VGIN)

Northern Neck Channels

Dredge volumes were determined using ArcMap GIS 3D analyst and spatial analyst tools and data downloaded from the US Army Corps of Engineers including channel boundaries and depth survey. Some channels did not have channel boundaries and those were approximated from navigation data and survey data.

The historic dredge volume amounts and disposal areas were approximated from a 1973 hard copy report by the U.S. Army Corps of Engineers and digitized into GIS. The most recent projected dredge volume amount was determined to the controlling depth only. No over-dredge was used in the calculation.

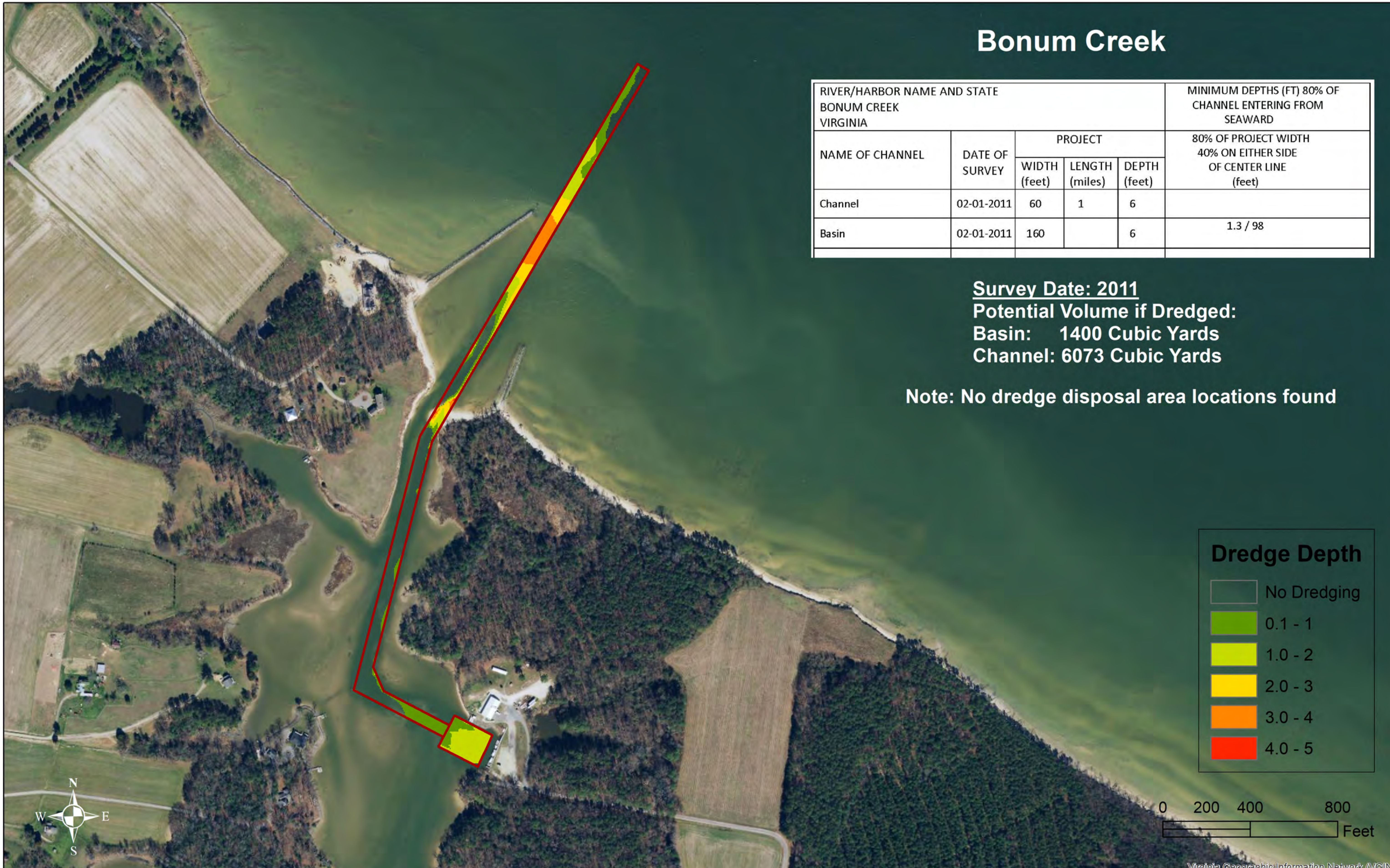
The channel dredging data and the disposal location data may not be complete. The data was compiled from existing sources. However, it was difficult to locate information on each channel.

Bonum Creek

RIVER/HARBOR NAME AND STATE BONUM CREEK VIRGINIA					MINIMUM DEPTHS (FT) 80% OF CHANNEL ENTERING FROM SEAWARD
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% OF PROJECT WIDTH 40% ON EITHER SIDE OF CENTER LINE (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Channel	02-01-2011	60	1	6	
Basin	02-01-2011	160		6	1.3 / 98

<u>**Survey Date: 2011**</u>
Potential Volume if Dredged:
Basin: 1400 Cubic Yards
Channel: 6073 Cubic Yards

Note: No dredge disposal area locations found



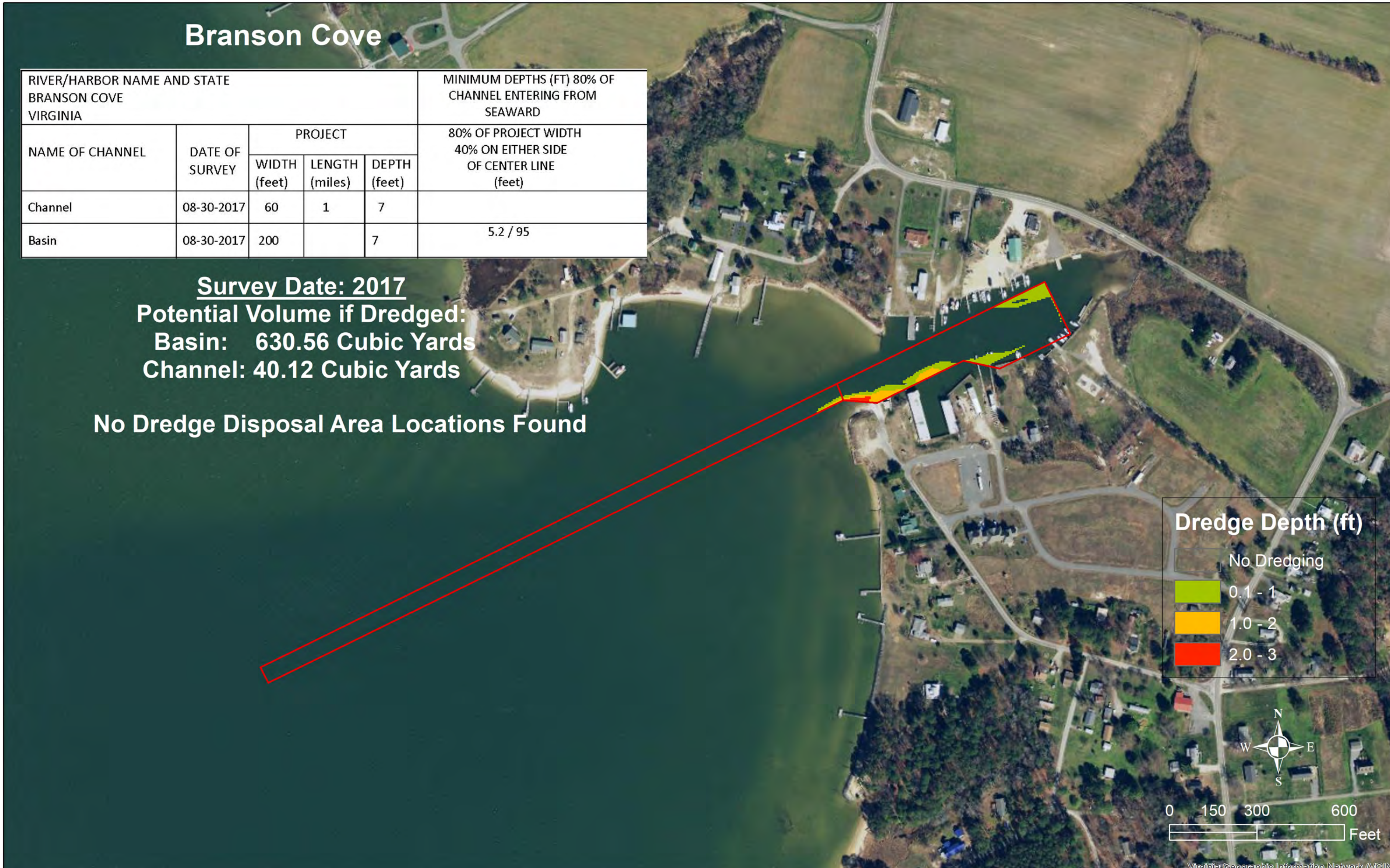
Branson Cove

RIVER/HARBOR NAME AND STATE BRANSON COVE VIRGINIA						MINIMUM DEPTHS (FT) 80% OF CHANNEL ENTERING FROM SEAWARD
NAME OF CHANNEL	DATE OF SURVEY	PROJECT				80% OF PROJECT WIDTH 40% ON EITHER SIDE OF CENTER LINE (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)		
Channel	08-30-2017	60	1	7		
Basin	08-30-2017	200		7		5.2 / 95

Survey Date: 2017

Potential Volume if Dredged:
Basin: 630.56 Cubic Yards
Channel: 40.12 Cubic Yards

No Dredge Disposal Area Locations Found

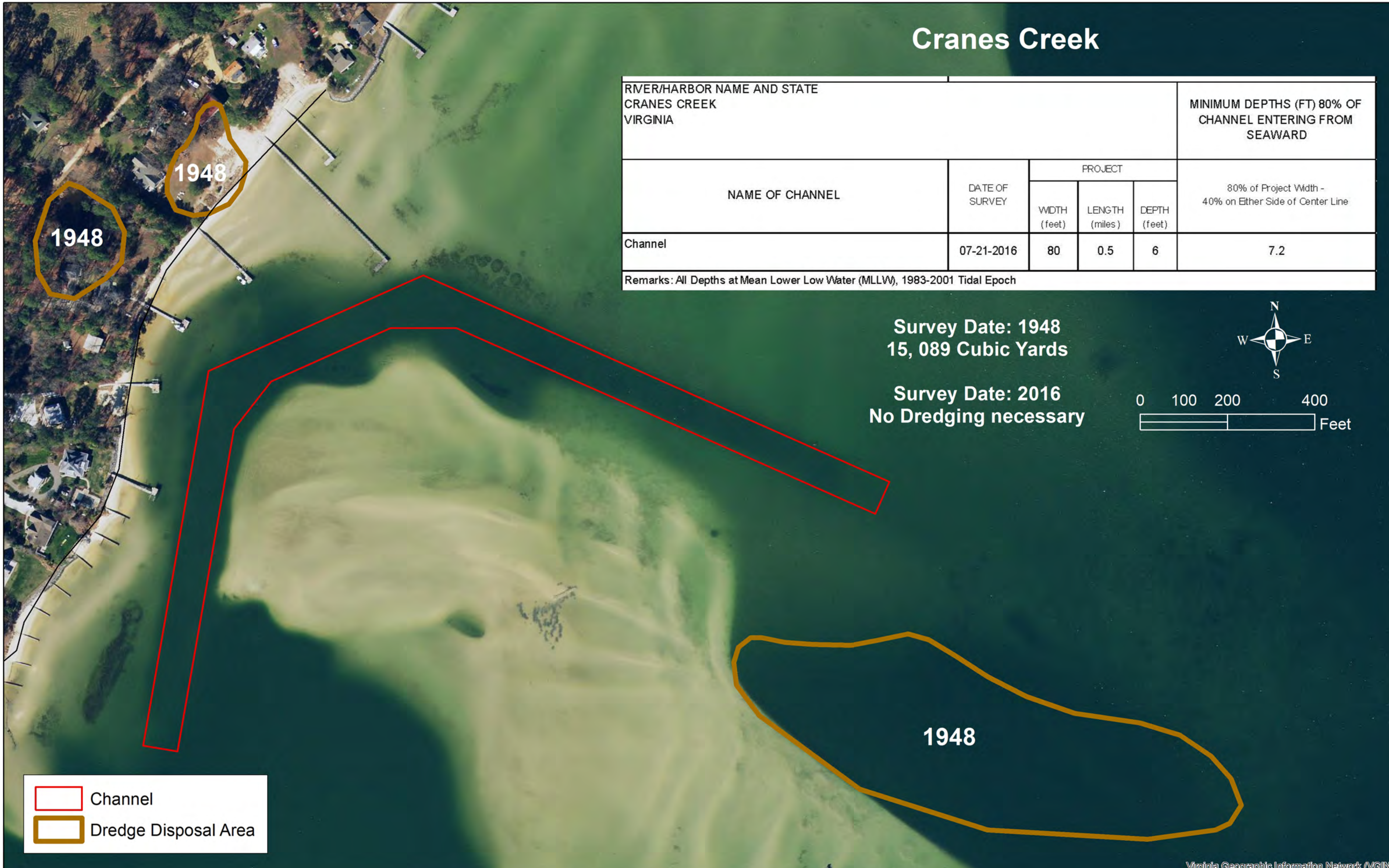


Carters Creek
Survey Date: July 19, 2016
Potential Volume if Dredged:
169,507 Cubic Yards
Dredge Depth (ft)
No Dredging
0.1 - 1
1.0 - 2
2.0 - 3
3.0 - 4
4.0 - 5
5.0 - 6
6.0 - 7
7.0 - 8
8.0 - 9
9.0 - 10
10.0 - 11
11.01 - 12
12.0 - 13
NOTE:
Channel boundaries estimated off
Navigation Charts and VBMP 2017 imagery
NOTE:
No Dredge Disposal Area Locations Found
Virginia Geographic Information Network (VGIN)

Cranes Creek

RIVER/HARBOR NAME AND STATE CRANES CREEK VIRGINIA					MINIMUM DEPTHS (FT) 80% OF CHANNEL ENTERING FROM SEAWARD
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% of Project Width - 40% on Either Side of Center Line
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Channel	07-21-2016	80	0.5	6	7.2

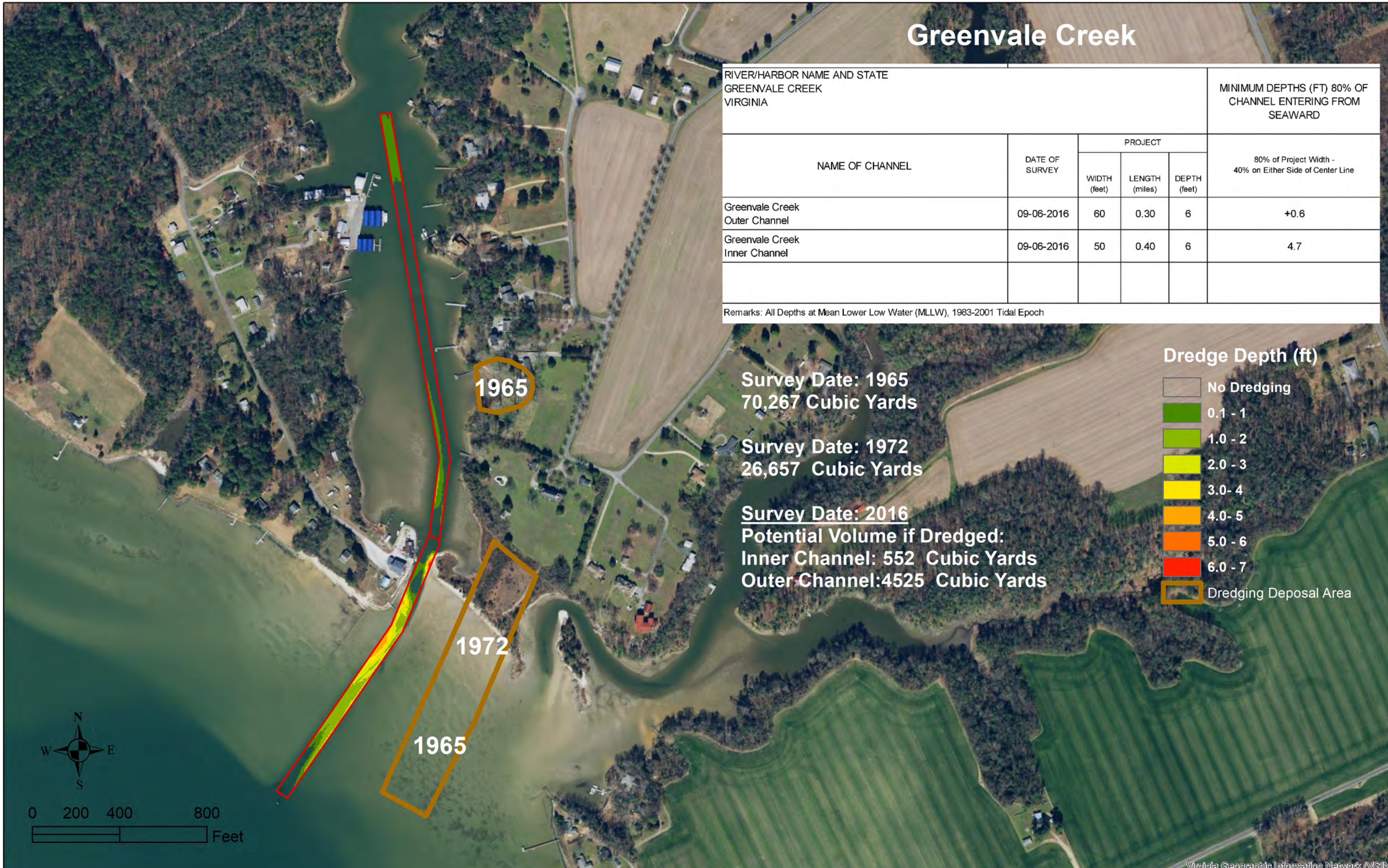
Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch



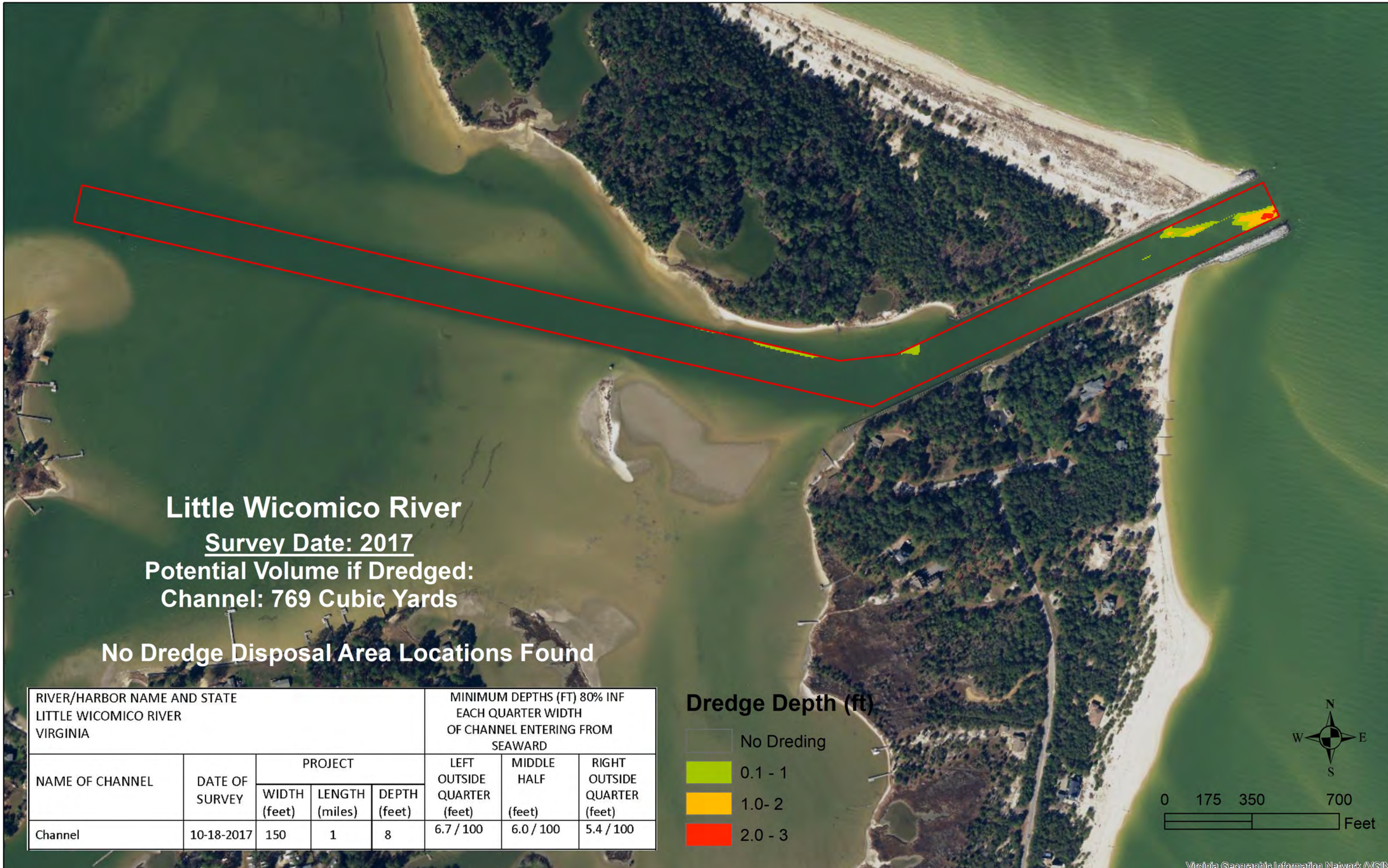
Greenvale Creek

RIVER/HARBOR NAME AND STATE GREENVALE CREEK VIRGINIA					MINIMUM DEPTHS (FT) 80% OF CHANNEL ENTERING FROM SEAWARD
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% of Project Width - 40% on Either Side of Center Line
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Greenvale Creek Outer Channel	09-06-2016	60	0.30	6	+0.6
Greenvale Creek Inner Channel	09-06-2016	50	0.40	6	4.7

Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch



RIVER/HARBOR NAME AND STATE LOWER MACHODOC CREEK MARYLAND					MINIMUM DEPTHS (FT) 80% OF CHANNEL ENTERING FROM SEAWARD
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% OF PROJECT WIDTH 40% ON EITHER SIDE OF CENTER LINE (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Channel	03-22-2011	150	1	9	5.9 / 99



RIVER/HARBOR NAME AND STATE LITTLE WICOMICO RIVER VIRGINIA					MINIMUM DEPTHS (FT) 80% INF EACH QUARTER WIDTH OF CHANNEL ENTERING FROM SEAWARD		
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			LEFT OUTSIDE QUARTER (feet)	MIDDLE HALF (feet)	RIGHT OUTSIDE QUARTER (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)			
Channel	10-18-2017	150	1	8	6.7 / 100	6.0 / 100	5.4 / 100

Monroe Bay and Creek

RIVER/HARBOR NAME AND STATE MONROE BAY VIRGINIA					MINIMUM DEPTHS (FT) 80% OF CHANNEL ENTERING FROM SEAWARD
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% OF PROJECT WIDTH 40% ON EITHER SIDE OF CENTER LINE (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Channel	08-25-2016	100	1	8	
Basin	08-25-2016	500		8	6.0 / 96

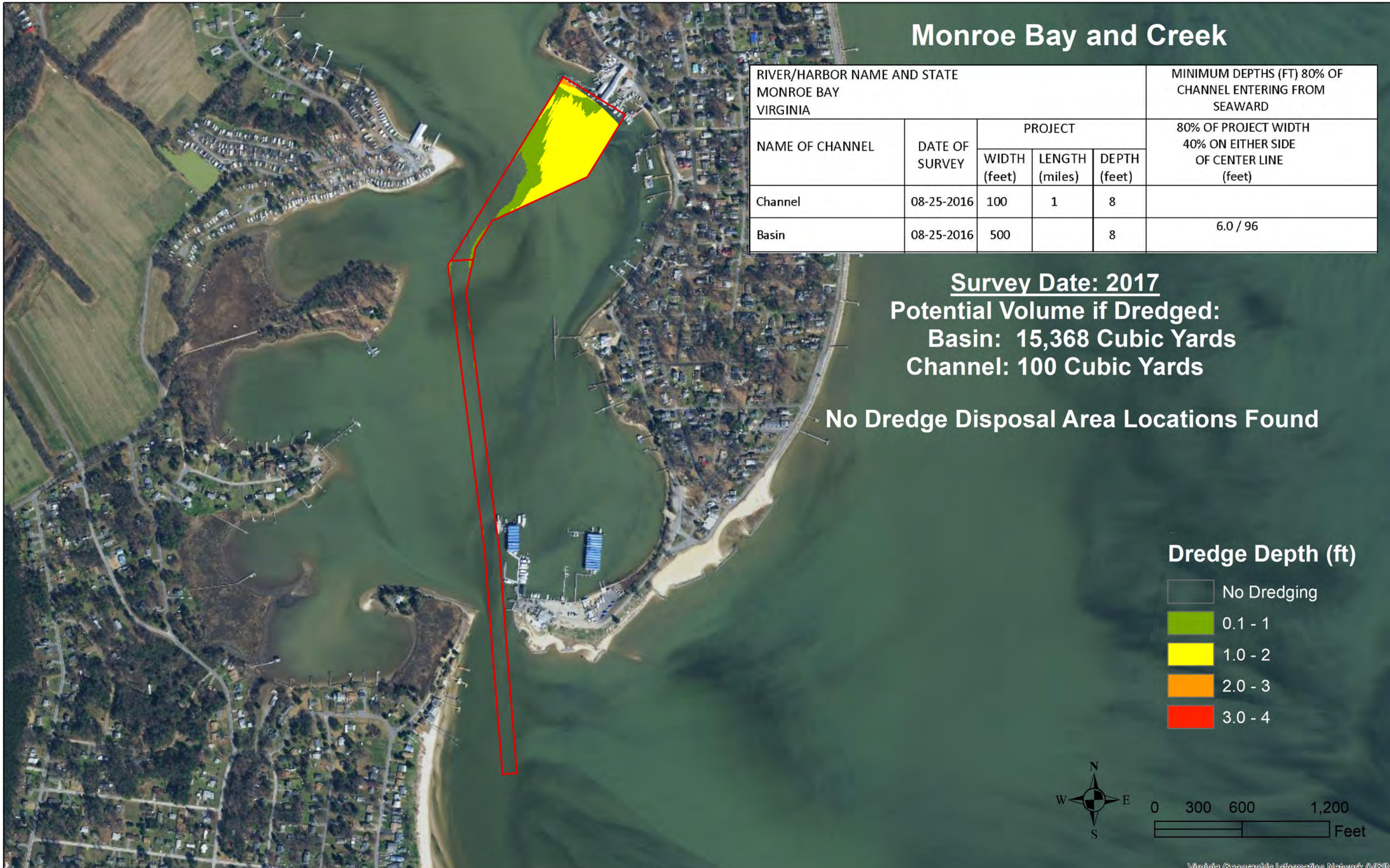
Survey Date: 2017

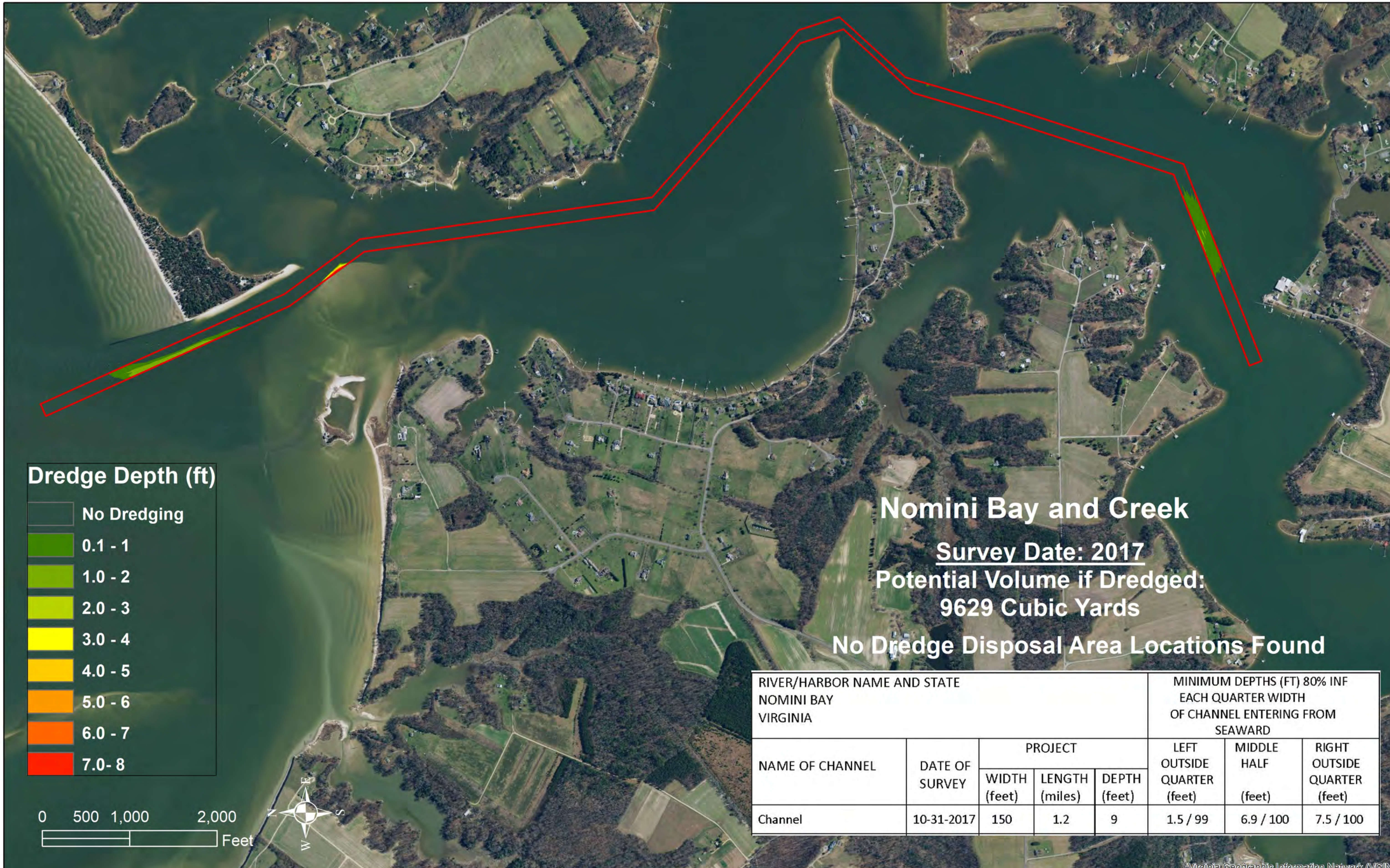
Potential Volume if Dredged:

Basin: 15,368 Cubic Yards

Channel: 100 Cubic Yards

No Dredge Disposal Area Locations Found





RIVER/HARBOR NAME AND STATE NOMINI BAY VIRGINIA					MINIMUM DEPTHS (FT) 80% INF EACH QUARTER WIDTH OF CHANNEL ENTERING FROM SEAWARD		
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			LEFT OUTSIDE QUARTER (feet)	MIDDLE HALF (feet)	RIGHT OUTSIDE QUARTER (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)			
Channel	10-31-2017	150	1.2	9	1.5 / 99	6.9 / 100	7.5 / 100

Eastern Shore Channels

Dredge volumes were determined using ArcMap GIS 3D analyst and spatial analyst tools and data downloaded from the US Army Corps of Engineers including channel boundaries and depth survey. Some channels did not have channel boundaries and those were approximated from navigation data and survey data.

The historic dredge volume amounts and disposal areas were approximated from a 1973 hard copy report by the U.S. Army Corps of Engineers and digitized into GIS. The most recent projected dredge volume amount was determined to the controlling depth only. No over-dredge was used in the calculation.

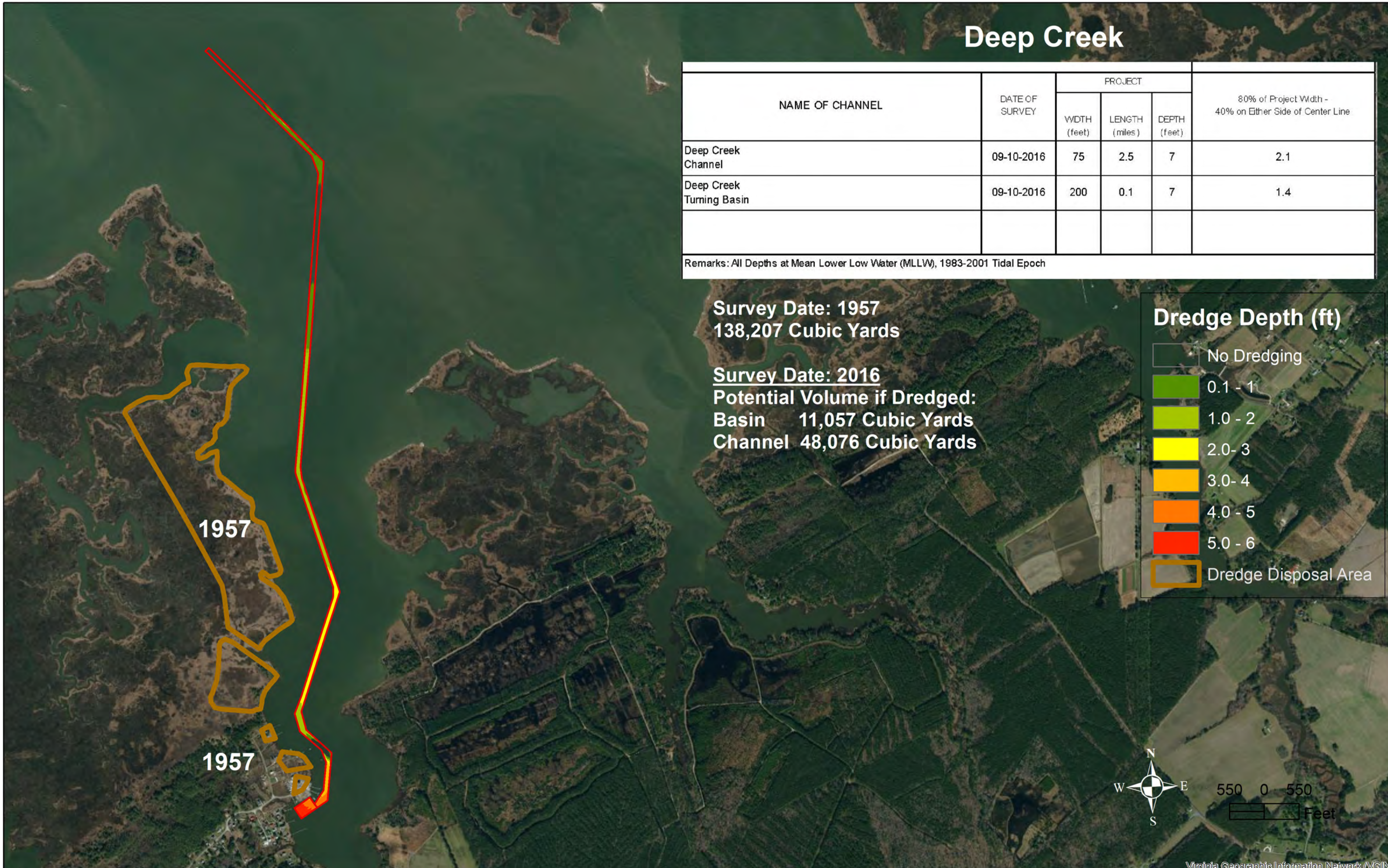
The channel dredging data and the disposal location data may not be complete. The data was compiled from existing sources. However, it was difficult to locate information on each channel.

Chesconessex Creek
Survey Date: 1967
31, 075 Cubic Yards
1967
1967
1967
Chesconessex Channel
Dredge Disposal Area
N
W
E
S
0 150 300 600
Feet
Virginia Geographic Information Network (VGIN)

Deep Creek

NAME OF CHANNEL	DATE OF SURVEY	PROJECT WIDTH (feet)	PROJECT LENGTH (miles)	PROJECT DEPTH (feet)	80% of Project Width - 40% on Either Side of Center Line
Deep Creek Channel	09-10-2016	75	2.5	7	2.1
Deep Creek Turning Basin	09-10-2016	200	0.1	7	1.4

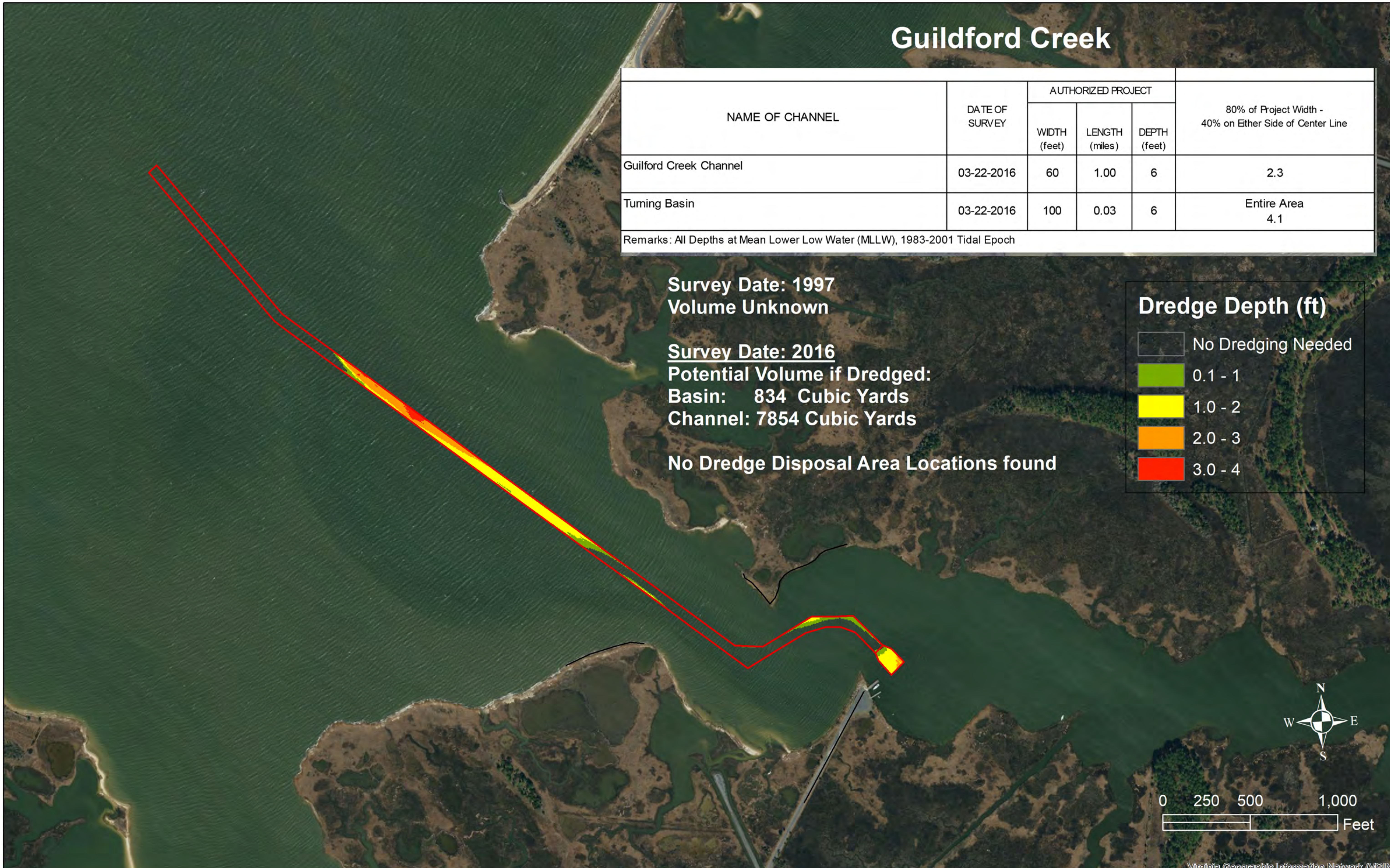
Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch

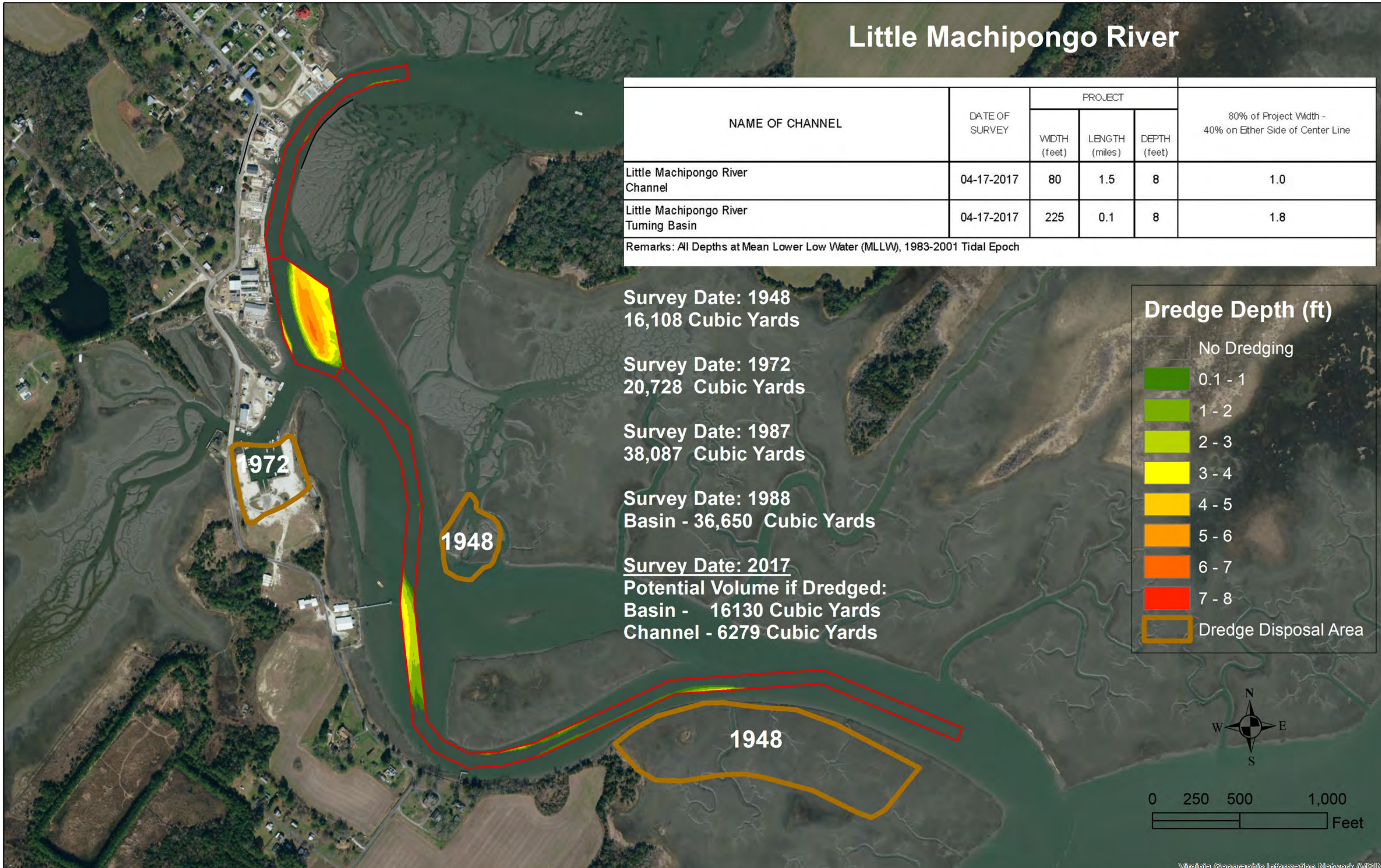


Guildford Creek

NAME OF CHANNEL	DATE OF SURVEY	AUTHORIZED PROJECT			80% of Project Width - 40% on Either Side of Center Line
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Guilford Creek Channel	03-22-2016	60	1.00	6	2.3
Turning Basin	03-22-2016	100	0.03	6	Entire Area 4.1

Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch



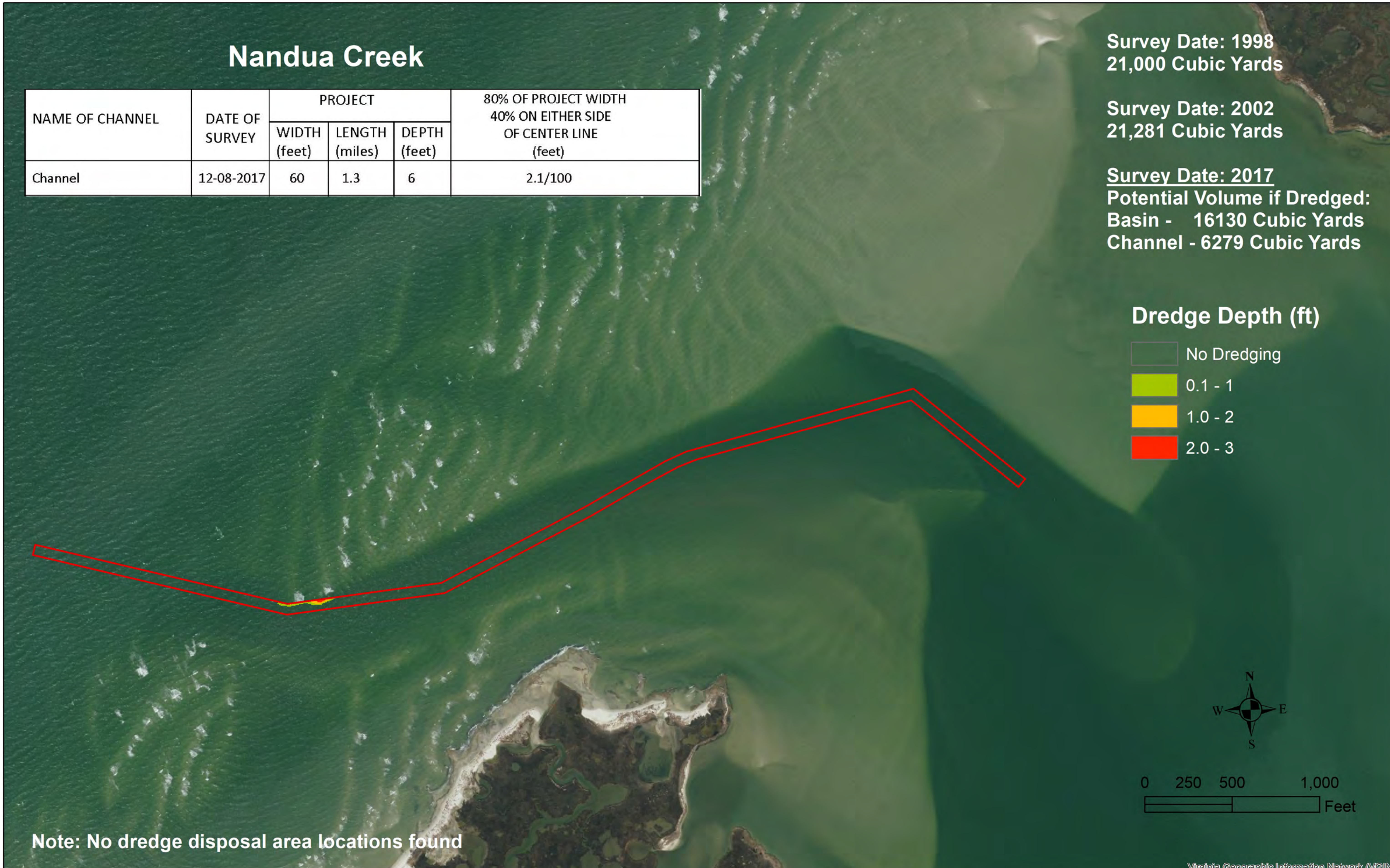


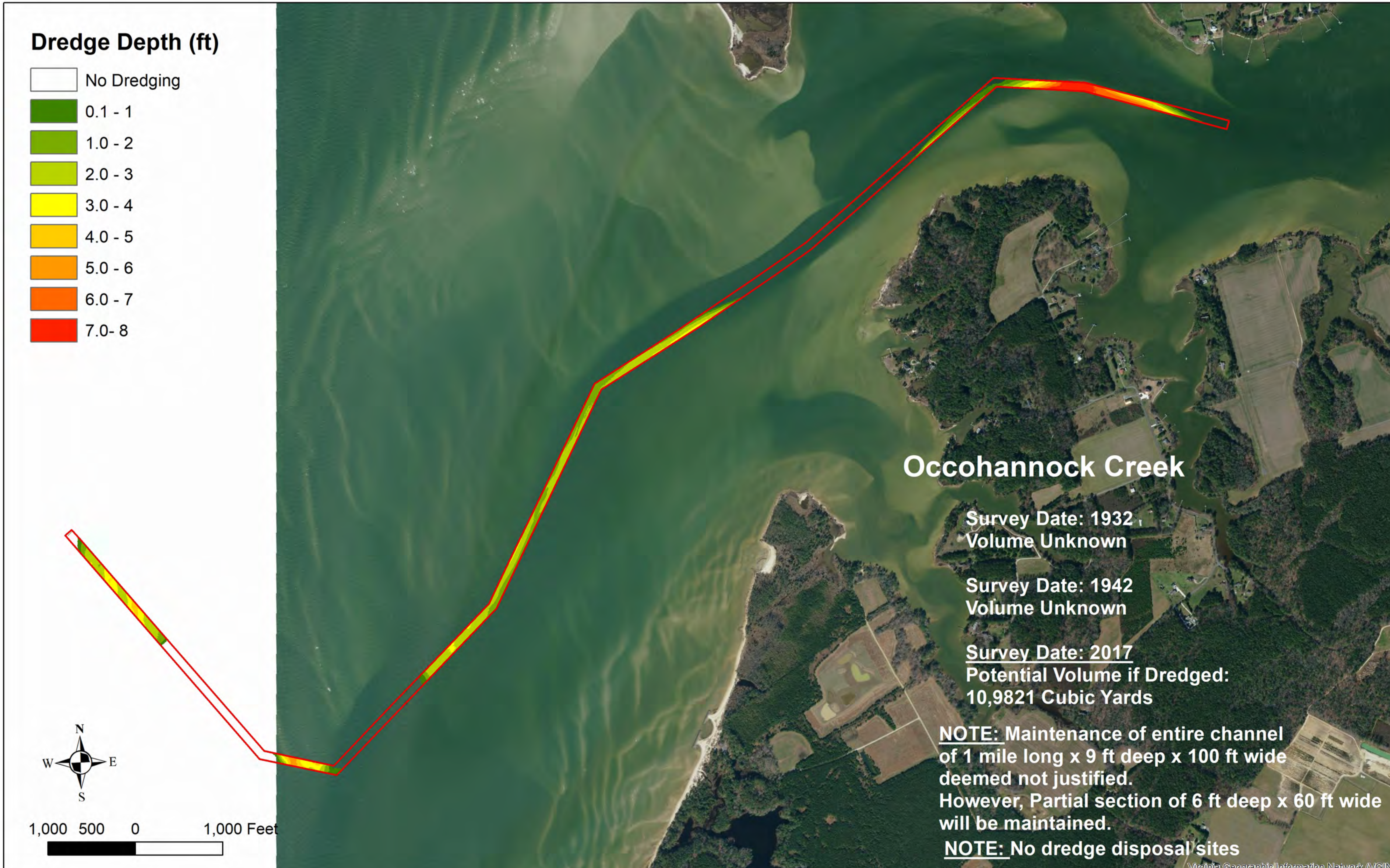
NAME OF CHANNEL	DATE OF SURVEY	PROJECT WIDTH (feet)	PROJECT LENGTH (miles)	PROJECT DEPTH (feet)	80% of Project Width - 40% on Either Side of Center Line
Little Machipongo River Channel	04-17-2017	80	1.5	8	1.0
Little Machipongo River Turning Basin	04-17-2017	225	0.1	8	1.8

Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch

Nandua Creek

NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% OF PROJECT WIDTH 40% ON EITHER SIDE OF CENTER LINE (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Channel	12-08-2017	60	1.3	6	2.1/100





Dredge Depth (ft)
No Dredging
0.1 - 1
1.0 - 2
2.0 - 3
3.0 - 4
4.0 - 5
5.0 - 6
6.0 - 7
7.0- 8
N
W
E
S
1,000 500 0 1,000 Feet
Occohannock Creek
Survey Date: 1932
Volume Unknown
Survey Date: 1942
Volume Unknown
Survey Date: 2017
Potential Volume if Dredged:
10,9821 Cubic Yards
NOTE: Maintenance of entire channel of 1 mile long x 9 ft deep x 100 ft wide deemed not justified.
However, Partial section of 6 ft deep x 60 ft wide will be maintained.
NOTE: No dredge disposal sites
Virginia Geographic Information Network (VGIN)

Onancock Creek

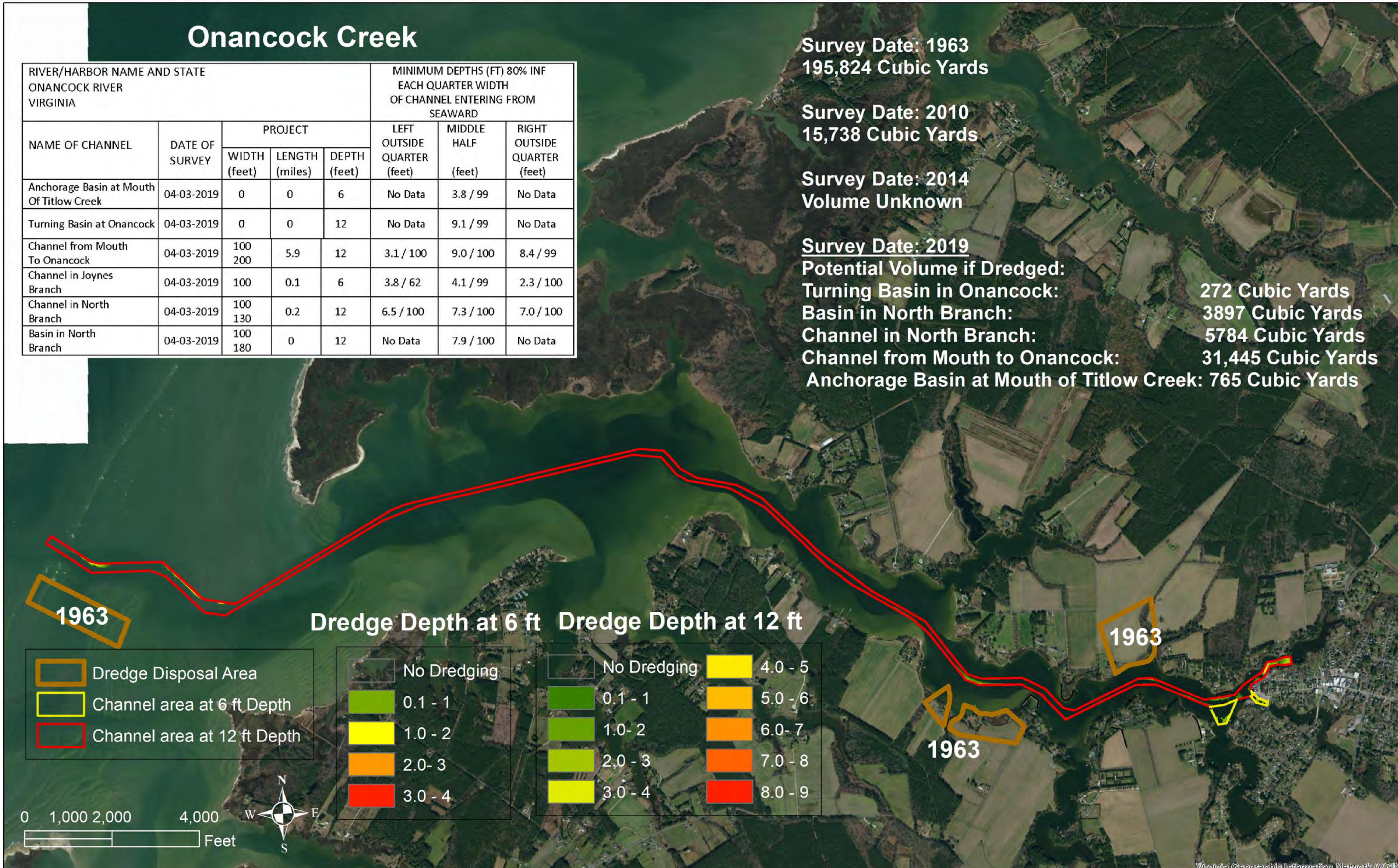
RIVER/HARBOR NAME AND STATE ONANCOCK RIVER VIRGINIA					MINIMUM DEPTHS (FT) 80% INF EACH QUARTER WIDTH OF CHANNEL ENTERING FROM SEAWARD		
NAME OF CHANNEL	DATE OF SURVEY	PROJECT			LEFT OUTSIDE QUARTER (feet)	MIDDLE HALF (feet)	RIGHT OUTSIDE QUARTER (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)			
Anchorage Basin at Mouth Of Titlow Creek	04-03-2019	0	0	6	No Data	3.8 / 99	No Data
Turning Basin at Onancock	04-03-2019	0	0	12	No Data	9.1 / 99	No Data
Channel from Mouth To Onancock	04-03-2019	100 200	5.9	12	3.1 / 100	9.0 / 100	8.4 / 99
Channel in Joynes Branch	04-03-2019	100	0.1	6	3.8 / 62	4.1 / 99	2.3 / 100
Channel in North Branch	04-03-2019	100 130	0.2	12	6.5 / 100	7.3 / 100	7.0 / 100
Basin in North Branch	04-03-2019	100 180	0	12	No Data	7.9 / 100	No Data

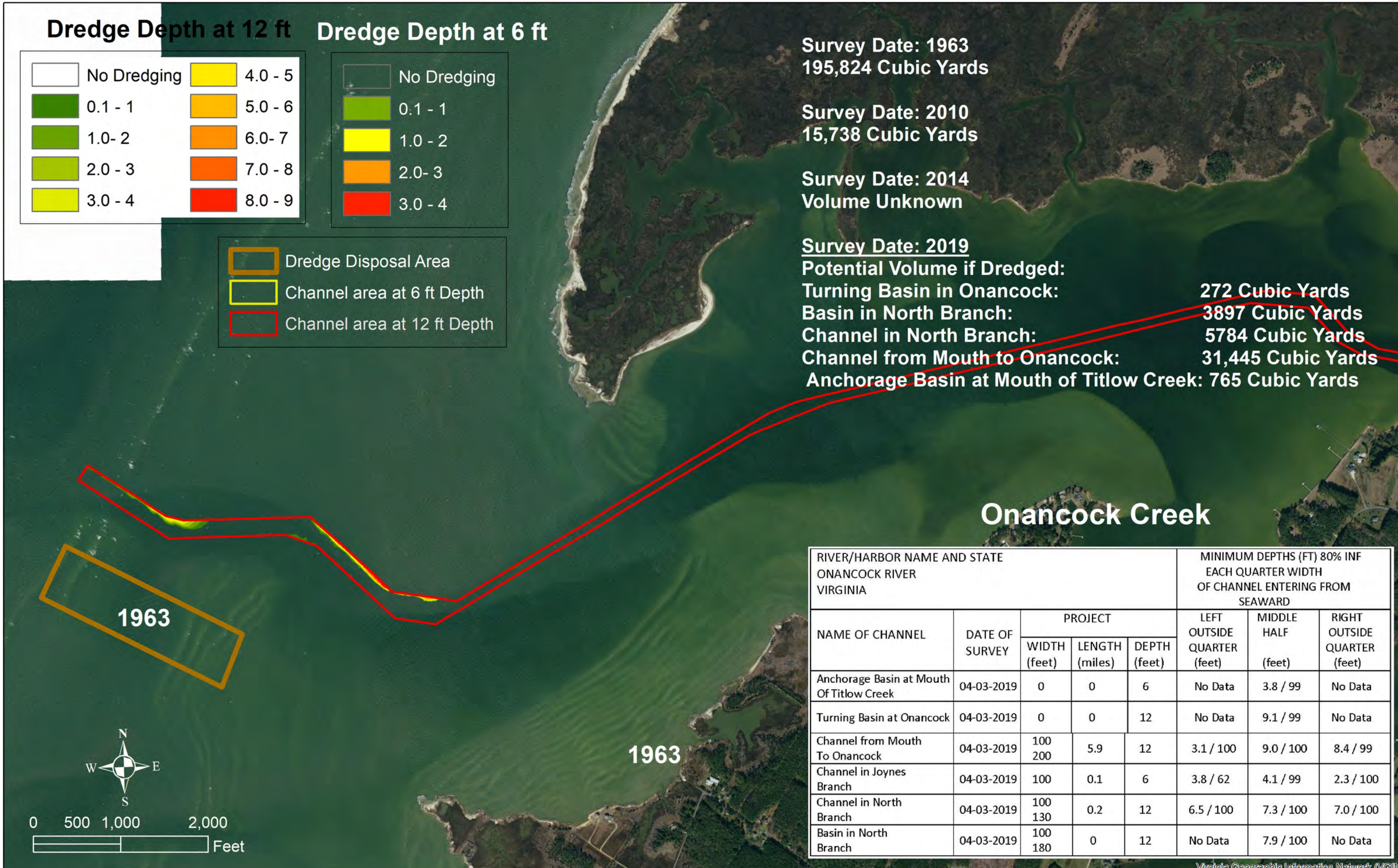
Survey Date: 1963
195,824 Cubic Yards

Survey Date: 2010
15,738 Cubic Yards

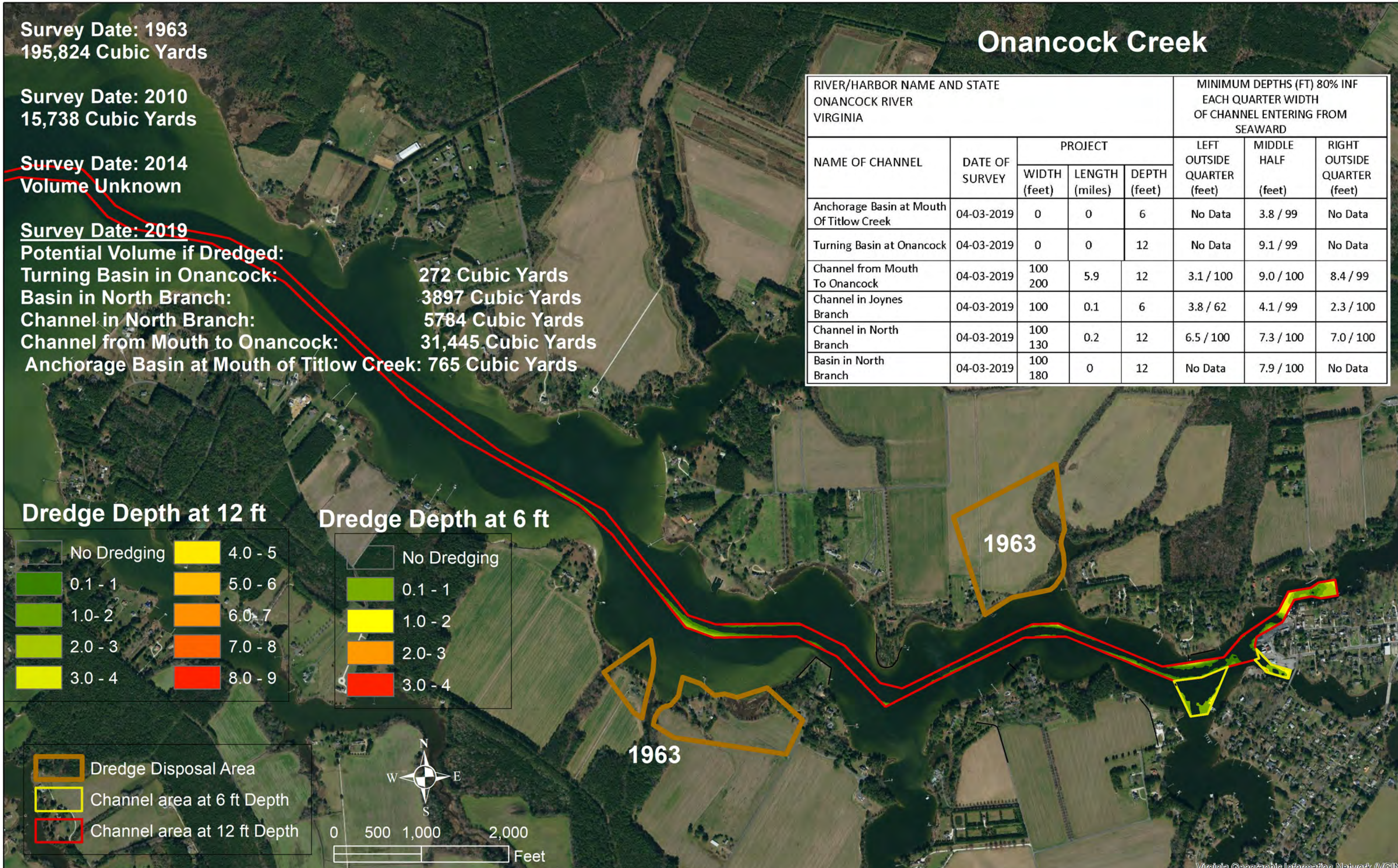
Survey Date: 2014
Volume Unknown

Survey Date: 2019
Potential Volume if Dredged:
Turning Basin in Onancock: 272 Cubic Yards
Basin in North Branch: 3897 Cubic Yards
Channel in North Branch: 5784 Cubic Yards
Channel from Mouth to Onancock: 31,445 Cubic Yards
Anchorage Basin at Mouth of Titlow Creek: 765 Cubic Yards





RIVER/HARBOR NAME AND STATE ONANCOCK RIVER VIRGINIA					MINIMUM DEPTHS (FT) 80% INF EACH QUARTER WIDTH OF CHANNEL ENTERING FROM SEAWARD		
NAME OF CHANNEL	DATE OF SURVEY	PROJECT WIDTH (feet)	PROJECT LENGTH (miles)	PROJECT DEPTH (feet)	LEFT OUTSIDE QUARTER (feet)	MIDDLE HALF (feet)	RIGHT OUTSIDE QUARTER (feet)
Anchorage Basin at Mouth Of Titlow Creek	04-03-2019	0	0	6	No Data	3.8 / 99	No Data
Turning Basin at Onancock	04-03-2019	0	0	12	No Data	9.1 / 99	No Data
Channel from Mouth To Onancock	04-03-2019	100 200	5.9	12	3.1 / 100	9.0 / 100	8.4 / 99
Channel in Joynes Branch	04-03-2019	100	0.1	6	3.8 / 62	4.1 / 99	2.3 / 100
Channel in North Branch	04-03-2019	100 130	0.2	12	6.5 / 100	7.3 / 100	7.0 / 100
Basin in North Branch	04-03-2019	100 180	0	12	No Data	7.9 / 100	No Data



RIVER/HARBOR NAME AND STATE ONANCOCK RIVER VIRGINIA						MINIMUM DEPTHS (FT) 80% INF EACH QUARTER WIDTH OF CHANNEL ENTERING FROM SEAWARD		
NAME OF CHANNEL	DATE OF SURVEY	PROJECT				LEFT OUTSIDE QUARTER	MIDDLE HALF	RIGHT OUTSIDE QUARTER
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)		(feet)	(feet)	(feet)
Anchorage Basin at Mouth Of Titlow Creek	04-03-2019	0	0	6		No Data	3.8 / 99	No Data
Turning Basin at Onancock	04-03-2019	0	0	12		No Data	9.1 / 99	No Data
Channel from Mouth To Onancock	04-03-2019	100 200	5.9	12		3.1 / 100	9.0 / 100	8.4 / 99
Channel in Joynes Branch	04-03-2019	100	0.1	6		3.8 / 62	4.1 / 99	2.3 / 100
Channel in North Branch	04-03-2019	100 130	0.2	12		6.5 / 100	7.3 / 100	7.0 / 100
Basin in North Branch	04-03-2019	100 180	0	12		No Data	7.9 / 100	No Data

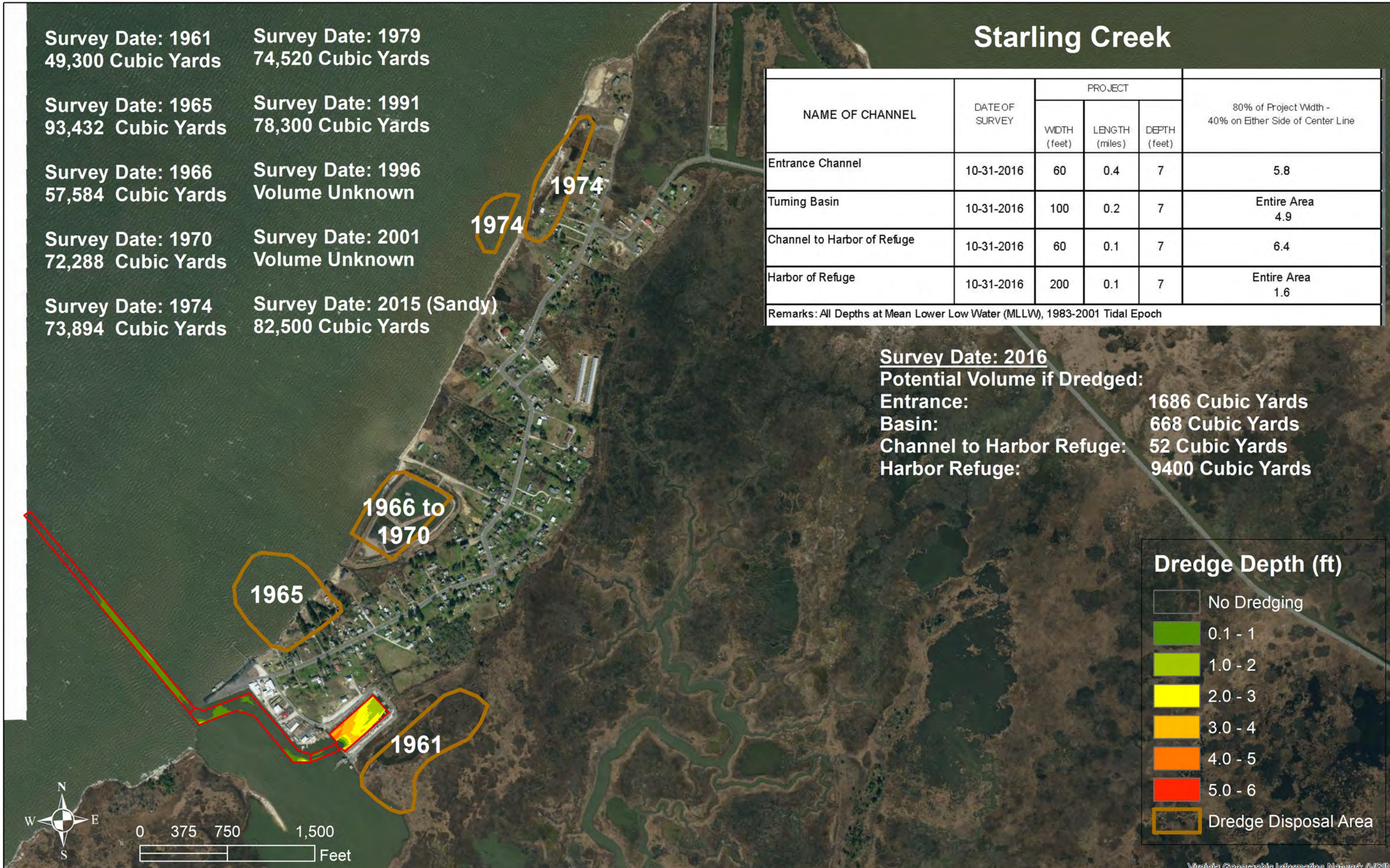
Parker Creek

NAME OF CHANNEL	DATE OF SURVEY	PROJECT			80% of Project Width - 40% on Either Side of Center Line
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	
Parkers Creek	12-05-2017	40	0.8	5	0.4
Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch					

Starling Creek

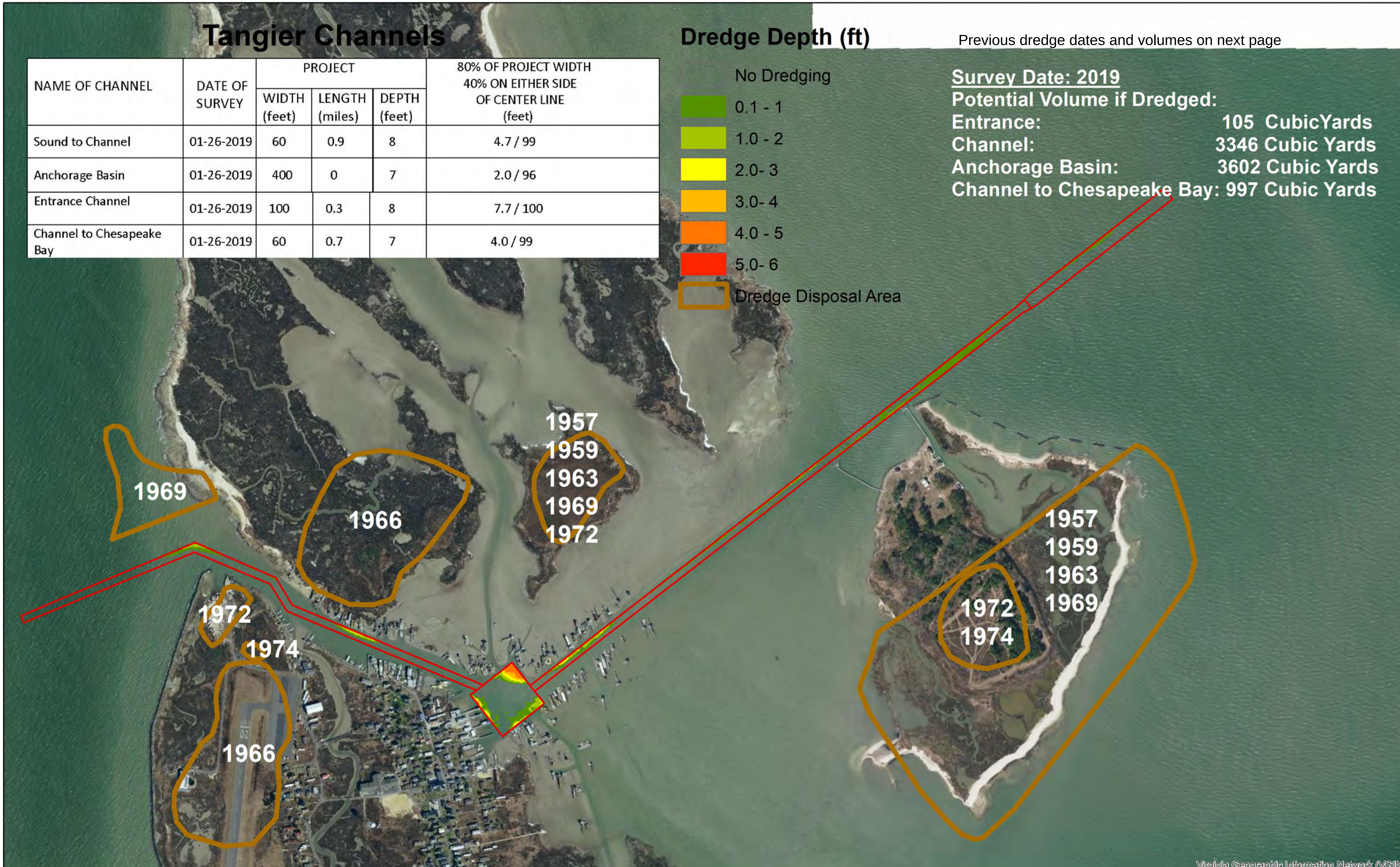
NAME OF CHANNEL	DATE OF SURVEY	PROJECT WIDTH (feet)	PROJECT LENGTH (miles)	PROJECT DEPTH (feet)	80% of Project Width - 40% on Either Side of Center Line
Entrance Channel	10-31-2016	60	0.4	7	5.8
Turning Basin	10-31-2016	100	0.2	7	Entire Area 4.9
Channel to Harbor of Refuge	10-31-2016	60	0.1	7	6.4
Harbor of Refuge	10-31-2016	200	0.1	7	Entire Area 1.6

Remarks: All Depths at Mean Lower Low Water (MLLW), 1983-2001 Tidal Epoch



Tangier Channels

NAME OF CHANNEL	DATE OF SURVEY	PROJECT WIDTH (feet)	PROJECT LENGTH (miles)	PROJECT DEPTH (feet)	80% OF PROJECT WIDTH 40% ON EITHER SIDE OF CENTER LINE (feet)
Sound to Channel	01-26-2019	60	0.9	8	4.7 / 99
Anchorage Basin	01-26-2019	400	0	7	2.0 / 96
Entrance Channel	01-26-2019	100	0.3	8	7.7 / 100
Channel to Chesapeake Bay	01-26-2019	60	0.7	7	4.0 / 99



Fiscal Year (Federal)	Cubic Yards Removed
Channel to Tangier Sound	
1957	51,508
1959	49,000
1963	77,222
1965-1966	99,920
1969	91,920
1972	92,170
1974	122,789
1977	117,146
1980	71,898
1982	79,041
1985	Portion of 108,041
1988	81,040
1991	69,479
2000	Volume Unknown
2005	49,800
2018 (Sandy)	Est. 55,000

Fiscal Year (Federal)	Cubic Yards Removed
Channel to Chesapeake Bay	
1966	99,920
1969	12,235
1977	31,491
1982	19,000
1985	Portion of 108,041
1988	10,803
1991	10,325
2000	Volume Unknown
2006	24,900
2009	49,768
2010	24,904
2015	56,353
2018 (Sandy)	Est. 55,000

Appendix B

Sediment analysis data from augers taken on land at Dutchman's Point potential disposal site and in the Davis Creek channel as shown on Figure 5-4

VIMS Analytical Service Center
Virginia Institute of Marine Science/ College of William and Mary
Rt 1208 Greate Road Gloucester Point, VA 23062
Contact: Carol Jeffery - Laboratory Manager tel. (804) 684-7213

Report Date: 8/8/2019
Project: Milligan Sediments

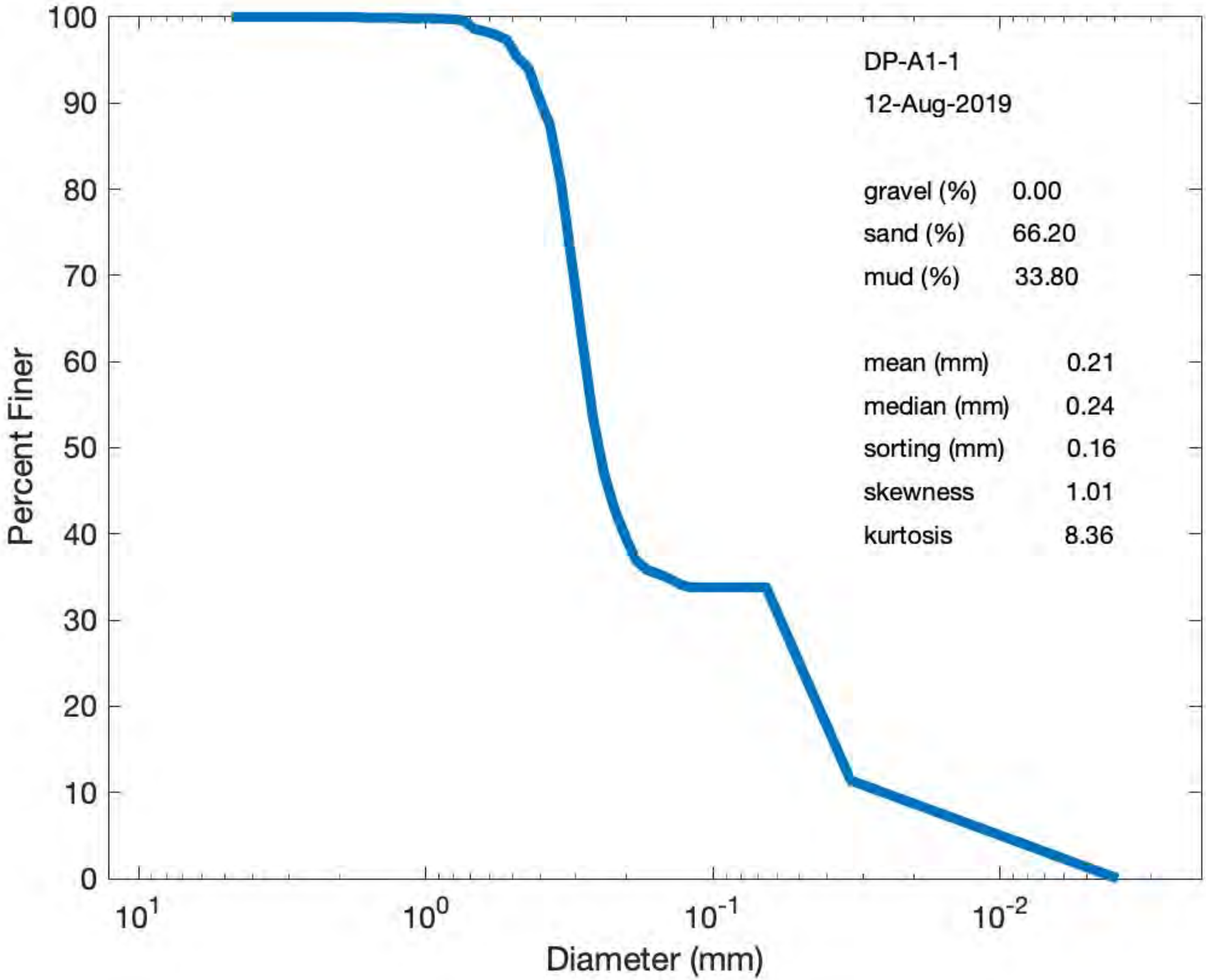
DP samples taken on land at Dutchman's Point, the potential CDF site.

Davis samples are taken in the channel.

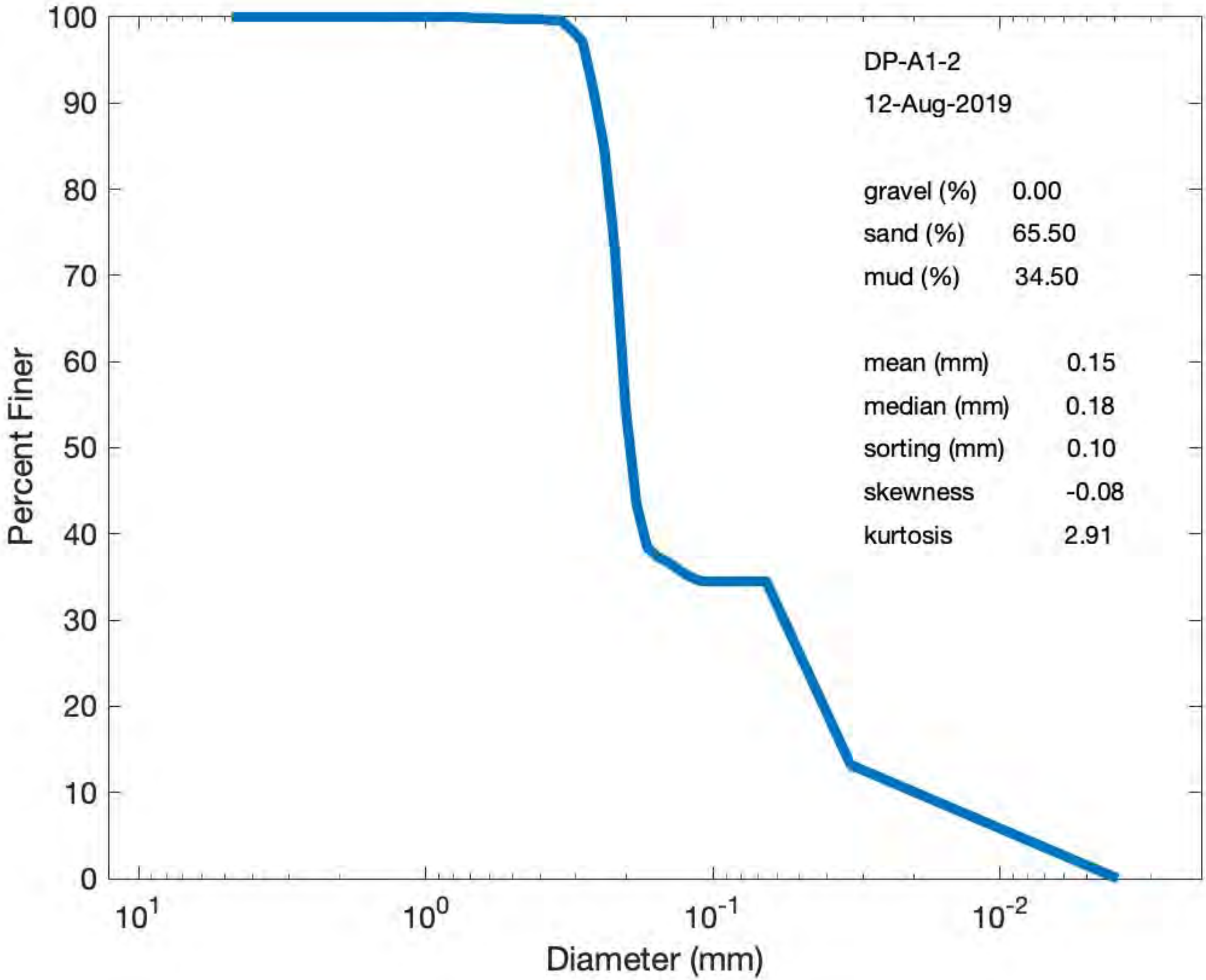
TEST RESULTS

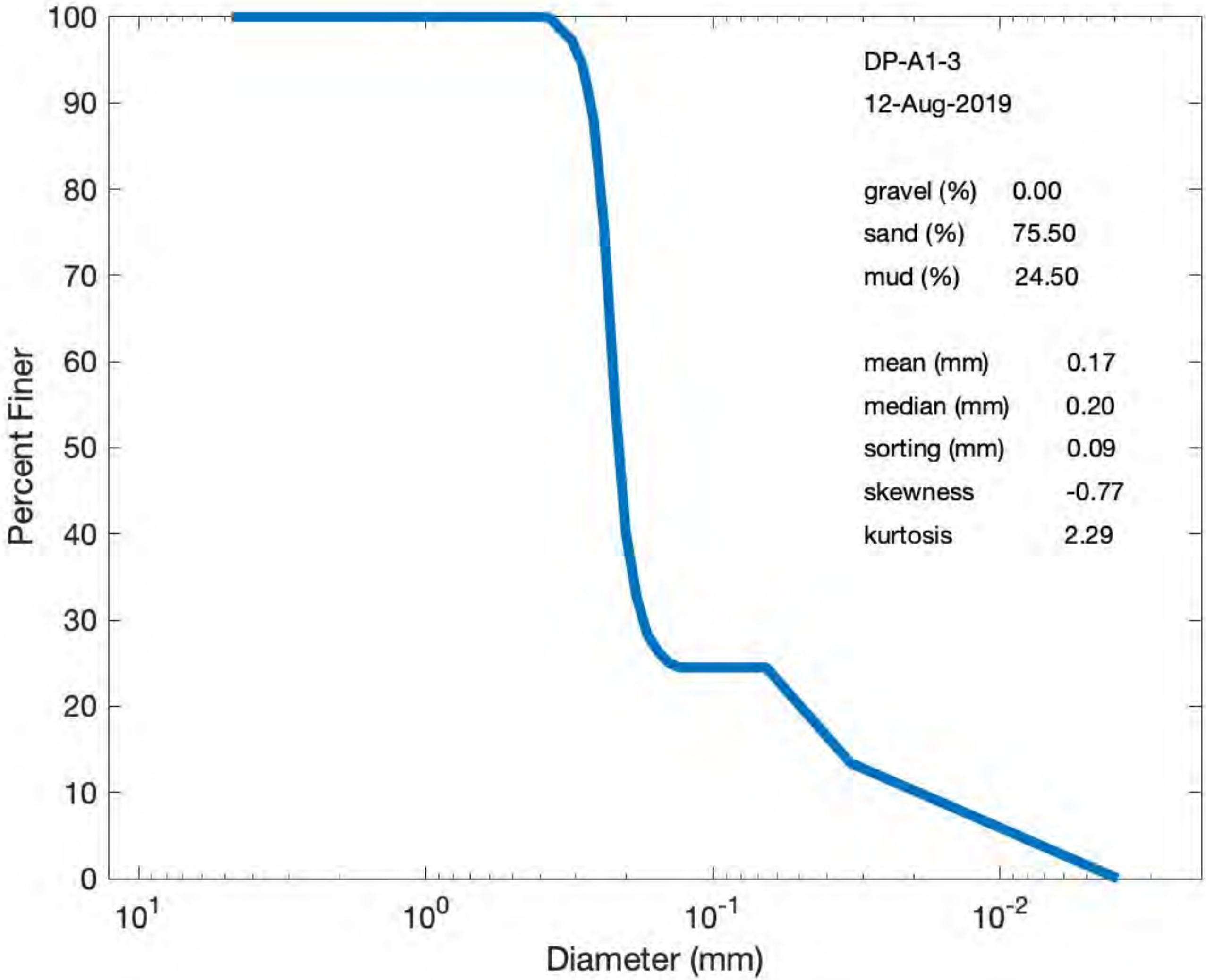
Lab#	Collect_Date	SampleID	% Gravel Units: % MDL: 0.1	% Sand Units: % MDL: 0.1	% Silt Units: % MDL: 0.1	% Clay Units: % MDL: 0.1
190802Q001	7/18/2019	DP A1-1	0.0	66.2	22.4	11.4
190802Q002	7/18/2019	DP A1-2	0.0	65.5	21.3	13.2
190802Q003	7/18/2019	DP A1-3	0.0	75.5	11.1	13.4
190802Q004	7/18/2019	Davis B1-1	0.0	3.5	50.2	46.3
190802Q005	7/18/2019	Davis B2-1	0.0	26.2	43.8	29.9
190802Q006	7/18/2019	Davis B3-1	0.0	91.0	4.2	4.8
190802Q007	7/18/2019	Davis B3-2	0.0	76.1	13.9	10.0
190802Q008	7/18/2019	Davis B4-1	0.0	93.2	3.1	3.7
190802Q009	7/18/2019	Davis B4-2	0.0	62.1	19.7	18.2
190802Q010	7/18/2019	Davis B5-1	0.0	95.3	1.9	2.8
190802Q011	7/18/2019	Davis B5-2	0.0	92.9	3.4	3.7

sample	mean (mm)	median (mm)	stddev (mm)	skewness (mm)	kurtosis (mm)
DP-A1-1	0.21	0.24	0.16	1.01	8.36
DP-A1-2	0.15	0.18	0.10	-0.08	2.91
DP-A1-3	0.17	0.20	0.09	-0.77	2.29
DP-B1-1	0.02	0.03	0.03	14.97	470.00
DP-B2-1	0.04	0.03	0.04	2.26	12.93
DP-B3-1	0.12	0.13	0.04	-0.96	4.08
DP-B3-2	0.10	0.11	0.10	12.35	210.50
DP-B4-1	0.15	0.16	0.06	0.31	6.53
DP-B4-2	0.09	0.11	0.06	-0.01	1.68
DP-B5-1	0.16	0.17	0.09	10.46	178.14
DP-B5-2	0.15	0.17	0.06	3.39	61.33

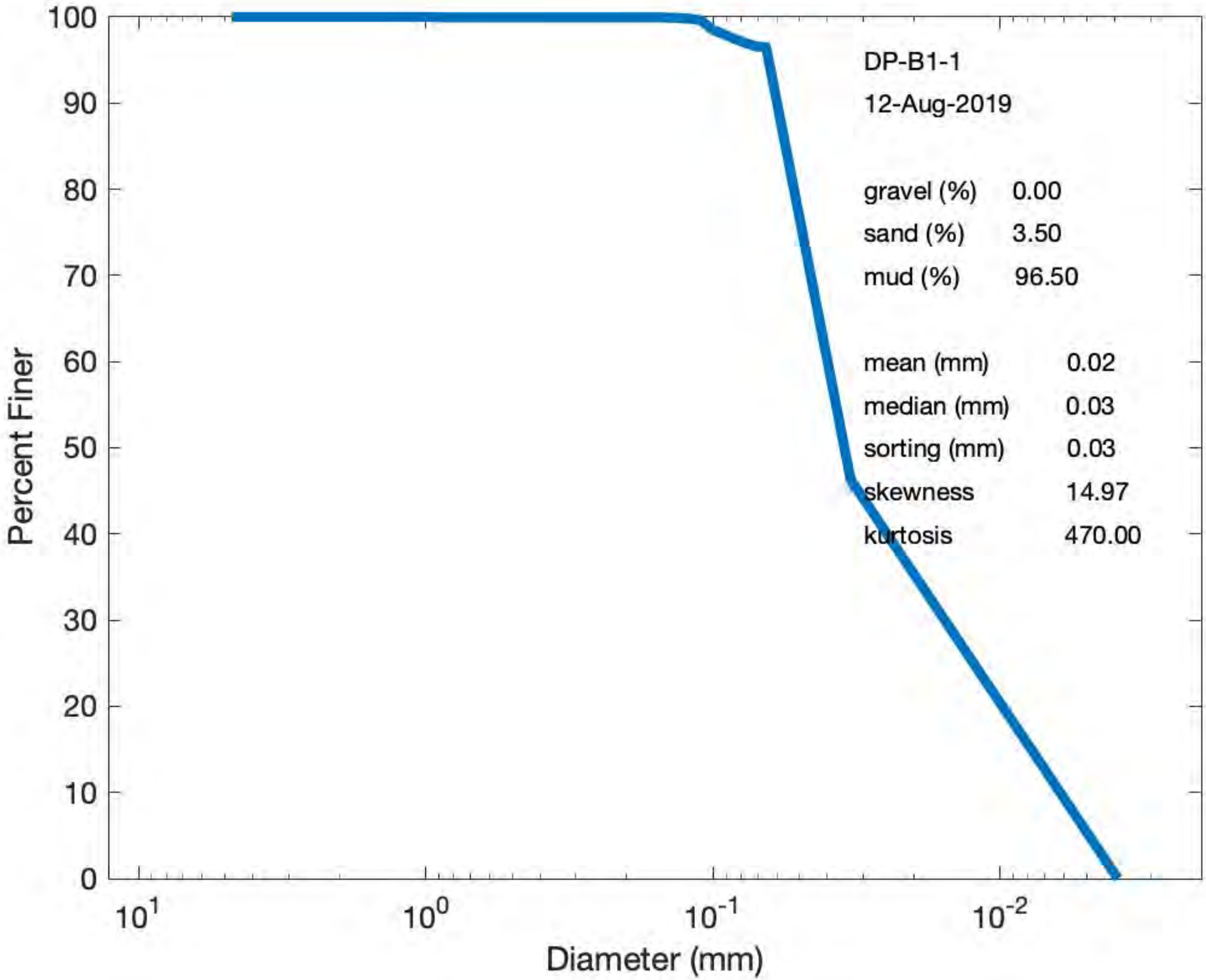


DP-A1-1
12-Aug-2019
gravel (%) 0.00
sand (%) 66.20
mud (%) 33.80
mean (mm) 0.21
median (mm) 0.24
sorting (mm) 0.16
skewness 1.01
kurtosis 8.36
Percent Finer
Diameter (mm)
100
90
80
70
60
50
40
30
20
10
0
10^1
10^0
10^{-1}
10^{-2}

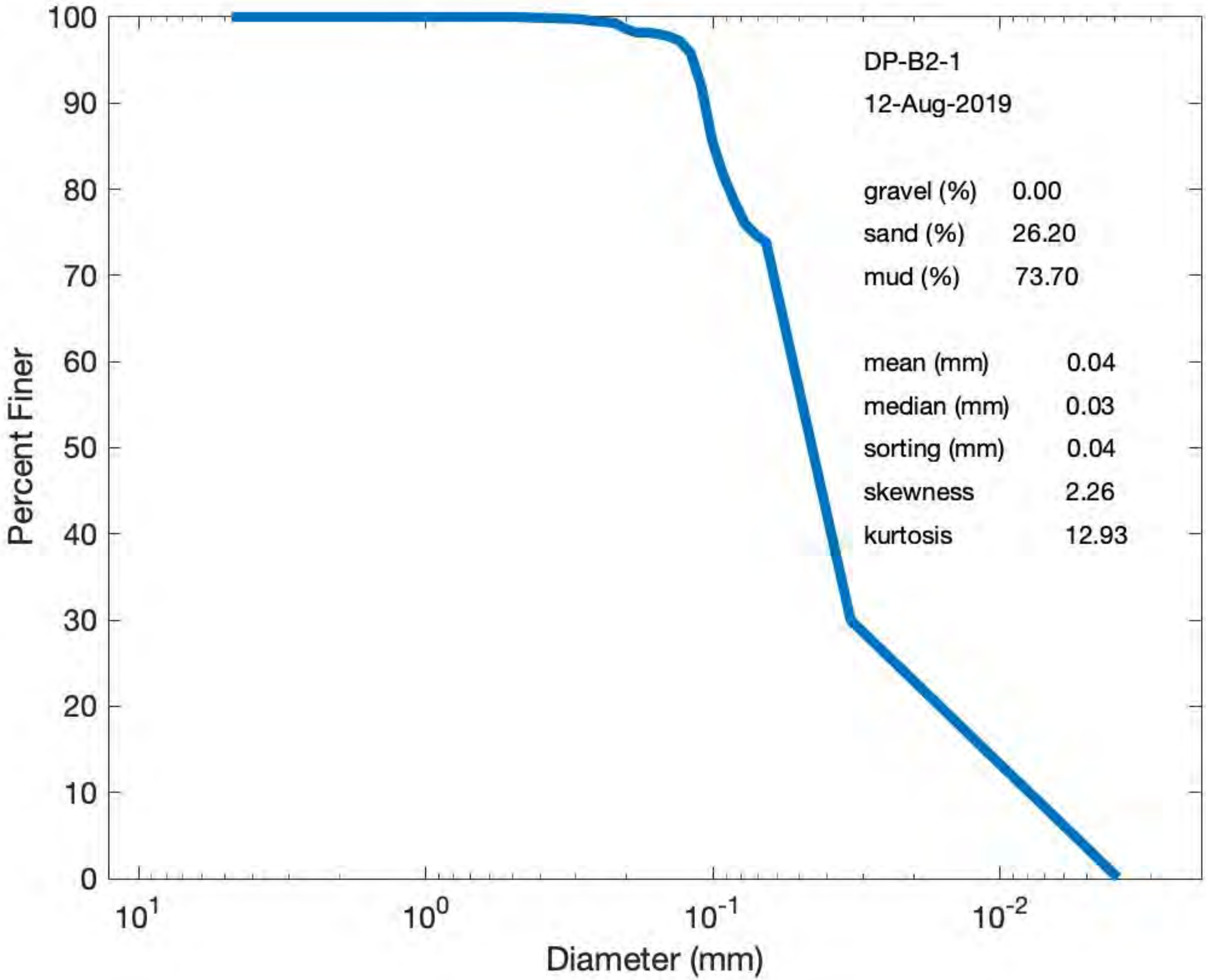

DP-A1-2
12-Aug-2019
gravel (%) 0.00
sand (%) 65.50
mud (%) 34.50
mean (mm) 0.15
median (mm) 0.18
sorting (mm) 0.10
skewness -0.08
kurtosis 2.91
Percent Finer
Diameter (mm)
100
90
80
70
60
50
40
30
20
10
0
10^1
10^0
10^{-1}
10^{-2}



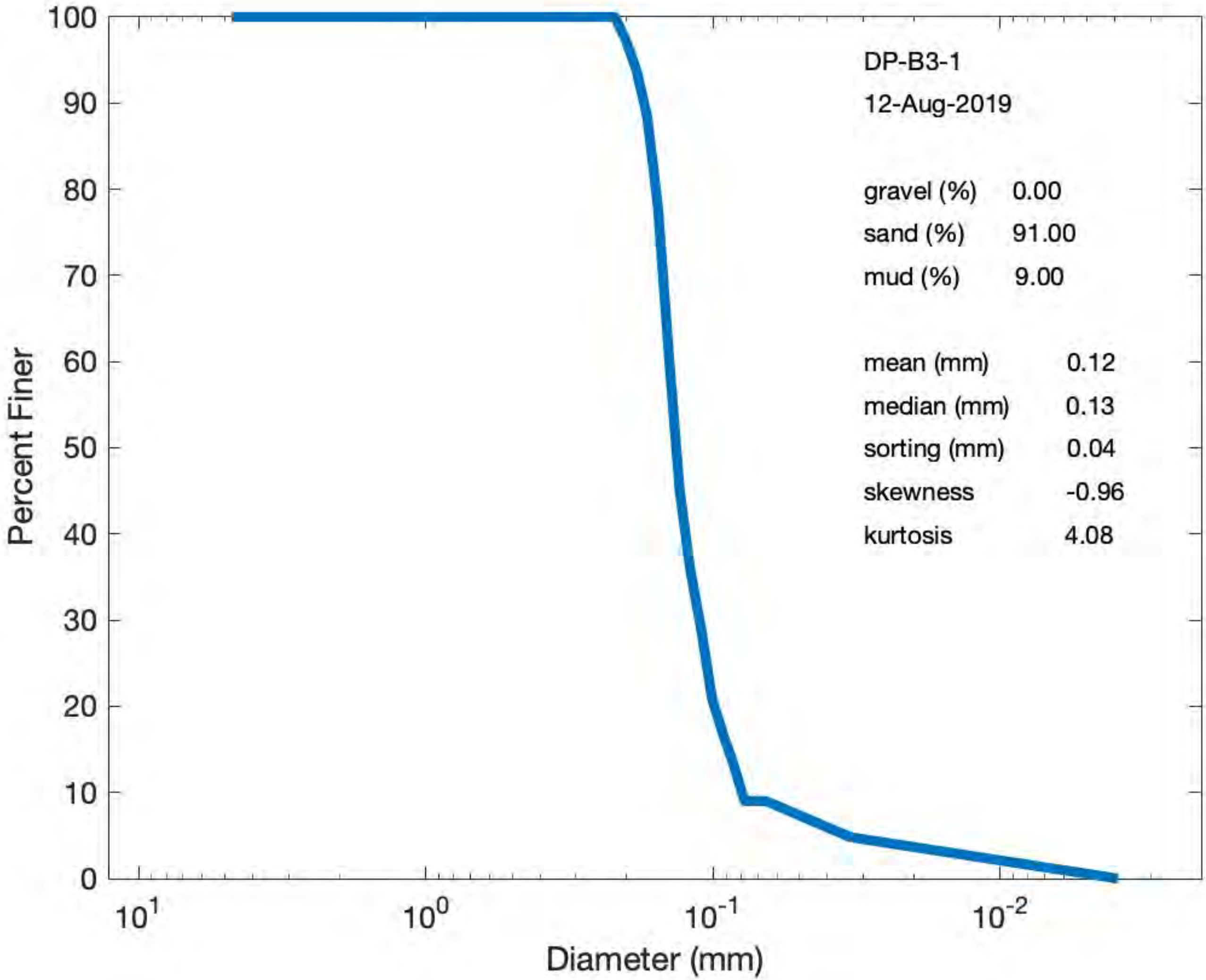
DP-A1-3
12-Aug-2019
gravel (%) 0.00
sand (%) 75.50
mud (%) 24.50
mean (mm) 0.17
median (mm) 0.20
sorting (mm) 0.09
skewness -0.77
kurtosis 2.29
Percent Finer
Diameter (mm)
100
90
80
70
60
50
40
30
20
10
0
10^1
10^0
10^{-1}
10^{-2}



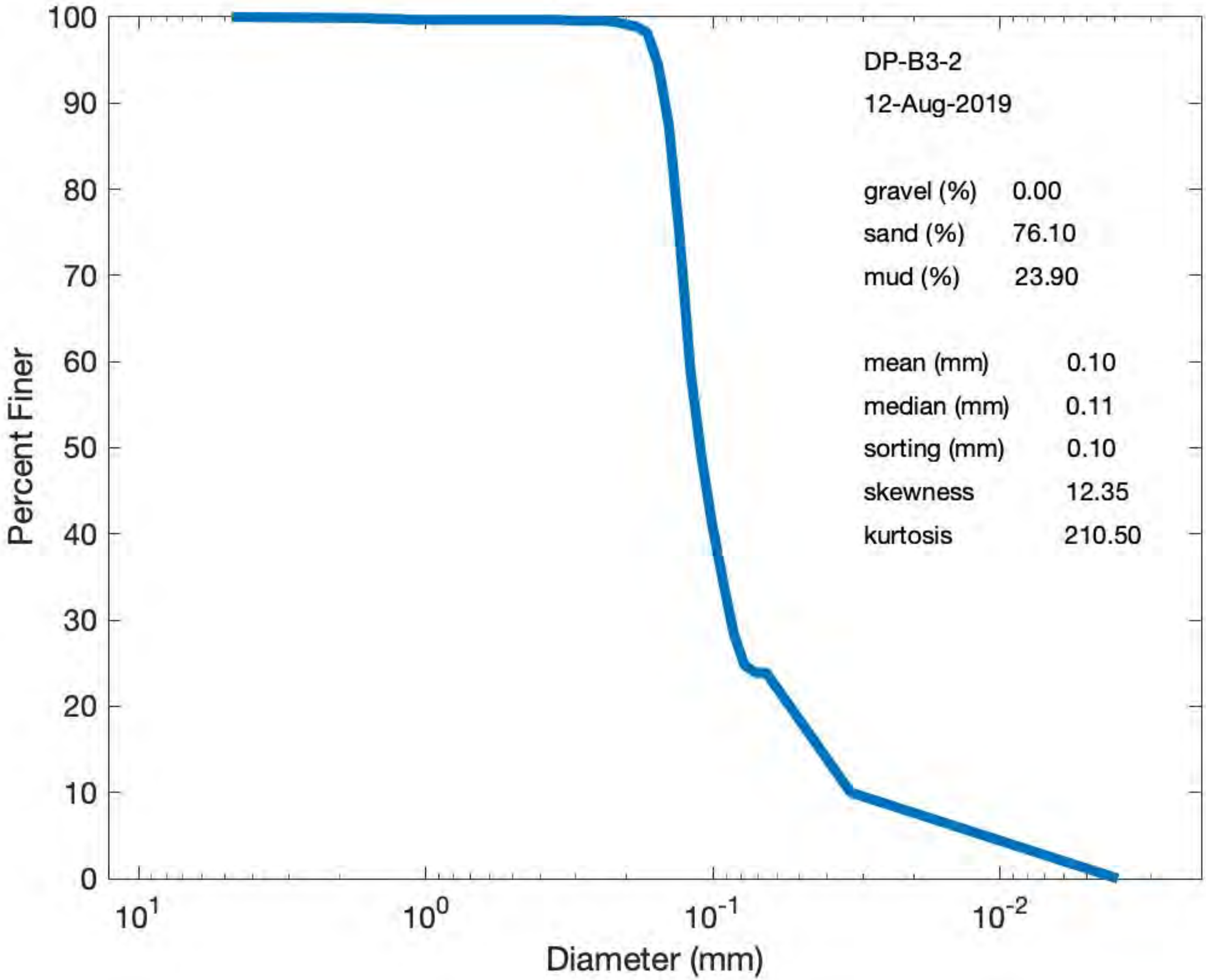
DP-B1-1
12-Aug-2019
gravel (%) 0.00
sand (%) 3.50
mud (%) 96.50
mean (mm) 0.02
median (mm) 0.03
sorting (mm) 0.03
skewness 14.97
kurtosis 470.00
Percent Finer
Diameter (mm)
100
90
80
70
60
50
40
30
20
10
0
10^1
10^0
10^{-1}
10^{-2}



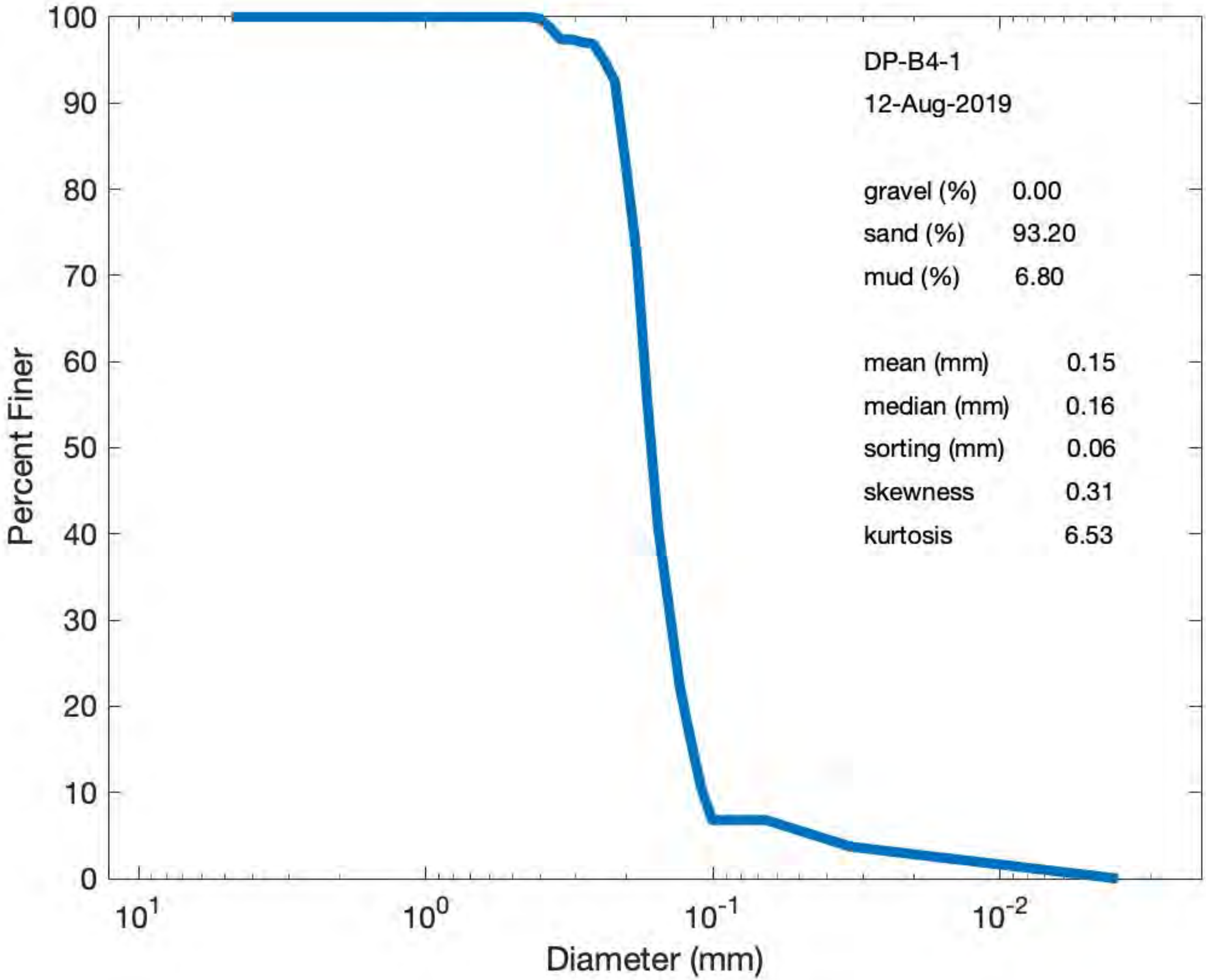
100
90
80
70
60
50
40
30
20
10
0
Percent Finer
10^1
10^0
10^{-1}
10^{-2}
Diameter (mm)
DP-B2-1
12-Aug-2019
gravel (%) 0.00
sand (%) 26.20
mud (%) 73.70
mean (mm) 0.04
median (mm) 0.03
sorting (mm) 0.04
skewness 2.26
kurtosis 12.93

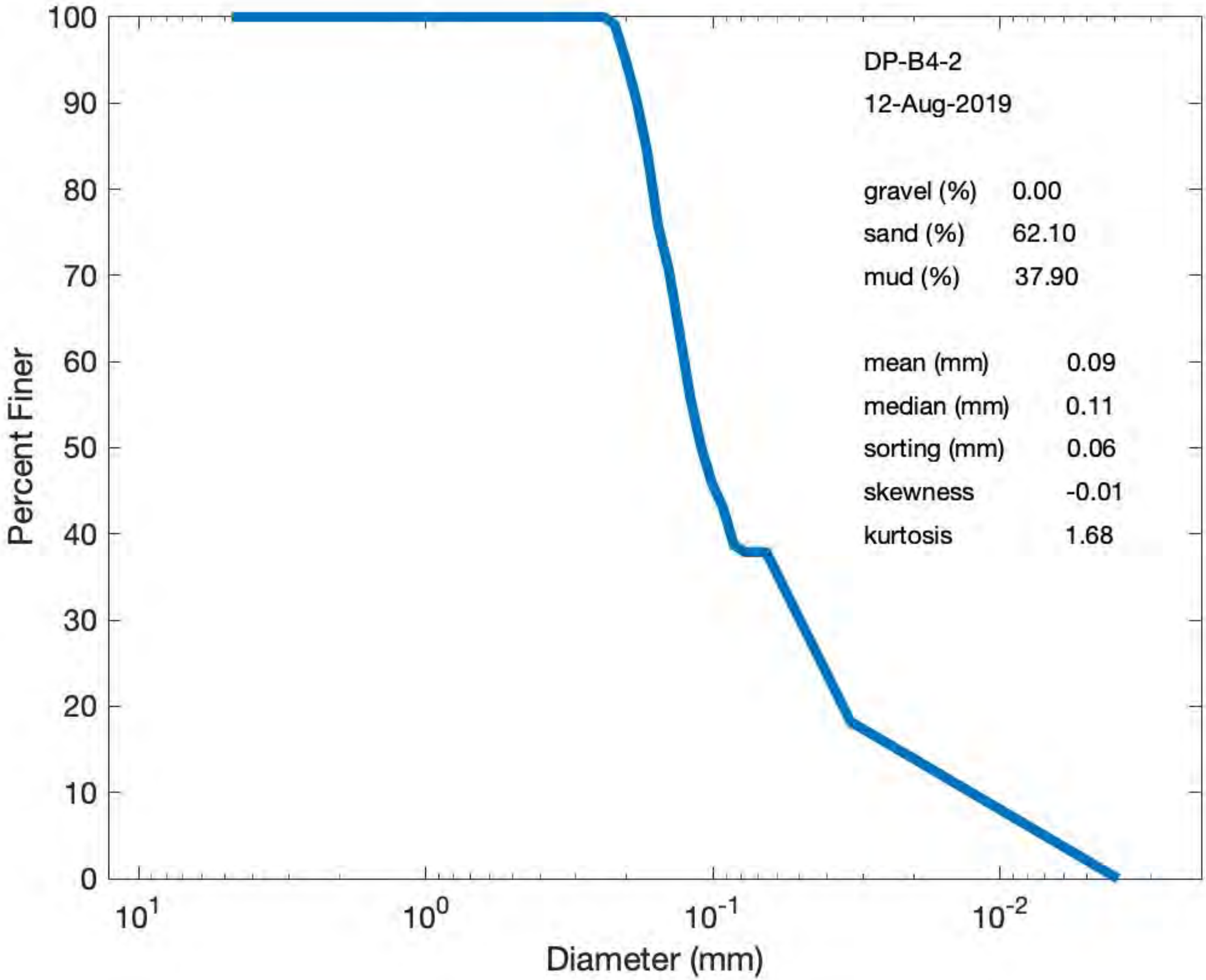


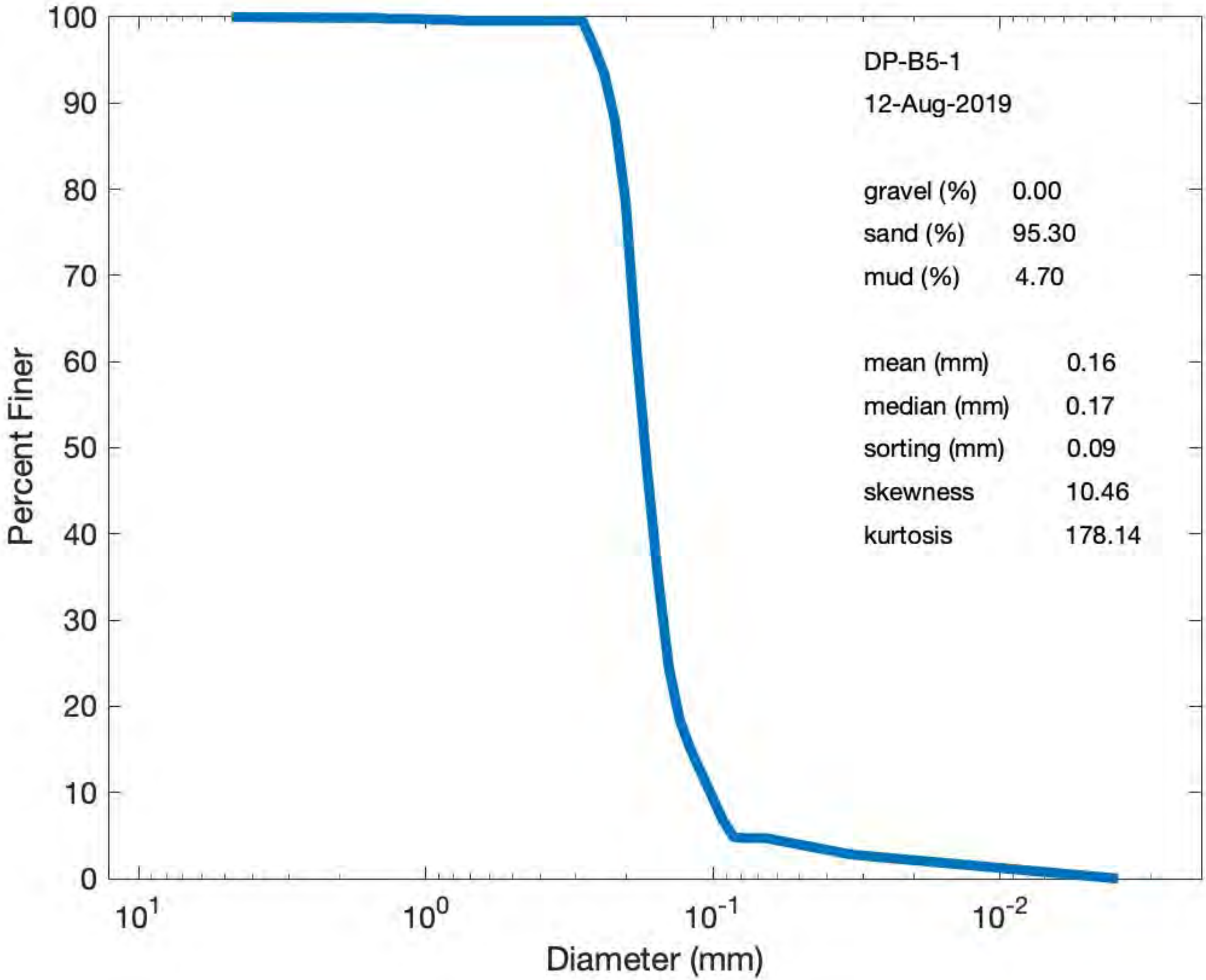
DP-B3-1
12-Aug-2019
gravel (%) 0.00
sand (%) 91.00
mud (%) 9.00
mean (mm) 0.12
median (mm) 0.13
sorting (mm) 0.04
skewness -0.96
kurtosis 4.08
Percent Finer
0
10
20
30
40
50
60
70
80
90
100
Diameter (mm)
10^1
10^0
10^{-1}
10^{-2}

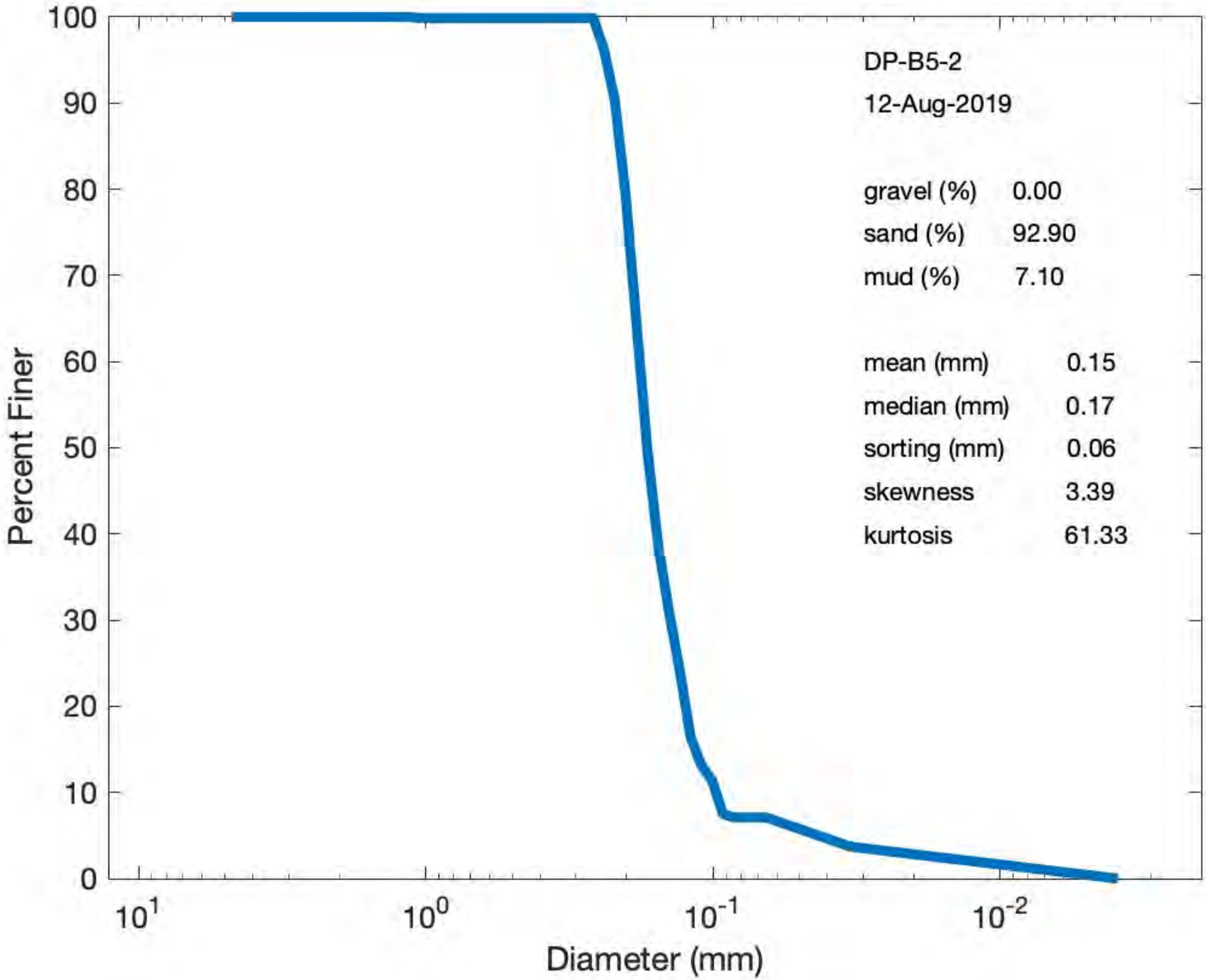


DP-B3-2
12-Aug-2019
gravel (%) 0.00
sand (%) 76.10
mud (%) 23.90
mean (mm) 0.10
median (mm) 0.11
sorting (mm) 0.10
skewness 12.35
kurtosis 210.50
Percent Finer
Diameter (mm)
100
90
80
70
60
50
40
30
20
10
0
10^{1}
10^{0}
10^{-1}
10^{-2}


DP-B4-1
12-Aug-2019
gravel (%) 0.00
sand (%) 93.20
mud (%) 6.80
mean (mm) 0.15
median (mm) 0.16
sorting (mm) 0.06
skewness 0.31
kurtosis 6.53
Percent Finer
0
10
20
30
40
50
60
70
80
90
100
10^1
10^0
10^{-1}
10^{-2}
Diameter (mm)


DP-B4-2
12-Aug-2019
gravel (%) 0.00
sand (%) 62.10
mud (%) 37.90
mean (mm) 0.09
median (mm) 0.11
sorting (mm) 0.06
skewness -0.01
kurtosis 1.68
Percent Finer
100
90
80
70
60
50
40
30
20
10
0
10^1
10^0
10^-1
10^-2
Diameter (mm)


DP-B5-1
12-Aug-2019
gravel (%) 0.00
sand (%) 95.30
mud (%) 4.70
mean (mm) 0.16
median (mm) 0.17
sorting (mm) 0.09
skewness 10.46
kurtosis 178.14
Percent Finer
Diameter (mm)
0
10
20
30
40
50
60
70
80
90
100
10^1
10^0
10^-1
10^-2



DP-B5-2
12-Aug-2019
gravel (%) 0.00
sand (%) 92.90
mud (%) 7.10
mean (mm) 0.15
median (mm) 0.17
sorting (mm) 0.06
skewness 3.39
kurtosis 61.33
Percent Finer
100
90
80
70
60
50
40
30
20
10
0
10^1
10^0
10^{-1}
10^{-2}
Diameter (mm)

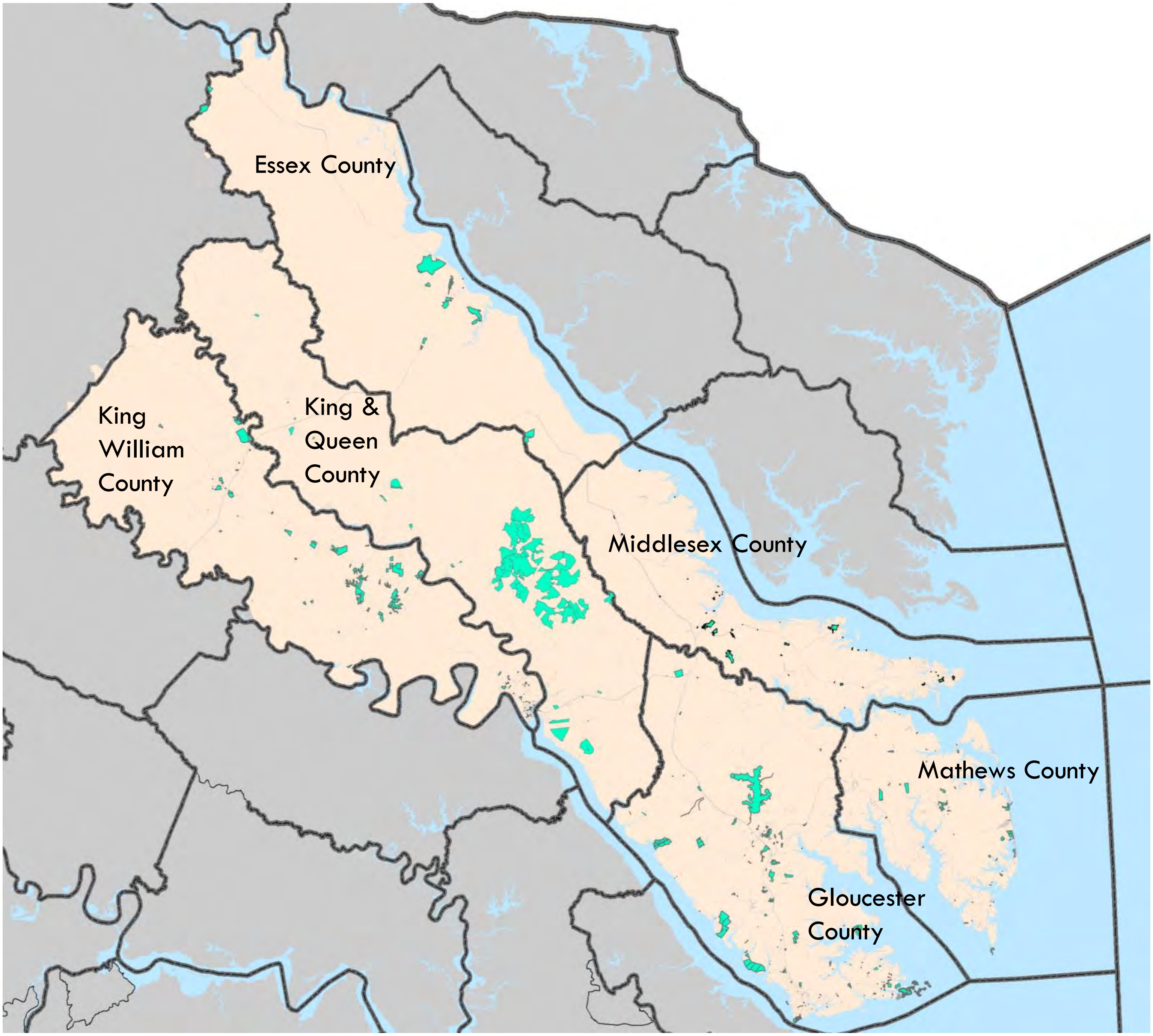
Appendix C

Publicly-owned land within the Middle Peninsula, Northern Neck, and Accomack-Northampton Planning District Commissions

In compiling these sites from locality Commissioners of Revenue, GIS specialists, and/or planners, these maps will improve the long-term planning of dredging projects and the placement of dredged material and will be useful upon the finalization of regulations for fast-tracking permitting of dredging proposals in Virginia.

It should be noted that several Commissioners of Revenue would not provide the requested public data and as other data sets were utilized, it reduced the accuracy and or the completeness of illustrating all publicly owned tax-exempt land within their jurisdictional boundary.

Publicly Owned Lands in the Middle Peninsula Region of Virginia



Legend

Middle Peninsula Region

Publicly Owned Land

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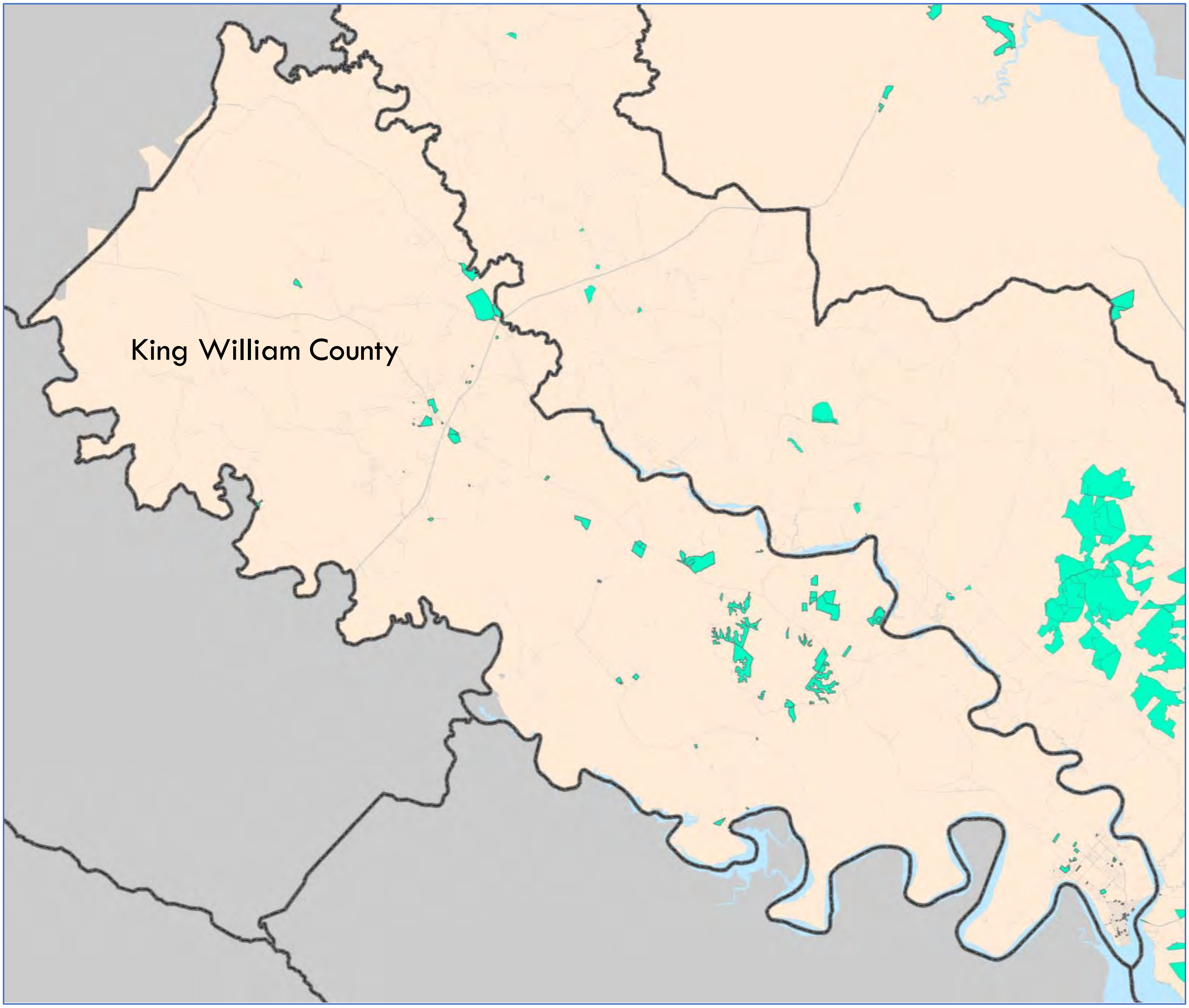
Virginia Coastal Zone MANAGEMENT PROGRAM

MIDDLE PENINSULA PLANNING DISTRICT COMMISSION

Publicly Owned Lands in King William County



Legend

Middle Peninsula Region

Publicly Owned Land

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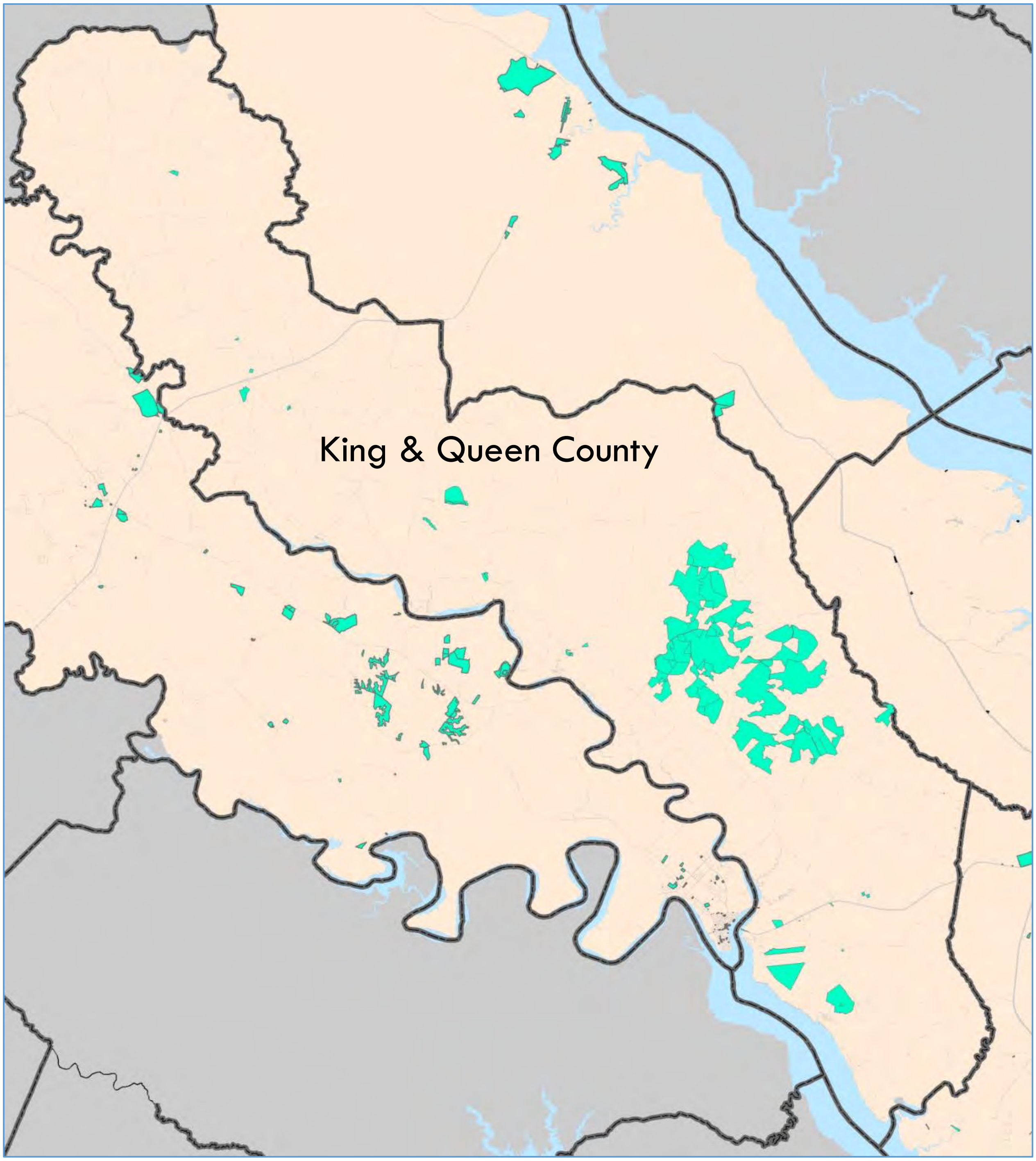
Publicly Owned Lands in King & Queen County



Legend

Middle Peninsula Region

Publicly Owned Land

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Virginia Coastal Zone MANAGEMENT PROGRAM

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MIDDLE PENINSULA PLANNING DISTRICT COMMISSION

Publicly Owned Lands in Essex County

Legend

Middle Peninsula Region

Publicly Owned Land

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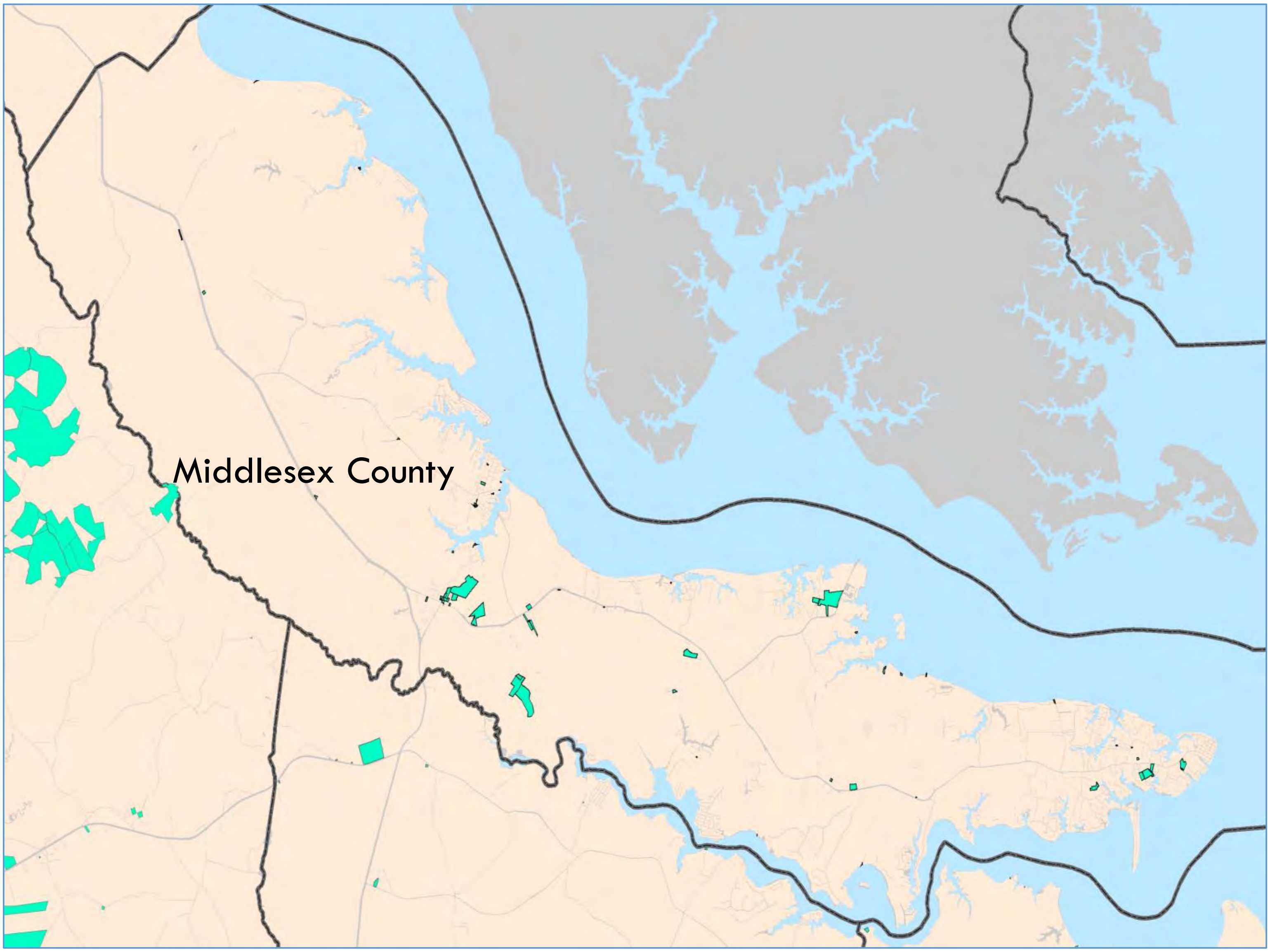
Publicly Owned Lands in Middlesex County



Legend

Middle Peninsula Region

Publicly Owned Land

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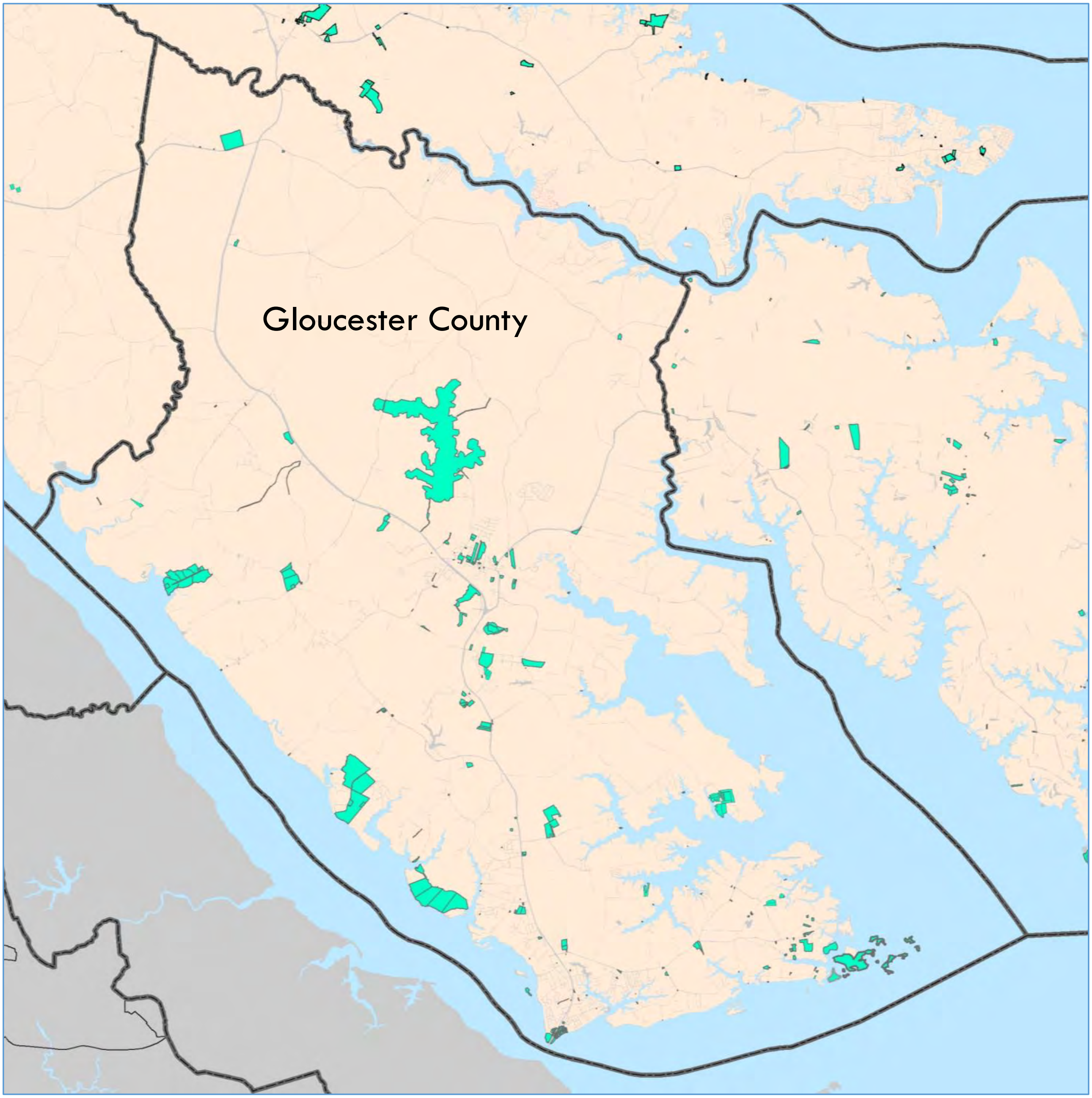
Virginia Coastal Zone MANAGEMENT PROGRAM

MIDDLE PENINSULA PLANNING DISTRICT COMMISSION

Publicly Owned Lands in Gloucester County



Legend

Middle Peninsula Region

Publicly Owned Land

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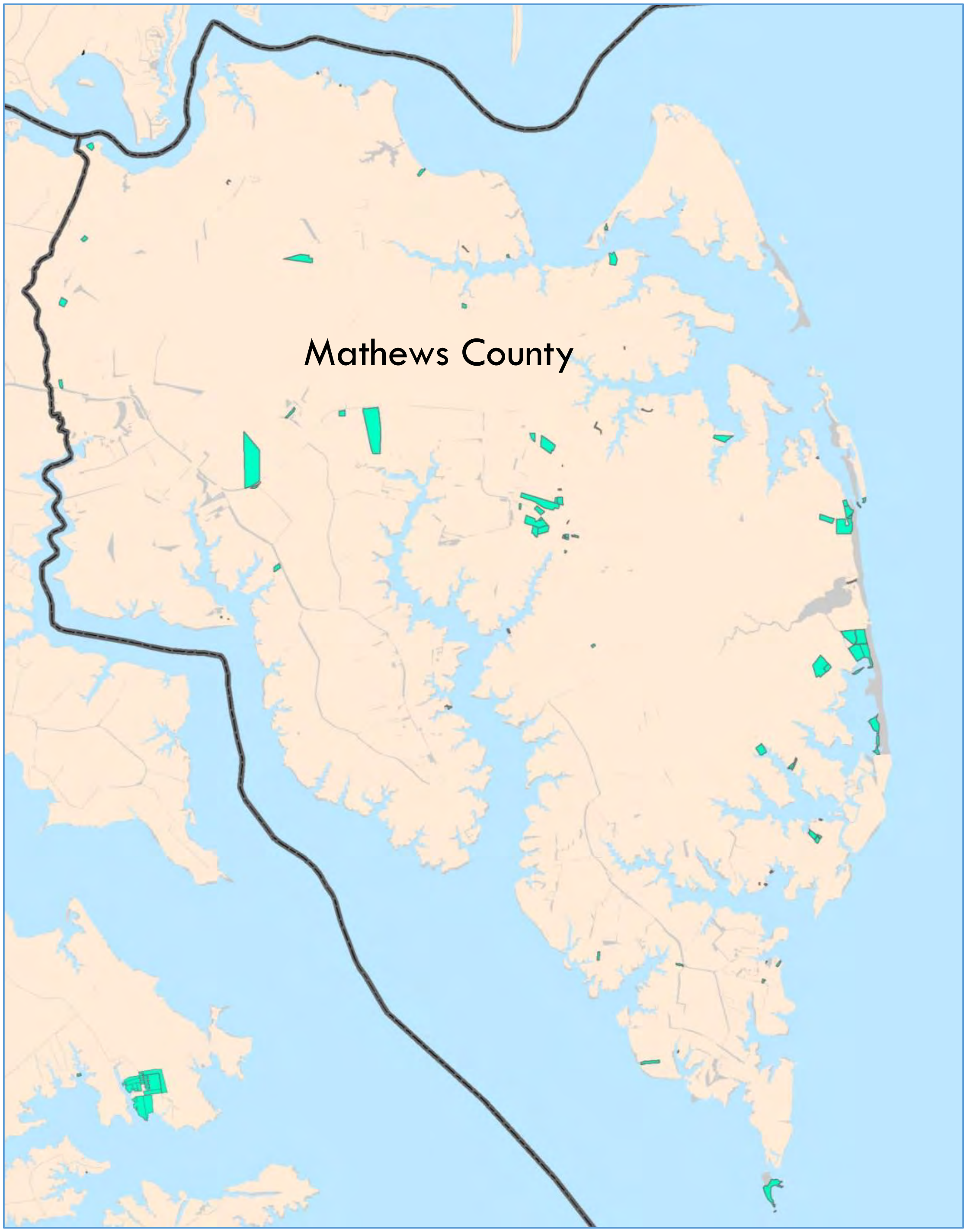
Publicly Owned Lands in Mathews County



Legend

Middle Peninsula Region

Publicly Owned Land

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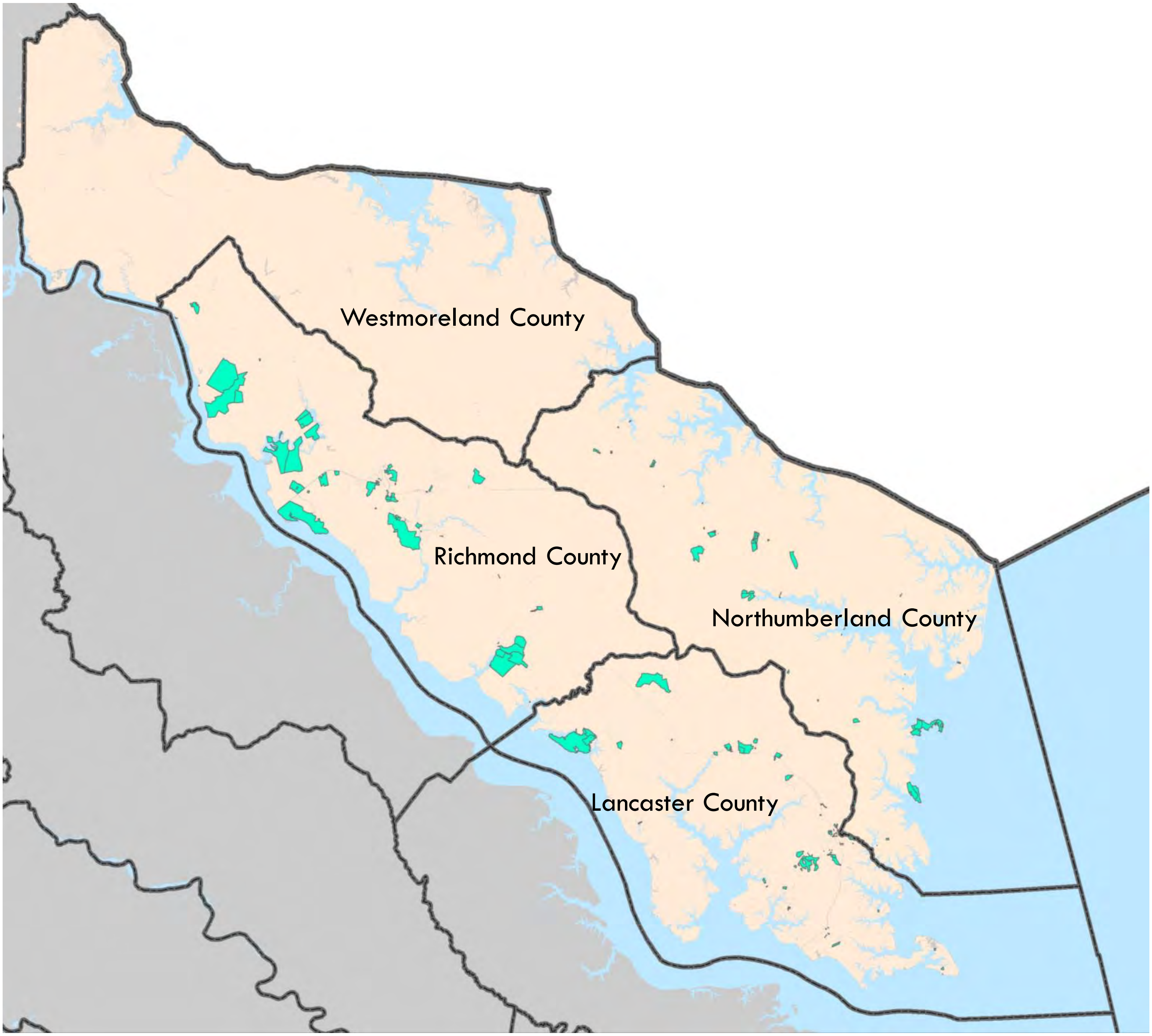
Virginia Coastal Zone MANAGEMENT PROGRAM

MIDDLE PENINSULA PLANNING DISTRICT COMMISSION

Publicly Owned Lands in the Northern Neck Region of Virginia

Please note that Westmoreland County did not provide land data.



Legend

- Northern Neck Region
- Publicly Owned Land

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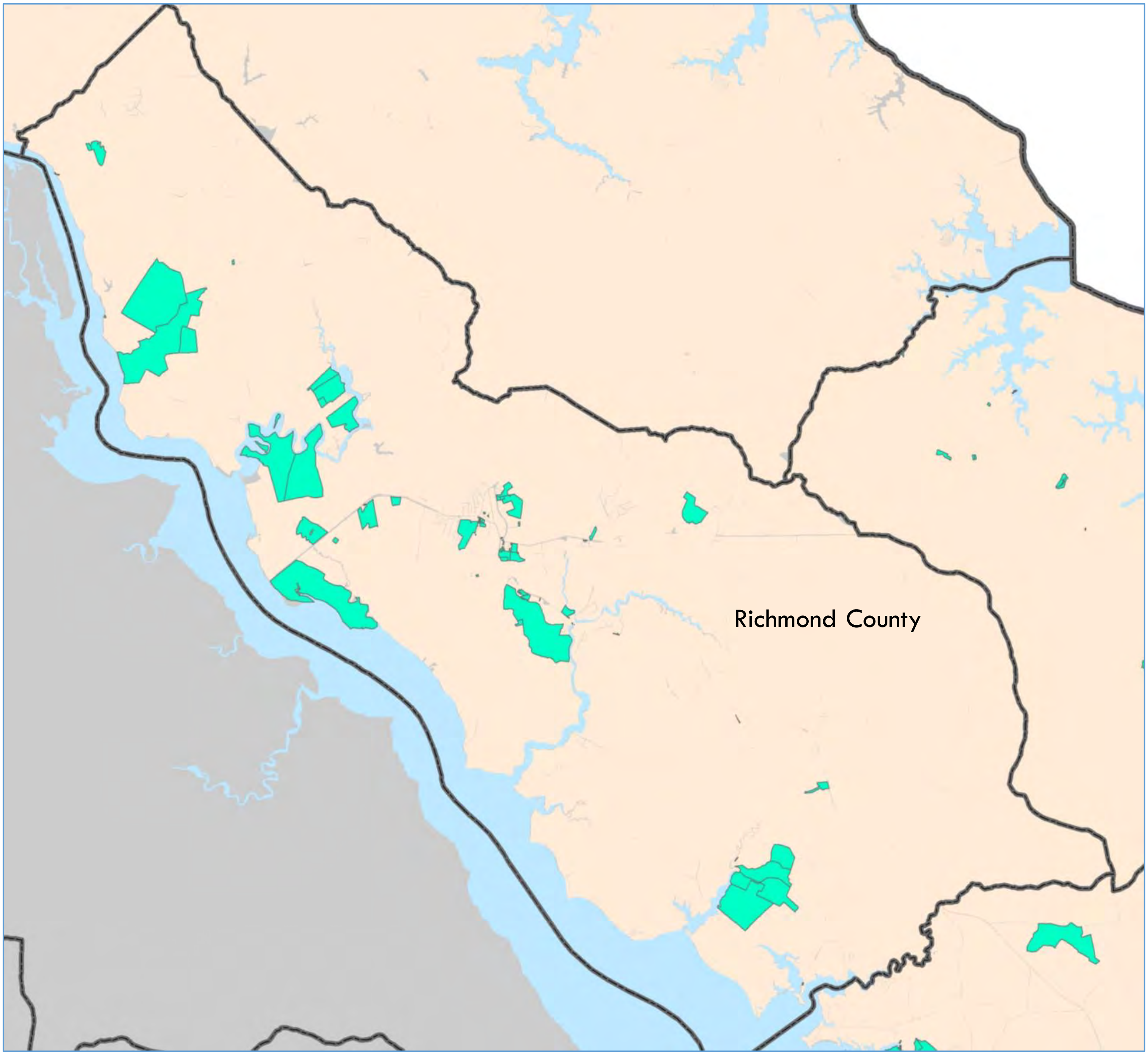
Virginia Coastal Zone MANAGEMENT PROGRAM

MIDDLE PENINSULA PLANNING DISTRICT COMMISSION

Publicly Owned Lands in Richmond County



Legend

Northern Neck Region

Publicly Owned Land

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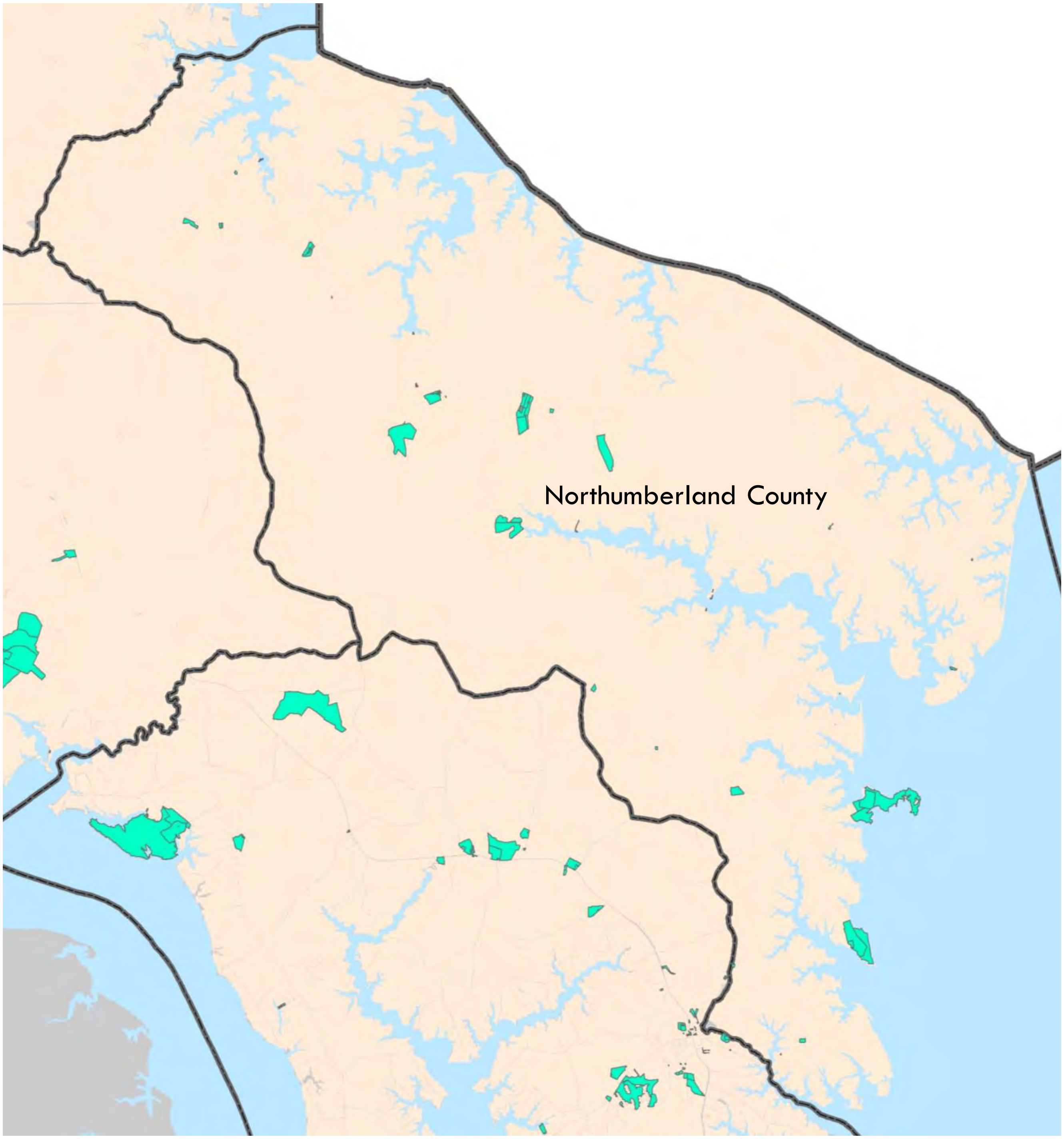
Publicly Owned Lands in Northumberland County



Legend

Northern Neck Region

Publicly Owned Land

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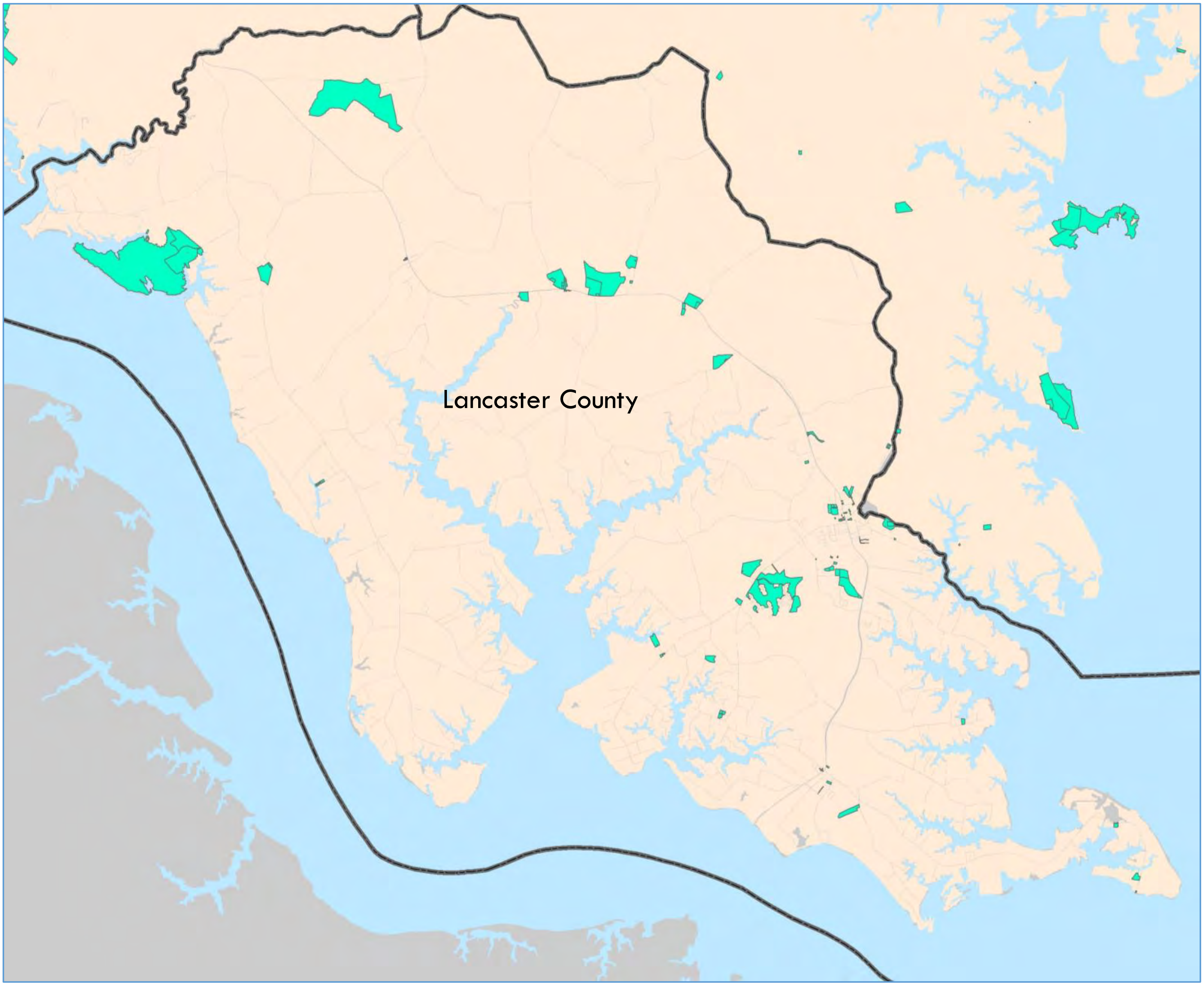
Virginia Coastal Zone MANAGEMENT PROGRAM

MIDDLE PENINSULA PLANNING DISTRICT COMMISSION

Publicly Owned Lands in Lancaster County



Legend

Northern Neck Region

Publicly Owned Land

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Virginia Coastal Zone MANAGEMENT PROGRAM

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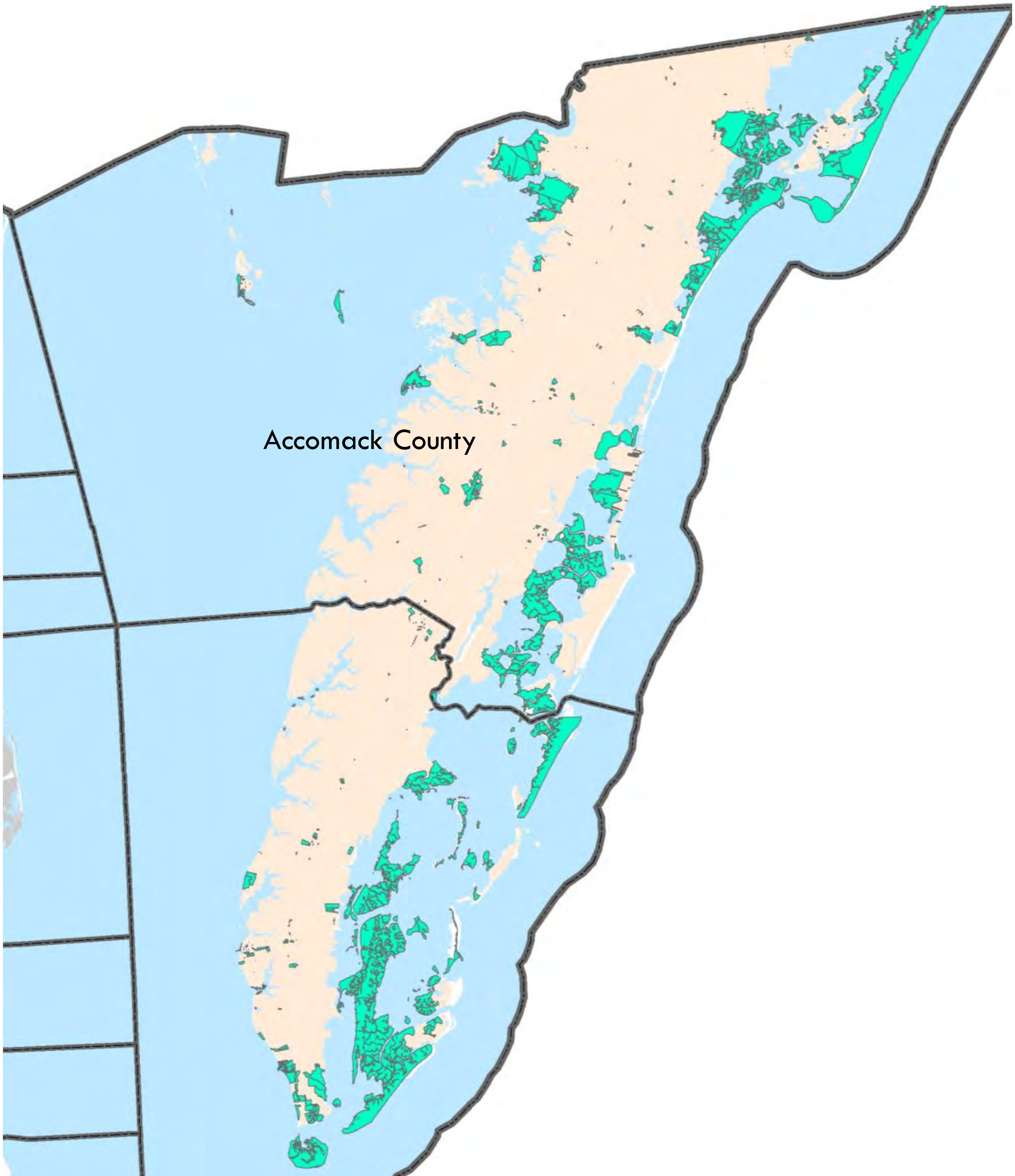
MIDDLE PENINSULA PLANNING DISTRICT COMMISSION

Publicly Owned Lands in the Eastern Shore Region of Virginia



Legend

Eastern Shore Region

Publicly Owned Land

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Virginia Coastal Zone MANAGEMENT PROGRAM

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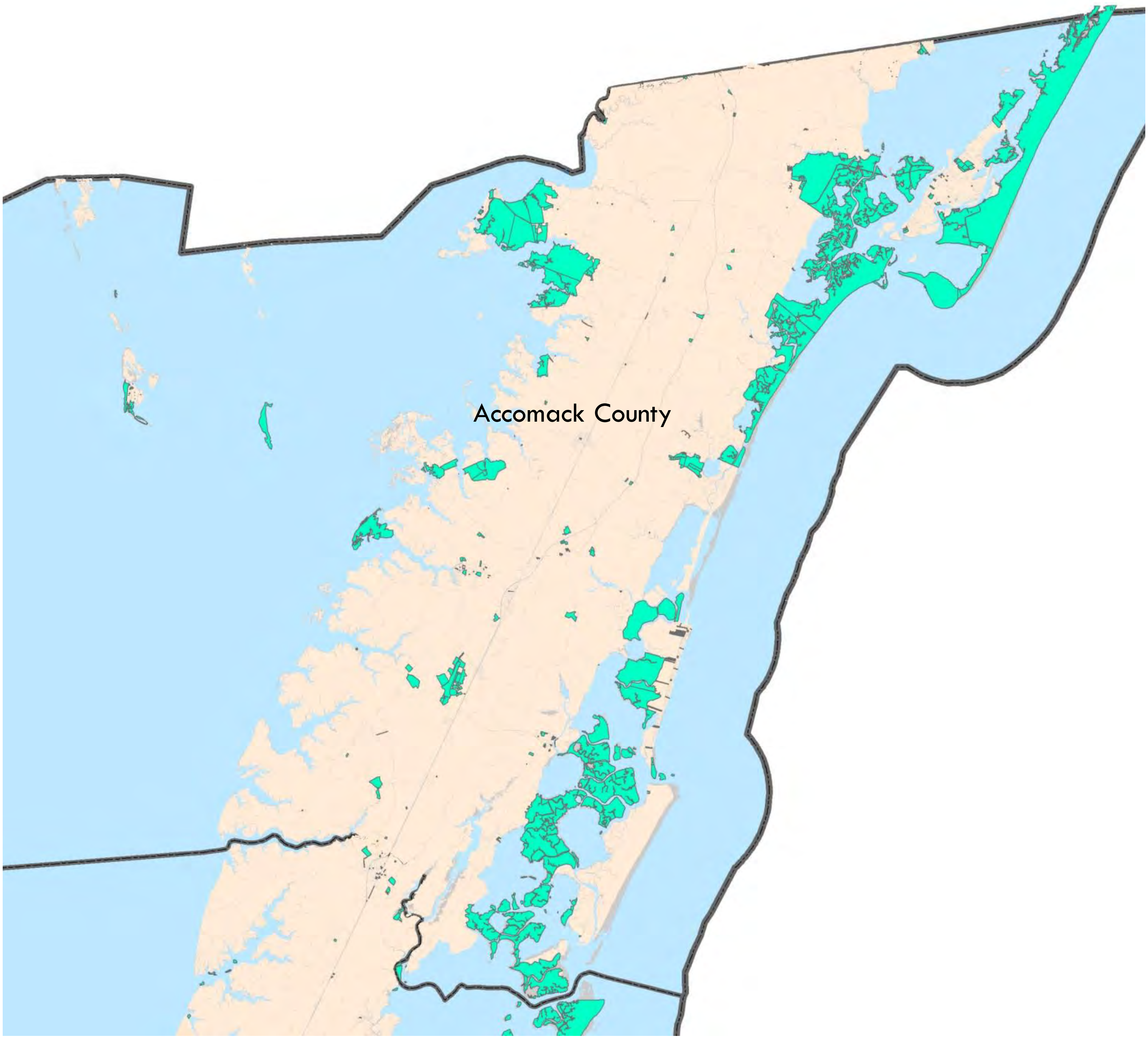
MIDDLE PENINSULA PLANNING DISTRICT COMMISSION

Publicly Owned Lands in Accomack County



Legend

Eastern Shore Region

Publicly Owned Land

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Virginia Coastal Zone MANAGEMENT PROGRAM

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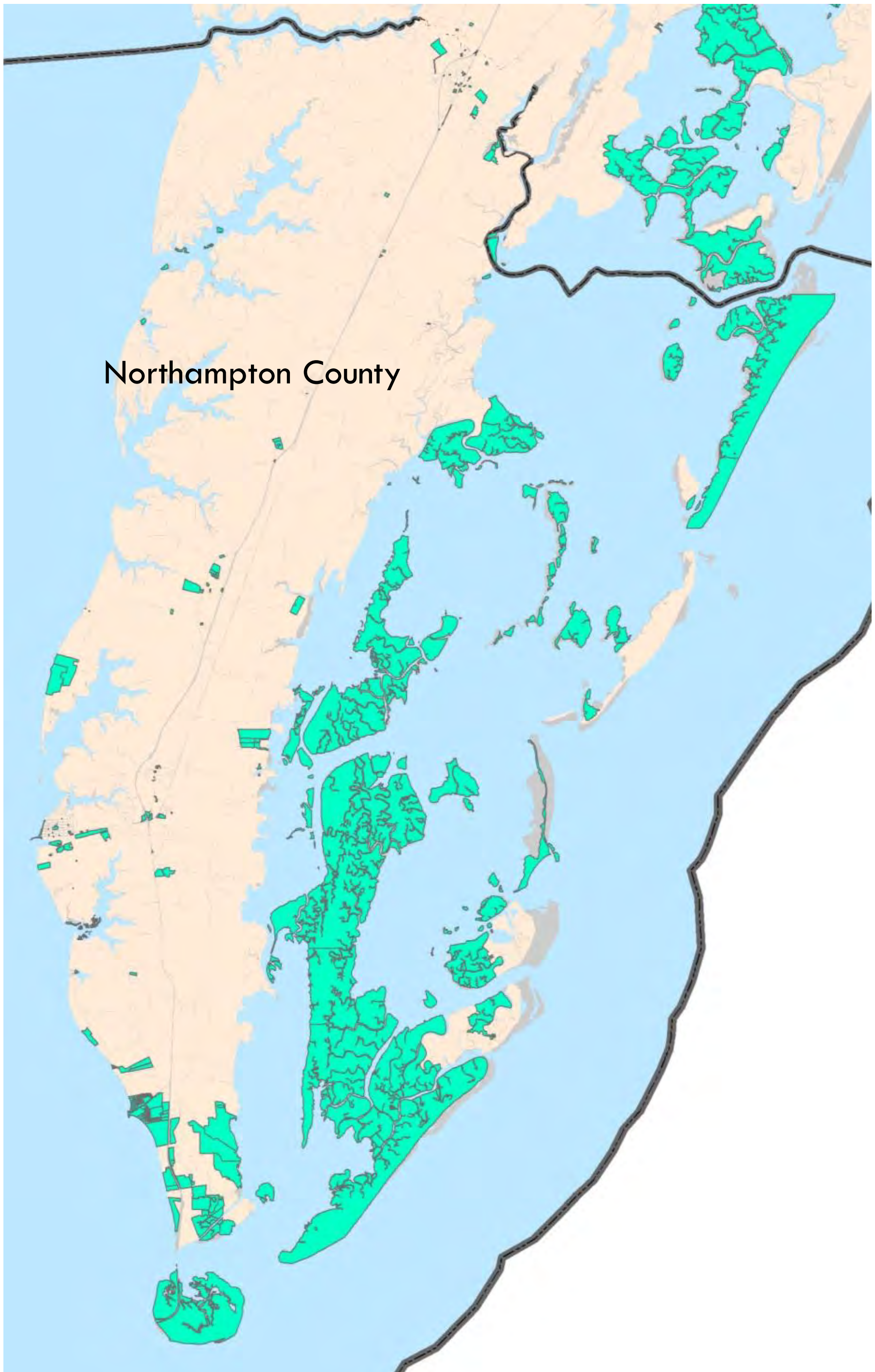
MIDDLE PENINSULA PLANNING DISTRICT COMMISSION

Publicly Owned Lands in Northampton County



Legend

Eastern Shore Region

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MIDDLE PENINSULA PLANNING DISTRICT COMMISSION