Prepared in cooperation with the U.S. Department of Transportation
Federal Highway Administration

Borehole Sampling of Surficial Sediments in Northern Virginia and Southern Maryland

Open-File Report 2021–1038

U.S. Department of the Interior
U.S. Geological Survey

Cover. U.S. Geological Survey drill operators extract a sediment core from the field site at Algonkian Regional Park in Sterling, Va. Photograph by Jessica DeWitt, U.S. Geological Survey.

Borehole Sampling of Surficial Sediments in Northern Virginia and Southern Maryland

By Peter G. Chirico, Jessica D. DeWitt, and Sarah E. Bergstresser

Prepared in cooperation with the U.S. Department of Transportation
Federal Highway Administration

Open-File Report 2021–1038

U.S. Department of the Interior
U.S. Geological Survey

U.S. Geological Survey, Reston, Virginia: 2021

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment—visit https://www.usgs.gov or call 1–888–ASK–USGS.

For an overview of USGS information products, including maps, imagery, and publications, visit https://store.usgs.gov/.

Suggested citation:
Chirico, P.G., DeWitt, J.D., and Bergstresser, S.E., 2021, Borehole sampling of surficial sediments in Northern Virginia and Southern Maryland: U.S. Geological Survey Open-File Report 2021–1038, 27 p., https://doi.org/10.3133/ofr20211038.

Associated data release:
Chirico, P.G., DeWitt, J.D., and Bergstresser, S.E., 2021, Datasheets associated with borehole sampling of surficial sediments in Northern Virginia and Southern Maryland conducted by the U.S. Geological Survey for the Federal Highways Administration Turner-Fairbanks Research Center In Situ Scour Testing Device: U.S. Geological Survey data release, https://doi.org/10.5066/P9A8G5LQ.

ISSN 2331–1258 (online)

Acknowledgments

This work was conducted in cooperation with the U.S. Department of Transportation Federal Highway Administration.

The authors would like to recognize Gene Cobbs, Jeff Grey, Bryan Landacre, Keith Moody, Robert Leininger, Greg Lutwack, and Derek Kragenbrink for assistance in drilling the boreholes, and Thomas Cronin, Ronald Litwin, David Powars, and Stephen Schindler for geologic assistance of the borehole sampling.

Contents

Figures

Tables

Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)

Abbreviations

ASTM	American Society for Testing and Materials
EGPSC	Eastern Geologic and Paleoclimate Science Center
FBGC	Florence Bascom Geoscience Center
FHWA	Federal Highway Administration
ft	foot
ISTD	in situ scour testing device
lb	pound
mm	millimeter
NAIP	National Agriculture Imagery Program
SPT	standard penetration test
TFHRC	Turner-Fairbank Highway Research Center
USGS	U.S. Geological Survey
VDMR	Virginia Division of Mineral Resources

Borehole Sampling of Surficial Sediments in Northern Virginia and Southern Maryland

By Peter G. Chirico,[1] Jessica D. DeWitt,[1] and Sarah E. Bergstresser[2]

Abstract

From 2014 to 2017, the U.S. Geological Survey's Florence Bascom Geoscience Center (FBGC) entered into an inter-agency agreement with the Federal Highway Administration's Turner-Fairbank Highway Research Center (TFHRC) to assist in field site selection and auger drilling fieldwork. The TFHRC was developing a device to measure the erosional properties of clay-rich sediments to be used for in situ testing at locations of bridge pier construction. FBGC scientists selected 15 drilling locations at 14 different field sites across Northern Virginia and Southern Maryland for the investigation of near-surface sediment properties and the development and testing of the TFHRC's in situ scour testing device (ISTD). This report provides information about the project and summarizes the data collected during fieldwork including sediment descriptions of the borehole cores and the methods used during fieldwork.

Introduction

The U.S. Geological Survey's (USGS) Florence Bascom Geoscience Center (FBGC), formerly the Eastern Geologic and Paleoclimate Science Center (EGPSC), conducted an auger drilling fieldwork study to investigate the sedimentological and engineering properties of different layers of the near-surface sediment column, up to a maximum depth of 60 feet below the surface. Previous work by the FBGC includes a wide range of diverse geologic projects, from the acquisition of shallow samples of loose sediment in marshlands to 1,640-feet-deep sampling of consolidated rock. Due to this diverse expertise and experience, an interagency agreement was formed between the FBGC and the U.S. Department of Transportation Federal Highway Administration (FHWA) to explore the development of new equipment to perform in-situ measurements of erosion rates for clay-rich sediments. From 2014 to 2017, 14 field sites were established within Accomack, Fairfax, and Loudoun Counties in Virginia, and Charles, Calvert, and Queen Anne's Counties in Maryland. Fifteen drilling locations were identified within these 14 field sites (fig. 1); more than 1 drilling location was selected at the FHWA's Turner-Fairbank Highway Research Center (TFHRC) field site and the Meadowood Recreation Area field site. Drilling locations at these field sites were labeled by the field site name followed by a number to indicate each drilling location (for example, Meadowood 1 and Meadowood 2). Where sediment and clay layers were found to be favorable for FHWA project objectives, multiple boreholes were drilled (a few feet apart) at the same drilling location. In these instances, the word "core" is followed by a number indicating the core number (for example, TFHRC 1 core 1 and TFHRC 1 core 2). Ultimately, 27 boreholes were drilled to allow for adequate testing of surficial sediments and FHWA equipment. Table 1 provides an overview that shows the drilling location number, date(s), park name or area containing the field site (followed by the drilling location name), number of cores drilled, maximum borehole depth, in situ scour testing device (ISTD) tested (yes or no), and the city and State of each drilling location. This report describes the methods and summarizes sediment descriptions performed during this fieldwork. The datasets collected, including site locations, data tables, and sediment profiles in graphic form are published in the data release associated with this report (Chirico and others, 2021).

[1]U.S. Geological Survey.

[2]Natural Systems Analysts, Inc., under contract to the U.S. Geological Survey.

Table 1. Summary of drilling location information.

[Where preliminary core logs were collected, data are from Chirico and others (2021). Data collected from the Oak Hall core was published in Mixon (1985); and the core log, core location, and preliminary lithologic information for the Queenstown quadrangle were published in Hess (1977). ISTD, in situ scour testing device; Md., Maryland; no., number; TFHRC, Turner-Fairbank Highway Research Center; Va., Virginia]

Drilling location no.	Drilling date(s)	Park or area name containing (or near) field site (drilling location name in parenthesis)	Number of cores drilled	Maximum borehole depth, in feet	ISTD tested?	Drilling location (City, State)
1	07/29/2014	Bennsville (Bennsville)	1	40	No	Bennsville, Md.
2	05/05/2015 to 05/08/2015	TFHRC (TFHRC 1)	1	30	No	McLean, Va.
3	05/14/2015 to 05/29/2015	TFHRC (TFHRC 2)	1	30	Yes	McLean, Va.
4	06/22/2015 to 06/25/2015	Difficult Run Stream Valley Park (Difficult Run)	1	15	No	Great Falls, Va.
5	06/22/2015 to 06/25/2015	Oak Hall (Oak Hall)	1	70	No	Oak Hall, Va.
2	07/2015	TFHRC (TFHRC 1)	1	Unknown	No	McLean, Va.
3	07/2015	TFHRC (TFHRC 2)	1	Unknown	Yes	McLean, Va.
6	08/04/2015 to 08/05/2015	Janelia (Janelia)	2	20	No	Ashburn, Va.
7	08/11/2015 to 08/12/2015	Moran Landing (Moran Landing)	1	65	No	Lusby, Md.
8	09/23/2015 to 10/02/2015	Algonkian Regional Park (Algonkian)	1	20	Yes	Sterling, Va.
9	10/26/2015	Queenstown Harbor Golf (Queenstown)	1	70	No	Queenstown, Md.
10	11/13/2015	Foxboro (Foxboro)	1	59	Yes	Bennsville, Md.
8	07/2016 to 08/2016	Algonkian Regional Park (Algonkian)	1	20	Yes	Sterling, Va.
10	07/18/2016 to 07/26/2016	Foxboro (Foxboro)	1	Unknown	Yes	Bennsville, Md.
11	09/02/2017, 09/05/2017	Huntley Meadows Park (Huntley Meadows)	2	50	Yes	Alexandria, Va.
12	09/03/2017, 09/07/2017	Grist Mill Park (Grist Mill)	2	50	Yes	Alexandria, Va.
13	09/04/2017, 09/08/2017	Muddy Hole Farm Park (Muddy Hole)	2	35	Yes	Alexandria, Va.
14	10/24/2017	Meadowood Recreation Area (Meadowood 1)	1	31	No	Lorton, Va.
15	10/25/2017, 10/27/2017	Meadowood Recreation Area (Meadowood 2)	2	45	Yes	Lorton, Va.
8	10/26/2017	Algonkian Regional Park (Algonkian)	1	5	Yes	Sterling, Va.
8	11/06/2017, 11/07/2017	Algonkian Regional Park (Algonkian)	2	20	Yes	Sterling, Va.

Background

Historically, bridge scour is a leading cause of bridge failures (Wang and others, 2017; Deng and Cai, 2010). Current methods of predicting scour depths around bridge piers typically involve equations derived from physical model studies using non-cohesive, uniformly graded sands (Deng and Cai, 2010). However, sediments found beneath bridge piers are diverse, ranging from resistant rock to unconsolidated coarse sediment. That these equations are used for all sediment types in bridge pier construction means that they represent worst-case scenarios, as non-cohesive sands are highly erodible (Schuring and others, 2012). Many factors affect the susceptibility of sediments to scour, including sediment grain size, texture heterogeneity, permeability, water content, compaction, mineral cementation, and weathering. Therefore, direct on-site measurement of these factors is valuable since the removal of sediment samples from the field sites often introduces uncontrollable variations that may hinder laboratory testing (Hansen, 1990). Little information is available to evaluate scour in non-erodible sediments, so engineering experience is required to quantify the reduction in scour using the equations. Therefore, estimates are typically conservative, resulting in unnecessarily deep and expensive pier foundations.

FHWA's TFHRC is conducting research to develop an ISTD to determine site-specific sediment characteristics for scour prediction. This device measures erosion of fine-grained subsurface cohesive sediments with the use of drilling equipment and flowing water. To test the prototype ISTD, field trials were performed in boreholes created by a drill rig. The ISTD was put within the borehole equipment to test the device's ability to measure the erodibility of sediments. These trials allowed the TFHRC team to validate the ISTD concept, test the device's practicality, and experiment with improvements to its functionality. The USGS's FBGC identified appropriate field sites for testing based on TFHRC criteria, and then provided preliminary sediment sampling, equipment, expert staff, and flexible scheduling procedures necessary for research and development of the ISTD.

Field Site Selection

Field sites were identified in Northern Virginia and Southern Maryland to reduce the transportation distances necessary for USGS and FHWA equipment and scientists. Due to the geology of the region, most field sites were selected above the alluvial floodplain on exposed paleo-sedimentary surficial stratigraphic units. Between July 2014 and November 2017, 14 different field sites were selected within the counties of Accomack, Fairfax, and Loudoun in Virginia, and Charles, Calvert, and Queen Anne's in Maryland. One or more drilling locations were identified at each of these field sites. The map in figure 1 shows the 14 field sites, and figures 2 and 3 show the drilling locations compared to orthoimagery.

Surficial Geology

The goal of the field site selection process was to find publicly accessible areas that contained one or more clay-rich layers of sediment in the top 30 ft of the soil and sediment column. The geomorphology and surficial geology layers of the Fairfax and eastern Loudoun region are heavily influenced by the migrating drainage of the Potomac River, and clay-rich sediments are commonly found in the floodplain, paleochannels, and low terraces of this drainage system. The remaining field sites are located within the Coastal Plain region, characterized by deposits of unconsolidated sand, gravel, and clay.

Each of the field sites was overlain on geologic maps to determine the likely composition of the sediment column, and specifically the potential presence of clay or fine sediment deposits in that column (fig. 4, fig. 5, and fig. 6). Based on these geologic maps, the Foxboro and Meadowood field sites are located in areas that could be characterized by multiple deposits, depending on the exact drilling location. Most of the other field sites (Algonkian, Bennsville, Difficult Run, Janelia, Moran Landing, and Foxboro) are located in large areas of alluvium deposits. The alluvium deposits are characterized by light- to medium-gray and yellowish-gray, fine to coarse gravelly sand and sandy gravel, silt, and clay. Particles mainly consist of vein quartz, quartzite, and other metamorphic rocks. The Grist Mill field site is located in the Sedgefield Member of the Tabb Formation (upper Pleistocene), which is characterized by an upward fining sequence of gravelly sand, silt, and clay. The upper third of the sequence is mainly tan to orange, poorly to well sorted, fine to coarse sand; the lower two-thirds is mainly gray to olive, poorly sorted silty clay; and the base is olive-gray pebbly sand. Drilling locations for the Huntley Meadows, Muddy Hole, and Foxboro field sites were selected within the Shirley Formation. This sequence generally includes at least three of the following sediment types: (1) light-gray to white, medium- to coarse-sand that is thick-bedded, coarsely stratified, and often oxidized bright yellow or orange; (2) light- to medium-gray sand, interbedded with thin silt and clay beds, that is thin bedded and often contains wood fragments and thin beds of limonite; (3) light-gray or greenish-gray sandy clay and silt with scattered pebbles, cobbles, and limonite-filled root tubes; or (4) orange-brown fine- to coarse-sand that includes pebble- to cobble-gravel. The Meadowood field sites have multiple geologic units, so the selected drilling locations are characterized by the Bacons Castle Formation. This formation is composed of sandy gravel and feldspathic quartz sand with basal beds that are mainly quartz, quartzite, and to a lesser extent chert and sandstone cobble and gravel. It is also possible that the Meadowood 2 drilling location is part of the Potomac Formation, which is characterized by (1) very light gray to pinkish-gray, medium to very coarse feldspathic quartz sand; (2) green montmorillonite-illite clay and clayey sand; and (3) dark-yellowish-brown to olive-gray lignitic sandy silt and clay that often contains poorly preserved leaf and stem impressions of ferns, cycads, and gymnosperms and silicified tree trunks. Finally, both drilling locations at the TFHRC field site are located within medium- to coarse-grained, massive to foliated biotite-hornblende tonalite that contains many ultramafic and mafic xenoliths and (or) autoliths, and metasedimentary rock xenoliths (McCartan and others, 1996; Southworth and others, 2007; Lyttle and others, 2017).

Although 1:100,000-scale USGS geologic maps were not available for the Oak Hall and Queenstown field sites, the 1:500,000-scale geologic map of Virginia and the 1:250,000-scale geologic map of Maryland were used for generalized descriptions of the surficial geology. The sediment at the Oak Hall field site is part of the Kent Island Formation, characterized by medium- to coarse-grained sand and sandy gravel grading upward into poorly to well-sorted, fine- to medium-grained clayey and silty sand (Virginia Division of Mineral Resources, 1993). The Queenstown field site is located in lowland deposits composed of medium- to coarse-grained sand and gravel, with varied-colored silts and clays, brown to dark-gray lignitic silty clay, and cobbles and boulders near the base of the deposits. Lowland deposits also commonly contain Eocene glauconite and estuarine to marine fauna in some places (Cleaves and others, 1968).

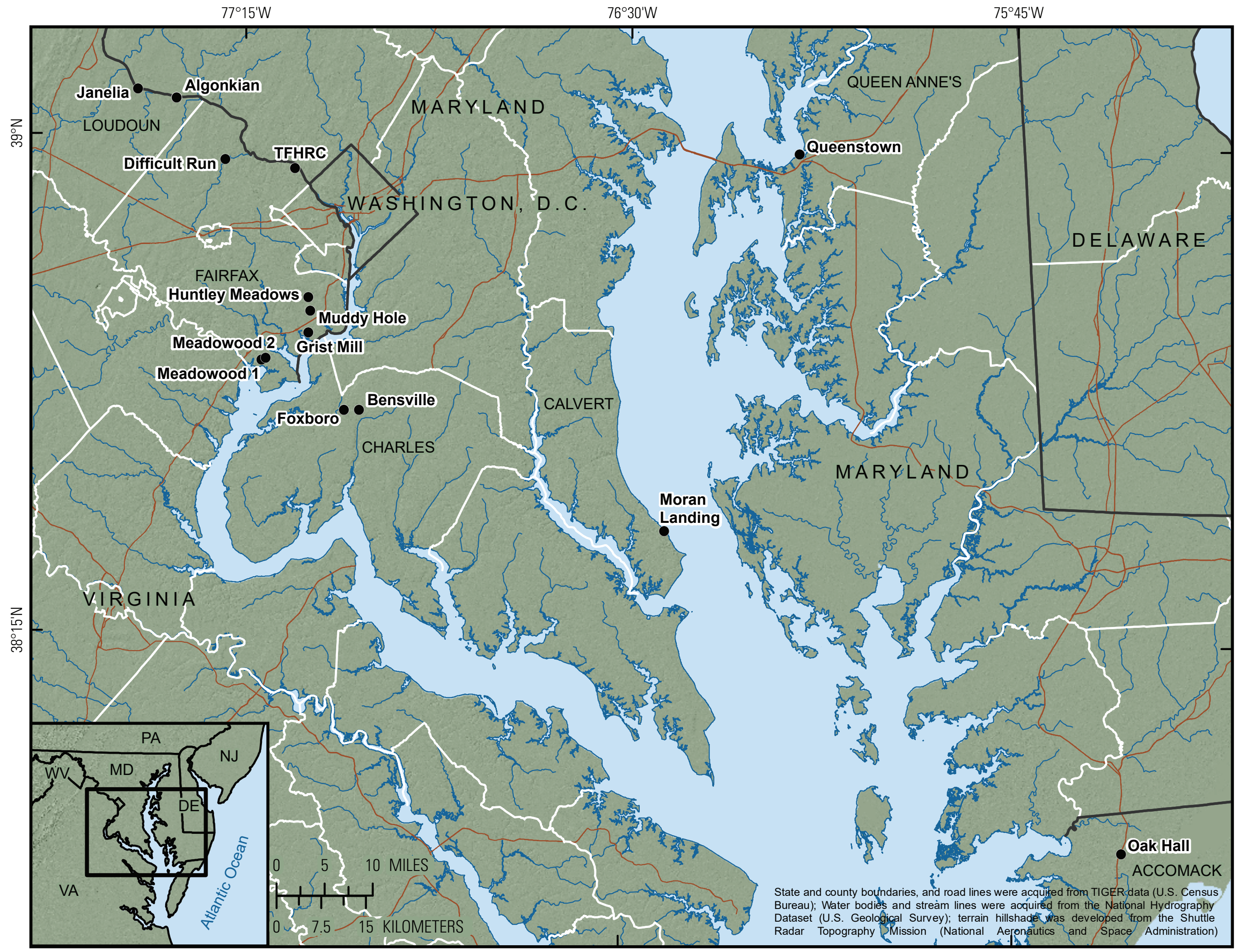

Figure 1. Map showing the 14 selected field sites located in Northern Virginia and Southern Maryland.

Figure 2. Digital orthophoto imagery of selected drilling locations in Northern Virginia. Each drilling location is named after the field site. Where multiple drilling locations were selected within a single field site, the name is appended by a number. The imagery of the Janelia, Algonkian, and Difficult Run drilling locations was acquired on July 11, 2016; the imagery of the TFHRC drilling locations was acquired on July 18, 2016; the imagery of the Huntley Meadows, Muddy Hole, and Grist Mill drilling locations was acquired on September 27, 2014; and the imagery of the Meadowood 2 drilling location was acquired on August 26, 2014. Imagery is from the National Agriculture Imagery Program (NAIP).

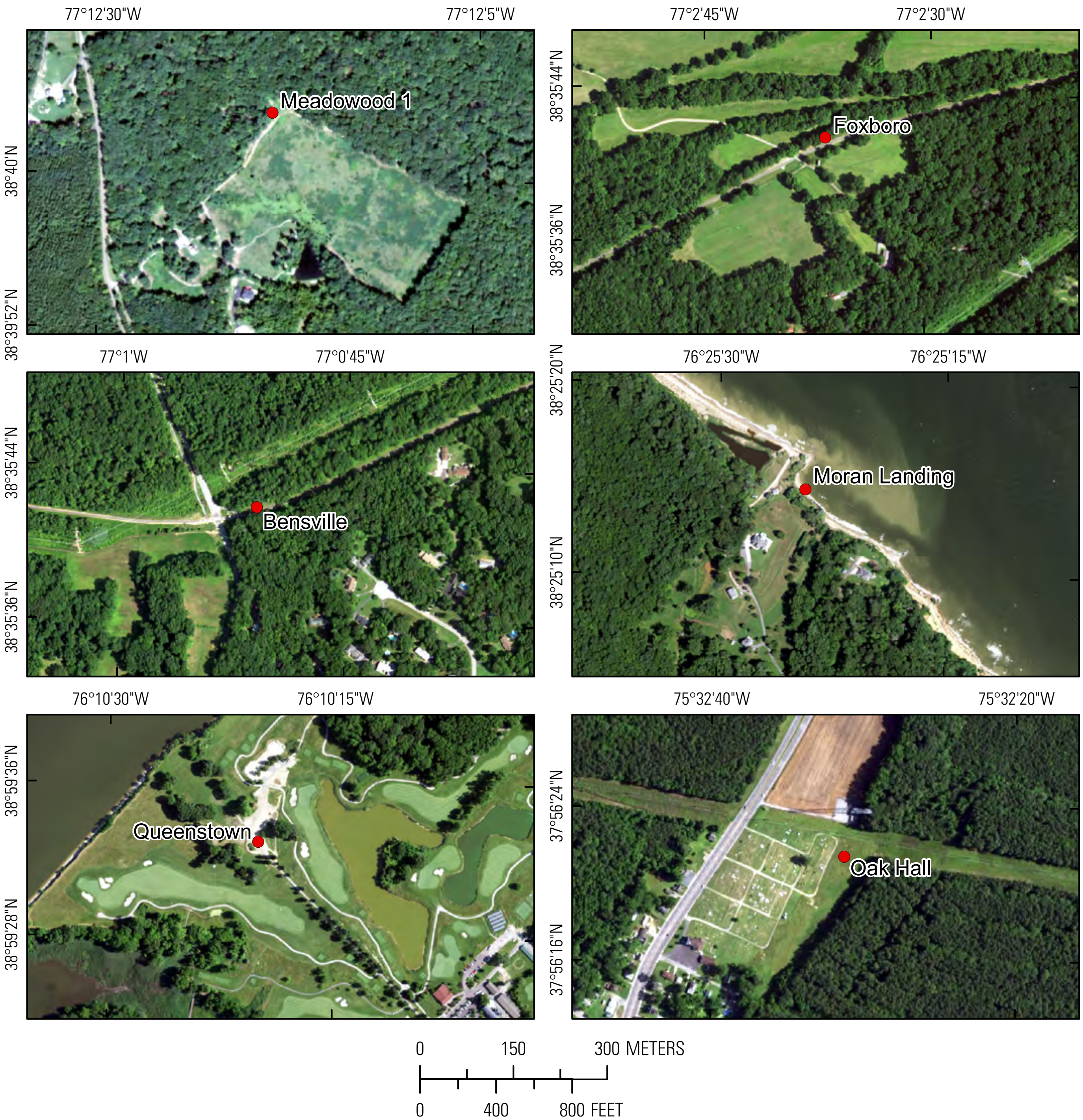

Figure 3. Digital orthophoto imagery of selected drilling locations in Northern Virginia and Southern Maryland. Each drilling location is named after the field site. Where multiple drilling locations were selected within a single field site, the name is appended by a number. The imagery of the Meadowood 1 drilling location was acquired on August 26, 2014; the imagery of the Foxboro and Bennsville drilling locations was acquired on July 16, 2017; the imagery of the Moran Landing drilling location was acquired on July 30, 2017; the imagery of the Queenstown drilling location was acquired on June 11, 2017; and the imagery of the Oak Hall drilling location was acquired on June 26, 2016. Imagery is from the National Agriculture Imagery Program (NAIP).

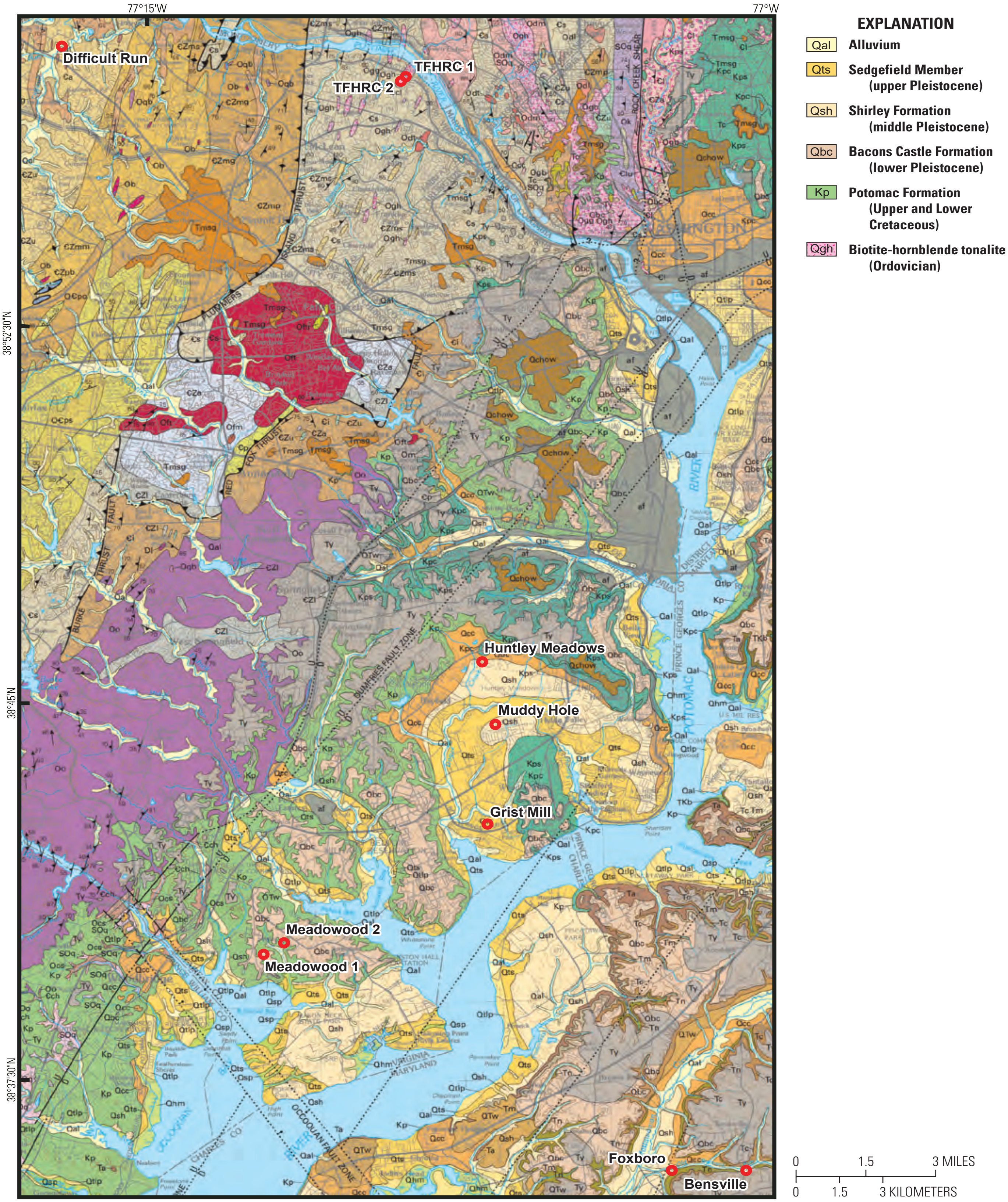

Figure 4. Map showing the Difficult Run, TFHRC 1 and TFHRC 2, Huntley Meadows, Muddy Hole, Grist Mill, Meadowood 1 and Meadowood 2, Foxboro, and Bennsville drilling locations overlaid on part of the U.S. Geological Survey's geologic map of the Washington West 30' x 60' quadrangle (Lyttle and others, 2017). Geologic units shown in the legend are for the purposes of this report. For a complete explanation of map and unit symbols see Lyttle and others (2017).

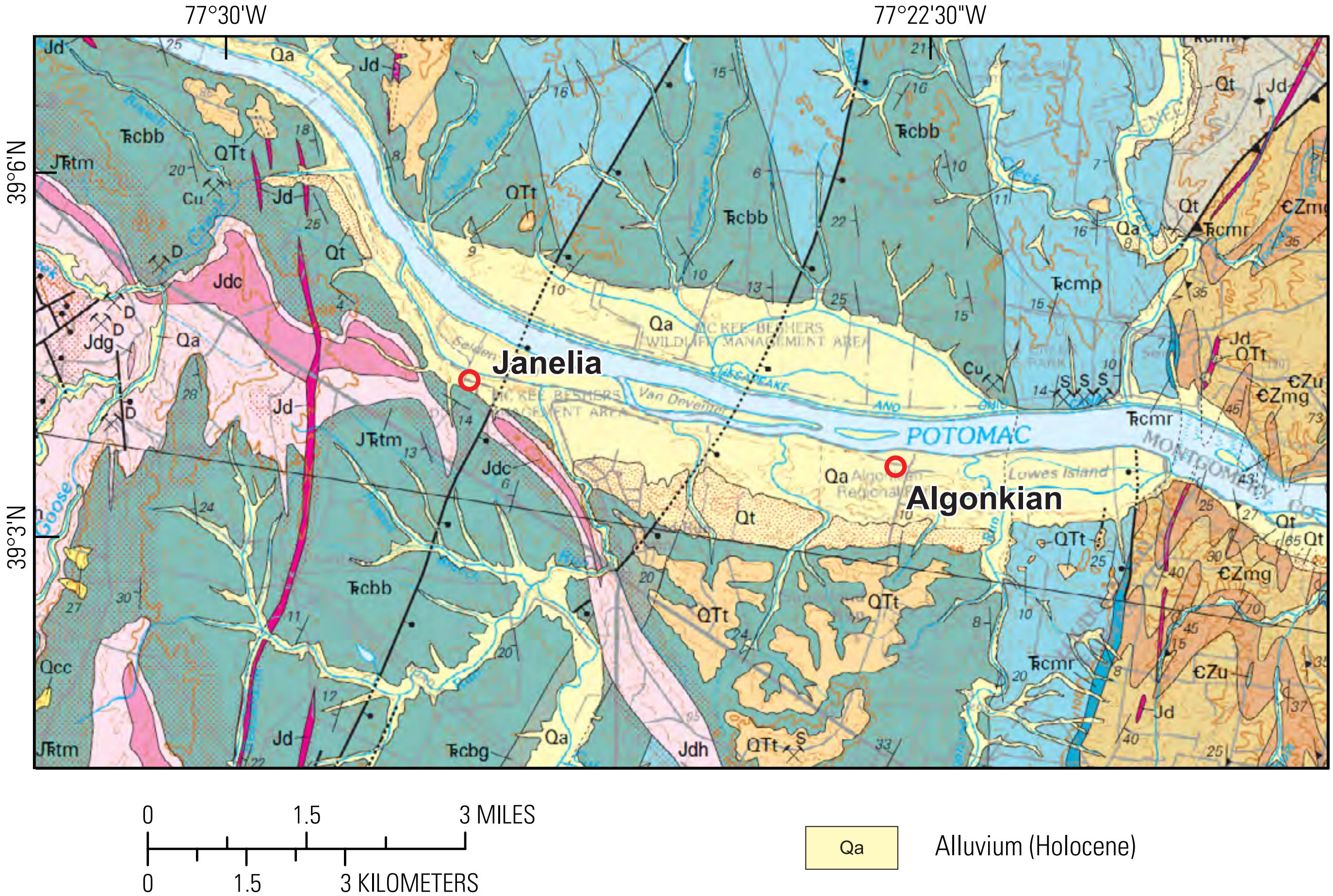

Figure 5. Map showing the Janelia and Algonkian drilling locations overlaid on part of the U.S. Geological Survey's geologic map of the Frederick 30′ x 60′ quadrangle (Southworth and others, 2007). The geologic unit shown in the legend is for purposes of this report. For a complete explanation of map and unit symbols see Southworth and others (2007).

Methods

At each drilling location, the USGS team bored continuous cores using 4.25-inch diameter hollow stem augers (fig. 7, fig. 8). The boreholes were drilled to various depths depending on the requirements for testing and refining the ISTD. Preliminary field logs describing the characteristics of the sediment of the cores were provided to the FHWA team prior to testing the ISTD at 11 of the 14 field sites (fig. 9). The ISTD was utilized at 12 of the 15 drilling locations (fig. 10). Boreholes at the other 7 drilling locations were conducted for ISTD refinement, testing, or field configuration; or represented sites that were not suitable for the use of the ISTD.

Field logs were created for 9 of the 14 field sites to record soil characteristics observed in the extracted cores. Detailed descriptions were made of 6 boreholes drilled in 2017, including characteristics of soil color, grain size, percentage of gravel/sand/fines, grain angularity, grading and sorting, water content, plasticity, and sediment classification for each sample increment (fig. 9). More information is provided about the methods used to collect these observations in the following section.

Sample Collection

A 4.25-inch diameter hollow stem auger was used to collect a 3.5-inch diameter continuous sediment core in order to sample sedimentary layers at the drilling locations (fig. 7). Extraction of the sediment core occurred in 5-ft increments, corresponding to the length of each auger section. At the 2017 drilling locations, prior to extraction of each 5-ft increment, a standard penetration test (SPT) was conducted using a SPT spoon and the drill rig's 140-lb autohammer, and was recorded as the blow count per 6 inches over an 18-inch depth. The SPT was not conducted on the sample's first 5-ft increment due to the presence of topsoil, bioturbation, and other sedimentary inconsistencies. These 6-inch blow counts were used to calculate an N-value, where the N-value = $BlowCount_{6''-12''} + BlowCount_{12''-18''}$. The first 6 inches of blows are considered necessary to seat the SPT spoon in the correct layer of sediments.

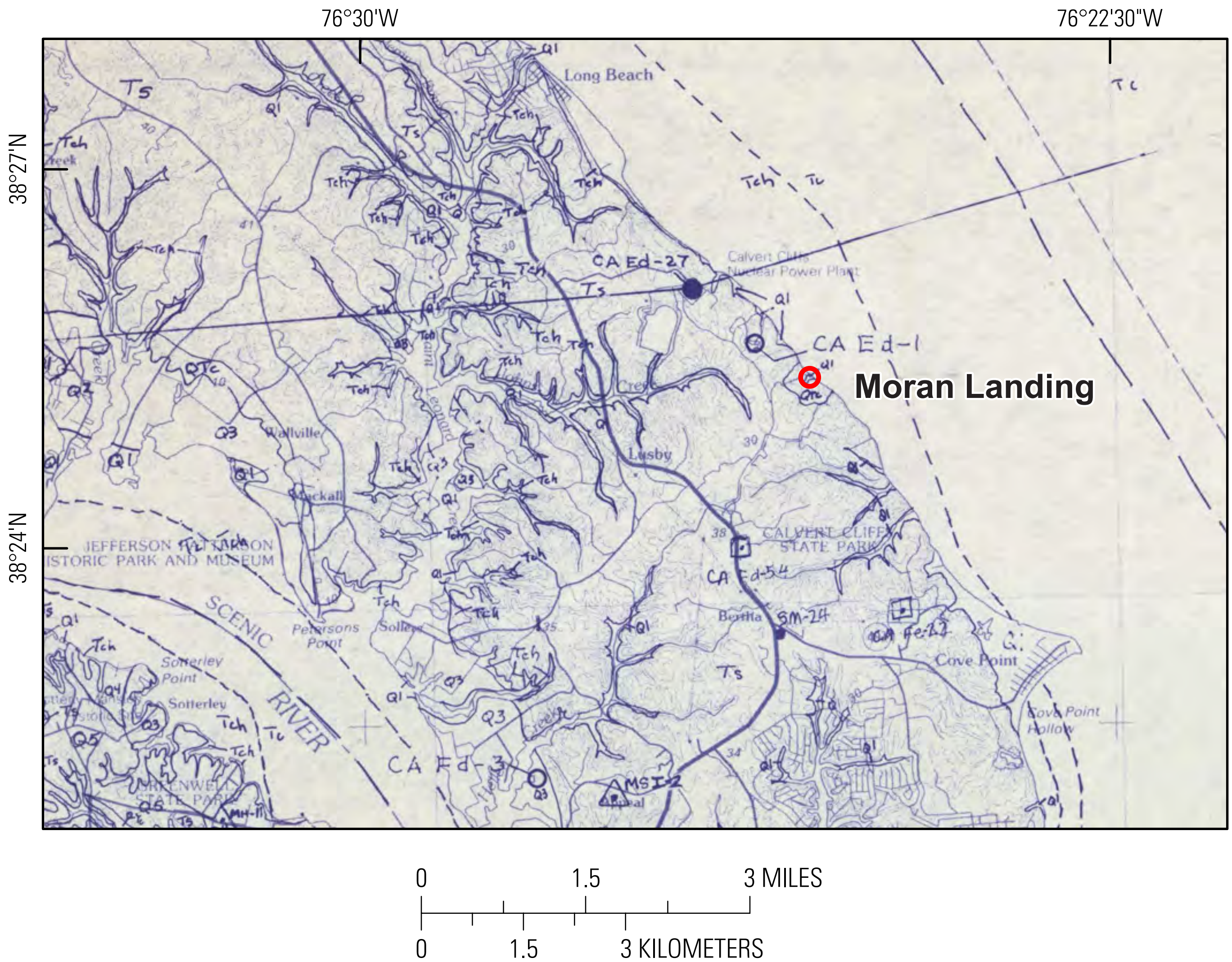

Figure 6. Map showing the Moran Landing drilling location overlaid on part of the U.S. Geological Survey's geologic map of the Leonardtown 30′ x 60′ quadrangle (McCartan and others, 1996). For a complete explanation of map and unit symbols see McCartan and others (1996).

The final N-value is a measure of penetration resistance, indicative of the density and plasticity of the soil at depth. The results of the SPT were provided to the FHWA team prior to ISTD testing to indicate the geotechnical engineering properties of the soil.

Following extraction using the hollow-stem auger spoon, each 5-ft increment of the continuous core (at the 2017 drilling locations) was removed from the auger (fig. 8), photographed, and a series of sediment characteristics including color code, grain size, percentage of gravel/sand/fines, grain angularity, grading/sorting, water content, plasticity, and sediment classification were described at each interval of visual change in sediment characteristics (fig. 9). Details regarding the observation of sediment characteristics are provided in table 2.

The length of the recovered core was also recorded, and in many cases the length was less than the length of the 5-ft auger spoon due to compression of the soil. To improve the consistency and precision with which these characteristics were recorded, the same USGS team member was tasked with describing the entire core at each drilling location. Following the on-site descriptions, cores were temporarily preserved in boxes to allow for a follow-up analysis.

Table 2. Sample characteristics recorded during the visual analysis of sediment cores.

[cm, centimeters; in., inches; mm, millimeters; %, percent]

Sediment characteristic	Characteristic description and reference
Color code	Color of the sample sediments, based on color swatches in the Globe Professional Soil Color Books (Visual Color Systems, 2015).
Grain size (largest, primary, and secondary)	Size categories (mm) of sediment grains. Categories were based on the Unified Soil Classification System (American Society for Testing and Materials Committee D-18 on Soil and Rock, 2017) but modified to subdivide sand and coarse gravel classes based on Gee and Bauder (1986) and JL Darling LLC (2015). Largest grain size reflects the measurement of the largest sediment occurring in the sample. Primary grain size indicates the most frequently occurring sediment size in the sample. Secondary grain size indicates the second-most frequently occurring sediment size in the sample.
Sediment composition percentages	Percentage of sand, gravel, and fine grain-size categories occurring in the sample, where the percentages for sand, gravel, and fines add up to 100 % (Terry and Chilingar, 1955).
Grain angularity	Degree of angularity of each sediment grain, based on Coe and others (2010).
Sorting	Degree to which grains of similar size and angularity occur next to each other, where a well-sorted sample has sediments of similar size and shape next to each other, and a poorly sorted sample has sediments of substantially different sizes and shapes next to each other, based on the Coe and others (2010).
Water content	Categorized amount of water observed in the sample: (1) where the crumbling sediments are characterized as dry, (2) sediments with open pore water are characterized as saturated, and (3) other sediments are characterized as moist; based on Schoeneberger and others (2002).
Plasticity	The degree to which a handful of the sediment sample and added water may be kneaded together without crumbling into a ribbon. The length of the ribbon prior to its crumbling is indicative of the sediment plasticity. Where the ribbon length is less than 1 in. (2.5 cm), the plasticity is low; where the ribbon length is 1 to 2 in. (2.5 to 5 cm), the plasticity is medium; and where the ribbon length is greater than 2 in. (5 cm), the plasticity is high (Thien, 1979).
Unified Soil Classification System	Names for different categories of soil based on the presence of organics, presence of fines, grain size, and plasticity. The naming system is adopted from the Unified Soil Classification System (U.S. Army Corps of Engineers, Waterways Experiment Station, 1960).

Figure 7. Photograph of a U.S. Geological Survey drill rig operator extracting a 5-ft increment of a continuous sediment core at the Huntley Meadows drilling location in Alexandria, Va. Photograph by Jessica DeWitt, U.S. Geological Survey.

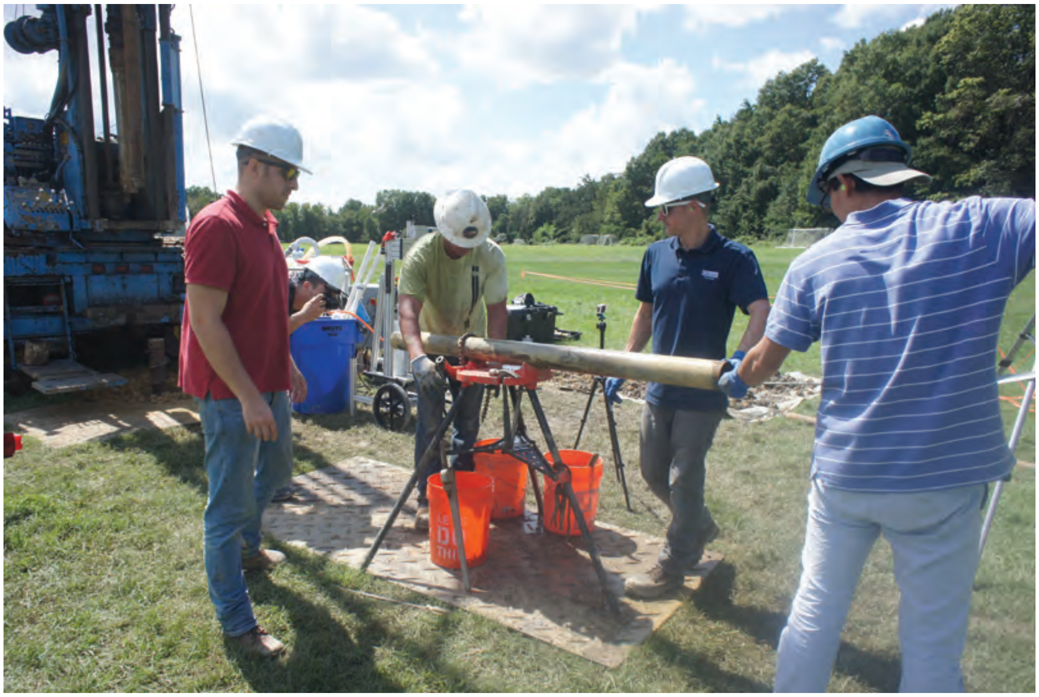

Figure 8. Photograph of a U.S. Geological Survey drill rig operator and Federal Highway Administration researchers opening the auger spoon to observe sediment from a core at the Grist Mill drilling location in Alexandria, Va. Photograph by Peter Chirico, U.S. Geological Survey.

Figure 9. Photograph of a U.S. Geological Survey and Federal Highway Administration researchers observing and describing increments of sediment from a core sample at the Grist Mill drilling location in Alexandria, Va. Photograph by Jessica DeWitt, U.S. Geological Survey.

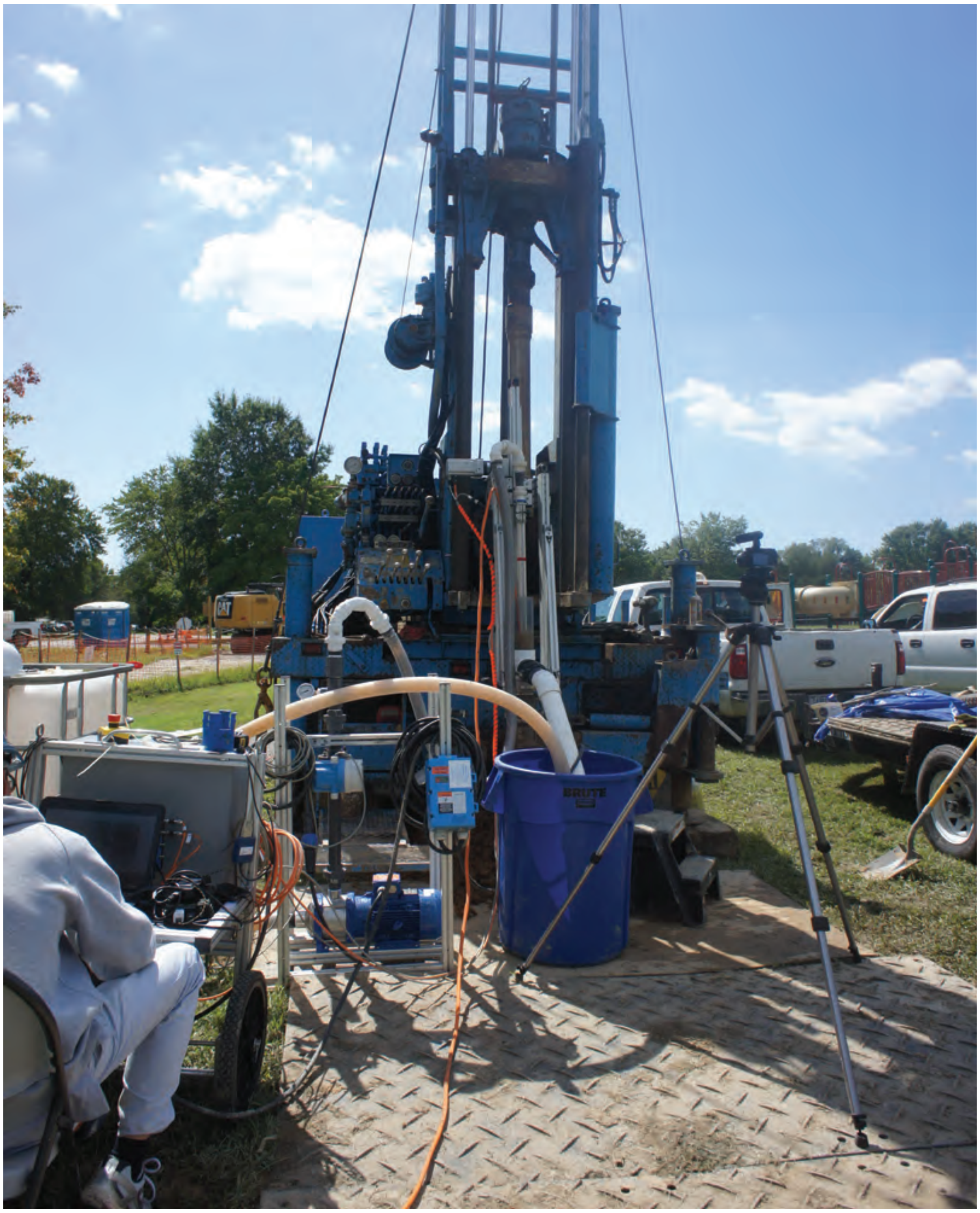

Figure 10. Photograph of the in situ scour testing device (ISTD) being tested at the Muddy Hole drilling location in Alexandria, Va. Photograph by Sarah Bergstresser, Natural Systems Analysts, Inc.

Table 3. Detailed results of U.S. Geological Survey coring activities conducted in support of the FHWA and TFHRC's in situ scour testing device (ISTD) project.

[Core logs and details are available in Chirico and others (2021). Aug., August; FHWA, Federal Highways Administration; FY, fiscal year; ISTD, in situ scour testing device; Mob./demob. days, number of days for mobilization and demobilization; n/r, not recorded; NASA, National Aeronautics and Space Administration; no., number; Nov., November; Prelim., Preliminary; Oct., October; Sept., September; TFHRC, Turner-Fairbank Highway Research Center]

Core no.	Drilling location no.	Core name (drilling location and core number, if applicable)	Year	Month	Beginning drill date	Number of coring days	Mob./demob. days	Description of drilling location	Latitude	Longitude	Depth of core, in feet	Driller(s) and geologist(s), if present, in parenthesis	Summary of bulk lithology of core	Prelim. log recorded?	ISTD status	Photographs taken?
FY 2015																
1	1	Bennsville core 1	2014	July	07/29/2014	2	2	5 miles NNW of La Plata, Md., along Indian Head Trail (Charles County Parks), east of Bennsville Rd. and near Old Woman Creek.	38.595	−77.0141	40	Jeff Grey, Gene Cobbs, Rodney (David Powars)	Marine clay with sandy silt and clay layer, and intervals of leached shell and minor gravels.	No	No ISTD; test drilling was carried out for field configuration, core samples were sent to TFHRC lab.	Yes
2	2	TFHRC 1 core 1	2015	May	05/05/2015	4	1	Turner Fairbanks Highway Research Center (FHWA) in Langley, Va.; NE of the main building at the east end of the test track.	38.9579	−77.1489	30	Jeff Grey (Steve Schindler)	Sandy clay saprolite derived from weathered phyllites; common quartz veins.	No	No ISTD; test drilling was carried out for field configuration.	No
3	3	TFHRC 2 core 1	2015	May	05/14/2015	6	2	Turner Fairbanks Highway Research Center (FHWA) in Langley, Va.; NW of the main building on the knoll above the test track.	38.9572	−77.1504	30	Jeff Grey, Gene Cobbs	Sandy clay saprolite derived from weathered phyllites; sporadic quartz veins.	No	ISTD was utilized onsite.	No
4	4[1]	Difficult Run core	2015	June	06/22/2015	1	1	Difficult Run Park Trail, 450 meters downstream from the Rt. 7 bridge.	38.9688	−77.2834	15	Jeff Grey (Steve Schindler)	River sediment; layers of mostly sandy clayey silt with sporadic gravels.	No	No ISTD.	No
5	5[2]	Oak Hall core	2015	June	06/22/2015	3	2	Oak Hall, Va., 4 miles west of the NASA Wallops Island Test Facility; east of Rt. 13 on the east side of cemetery.	37.9393	−75.542	70	Gene Cobbs, Keith Moody (Tom Cronin, Steve Schindler)	Marine sandy silt and clay with intervals of leached shell.	No	Deferred to ISTD refinement.	Yes
6	2	TFHRC 1 core 2	2015	July	07/2015	4	1	Turner Fairbanks Highway Research Center (FHWA) in Langley Va.; NE of the main building at east end of the test track.	38.9579	−77.1489	n/r	Jeff Grey	Sandy clay saprolite derived from weathered phyllites; common quartz veins.	No	No ISTD; test drilling was carried out for field configuration.	No
7	3	TFHRC 2 core 2	2015	July	07/2015	6	2	Turner Fairbanks Highway Research Center (FHWA) in Langley, Va.; NW of the main building on the knoll above the test track.	38.9572	−77.1504	n/r	Jeff Grey	Sandy clay saprolite derived from weathered phyllites; sporadic quartz veins.	No	ISTD was utilized onsite.	No

Table 3. Detailed results of U.S. Geological Survey coring activities conducted in support of the FHWA and TFHRC's in situ scour testing device (ISTD) project.—Continued

[Core logs and details are available in Chirico and others (2021). Aug., August; FHWA, Federal Highways Administration; FY, fiscal year; ISTD, in situ scour testing device; Mob./demob. days, number of days for mobilization and demobilization; n/r, not recorded; NASA, National Aeronautics and Space Administration; no., number; Nov., November; Prelim., Preliminary; Oct., October; Sept., September; TFHRC, Turner-Fairbank Highway Research Center]

Core no.	Drilling location no.	Core name (drilling location and core number, if applicable)	Year	Month	Beginning drill date	Number of coring days	Mob./demob. days	Description of drilling location	Latitude	Longitude	Depth of core, in feet	Driller(s) and geologist(s), if present, in parenthesis	Summary of bulk lithology of core	Prelim. log recorded?	ISTD status	Photographs taken?
FY 2015—Continued																
8	6	Janelia core 1	2015	Aug.	08/04/2015	1	1	Janelia Research Campus property at the west end of Potomac Dr. on the Potomac River floodplain, south of Seldon Island.	39.0724	−77.457	20	Jeff Grey (Steve Schindler)	River sediment; layers of mostly sandy clayey silt with sporadic gravels.	Yes	Deferred ISTD due to sand and gravel layers between clay layers.	Yes
9	6	Janelia core 2	2015	Aug.	08/05/2015	1	1	Janelia Research Campus property at the west end of Potomac Dr. on the Potomac River floodplain, south of Seldon Island.	39.0727	−77.4569	20	Jeff Grey, Gene Cobbs (Steve Schindler)	River sediment; layers of mostly sandy clayey silt with sporadic gravels.	No	Deferred ISTD due to sand and gravel layers between clay layers.	Yes
10	7	Moran Landing core	2015	Aug.	08/11/2015	2	2	Calvert Cliffs, Md., area, about 30 m from the shoreline of Chesapeake Bay at east end of Conoy Camp Rd.; on the Fowler property.	38.4207	−76.4234	65	Jeff Grey, Keith Moody (Steve Schindler)	Marine sandy silt and clay with intervals of leached shell and minor gravels.	Yes	Deferred to ISTD refinement.	Yes
11	8	Algonkian core 1	2015	Sept.	09/23/2015	10	2	Algonkian Regional Park on the Potomac floodplain along the side of Fairway Dr. and the golf course, near the utility buildings.	39.0604	−77.3814	20	Jeff Grey	River sediment; layers of mostly sandy clayey silt with sporadic gravels.	No	ISTD was utilized onsite.	No
FY 2016																
12	9	Queenstown core	2015	Oct.	10/26/2015	1	1	Queenstown, Md., on the south side of Chester River in the Queenstown Harbor Golf Couse, near the site of the demolished farmhouse.	38.9925	−76.1722	70	Jeff Grey, Keith Moody (Ron Litwin, David Powars)	Estuarine clay with sandy silt and clay layers, and intervals of minor gravels.	No	Deferred to ISTD refinement.	No
13	10	Foxboro core 1	2015	Nov.	11/13/2015	10	3	5.5 miles NW of La Plata, Md., along Indian Head Trail (Charles County Parks), east of Pomfret Rd. near the crossing of Foxboro Place (that changes to Chapel Springs Place Southward), and near Old Woman Creek.	38.5949	−77.0435	59	Jeff Grey, Keith Moody (David Powars, Steve Schindler)	Marine clay with sandy silt and clay layers, and intervals of leached shell and minor gravels.	Yes	ISTD was utilized onsite.	No

Table 3. Detailed results of U.S. Geological Survey coring activities conducted in support of the FHWA and TFHRC's in situ scour testing device (ISTD) project.—Continued

[Core logs and details are available in Chirico and others (2021). Aug., August; FHWA, Federal Highways Administration; FY, fiscal year; ISTD, in situ scour testing device; Mob./demob. days, number of days for mobilization and demobilization; n/r, not recorded; NASA, National Aeronautics and Space Administration; no., number; Nov., November; Prelim., Preliminary; Oct., October; Sept., September; TFHRC, Turner-Fairbank Highway Research Center]

Core no.	Drilling location no.	Core name (drilling location and core number, if applicable)	Year	Month	Beginning drill date	Number of coring days	Mob./demob. days	Description of drilling location	Latitude	Longitude	Depth of core, in feet	Driller(s) and geologist(s), if present, in parenthesis	Summary of bulk lithology of core	Prelim. log recorded?	ISTD status	Photographs taken?
FY 2016—Continued																
14	8	Algonkian core 2	2016	July	07/2016	2	2	Algonkian Regional Park on the Potomac River floodplain along the side of Fairway Dr. and the golf course, near the utility buildings.	39.0604	−77.3814	20	Jeff Grey, Keith Moody	River sediment; layers of mostly sandy clayey silt with sporadic gravels.	No	ISTD was utilized onsite.	No
15	10	Foxboro core 2	2016	July	07/18/2016	2	2	5.5 miles NW of La Plata, Md., along Indian Head Trail (Charles County Parks), east of Pomfret Rd. near the crossing of Foxboro Place (that changes to Chapel Springs Place Southward), and near Old Woman Creek.	38.5949	−77.0435	n/r	Jeff Grey, Keith Moody	Marine clay with sandy silt and clay layers, and intervals of leached shell and minor gravels.	No	ISTD was utilized onsite.	No
FY 2017																
16	11	Huntley Meadows core 1	2017	Sept.	09/02/2017	1	3	Huntley Meadows Park in Alexandria, Va., in the limited-access northern end of the park, off S. Kings Highway, just south of the park maintenance offices.	38.76394	−77.1174	50	Robert Leininger, Jeff Grey, Derek Kragenbrink (Pete Chirico, Jessica DeWitt)	Layers of clay and sand with sporadic gravel/pebbles, and pockets of organics.	Yes	No ISTD; test drilling was carried out for ISTD specifications.	Yes
17	12	Grist Mill core 1	2017	Sept.	09/03/2017	1	1	Grist Mill Park in Alexandria, Va., in the grassy area immediately to the west of the baseball diamond at the end of the gravel access road.	38.71038	−77.11585	50	Robert Leininger, Derek Kragenbrink (Pete Chirico, Jessica DeWitt)	Primarily clays and clayey sands with organics throughout, and pockets of gravels.	Yes	No ISTD; test drilling was carried out for ISTD specifications.	Yes

Table 3. Detailed results of U.S. Geological Survey coring activities conducted in support of the FHWA and TFHRC's in situ scour testing device (ISTD) project.—Continued

[Core logs and details are available in Chirico and others (2021). Aug., August; FHWA, Federal Highways Administration; FY, fiscal year; ISTD, in situ scour testing device; Mob./demob. days, number of days for mobilization and demobilization; n/r, not recorded; NASA, National Aeronautics and Space Administration; no., number; Nov., November; Prelim., Preliminary; Oct., October; Sept., September; TFHRC, Turner-Fairbank Highway Research Center]

Core no.	Drilling location no.	Core name (drilling location and core number, if applicable)	Year	Month	Beginning drill date	Number of coring days	Mob./demob. days	Description of drilling location	Latitude	Longitude	Depth of core, in feet	Driller(s) and geologist(s), if present, in parenthesis	Summary of bulk lithology of core	Prelim. log recorded?	ISTD status	Photographs taken?
FY 2017—Continued																
18	13	Muddy Hole core 1	2017	Sept.	09/04/2017	1	1	Muddy Hole Farm Park in Alexandria, Va., between the playground and the drainage ditch, adjacent to the walkway in the northern part of the park.	38.74359	−77.1129	35	Robert Leininger, Derek Kragenbrink (Pete Chirico, Jessica DeWitt)	Silty sands and silty clays with gravels, sand, and trace organics at the bottom of the core.	Yes	No ISTD; test drilling was carried out for ISTD specifications.	Yes
19	11	Huntley Meadows core 2	2017	Sept.	09/05/2017	1	1	Huntley Meadows Park in Alexandria, Va., in limited-access northern end of the park, off S. Kings Highway, just south of the park maintenance offices.	38.7639	−77.1174	n/r	Robert Leininger, Jeff Grey, Derek Kragenbrink (Pete Chirico, Jessica DeWitt)	Layers of clay and sand with sporadic gravel/pebbles, and pockets of organics.	No	ISTD was utilized onsite.	Yes
20	12	Grist Mill core 2	2017	Sept.	09/07/2017	1	1	Grist Mill Park in Alexandria, Va., in the grassy area immediately to the west of the baseball diamond at the end of the gravel access road.	38.7104	−77.1159	10	Robert Leininger, Derek Kragenbrink (Pete Chirico, Jessica DeWitt, Sarah Bergstresser)	Primarily clays and clayey sands with organics throughout, and pockets of gravels.	No	ISTD was utilized onsite.	Yes
21	13	Muddy Hole core 2	2017	Sept.	09/08/2017	1	1	Muddy Hole Farm Park in Alexandria, Va., between the playground and the drainage ditch, adjacent to the walkway in the northern part of the park.	38.7434	−77.113	n/r	Robert Leininger, Derek Kragenbrink (Pete Chirico, Jessica DeWitt, Sarah Bergstresser)	Silty sands and silty clays with gravels, sand, and trace organics at the bottom of the core.	No	ISTD was utilized onsite.	Yes

Table 3. Detailed results of U.S. Geological Survey coring activities conducted in support of the FHWA and TFHRC's in situ scour testing device (ISTD) project.—Continued

[Core logs and details are available in Chirico and others (2021). Aug., August; FHWA, Federal Highways Administration; FY, fiscal year; ISTD, in situ scour testing device; Mob./demob. days, number of days for mobilization and demobilization; n/r, not recorded; NASA, National Aeronautics and Space Administration; no., number; Nov., November; Prelim., Preliminary; Oct., October; Sept., September; TFHRC, Turner-Fairbank Highway Research Center]

Core no.	Drilling location no.	Core name (drilling location and core number, if applicable)	Year	Month	Beginning drill date	Number of coring days	Mob./demob. days	Description of drilling location	Latitude	Longitude	Depth of core, in feet	Driller(s) and geologist(s), if present, in parenthesis	Summary of bulk lithology of core	Prelim. log recorded?	ISTD status	Photographs taken?
FY 2018																
22	14	Meadowood 1 core	2017	Oct.	10/24/2017	1	1	Meadowood Recreation Area in Lorton, Va., in the southern part of the recreation area, on the edge of one of the Meadowood fields near the Hidden Pond Trailhead, just off of Belmont Boulevard.	38.74359	−77.1129	35	Robert Leininger, Derek Kragenbrink (Pete Chirico, Jessica DeWitt)	Clayey silts and clayey sands with layers of clayey gravels and organics.	Yes	No ISTD; test drilling was carried out for ISTD specifications.	Yes
23	15	Meadowood 2 core 1	2017	Oct.	10/25/2017	1	1	Meadowood Recreation Area in Lorton, Va., just south of the Meadow Wood Stables, right off the main access road.	38.6702	−77.19704	45	Derek Kragenbrink, Greg Lutwack (Pete Chirico, Jessica DeWitt)	Silty clays and clays with pockets of coarse sand and gravels towards top of core, transitioning to silty sands and sands at bottom of core.	Yes	No ISTD; test drilling was carried out for ISTD specifications.	Yes
24	8	Algonkian core 3	2017	Oct.	10/26/2017	1	1	Algonkian Regional Park in Sterling, Va., on the edge of a field near the grounds maintenance building in the northwest corner of the golf course, right off Fairway Dr.	39.06041	−77.38133	5	Derek Kragenbrink, Greg Lutwack (Pete Chirico, Sarah Bergstresser)	River sediments; layers of primarily silts and silty clays with clayey gravels towards bottom of core.	Yes	ISTD was utilized onsite.	Yes
25	15	Meadowood 2 core 2	2017	Oct.	10/27/2017	1	1	Meadowood Recreation Area in Lorton, Va., just south of the Meadow Wood Stables, right off the main access road.	38.67024	−77.19696	3	Derek Kragenbrink, Greg Lutwack (Jessica DeWitt, Sarah Bergstresser)	Silty clays and clays with pockets of coarse sand and gravels towards top of core, transitioning to silty sands and sands at bottom of core.	No	ITSD was utilized onsite.	Yes

Table 3. Detailed results of U.S. Geological Survey coring activities conducted in support of the FHWA and TFHRC's in situ scour testing device (ISTD) project.—Continued

[Core logs and details are available in Chirico and others (2021). Aug., August; FHWA, Federal Highways Administration; FY, fiscal year; ISTD, in situ scour testing device; Mob./demob. days, number of days for mobilization and demobilization; n/r, not recorded; NASA, National Aeronautics and Space Administration; no., number; Nov., November; Prelim., Preliminary; Oct., October; Sept., September; TFHRC, Turner-Fairbank Highway Research Center]

Core no.	Drilling location no.	Core name (drilling location and core number, if applicable)	Year	Month	Beginning drill date	Number of coring days	Mob./demob. days	Description of drilling location	Latitude	Longitude	Depth of core, in feet	Driller(s) and geologist(s), if present, in parenthesis	Summary of bulk lithology of core	Prelim. log recorded?	ISTD status	Photographs taken?
FY 2018—Continued																
26	8	Algonkian core 4	2017	Nov.	11/06/2017	1	1	Algonkian Regional Park in Sterling, Va., on the edge of a field near the grounds maintenance building in the northwest corner of the golf course, right off Fairway Dr.	39.06043	−77.38139	20	Derek Kragenbrink, Brian Landacre, Jeff Grey (Pete Chirico, Jessica DeWitt)	River sediments; layers of primarily silts and silty clays with clayey gravels towards bottom of core.	No	ITSD was utilized onsite.	Yes
27	8	Algonkian core 5	2017	Nov.	11/07/2017	1	1	Algonkian Regional Park in Sterling, Va., on the edge of a field near the grounds maintenance building in the northwest corner of the golf course, right off Fairway Dr.	39.0604	−77.3814	6	Derek Kragenbrink, Brian Landacre, Jeff Grey (Pete Chirico, Jessica DeWitt, Sarah Bergstresser)	River sediments; layers of primarily silts and silty clays with clayey gravels towards bottom of core.	No	ISTD was utilized onsite.	Yes

[1]Successfully augered the test hole with a CME45 drill rig through 13 feet of alluvial sediment; it was determined the ground was too soft for a CME75 drill rig during the wet season.

[2]Tested custom drill bit; marginally successful and yielded lower recovery. Bag samples were taken from outside the auger. A B45 auger rig was used.

Results

A total of 27 boreholes were drilled between July 2014 and November 2017. These boreholes provided an opportunity for testing and refinement of the ISTD (fig. 10), and the extracted cores provided an opportunity for detailed understanding of surficial sedimentary layers in the Northern Virginia and Southern Maryland areas.

Borehole depths ranged from 3 ft to 70 ft below the surface. Boreholes with depths less than 10 ft were drilled when the ISTD was utilized, because it was not necessary to drill as deep. The maximum depth of drilling for the FHWA objectives was 30 ft, however, greater depths were drilled to collect additional surficial sedimentary data for USGS research. At certain drilling locations the borehole could not be continued after a certain depth due to the presence of sands, which prevented the lowest sedimentary layers from being retrieved (for example, at the Muddy Hole drilling location). In other cases, the presence of dense clays (for example, at the Meadowood 1 and Meadowood 2 drilling locations) or gravel and bedrock (for example, at the Algonkian drilling location) prevented deeper drilling. In general, the sedimentary layers of each borehole were found to be typical of Quaternary alluvial floodplain sediments.

A detailed summary of the boreholes drilled during the FHWA-TFHRC project is shown in table 3. The data is organized by fiscal year and includes a core number, the drilling location number, the core name (drilling location and core number), year, month, beginning drill date, number of coring days, number of days for mobilization and demobilization (Mob./demob. days), a detailed description of the drilling location, latitude, longitude, depth of the core, the drillers and (or) geologists present, a summary of the bulk lithology of the core, whether a preliminary core log was recorded, the status of the ISTD, and whether photographs were taken.

Borehole details are summarized below. The full dataset[3], including a complete record of the logs generated for the boreholes, is available in Chirico and others (2021). Full logs were not recorded for every core. The cores for which logs were recorded include Janelia, Moran Landing, Foxboro, Huntley Meadows, Grist Mill, Muddy Hole, Meadowood 1 core 1, Meadowood 2 core 1, and Algonkian core 3. Certain characteristics were not recorded for the Janelia, Moran Landing, and Foxboro cores, however, the categories of the logs were kept the same for consistency in this report.

Graphical sediment profile logs were created for the 9 cores for which detailed field logs were recorded. Where more than one core was collected at a drilling location, the corresponding figure (figs. 11 to 15) is labeled by the core name (from table 3). Each sediment layer in these graphical profiles is shown with a color that corresponds to a matching color from the Globe Professional Soil Color Book (Visual Color Systems, 2015). Where two consecutive layers have similar colors, a different pattern overlay is used to differentiate them. The depth of each layer in the graphic profile (y-axis) corresponds to the depth of the layer in the core log. The width of each layer (x-axis) corresponds to the observed primary size of the sediments (also recorded in the core log). Other field observations about the sediment cores are available in Chirico and others (2021).

Janelia core 1 is shown in figure 11*A*. Both cores extracted from the Janelia drilling location are characterized primarily by gray to reddish-brown and brown silty clay, and then reddish-brown to gray sand towards the bottom of the cores. Algonkian core 3 is shown in figure 11*B*. The cores extracted from the Algonkian drilling location are characterized by brown to reddish-brown fine sand and silts for the majority of the core and brown to dark-brown clayey gravels at the bottom of the cores. Huntley Meadows core 1 is depicted in figure 12*A*. The core extracted from the Huntley Meadows drilling location has layers of brown to orange to tan clay, interbedded with layers of tan to gray clayey and silty sands. Muddy Hole core 1 is depicted in figure 12*B*. The cores extracted from the Muddy Hole drilling location have layers of clays, silty sands, and clayey gravels, and sands at the bottom of the cores. The colors of the sediment range from mottled gray with orange at the top of the cores to yellow-brown and brown at the bottom of the cores. Grist Mill core 1 is depicted in figure 13*A*. The core extracted from the Grist Mill drilling location has bands of clays and silts of a gray color mottled with orange at the top of the core and dark-brown silty sands and clayey sands at the bottom of the core. The Meadowood 2 core 1 is depicted in figure 13*B*. The cores extracted from the Meadowood 2 drilling location have orange and orange-brown silty clays and clayey silts at the top of the core and brown to tan silty sands and sands at the bottom of the cores. The Meadowood 1 core is depicted in figure 14*A*. The core extracted from the Meadowood 1 drilling location is characterized by reddish-brown clayey silt that transitions to layers of orange, tan, brown, and yellow silty sands, clayey sands, and clayey gravels, with at matrix of gray and reddish clay and clayey silts at the bottom of the core. The Foxboro core 1 is depicted in figure 14*B*. The cores extracted from the Foxboro drilling location begin as orange-brown silty sands and clayey sands, transitioning to gray and blue-gray silts and banded brown, gray, and orange. The Moran Landing core is depicted in figure 15. The core extracted from the Moran Landing drilling location is yellow clayey silty sand and yellow shell hash that is interbedded with sand in the upper part of the core, to blue-gray sand with clayey silt in the lower part of the core.

[3]The Oak Hall core was published in Mixon (1985), and the same area was re-cored for the FHWA project in 2015. The core log, map of core location, and preliminary lithologic information for the Queenstown quadrangle were published by Hess (1977), and the geology of the region was described in detail by Owens and Denny (1979). The data includes general information about the core(s) as well as detailed sediment characteristics, notes and comments on the lithology, whether photos were taken, the number of blows and the N-value of the standard penetration test (SPT), and the amount of sediment recovered of that section of the core. The Queenstown location was re-cored in 2015 for the FHWA project (D.P. Powars and L.E. Edwards, U.S. Geological Survey, written commun., 2017).

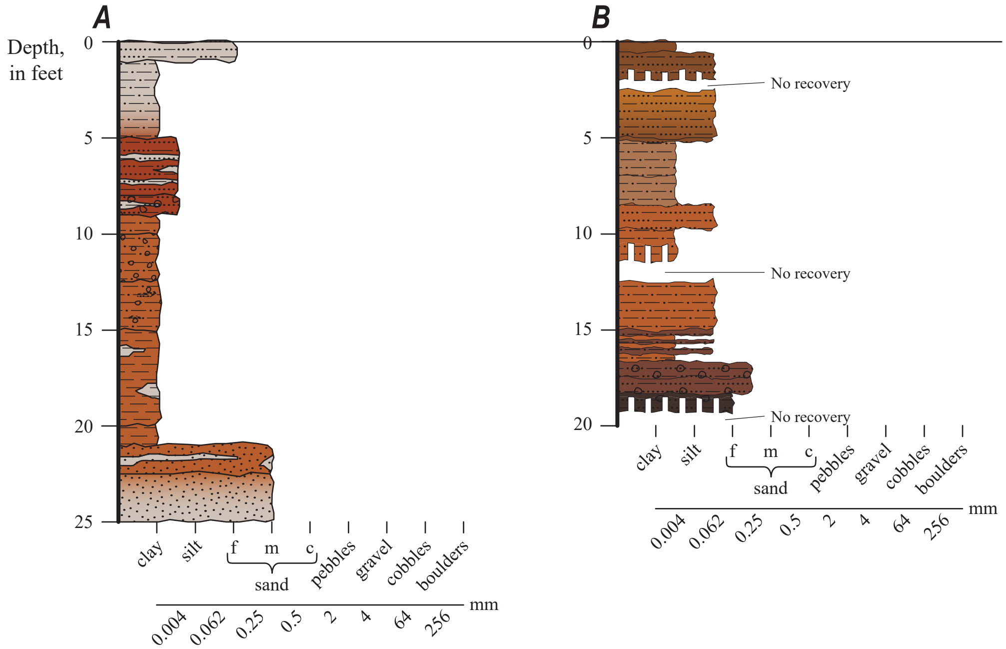

Figure 11. Profile depictions of sediment cores extracted during fieldwork in Northern Virginia. *A*, Janelia core 1 from Ashburn, Va.; and *B*, Algonkian core 3 from Sterling, Va. Sediment color corresponds to a matching color from the Globe Professional Soil Color Book (Visual Color Systems, 2015). Width of the layer (x-axis) corresponds to the primary grain size of the layer. Detailed observations about each core can be found in Chirico and others (2021). Abbreviations: c, coarse sand; f, fine sand; m, medium sand; mm, millimeters.

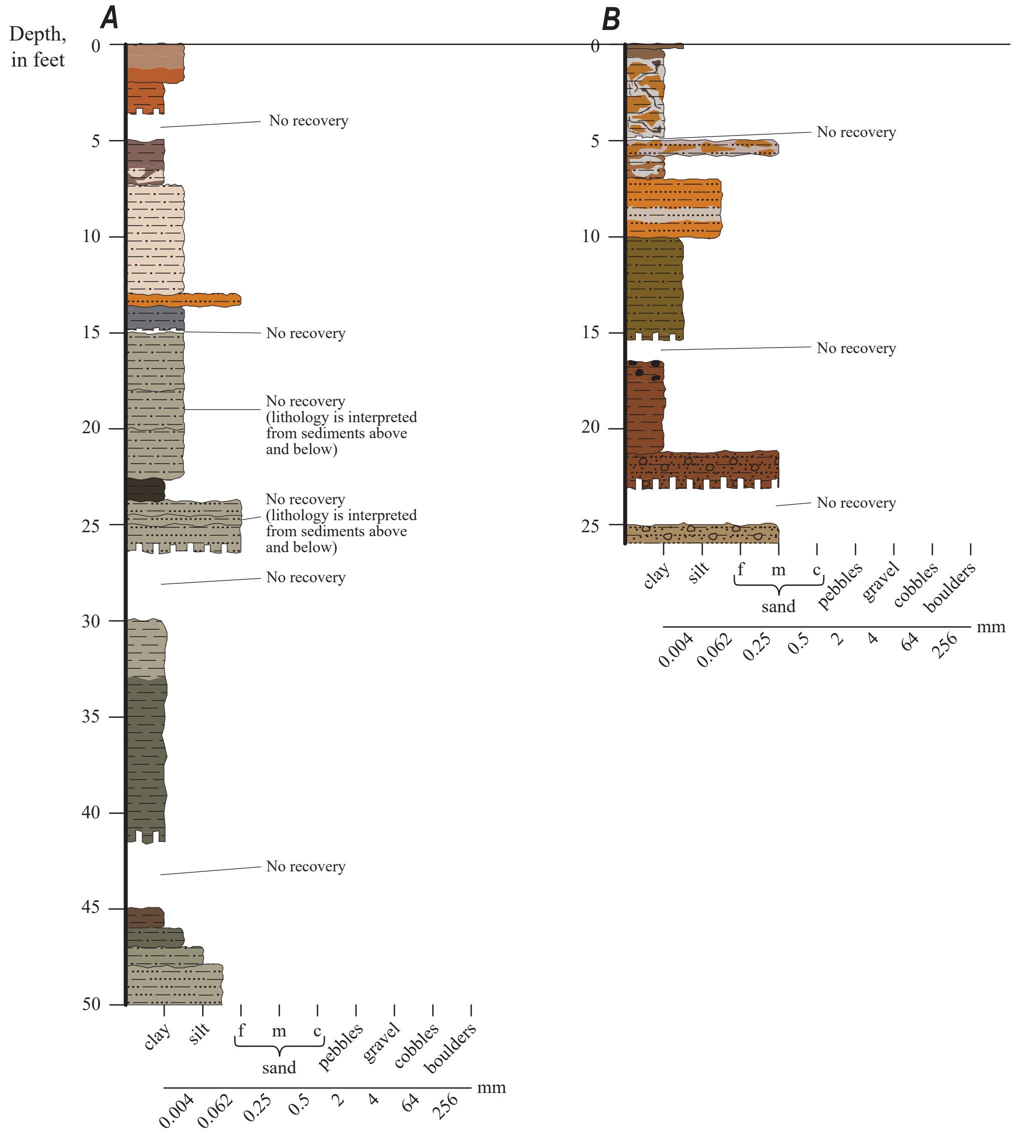

Figure 12. Profile depictions of sediment cores extracted during fieldwork in Northern Virginia. *A*, Huntley Meadows core 1 from Alexandria, Va.; and *B*, Muddy Hole core 1 from Alexandria, Va. Sediment color corresponds to a matching color from the Globe Professional Soil Color Book (Visual Color Systems, 2015). Width of the layer (x-axis) corresponds to the primary grain size of the layer. Detailed observations about each core can be found in Chirico and others (2021). Abbreviations: c, coarse sand; f, fine sand; m, medium sand; mm, millimeters.

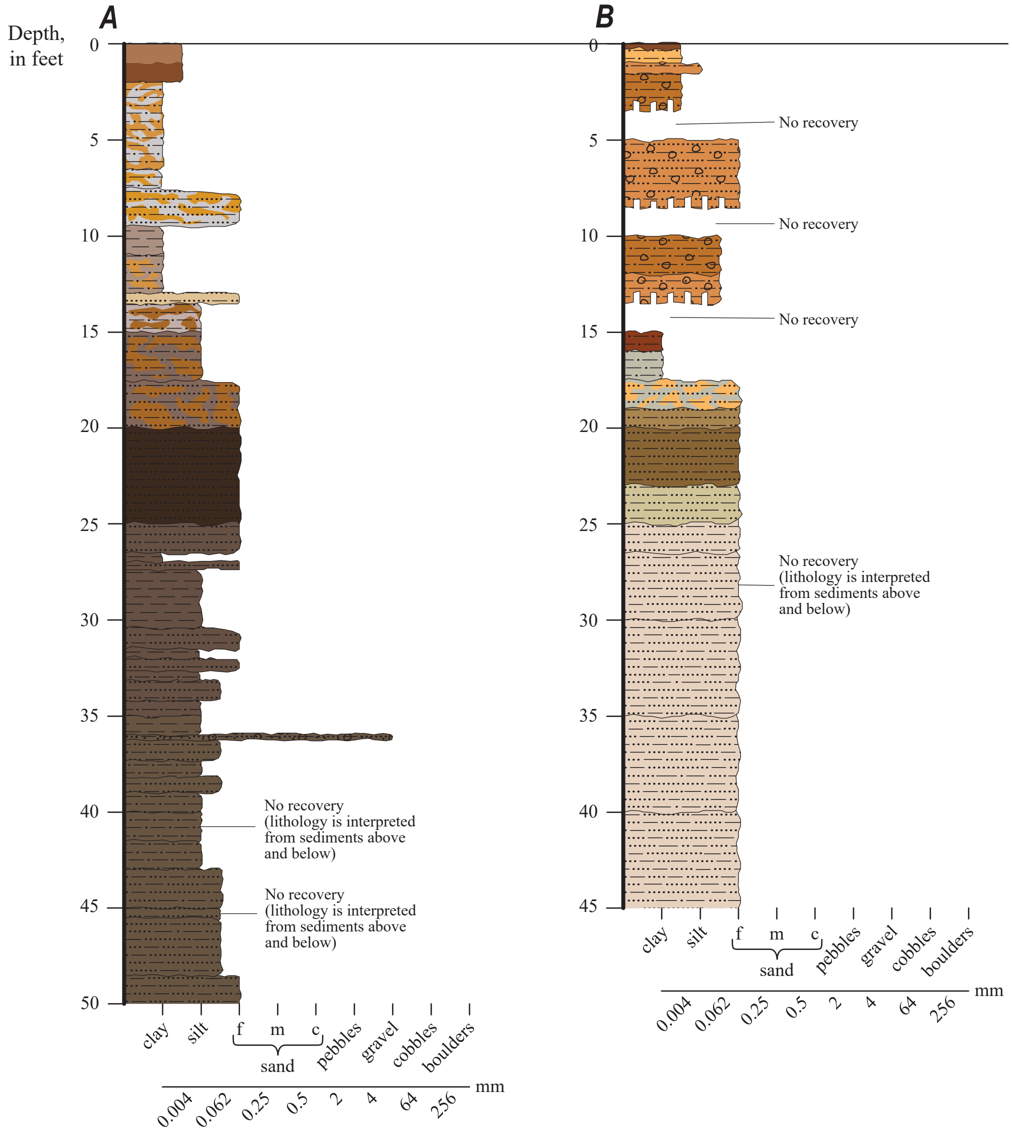

Figure 13. Profile depictions of sediment cores extracted during fieldwork in Northern Virginia. *A*, Grist Mill core 1 from Alexandria, Va.; and *B*, Meadowood 2 core 1 from Lorton, Va. Sediment color corresponds to a matching color from the Globe Professional Soil Color Book (Visual Color Systems, 2015). Width of the layer (x-axis) corresponds to the primary grain size of the layer. Detailed observations about each core can be found in Chirico and others (2021). Abbreviations: c, coarse sand; f, fine sand; m, medium sand; mm, millimeters.

Figure 14. Profile depictions of sediment cores extracted during fieldwork in Northern Virginia and Southern Maryland. *A*, Meadowood 1 core from Lorton, Va.; and *B*, Foxboro core 1 from Bennsville, Md. Sediment color corresponds to a matching color from the Globe Professional Soil Color Book (Visual Color Systems, 2015). Width of the layer (x-axis) corresponds to the primary grain size of the layer. Detailed observations about each core can be found in Chirico and others (2021). Abbreviations: c, coarse sand; f, fine sand; m, medium sand; mm, millimeters.

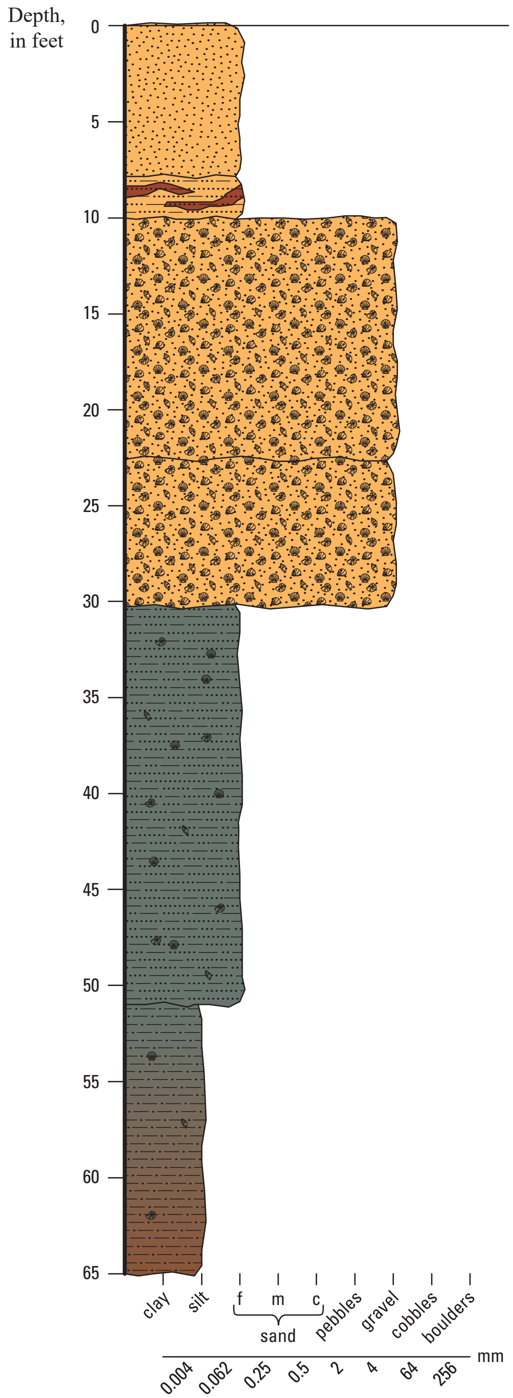

Figure 15. Profile depiction of the Moran Landing sediment core extracted during fieldwork in Lusby, Md. Sediment color corresponds to a matching color from the Globe Professional Soil Color Book (Visual Color Systems, 2015). Width of the layer (x-axis) corresponds to the primary grain size of the layer. Detailed observations about each core can be found in Chirico and others (2021). Abbreviations: c, coarse sand; f, fine sand; m, medium sand; mm, millimeters.

Summary

The U.S. Geological Survey (USGS) Florence Bascom Geoscience Center (FBGC) conducted an auger drilling fieldwork study to gain insight into the sedimentological and engineering properties of different layers of near-surface soil columns. This study was initiated through an inter-agency agreement between the FGBC and the Federal Highway Administration (FHWA) to further the development of new equipment for in situ measurements of erosion rates for clay-rich sediments. Between 2014 and 2017, 15 drilling locations at 14 geographic field sites were selected within Accomack, Fairfax, and Loudoun Counties in Virginia, and Charles, Calvert, and Queen Anne's Counties in Maryland.

Twenty-seven boreholes were drilled to allow for testing of near-surface sediments and the FHWA in situ scour testing device (ISTD) equipment. The surface and subsurface geology of the field sites located in the Fairfax and eastern Loudoun County areas are influenced by the migrating drainage of the Potomac River. Sediments deposited by the river are typically comprised of clay-rich particles, which are commonly found in the floodplain, paleochannels, and low terraces of the drainage system. The remaining field sites are located in the Coastal Plain region, typically characterized by unconsolidated beds of sand, gravel, and clay. The boreholes were drilled to various depths not exceeding 70 ft, depending on the requirements for ISTD testing, using a 4.25-inch diameter hollow stem auger.

Preliminary field logs describing the sediment characteristics of the borehole cores were recorded at 11 of the 14 field sites, and the standard penetration test results that indicated the density and plasticity of the soil were provided for the cores drilled in 2017. The sediment characteristics recorded included soil color, grain size, percentage of gravel/sand/fines, grain angularity, grading and sorting, water content, plasticity, and sediment classification. Generally, the sedimentary layers of the cores were Quaternary alluvial floodplain material.

References Cited

American Society for Testing and Materials Committee D-18 on Soil and Rock, 2017, Standard practice for classification of soils for engineering purposes (Unified Soil Classification System)—Active standard ASTM D2487-17e1, *in* ASTM International, Book of Standards: v. 04.08, West Conshohocken, Pa., 12 p.

Chirico, P.G., DeWitt, J.D., and Bergstresser, S.E., 2021, Datasheets associated with borehole sampling of surficial sediments in Northern Virginia and Southern Maryland conducted by the U.S. Geological Survey for the Federal Highways Administration Turner-Fairbanks Research Center In Situ Scour Testing Device: U.S. Geological Survey data release, https://doi.org/10.5066/P9A8G5LQ.

Cleaves, E.T., Edwards, J., Jr., and Glaser, J.D., 1968, Geologic map of Maryland: Maryland Geological Survey, 1 sheet, scale 1:250,000, accessed April 6, 2020, at https://ngmdb.usgs.gov/Prodesc/proddesc_16548.htm.

Coe, A.L., Argles, T.W., Rothery, D.A., and Spicer, R.A., 2010, Sedimentary, appendix A6, *in* Coe, A.L., ed., Geological field techniques: Walton Hall, Milton Keynes, United Kingdom, Blackwell Publishing Ltd., 323 p. [Also available at http://www.science.earthjay.com/instruction/HSU/2016_spring/GEOL_335/COE_2010_geological_field_techniques.pdf.]

Deng, L., and Cai, C.S., 2010, Bridge scour—Prediction, modeling, monitoring, and countermeasures: Practice Periodical on Structural Design and Construction, v. 15, no. 2, p. 125–134, accessed April 26, 2021, at https://doi.org/10.1061/(ASCE)SC.1943-5576.0000041.

Gee, G.W., and Bauder, J.W., 1986, Particle-size analysis, chap. 15 *in* Klute, A., ed., Methods of soil analysis—Part 1, physical and mineralogical methods (2d ed.): Madison, Wis., American Society of Agronomy Inc., Soil Science Society of America Inc., p. 393–411. [Also available at https://doi.org/10.2136/sssabookser5.1.2ed.c15.]

Hansen, G.J., 1990, Surface erodibility of earthen channels at high stresses part II—Developing an in situ testing device: Transactions of the American Society of Agricultural and Biological Engineers [ASABE], v. 33, no. 1, p. 132–137, accessed April 26, 2021, at https://elibrary.asabe.org/abstract.asp?aid=31306.

Hess, M., 1977, Drill-hole logs and location map of surface and shallow subsurface materials, central and southern Delmarva Peninsula, Maryland, Delaware, and Virginia: U.S. Geological Survey Miscellaneous Field Studies Map MF–899, 2 sheets, scale 1:250,000, accessed April 26, 2021, at https://pubs.er.usgs.gov/publication/mf899.

JL Darling LLC, 2015, Rite in the rain—All-weather geological field book no. 540F: Tacoma, Wash., JL Darling LLC, 158 p.

Lyttle, P.T., Aleinikoff, J.N., Burton, W.C., Crider, E.A., Drake, A.A., Froelich, A.J., Horton, J.W., Kasselas, G., Mixon, R.B., McCartan, L., Nelson, A.E., Newell, W.L., Pavlides, L., Powars, D.S., Southworth, C.S., and Weems, R.E., 2017, Geologic map of the Washington West 30' × 60' quadrangle, Maryland, Virginia, and Washington D.C.: U.S. Geological Survey Open-File Report 2017–1142, 1 sheet, scale 1:100,000, accessed April 7, 2020, at https://doi.org/10.3133/ofr20171142.

McCartan, L., Newell, W.L., Owens, J.P., and Bradford, G.M., 1996, Geologic map and cross sections of the Leonardtown 30 x 60-minute quadrangle, Maryland and Virginia: U.S. Geological Survey Open-File Report 95–665, 1 sheet, scale 1:100,000, 37-p. pamphlet, accessed April 8, 2020, at https://doi.org/10.3133/ofr95665. [Map sheet available at https://ngmdb.usgs.gov/Prodesc/proddesc_19356.htm.]

Mixon, R.B., 1985, Stratigraphic and geomorphic framework of uppermost Cenozoic deposits in the southern Delmarva Peninsula, Virginia and Maryland: U.S. Geological Survey Professional Paper 1067–G, accessed February 5, 2021, at https://doi.org/10.3133/pp1067G.

Owens, J.P., and Denny, C.S., 1979, Upper Cenozoic deposits of the central Delmarva Peninsula, Maryland and Delaware—Surface and shallow subsurface geologic studies in the emerged coastal plain of the middle Atlantic states: U.S. Geological Survey Professional Paper 1067–A, 28 p., accessed April 26, 2021, at https://pubs.er.usgs.gov/publication/pp1067A.

Schoeneberger, P.J., Wysocki, D.A., Benham, E.C., and Broderson, W.D., eds., 2002, Field book for describing and sampling soils (ver. 2.0): Lincoln, Nebr., Natural Resources Conservation Service, National Soil Survey Center, 300 p.

Schuring, J.R., Dresnack, R., Golub, E., Khan, M.A., Young, M.R., Dunne, R., and Aboobaker, N., 2012, Review of bridge scour practice in the U.S.: International Conference on Scour and Erosion (ICSE-5), 10 p., accessed April 26, 2021, at https://doi.org/10.1061/41147(392)112.

Southworth, S., Brezinski, D.K., Drake, A.A., Burton, W.C., Orndorff, R.C., Froelich, A.J., Reddy, J.E., Denenny, D., and Daniels, D.L., 2007, Geologic map of the Frederick 30' x 60' quadrangle, Maryland, Virginia, and West Virginia: U.S. Geological Survey Scientific Investigations Map 2889, 1 sheet, scale 1:100,000, 48-p. pamphlet, accessed April 7, 2020, at https://doi.org/10.3133/sim2889. [Map available at https://ngmdb.usgs.gov/Prodesc/proddesc_83523.htm.]

Terry, R.D., and Chilingar, G.V., 1955, Summary of “Concerning some additional aids in studying sedimentary formations” by M.S. Shvetsov: Journal of Sedimentary Research, v. 25, no. 3, p. 229–234, accessed February 5, 2021, at https://doi.org/10.1306/74D70466-2B21-11D7-8648000102C1865D.

Thien, S.J., 1979, A flow diagram for teaching texture-by-feel analysis: Journal of Agronomic Education, v. 8, no. 1, p. 54–55. [Also available at https://doi.org/10.2134/jae.1979.0054.]

U.S. Army Corps of Engineers, Waterways Experiment Station, 1960, The unified soil classification system: Vicksburg, Miss., U.S. Army Corps of Engineers, Waterways Experiment Station, Technical Memorandum No. 3–357, v. 1, 44 p. [Also available at https://erdc-library.erdc.dren.mil/jspui/bitstream/11681/21368/1/WES-Technical-Memorandum-No.3-357-Appendix-A-B.pdf.]

Virginia Division of Mineral Resources, 1993, Geologic map of Virginia: Virginia Division of Mineral Resources, 1 sheet, scale 1:500,000, accessed April 15, 2020, at https://ngmdb.usgs.gov/Prodesc/proddesc_34878.htm.

Visual Color Systems, 2015, The globe professional soil color book—A pocket guide for the identification of soil colors: Kingston, N.Y., Visual Color Systems, Inc., 53 p.

Wang, C., Yu, X., and Liang, F., 2017, A review of bridge scour—Mechanism, estimation, monitoring, and counter-measures: Natural Hazards, v. 87, no. 3, p. 1881–1906, accessed April 26, 2021, at https://doi.org/10.1007/s11069-017-2842-2.

Chirico and others—**Borehole Sampling of Surficial Sediments in Northern Virginia and Southern Maryland**—OFR 2021–1038

ISSN 2331-1258 (online)
https://doi.org/10.3133/ofr20211038