Appendix C - Soil Report

Hampton Roads AREC Soils Suitability Study

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Executive Summary

TerraScience LLC and Soil Horizons LLC have been tasked with evaluating the existing soil resources at three potential sites in Virginia Beach that have been proposed by AECOM for the relocation of extension and research activities currently housed and delivered at the Virginia Tech Hampton Roads Agricultural Research Extension Center (HR AREC) on Diamond Springs Road. In addition to (a) collecting and providing information on current soil resources as described in more detail below, we were also asked to (b) develop recommendations for potential soil/site modifications to address the research and demonstration needs of the AREC mission, and (c) determine if any other direct land use limitations such as wetlands are present on the proposed potential relocation sites. We addressed these objectives via a mix of apriori review of web based resources coupled with detailed surface soil fertility sampling and deeper soil boring efforts at three proposed sites along North Landing Road and at the existing AREC.

The existing soils at the three proposed sites more than likely would not pose any direct soil fertility or pH limitations for plant growth other than restricted internal drainage and near-surface soil wetness limitations. In contrast, the current AREC soils are dominantly moderately well and well-drained and support a wide range of predominantly upland soil plantings and research areas.

Regardless of each of the proposed site's unique mix of potential soil limitations, it is important to emphasize that overall poorly drained soil and near-surface saturation are the dominant challenges posed at all three relocation sites evaluated here. Potential secondary limitations include presence of jurisdictional wetlands, a buried petroleum pipeline on the Brown Farm, and potential for high stormwater flows. Unfortunately, there are no "magic bullets" for improving or varying local drainage related rooting and plant growth limitations via adding soil amendments per se. Thus, the only viable alternatives for these three proposed sites to support a full range of managed landscape, vegetable, turf and woody shrub and tree plantings will be via engineered approaches that integrate active subsoil drainage and/or raised elevation planting zones that are carefully coordinated and integrated with stormwater and drainage management plans.

However, if the decision to relocate the current AREC operations is made, the development of a completely new facility at any of these three proposed locations would provide a range of research and demonstration opportunities as described in more detail at the end of this report. These opportunities are particularly pertinent in the Hampton Roads area due to rapid development into historically wetter areas and the need to manage highly disturbed "urban soils". These development challenges are closely integrated with an increasing focus on managing both the quantity and quality of stormwater runoff and local groundwater resources.

Introduction and Soils Study Objectives

The current Hampton Roads Agricultural Research & Extension Center (HR AREC) supports a wide array of outreach, extension, research and teaching activities along with associated supporting research/demonstration plots and gardens. The majority of existing research and demonstration plot areas were established and have been managed in relatively undisturbed upland soils. Major local and regional clientele groups include the landscaping, turf management and development sectors along with small fruit and vegetable producers, homeowners/gardeners and numerous civic and nonprofit organizations. In particular, a majority of the existing research and demonstration areas are focused on plant materials that generally require well- to moderately well-drained soil conditions such that the upper 18 to 36" of the rooting zone is seldom saturated during the growing season.

TerraScience LLC and Soil Horizons LLC have been tasked with evaluating the existing soil resources at three potential sites that have been proposed by AECOM for the relocation of extension and research activities currently housed and delivered at the (HR AREC) at their Diamond Springs Road location. In addition to (a) collecting and providing information on current soil resources as described in more detail below, we were also asked to (b) develop recommendations for potential soil/site modifications to address the research and demonstration needs of the AREC mission, and (c) determine if any other direct land use limitations such as wetlands are present on the proposed potential relocation sites.

Study Approach and Methods

Following final agreement on the final scope of work, we proceeded with field investigations on three potential proposed relocation sites as delineated by AECOM. Following an initial assessment of the properties via review of pertinent NRCS Web Soil Survey (WSS; Appendix A) and USDI-FIW National Wetlands Inventory (NWI; Appendix B) maps and other available resources, we made a preliminary site visits on Sept. 22 to 29 to assess actual onsite conditions and features. Utilizing initial conceptual plans for each site developed by AECOM and delivered via email on September 22, the location of various important features and potential use limitations were noted and we used those plans to develop a stratified soil sampling protocol to be uniformly applied to all three proposed relocation sites. It is important to note that we also received an updated set of differing and more detailed conceptual maps the morning of October 6, we were not able to review them until after our final site visit that day.

All initial field visits, soil descriptions, soil sampling and other assessments referred to in this report were conducted by Angela Whitehead, a Virginia Licensed Professional Soil Scientist. Prior to field sampling, preliminary studies included review of WSS soil maps and other supporting materials provided by AECOM and HR AREC personnel by W. Lee Daniels (PhD soil scientist). Subsequently, Dr. Daniels reconfirmed actual site/soil observations on October 5th and 6th, 2022. This report and all associated data sets and interpretations are the mutual product of Ms. Whitehead and Dr. Daniels and reflect their professional opinion and judgement related to the original study objectives as stated above.

Since our primary focus was on soils x potential plant growth potentials and limitations, we focused our soil sampling efforts on the initial conceptual plans provided by AECOM that showed potential (a) research areas, (b) demonstration areas and (c) pond locations (Appendix C). Five composite soil fertility samples were taken following Virginia Tech soil sampling protocols (https://www.soiltest.vt.edu/sampling-insttructions.html), with three samples taken from designated research areas and two from demonstration areas. These 15 bulk samples (0-4”) were shipped immediately to Virginia Tech service laboratories for standard soil fertility (Mehlich I extract) and organic matter analyses, saturated paste extract pH and specific conductance (soluble salts), and standard USDA-NRCS particle size analysis (texture). The following week (September 28 and 29) Ms. Whitehead returned to the three proposed sites and bored and described five complete soil profiles down to 60” at each location and collected bulk samples from their major A, B and C horizons. We also visited the HR AREC on October 6 and located three deep soil borings across a range of expected soil conditions as described below. All deep boring samples were shipped to Virginia Tech on October 7 and are currently undergoing lab analysis on selected horizons.

Our team also investigated all wooded areas and major ditches to confirm hydric soil conditions and look for other potential primary and secondary indicators (if present) of their hydric soil and/or wetland hydrology status.

As detailed below, extensive soil fertility testing data was available for us to review for the HR AREC due to the current DCR approved Nutrient Management Plan (from 2021) and we were provided input on current AREC plots and demonstration areas by AECOM and HR AREC personnel. We visited the AREC site on October 6 and located, described and sampled three additional soil profiles to confirm existing WSS soil mapping.

With respect to understanding and interpreting local soil maps and distributions, we are collectively fortunate that the original Virginia Beach Cooperative Soil Survey was conducted by a highly skilled Virginia Tech soil mapping team in the early 1980’s (Hatch et al., 1985). This was one of the first counties in Virginia where soil mapping and associated interpretative efforts were clearly focused on potential limitations to urban development coupled with water quality protection. Furthermore, Dr. Daniels served as an expert soil scientist for USCOE/DOJ on several major litigated wetland impact cases on similar landscapes in the area in the late 1990’s and early 2000’s. Most recently, Dr. Daniels completed a detailed study of the overall wetness regime and associated hydroperiods of several long term USCOE/Nature Conservancy wetland restoration and preservation sites in the Princess Anne region (Sneesby, 2019).

Existing Soils at Proposed Relocation Sites

Existing WSS mapping was confirmed at all sites by Daniels & Whitehead on October 5th and 6th. This was an important step since the original mapping by Hatch et al. was recompiled from its original scale of 1:15,840 to a scale of 1:24,000 once the new WSS platform was launched. As such, many smaller original delineations ($\leq$ 5 acres) would not have been separated at either scale. Thus, while we can be confident of the relative composition of these mapping units with respect to presumed use and management limitations, site-specific soil series confirmations must be made for any detailed land use interpretations at a local scale.

The three potential relocation sites are located on a contiguous landform in west central Virginia Beach with an average elevation of 11 feet AMSL with a very low local slope gradients ($\leq$ 2%). The dominant soil type is Acredale silt loam (*Fine-loamy, mixed, active thermic Typic Endoaqualfs*; see Appendix A and E for WSS maps and Series descriptions). Local soils also contain smaller amounts of similar Nimmo loam and Tomotley loam on locally sandier locations. All three of these dominant soils are poorly drained and are on the NRCS Hydric Soils List. Much smaller areas of somewhat poorly drained Dragston and moderately well drained Munden soils also occur on slightly higher relict sand dune ridge crests. Since Acredale and similar related hydric soils dominate the areas proposed for research and demonstration plots, we will focus this discussion on Acredale and related soils.

On-site soil borings and detailed morphological descriptions (Appendix D) confirmed that 14 of 15 pedons investigated fit the Acredale series criteria (Appendix E) or similar soils with respect to use and management (e.g. Tomotley). Detailed follow-up borings on October 6 and 7 confirmed that the vast majority all three properties are dominated by Acredale or similar poorly drained soils with respect to use and management. A typical soil profile image of Acredale is presented below in Figure 1 and multiple images are shown in Appendix D along with their matching field morphological descriptions.

Acredale is classified as a *Typic Endoaqualf* in USA Soil Taxonomy (NRCS, 2014) based upon the presence of a clay-enriched moderate pH subsoil (Btg horizon) along evidence of seasonal saturation within 12 inches of the surface. The endoaquic soil moisture regime indicates that the elevation of the saturated zone is controlled primarily by the regional water table which falls during the growing season due to plant/crop evapotranspiration (ET) and then rises again in the winter and late spring when precipitation exceeds ET. This seasonal response of the saturated zone in known as the *hydroperiod*, is taken as the difference between the late winter high and late summer lows, and may be as much as 36" or more. However, this discussion of overall soil/site hydrology is simplistic since these soils contain a relatively impermeable subsoil (Btg) horizon that is high in silt+clay and greatly limits downward rates of water movement (Ksat or permeability) such that water commonly "perches" in the Ap (topsoil) horizon for extended periods of time (e.g. days) even when the subsoil remains unsaturated. This was very obvious to us as we traversed the three proposed sites on October 5th and 6th following several days of heavy rain associated with the remnants of Hurricane Ian. We observed near-surface saturated or ponded conditions at dozens of locations across all three properties even though the immediately underlying subsoil was moist, but not saturated.

Figure 1. Acredale soil profile bored and evaluated by Daniels & Whitehead on October 6, 2022. Note the dominantly gray (e.g. ≤ soil chroma 2) colors throughout indicative of significant saturation for extended periods of time, including the growing season under normal conditions. However, yellowish/red concentrations in the subsoil (Btg horizon) indicate that the water table does fluctuate seasonally to deeper than - 36”. These soils are only suitable for intensive agricultural production due to artificial drainage. Silt + clay in the subsoil Btg is high, directly limiting internal permeability.

Intensive agricultural production here is only made possible by shallow (~12”) surface drainage to remove surface ponded/perched water in the spring and fall and following major summer storms. In their native undrained setting these areas historically have a significant probability of being jurisdictional wetlands that are now classified as prior converted (PC) farmland as long as the ditches and vegetation are managed and maintained. However as detailed later, certain deeper ditches on the Brown Farm are dominated by hydrophytic vegetation (e.g. Willow/*Salix* and cattails/*Typha*). Thus, there is some possibility these areas could be considered to be "farmed wetlands" by the USCOE.

Despite shallow surface drainage coupled with much deeper lateral drains, most of our soil borings (Appendix D) described a dominantly gray soil matrix due to prolonged seasonal saturation coupled with the presence of active redox concentrations (red mottles) immediately below the frequently tilled Ap horizon and often to a depth > 36". Many of these near-surface redox concentrations are associated with active plant roots (e.g. oxidized rhizospheres). The upper portion of the soil (Ap and Btg horizons) are considerably higher in silt+clay) than the underlying much sandier C horizons. In combination, this morphology indicates that the water table most likely rises up into the lower portion of the Ap horizon each winter (e.g. ≤ 12" from the surface) and remains there until early to mid-spring, or even later into the growing season. However, as discussed in more detail below, the sandy nature of the deeper C horizons (generally > 40") indicates that these soils could potentially be tile drained to better control the saturated zone if local receiving lateral drainage ditches would allow. The silt+clay enriched subsoil (Btg horizon) is much less permeable than the better aggregated overlying topsoil horizons and therefore is capable of leading to temporary near-surface "perching" of a saturated zone (epiaquic conditions) for extended periods following heavy precipitation events, particularly when the subsoil is already moist and its aerated macropore space is limited.

The slightly higher and convex ridge that underlies North Landing Road does support a small area of a moderately well-drained soil that is mapped as the Munden Series (Appendix E; See Figure 2), particularly in the zone ≤ 200' south of North Landing Road. While this soil may also extend into the Brown South property, much of it has more than likely been disturbed by the housing, driveways and outbuildings there.

Existing Soils at Hampton Roads AREC

The dominant soil underlying replicated research plot and demonstration areas at the HR AREC is the Tetotum series (See Appendix A/D/E and Figure 3), which are classified as *Fine-loamy, mixed, semiactive, thermic Aquic Hapludults.* Tetotum is a moderately well drained soil with a typical seasonal high water table of 18 to 30". Due to its better drained landscape position and higher elevation, these soils are more weathered, oxidized and more acidic (lower pH and base saturation) in their underlying Bt horizons than the Acredale soils at the proposed relocation sites. Smaller areas of the well-drained Bojac (See Appendix A/D/E and Figure 4) and State soils are also present in portions of the AREC along with a range of wetter soils including Acredale. The average elevation of the upland portions of the AREC ranges from 18-28 feet AMSL with the better drained soils occurring on more convex and upland local landforms. Due to better internal drainage, the subsoils here (Bt horizons) are better developed with respect to soil structure (aggregation) and are therefore more permeable than the wetter and siltier Acredale soils. Several (n = 3) onsite soil borings (See Appendix D) confirmed the moderately well to well drained nature of these soils and that depth to active redox features was > 36".

Figure 2. Munden soil profile bored and evaluated by Daniels & Whitehead on October 6, 2022, in the NE corner of the Brenneman tract. Note the "browner" hues in the subsoil down to ~30" indicative of moderately well drained conditions. This profile was much sandier in the subsoil than others we collectively observed over multiple field days.

Figure 3. Tetotum soil profile bored and evaluated by Daniels & Whitehead on October 6, 2022, at the HR AREC research plot area. The majority of active research plots at the AREC are located on this moderately well drained soil type moderately well drained conditions with a depth to the seasonally saturated zone of 18 to 30”. The auger shown is 60” for comparison.

Figure 4. Bojac (or possibly State) soil profile bored and evaluated by Daniels & Whitehead on October 6, 2022, at the HR AREC demonstration garden area. This soil was observed at two locations (see Appendix C), one located next to the local weather station and raised beds area and at a second location pictured here just east of Diamond Springs Road. The soil is well drained with > 40” to seasonal saturation and supports a wide-array of upland plantings in this immediate area and the nearby arboretum. Note: Lighter colored areas in this image were due to the soil drying down in the sun during the description period and were all ≥ chroma 3 when excavated moist. The C horizon encountered here at > 40” was a gravelly sand.

Soil Chemical and Physical Properties at Proposed/Existing Sites

Data for surface soil (0-4”) fertility samples for the HR AREC along with a sampling location map and other supporting lists of plot types are provided in Appendix C as reported in the recent DCR approved Nutrient Management Plan prepared by Jody Booze-Daniels for the AREC and the Virginia Tech College of Agriculture and Life Sciences in 2021. As would be expected from long-term and well managed research/demonstration plots, the plant available P levels are generally in the high to very high range at the AREC (See Appendix F). Levels of plant-available cations and soil pH are also within optimal ranges. A more recent soil fertility analysis for the “strawberry plots” was provided by the AREC for current year samples and was similar in overall fertility levels.

As part of our field sampling program, we collected five composite surface soil fertility samples from each of the proposed relocation sites (see Appendix C) with three taken from areas designated as “research” on the conceptual plans and two from areas designated “demonstration”. Those data are also reported in Appendix F and reflect a similar history of relatively intensive crop/soil management practices with dominantly medium to high levels of plant-available P and optimal cation and pH levels. Due to the uniform nature of the flat soil landscape and relatively intensive fertilization and liming practices, lateral variability among the fertility sub-samples was presumed to be relatively low, but certain side-by-side sampling areas (e.g. Brown South 2 and 3) were surprisingly different. Overall levels of fertility (particularly P) were also lower overall at Brenneman vs. Brown S+N.

The soil texture, organic matter and soluble salt levels (expressed as specific conductance – SC) are also presented in Appendix F. The data again support the relative uniformity of the dominantly Acredale soil surface at the proposed locations and are all within expected ranges. The laboratory data for particle size analyses (Appendix F) support the on-site confirmation of the classification of these soils as Acredale due to the very high overall ($\geq$ 60%) content of silt+clay in even these surface soil samples. The subsoil samples from the 18 deep soil boring sites are currently undergoing lab analyses at Virginia Tech and will be reported in a subsequent addendum if/as needed. Those will undoubtedly be even higher in their silt+clay content.

Direct Soil Related Limitations at Proposed and Existing AREC Sites

The existing soils at all three of the proposed relocation sites pose no direct soil fertility or texture/physical limitations for plant growth for the vast majority of current plant materials being researched or displayed at the current AREC. In fact, these soils are highly productive for agricultural row crops and would be expected to not pose direct fertility or pH limitations for turf, horticultural and landscaping plants. The exceptions would be if more acidic and less fertile soils were desired for native tree plantings or perhaps created wetland research or demonstration cells. Another exception would be for certain vegetables such as potatoes or onions that usually require loamy or sandier surface soil conditions.

However, there is no question that poor surface and internal soil drainage will be limiting for the majority of desired planting types due to their general requirement for moderately well to well-drained soil conditions during their extended growing seasons. As described above, the vast majority of our 15 detailed soil borings and associated morphological descriptions (Appendix D) indicate that the saturated zone does appear to occur within the upper 12 inches of soil during the winter and for long enough into the growing season to support the formation of active redox features. Thus, in order for a similar array of current AREC plantings to be established and maintained at any of the proposed sites, the local water table will need to be drawn down (at least locally) to accommodate plantings that demand well to moderately well-drained soil conditions. Assuming this is to be accomplished via tile drainage, the receiving primary and secondary drainage ditches may need to be deepened enough to support the necessary drawdown elevations in the late winter and early spring. The fact that the deeper C horizons in these soils are relatively sandy would assist in this effort, if and only if the free water level in the receiving ditches will support it. A number of relatively accurate drainage prediction models (e.g. Drainmod - https://www.bae.ncsu.edu/agricultural-water-management/drainmod/) are available to reliably predict the required depth and spacing of tile drains for this purpose based on site-specific soil and receiving ditch elevation and fluctuation conditions.

Another alternative for certain plantings (e.g. turf, fruit trees, vegetables, upland woody species) would be to bring in sufficient suitable soil fill materials to increase the overall elevation of zones within the sites requiring better aerated rooting depths. However, these areas would then not be representative of natural soil landscapes for research purposes, but could be carefully constructed to mimic a wide range of surface soil chemical and physical properties found in disturbed and managed urban and construction landscapes. However, even if a considerable thickness of new soil materials is used to increase local plot or demonstration area elevations, the fact that the directly underlying soils will frequently become saturated close to the surface will demand some level of intensive surface ditching and/or underlying tile drainage be maintained to keep overlying new soils in a well-drained condition.

If fill materials are to be utilized for raising overall surface elevations or other applications such as raised beds, every effort should be made to utilize local onsite cut materials from building, parking lot and pond excavations whenever possible. The native Ap horizons should be carefully salvaged and use for final topsoil reconstruction fill surfaces. Furthermore, the deeper pond excavations could provide significant volumes of sandy soil materials that could be used as improved media for turfgrass plots, etc. A wide range of final manufactured soil properties could be generated onsite via utilization of existing cut/stockpiled soils, selected imported soil materials from offsite, along with appropriate lime/fertilizer and organic amendments. Once a desired recipe for a given set of plots x species is developed, all components should be fully blended via use of a rotary tub mixer or a pug mill. Next, the manufactured soils should be placed over each new soil reconstruction plot/demo area to the desired thickness based on internal and surface drainage plans and predictions. Once placed, these materials will need to be loosened with appropriate tillage, including any grading related compaction that may occur immediately at and below the contact depth between the newly placed and pre-existing underlying soils.

Regardless of which option would potentially be utilized at these sites to improve soil drainage, great care needs to be taken to minimize disturbance of the existing native soils that are intended to support research and demonstration plantings. Any areas that receive any level of rubber-tired vehicle traffic and/or cut/fill operations are prone to excessive compaction which greatly complicates their infiltration/runoff characteristics. Soil disturbance, particularly cut/fill practices greatly increases the lateral and vertical variability of urban soils relative to their native soil counterparts and greatly complicates research replicated research designs.

Any disturbed areas that become compacted will need to be loosened to an acceptable bulk density (e.g. $\leq$1.70 for sands and $\leq$ 1.45 for clay loams) via appropriate tillage such as shank ripping followed by chisel-plowing and/or rototilling. Similarly, all disturbed areas, particularly those involving cut or fill operations will need to be carefully documented and mapped out to allow for appropriate planning and placement of proposed research and demonstration plots.

All site surface and subsurface drainage planning will need to be carefully integrated with the overall stormwater planning and applicable permitting procedures for the overall development. Due to their relatively flat landforms, low infiltration and permeability rates and high total silt+clay contents, these landscapes will produce significant peak surface runoff following most major rainfall events. Thus, these should all be considered as Hydrologic Soil Group D landscapes with relatively high runoff curve numbers (CN) for stormwater modeling applications that utilize current Virginia DEQ runoff reduction and/or NRCS TR-55 based prediction methods. As detailed in other sections of this report, all three proposed sites are extensively deep ditch drained and maintenance or actual deepening of those features would likely be required to support the range of plantings and uses currently supported at the current AREC.

Other Potential Soil/Landscape Related Limitations by Site

In addition to their suitability for supporting the current mix of planting types at the current AREC, a number of other potential soil/landform limitations are potentially present.

First and foremost, all three of these proposed sites are dominated by drained hydric soils. Thus, any areas that are currently in native forest vegetation that meets the USCOE hydrophytic vegetation criteria have a reasonable likelihood of being jurisdictional wetlands. Furthermore, existing vegetated pond margins and deeper ditches that support hydrophytic vegetation or have certain other features (e.g. clear normal high water marks) could also be potentially jurisdictional. As indicated below, several such areas currently appear on the USDI-FIW National Wetland Inventory (NWI) maps and certain ditch networks currently appear as blue line features in Web Soil Survey (Appendix A/B). If these areas are determined to be jurisdictional by the USCOE/DEQ, any disturbance of them will require a Section 404 permit and mandatory mitigation measures and/or appropriate management buffers. The issue of whether or not and the extent to which agricultural ditches are currently included in WOTUS in in flux within these agencies and a final agency determination would be necessary for these potential wetland areas. Similarly, a detailed and agency approved jurisdictional determination would be needed to confirm current status as PC farmlands vs. farmed wetlands.

Secondly, the presence of the surface ditching networks over the majority of these areas has produced a regular pattern of anthropogenic soil disturbance where the ditches have been cut down into underlying subsoil and the ditch shoulders are periodically mantled by fill. This leads to significant lateral and vertical soil variability in these regularly spaced approximately 2-3 foot wide ditches zones that will need to be carefully mapped out and accounted for in future research plot design. Simply grading these areas out will only further complicate this issue.

Thirdly, as detailed below, there are a number of human influenced small features and impacts on each of the three proposed relocation sites that could potentially require more detailed soil testing protocols and possibly local clean-up efforts. This includes the need to confirm the depth, location and status of the Sunoco petroleum pipeline on the Brown Farm along with the existence of municipal sewer service. If sewer connections are not available, approval of even advanced septic systems with pre-treatment will be possible only in very limited locations near North Landing Road.

Fourth, while we believe it to be unlikely at these particular locations, a range of underlying sediments in this region are known to contain naturally occurring sulfidic minerals (e.g. pyrite), particularly where they have been protected by the permanent water table. More detail on this issue is available at the following website:https://landrehab.org/home/programs/acid-sulfate-soils-management/. When these materials are exposed via active construction or land drainage activities they can oxidize to produce highly acidic (pH < 3.5) soil and water conditions. Locally, we have documented their occurrence within the common depth of excavation (5') at Sandy Bottom Nature Park in Hampton and in the Pungo area of Virginia Beach.

Fifth, certain faculty and staff at the current HR AREC have expressed an interest in obtaining "organic production certification status" for future research programs. To that end, they have reserved an area of former tall fescue turf plantings and eliminate all fertilizer and chemical applications for approximately three years to date. Conversion of any of the existing North Landing Road properties into a similar research effort would require a strict management input strategy applied for multiple years coupled with development of specific plans for approval by relevant regional and/or national certification entities. The exception could potentially be via use of several currently wooded tracts for this purpose, but again, their management histories would need to be carefully documented along with their actual current jurisdictional wetland status.

Finally, we need to reiterate the importance of maintaining existing soil profiles in a relatively intact state wherever future research or demonstration plantings are planned for. All traffic, parking, equipment storage and other impacts must be avoided on these areas and they must be clearly marked and surrounded by temporary fencing during development and construction operations.

<u>Specific Potential Limitations at Brown North</u>

NWI maps indicate wooded location and deeper ditches are likely jurisdictional. Some ditches on site are 4-5 deep and support hydrophytic vegetation.

Underground utility line (Sunoco - Petroleum) runs along the western edge of the site.

Specific Potential Limitations at Brown South

NWI maps indicate wooded location and deeper ditches are likely jurisdictional. Some ditches on site are 6 to 8' deep.

Two existing ponds in NE corner of property and likely jurisdictional for DEQ.

Underground utility line (Sunoco) cuts across SW corner of site and up the western edge.

Tire dump/pile (n = 50?) in SE portion needs removal.

There may be existing well pumps, possible abandoned groundwater drinking wells, etc., depending on past/current infrastructure supply.

Existing residence and farm buildings with existing fuel tanks, septic leach field and other potential contaminants (if verified by more intensive Phase I + II sampling).

Specific Potential Limitations at Brenneman

NWI maps indicate deeper ditches may be jurisdictional. Some ditches on site on 3' deep.

High voltage power line runs up eastern edge of property.

Existing residence with possible fuel tanks, septic leach field and other potential contaminants (if verified).

Regardless of each site's unique mix of potential soil related limitations, it is important to re-emphasize that overall poorly drained soil and near-surface saturation is the dominant challenge posed. Unfortunately, there are no "magic bullets" for improving or varying local drainage related rooting and plant growth limitations via adding soil amendments per se. For example, adding large amounts of medium or coarse sand to the surface Ap horizons could potentially improve their texture and surface aggregation, but would have essentially no effect on soil wetness regimes during the critical early spring and late fall management periods. Similarly, addition of chemical amendments such as gypsum may be highly touted by the landscaping commercial sector as "improving soil structure and drainage", but these claims are not applicable to these soils and landscapes. Thus, the only viable alternatives for these three sites to support the full range of managed landscape, vegetable, turf and woody tree plantings will be via engineered approaches that integrate active subsoil drainage and/or raised elevation planting areas that are carefully coordinated with overall stormwater management plans.

Potential for Alternative Research and Demonstration Areas

As discussed earlier, the existing soils at the three proposed sites more than likely would not pose any direct chemical/fertility or pH limitations for plant growth other than internal drainage and near-surface soil wetness limitations. Thus, management of the height of the seasonally saturated zone in these soils is their single greatest potential limitation.

However, if the decision to relocate the current AREC operations is made, the development of a completely new facility at any of these three proposed locations would provide a range of new research and demonstration opportunities as described below. These opportunities are particularly pertinent in the Hampton Roads area due to rapid expansion of development into historically wetter areas and the need to manage and plant into highly disturbed “urban soils”. These factors are then closely integrated with an increasing focus on managing both the quantity and quality of stormwater runoff and local groundwater resources.

Urban soils research and demonstration plots

As discussed above, soils associated with active site development are commonly plagued by soil compaction, altered hydrology and strong lateral and vertical variability in their basic physical and chemical properties (Daniels, 2011). Careful planning and management of site development and cut/fill construction activities as describe earlier has the potential to develop a full suite of replicated plots representative of a wide range of soil compaction, texturing and layering, while minimizing internal variation within replicate plots of a given treatment. This process could produce a regionally significant resource for urban soil x plant management research.

Wet soils management plots

One obvious alternative for new research if the AREC is relocated would be to dedicate an existing intact soil area to evaluate effectiveness of local surface/subsurface soil drainage alternatives along with plant/species response to drainage and other management inputs.

Created wetlands

All potential impacts to jurisdictional wetlands in the region are mitigated via a combination of avoidance, minimization, on-site restoration or off-site creation efforts. The development of a new site at any of these three locales would provide another significant opportunity to develop replicated research cells/plots to study effects of various soil reconstruction, water budget manipulations, soil amendment and revegetation strategies on wetland creation success. Depending on the final site layout, certain areas of these three site may also be suitable for study of wetland restoration practices.

Raingardens and other stormwater BMPs

New site development would allow for prior planning, installation and monitoring of a wide array of stormwater management BMP’s including infiltration basins, biofiltration structures, tree planters, parking lot stormwater detention/treatment areas, raingardens etc. In particular, these systems could be (a) replicated, (b) instrumented to measure both influent and effluent water quantity/quality, and (c) used to calibrate existing models for the development industry. Such a research/demonstration facility would be unique to the Mid-Atlantic region, particularly with respect to being able to monitor actual nutrient and contaminant removal rates and masses.

Manufactured soils and engineered growth media

Manufactured soils are increasingly being utilized and accepted as “topsoil substitutes” in the landscaping and site development industries along with being specified in a number of stormwater BMPs as discussed above. Via the process described above on development of alternative soil media for raised elevation type research/demonstration plantings, a range of manufactured and/or reconstructed soil profiles could be developed and instrumented at the new site.

New research site development could also allow for the efficient installation of relatively high cost and more sophisticated engineered turf areas such as USGA specification putting greens and actively drained and aerated sports turf.

Overall Conclusions to Date

The existing soils at the three proposed sites more than likely would not pose any direct chemical/fertility or pH limitations for plant growth other than internal drainage and near-surface soil wetness limitations. As discussed in detail above, management of the height of the seasonally saturated zone in these soils is their single greatest potential limitation. Certain plantings requiring sandier soils such as vegetables and upland native woody species would require texture modifications of at least the surface (Ap horizon) soil along with improved internal drainage.

Regardless of each site's unique mix of potential soil related limitations, it is important to re-emphasize that overall poorly drained soil and near-surface saturation is the dominant challenge posed. Potential secondary limitations include presence of jurisdictional wetlands, a buried petroleum pipeline on the Brown Farm, and potential for high peak stormwater flows. Unfortunately, there are no "magic bullets" for improving or varying local drainage related rooting and plant growth limitations via adding soil amendments per se. Thus, the only viable alternatives for these three sites to support the full range of managed landscape, vegetable, turf and woody tree plantings will be via engineered approaches that integrate active subsoil drainage and/or raised elevation planting areas that are carefully coordinated and integrated with overall stormwater management plans.

However, if the decision to relocate the current AREC operations is made, the development of a completely new facility at any of these three proposed locations would provide a range of research and demonstration opportunities as described below. These opportunities are particularly pertinent in the Hampton Roads area due to rapid development into historically wetter areas and the need to manage highly disturbed "urban soils". These factors are then closely integrated with an increasing focus on managing both the quantity and quality of stormwater runoff and local groundwater resources.

Recommendations for Follow Up Studies

Install and monitor piezometer nests, particularly next to and away from deeper ditches, to quantify seasonal shallow (< 12") vs. deeper (> 36") saturation conditions. This would greatly improve understanding of local soil wetness regimes, particularly following storm events.

Acquire accurate survey information on exact surface and drainage ditch elevations throughout the property and into off-site ditch discharge points.

Full wetland jurisdictional determinations (JD) with agency confirmation on potential wetland areas, ponds and ditches.

Determine and confirm all existing utilities, drainage easements and presence of existing abandoned wells, septic fields or other human infrastructure.

Conduct Phase I or II Environmental Study if the preferred site contains residential structures and outbuildings

References

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NRCS, Soil Survey Staff. 2014. Keys to Soil Taxonomy, 12th ed. USDA-Natural Resources Conservation Service, Washington, DC. Keys to Soil Taxonomy | NRCS Soils (usda.gov)

Sneesby, Ethan. 2019. Evaluation of a Water Budget Model for Created Wetland Design and Comparative Natural Wetland Hydroperiods. Ethan P. Sneesby, M.S. thesis, Virginia Tech, 2019.

Appendix C.1

Current Web Soils Survey (WSS) Maps and Legends for All Study Sites

Soil Map—City of Virginia Beach, Virginia
(Brenneman and Brown WSS)

Map Scale: 1:25,600 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 350, 700, 1400, 2100

Feet: 0, 1000, 2000, 4000, 6000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

USDA **Natural Resources Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

9/3/2022
Page 1 of 3

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: City of Virginia Beach, Virginia
Survey Area Data: Version 14, Sep 17, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

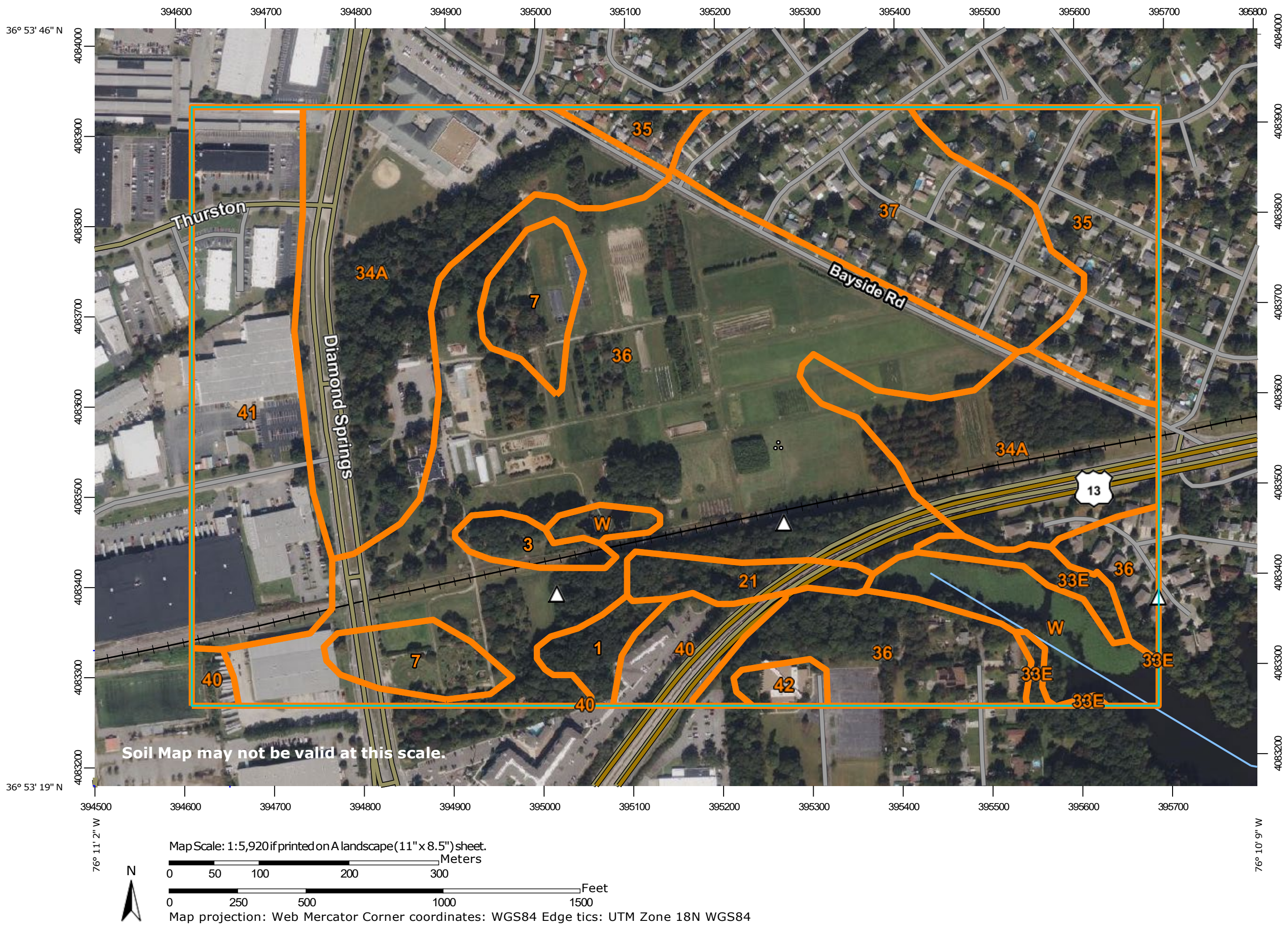
Date(s) aerial images were photographed: Jul 1, 2018—Aug 1, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Acredale silt loam	2,398.8	75.6%
3	Augusta loam	2.5	0.1%
8	Chapanoke silt loam	4.8	0.2%
12	Dorovan mucky peat	42.1	1.3%
13	Dragston fine sandy loam	45.5	1.4%
17	Hyde silt loam	4.6	0.1%
19	Munden fine sandy loam	18.8	0.6%
21	Nawney silt loam	22.5	0.7%
24	Nimmo loam	268.7	8.5%
38	Tomotley loam	340.2	10.7%
41	Udorthents-Urban land complex	23.7	0.7%
W	Water	1.7	0.1%
Totals for Area of Interest		**3,174.1**	**100.0%**

Soil Map—City of Virginia Beach, Virginia
(HR AREC Soil Map)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: City of Virginia Beach, Virginia
Survey Area Data: Version 16, Sep 6, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Oct 5, 2020—Oct 7, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Acredale silt loam	1.9	1.1%
3	Augusta loam	1.7	0.9%
7	Bojac fine sandy loam	6.5	3.7%
21	Nawney silt loam	2.7	1.5%
33E	Rumford fine sandy loam, 6 to 35 percent slopes	2.1	1.2%
34A	State loam, 0 to 2 percent slopes	36.5	20.6%
35	State-Urban land complex	13.0	7.4%
36	Tetotum loam	65.6	37.0%
37	Tetotum-Urban land complex	16.5	9.3%
40	Udorthents, loamy	4.1	2.3%
41	Udorthents-Urban land complex	19.1	10.8%
42	Urban land	1.1	0.6%
W	Water	6.5	3.7%
Totals for Area of Interest		**177.2**	**100.0%**

Appendix C.2

Current National Wetlands Inventory (NWI) Maps and Legends for North Landing Road Sites

U.S. Fish and Wildlife Service

National Wetlands Inventory

Brenneman Farm - Site 3

October 8, 2022

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

U.S. Fish and Wildlife Service
National Wetlands Inventory

Brown Farm North - Site 1

October 8, 2022

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

U.S. Fish and Wildlife Service

National Wetlands Inventory

Brown Farm South - Site 2

October 8, 2022

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

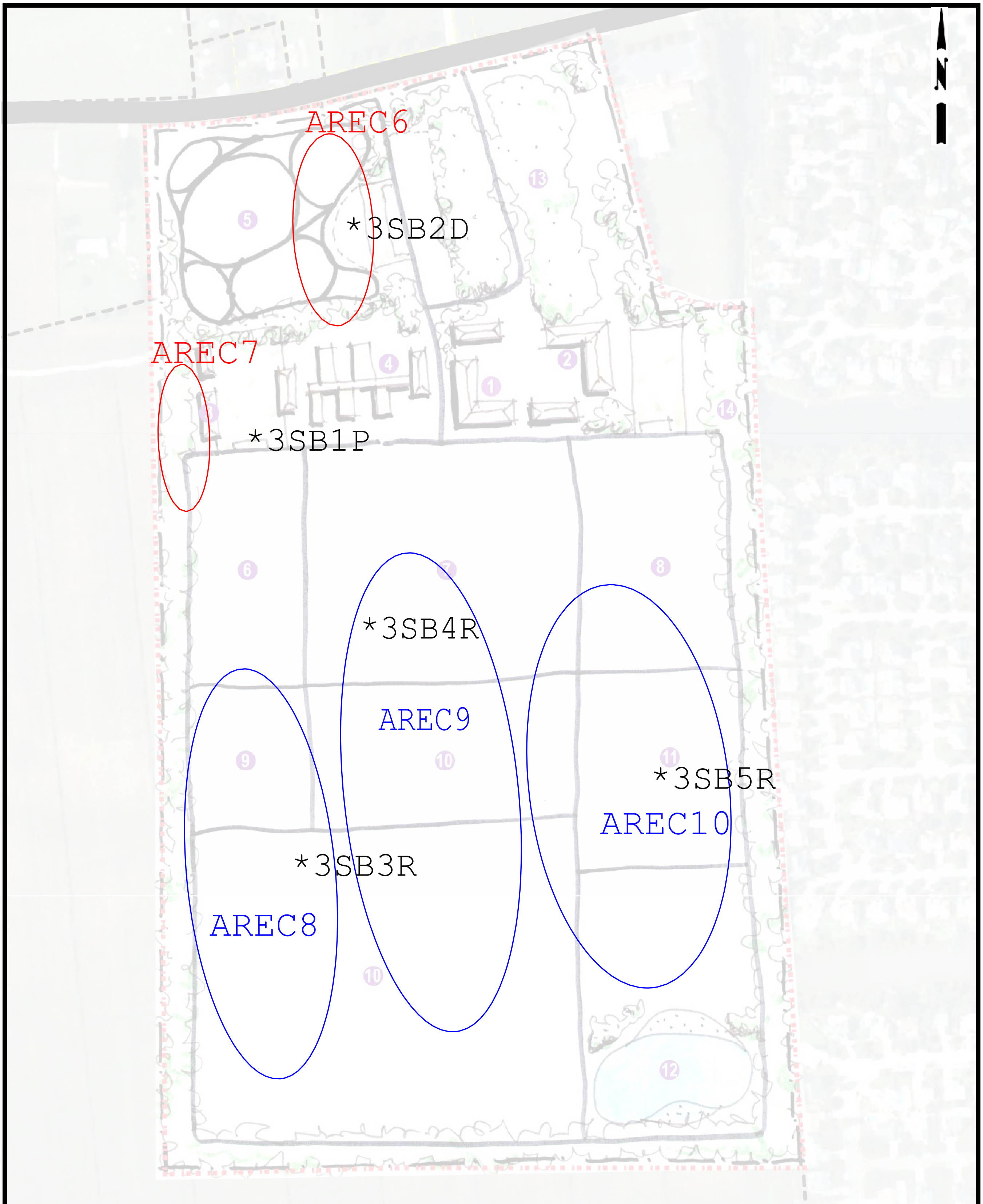
This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

Appendix C.3

Site Soil Sampling Maps for North Landing Road Proposed Sites

and NMP Plot Management & Sampling Plan for the HR AREC

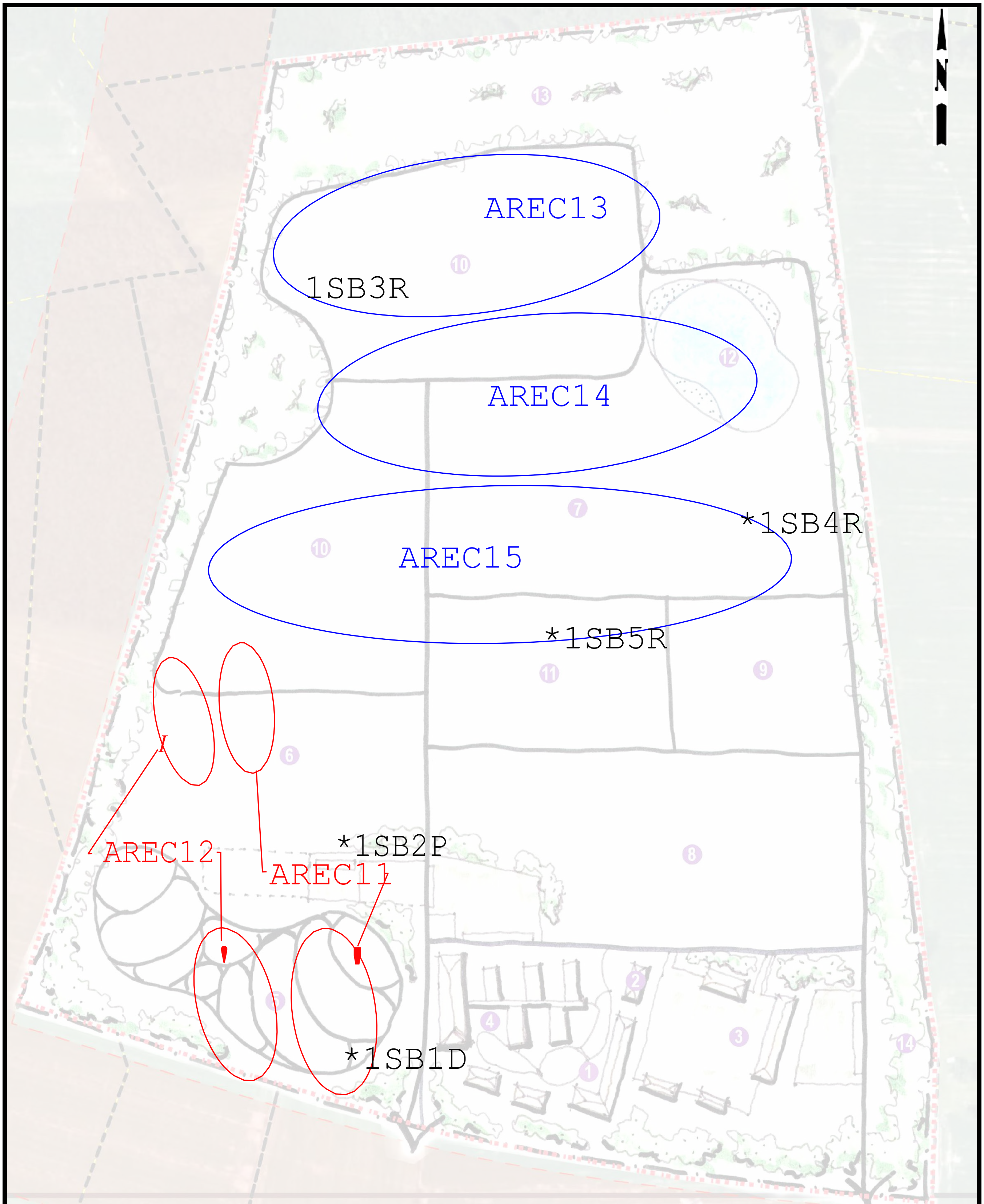


HAMPTON ROADS AREC RELOCATION SlUDY
BRENNEMAN FARM - SITE 3

DATE: 10/7/22
SCALE: 1 IN = 300 FT
BASE MAP PROVIDED BY: AECOM

SAMPLING LEGEND:
RESEARCH ZONE
DEMO GARDEN ZONE
SOIL BORING LOCATION *

300' 0 300'



HAMPTON ROADS AREC RELOCATION STIJDY BROWN FARM NORTH - SITE 1	DATE: 10/7/22 SCALE: 1 IN = 300 FT BASE MAP PROVIDED BY: AECOM	SAMPLING LEGEND RESEARCH ZONE DEMO GARDEN ZONE SOIL BORING LOCATION * 300' 0 300'

HAMPTON ROADS AREC RELOCATION STUDY

BROWN FARM SOUTH – SITE 2

DATE: 10/7/22

SCALE: 1 IN = 350 FT

BASE MAP PROVIDED BY: AECOM

SAMPLING LEGEND:

RESEARCH ZONE

DEMO GARDEN ZONE

SOIL BORING LOCATION *

350' 0 350'

HAMPTON ROADS AREC RELOCATION SIUDY

EXISTING HR AREC FACILITY

DATE: 10/7/22
SCALE: 1 IN = 500 FT

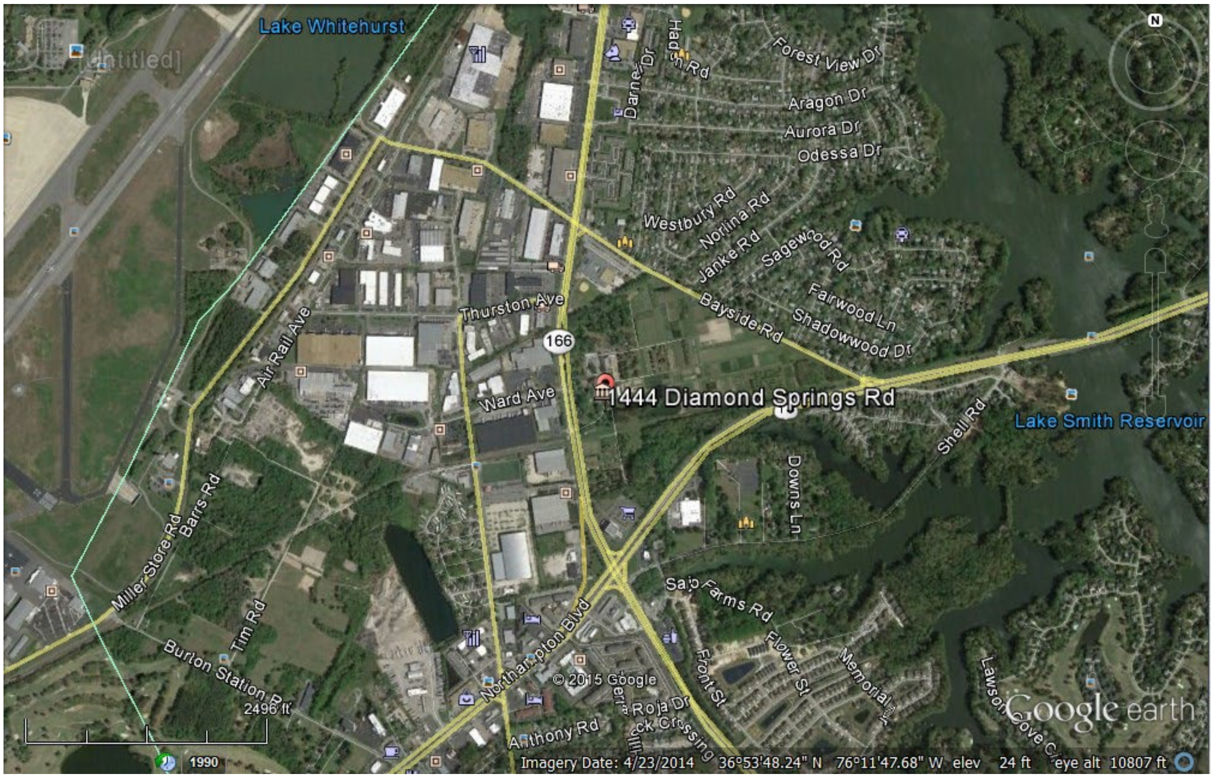
BASE MAP PRO DED B
VIRGINIA BEACH GIS

SAMPLING LEGEND:
SOIL BORING LOCATION *

500' 0 500'

Location and Plot-Area Maps, and Key

Location Map



Property Boundary Map

Management Areas Map with Key

Map Key - Predominant Soils & Environmentally Sensitive Designations

Management Area	Research Use	Acres	Predominant Soils	Environmentally Sensitive?
1	Arboretum - Mixed landscape	1.2	Tetotum	No
2	Bermuda & Zoysia	0.6	Bojac2	Yes- leaching
3	Arboretum - Mixed landscape	2.2	Tetotum	No
4	Arboretum - Mixed landscape	4.0	50% Tetotum/State	No
5	Bluegrass & Tall Fescue	1.5	Tetotum & Water	Yes, Pond
6	Cool Season Grass Shade Trial	7.3	50% Tetotum/State	No
7	Weed Science: Shrubs & annual weeds	0.6	Tetotum	No
8	Tall Fescue/Bluegrass	1.3	Tetotum	No
9	St Augustine	0.6	Tetotum	No
10	Mixed St. Augustine & cool season grass	0.6	Tetotum	No
11	Tall Fescue	1.0	Tetotum	No
12	Container Nursery	0.6	Tetotum	No
13	Bermuda	2.5	Tetotum	No
14	Vegetable	1.8	Tetotum	No
15	Fruit & Wood Ornamental	3.7	Tetotum	No
16	Arboretum	1.5	Tetotum	No
18	Strawberry	3.6	Tetotum	No
19	Woody Nursery	4.3	Tetotum	No

Overview of the Management Areas

Management Areas, plant type, size of area and predominant soils

Management Area	Research Use/Management System	Plant Type	Acres	Predominant Soils
1	Arboretum	Mixed Landscape	1.2	Tetotum
2	Lawn Variety Trials	Bermuda & Zoysia	0.6	Bojac2
3	Arboretum	Trees	2.2	State1
4	Arboretum	Mixed Landscape	4.0	Tetotum
5	Lawn Variety Trials	Bluegrass & Tall Fescue	1.5	Tetotum
6	Shade Variety Trials	Cool Season Fescue	7.3	Tetotum
7	Weed Science Research	Shrubs & Annual Weeds	0.6	Tetotum
8	Turf Variety Trial	Bluegrass & Tall Fescue	1.3	Tetotum
9	Turf Variety Trial	Saint Augustine	0.6	Tetotum
10	Turf Research	Mix of St Augustine & Cool Season	0.6	Tetotum
11	Turf Research	Tall Fescue	1.0	Tetotum
12	Container Production Pad	Woody/Herbaceous Ornamentals	0.6	Tetotum
13	Golf Fairway Research	Bermuda	2.5	Tetotum
14	Vegetable Research	Various Species	1.8	Tetotum
15	Fruit & Woody Ornamental	Fruit and Woody Ornamentals	3.7	Tetotum
16	Arboretum	Trees	1.5	Tetotum
18	Small Fruit Research	Strawberry	3.6	Tetotum
19	Ornamental Research	Woody Nursery Plants	4.3	Tetotum

[4] http://www.soils.wisc.edu/extension/materials/CCA_Legume_Manure_Credits.pdf

Appendix C.4

Morphological Descriptions of Deep (60”) Soil Borings at All Four Study Sites

Note: Borings labeled “R” for proposed research plot areas, “D” for demonstration areas and “P” for potential pond areas according to initial conceptual plan maps provided by AECOM on 9/22/22

Brenneman Farm (Site 3)

September 22, 2022 and September 28, 2022

See Maps in Appendix C for Boring Locations

3SB1P: (N36.7387689929°, W76.0884119757°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 12 inches; very dark grayish brown (2.5Y 3/2) loam; weak fine granular structure; friable, nonsticky, slightly plastic.

E--12 to 20 inches; gray (10YR 5/1) fine sandy loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg1--20 to 40 inches; dark gray (10YR 4/1) clay; weak coarse subangular blocky structure; very firm; slightly sticky, slightly plastic; common medium distinct yellowish brown (10YR 5/8) iron concentrations.

Btg2--40 to 50 inches; dark gray (10YR 4/1) sandy clay loam; weak medium subangular blocky structure; firm, slightly sticky, slightly plastic.

2Cg--50 to 60 inches; grayish brown (2.5Y 5/2) sand; single grain; loose.

Notes: Increased soil moisture observed 40-60”, no free water observed.

3SB2D: (N36.7401570361°, W76.0875390004°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 9 inches; olive brown (2.5Y 4/3) loam; weak fine granular structure; very friable; slightly sticky, slightly plastic.

Bt1--9 to 26 inches; yellowish brown (10YR 5/6) clay loam; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; few medium faint yellowish red (5YR 5/8) hard masses of iron accumulation at 26 inches.

Bt2--26 to 42 inches; dark yellowish brown (10YR 4/6) loamy sand; weak fine granular structure; very friable; slightly sticky, slightly plastic.

Bt3--42 to 52 inches; light olive brown (2.5Y 5/3) sandy loam; weak fine granular structure; friable; nonsticky, nonplastic.

C--52 to 60 inches; pale yellow (2.5Y 7/4), sand; single grain; loose.

Notes: No free water observed. Relative high spot

<u>3SB2D Image</u>

<u>3SB3R</u>: (N36.735926019°, W76.088107964°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 6 inches; dark grayish brown (10YR 4/2) very fine sandy loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg1--6 to 20 inches; dark gray (10YR 4/1) clay; weak coarse subangular blocky structure; very firm, slightly sticky, plastic; common medium distinct yellowish brown (10YR 5/8) iron concentrations.

Btg2--20 to 40 inches; dark gray (10YR 4/1) clay; weak coarse subangular blocky structure; very firm, slightly sticky, plastic.

BCg--40 to 50 inches; dark gray (10YR 4/1) sandy clay; weak coarse subangular blocky structure; very firm, slightly sticky, plastic; few medium distinct strong brown (7.5YR 5/8) iron concentrations, common coarse distinct (2.5Y 5/4) iron depletions.

2Cg--50 to 60 inches; gray (10YR 5/1) loamy sand; single grain; loose; common fine faint strong brown (7.5YR 5/8) iron concentrations.

<u>Notes</u>: Increased soil moisture observed 50-60”, no free water observed. Moderate shrink-swell potential in Btg.

3SB3R Image

3SB4R: (N36.7375009786°, W76.0874939896°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 8 inches; dark grayish brown (10YR 4/2) very fine sandy loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg--8 to 40 inches; gray (10YR 5/1) sandy clay; weak coarse subangular blocky structure; very firm, slightly sticky, plastic; common medium distinct yellowish brown (10YR 5/8) iron concentrations.

Cg--40 to 60 inches; yellowish brown (10YR 5/8) and gray (2.5Y 6/1) sandy loam; weak fine granular structure; friable, nonsticky, nonplastic; few fine distinct yellowish red (5YR 4/6) iron soft masses.

Notes: Increased soil moisture observed 55-60", no free water observed.

<u>3SB5R</u>: (N36.7364600301°, W76.0851400159°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 10 inches; dark grayish brown (10YR 4/2) very fine sandy loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg1--10 to 16 inches; dark gray (10YR 4/1) clay; weak coarse subangular blocky structure; very firm, slightly sticky, plastic; common medium distinct black (10YR 2/1) Mn soft masses.

Btg2--16 to 40 inches; dark gray (10YR 4/1) clay; weak coarse subangular blocky structure; very firm, slightly sticky, plastic; many medium distinct yellowish brown (10YR 5/8) iron concentrations.

BCg--40 to 50 inches; light brownish gray (2.5Y 6/2) sandy clay; weak coarse subangular blocky structure; firm, slightly sticky, plastic; common medium distinct strong brown (7.5YR 5/8) iron concentrations.

C--50 to 60 inches; gray (2.5Y 6/1) and brownish yellow (10YR 6/8) sandy loam; weak fine granular structure; friable, nonsticky, nonplastic; few common distinct bluish gray (10B 5/1) iron depletions, few fine distinct yellowish red (5YR 4/6) iron soft masses.

<u>Notes</u>: Increased soil moisture observed 50-60”, no free water observed. Moderate shrink-swell potential in Btg.

Brown Farm South (Site 2)

September 28, 2022 and September 29, 2022

2SB1R: (N36.7469789833°, W76.0926450044°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 10 inches; dark grayish brown (10YR 4/2) very fine sandy loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg--10 to 40 inches; dark gray (10YR 4/1) clay; weak medium subangular blocky structure; very firm, slightly sticky, plastic; common fine distinct yellowish brown (10YR 5/8) iron concentrations, few medium distinct black (10YR 2/1) Mn concentrations 36-40 inches.

2Cg--40 to 60 inches; light gray (2.5Y 7/1) very fine loamy sand; weak fine granular structure; friable, nonsticky, nonplastic; common medium distinct strong brown (7.5YR 5/8) iron concentrations.

Notes: Increased soil moisture observed 40-60", no free water observed.

2SB1R Image

<u>2SB2R</u>: (N36.7446270213°, W76.0945839901°), terrace, forested. Colors are moist.

Ap--0 to 6 inches; brown (10YR 4/3) very fine sandy loam; moderate fine granular structure; friable, nonsticky, slightly plastic.

E--6 to 18 inches; light brownish gray (2.5Y6/2) very fine sandy loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg--18 to 52 inches; gray (10YR 5/1) clay; weak medium subangular blocky structure; firm, slightly sticky, plastic; common medium distinct yellowish brown (10YR 5/8) iron concentrations.

Cg--52 to 60 inches; gray (2.5Y 6/1) very fine sandy clay loam; weak medium subangular blocky structure; friable, nonsticky, slightly plastic; common medium distinct strong brown (7.5YR 5/8) iron concentrations.

<u>Notes</u>: Increased soil moisture observed 52-60", no free water observed.

<u>2SB3R</u>: (N36.7442080099°, W76.0911500081°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 9 inches; dark grayish brown (10YR 4/2) very fine sandy loam; weak fine granular structure; very friable, nonsticky, slightly plastic.

Btg--9 to 38 inches; gray (10YR 5/1) clay; weak medium subangular blocky structure; very firm, slightly sticky, plastic; common fine distinct yellowish brown (10YR 5/8) iron concentrations.

Cg--38 to 60 inches; gray (2.5Y 6/1) very fine sandy clay loam; weak medium subangular blocky structure; friable, nonsticky, slightly plastic; common medium distinct strong brown (7.5YR 5/8) iron concentrations; common fine mica flakes.

<u>Notes</u>: Increased soil moisture observed 38-60", no free water observed.

<u>2SB4P</u>: (N36.7432699911°, W76.093970015°), terrace, forested. Colors are moist.

Ap--0 to 4 inches; dark grayish brown (10YR 4/2) loam; moderate fine granular structure; friable, nonsticky, slightly plastic.

E--4 to 11 inches; light brownish gray (2.5Y6/2) loam; weak fine platy structure; friable, nonsticky, slightly plastic; few medium faint yellowish brown (10YR 5/6) iron concentrations.

Btg1--11 to 30 inches; gray (10YR 5/1) clay loam; moderate fine platy structure; firm, slightly sticky, plastic; common medium distinct yellowish brown (10YR 5/8) iron concentrations.

Btg2--30 to 46 inches; gray (10YR 5/1) clay; weak coarse subangular blocky structure; very firm, slightly sticky, plastic; common medium distinct strong brown (7.5YR 5/8) iron concentrations, many medium distinct gray (2.5Y 6/1) iron depletions on ped faces.

2C--46 to 60 inches; strong brown (7.5YR 5/8) sand; single grain; loose.

<u>Notes</u>: Moderate shrink-swell potential in Btg2, no free water observed.

2SB4P Image

2SB5D: (N36.7425359879°, W76.0937199835°), terrace, cultivated field (standing soybeans). Colors are moist.

Ap--0 to 10 inches; dark grayish brown (10YR 4/2) loam; moderate fine granular structure; friable, nonsticky, slightly plastic.

Btg1--10 to 24 inches; gray (10YR 5/1) clay; weak coarse subangular blocky structure; very firm, slightly sticky, plastic; many medium distinct strong brown (7.5YR 5/8) iron concentrations, many medium distinct gray (2.5Y 6/1) iron depletions on ped faces.

Btg2--24 to 38 inches; grayish brown (2.5Y 5/2) clay loam; weak medium subangular blocky structure; firm, slightly sticky, plastic; common medium distinct yellowish brown (10YR 5/8) iron concentrations.

2C--38 to 60 inches; yellowish brown (10YR 5/6), light yellowish brown (2.5Y 6/3) and light gray (2.5Y 7/2) stratified sand; single grain; loose.

Notes: Moderate shrink-swell potential in Btg1, no free water observed.

VT AREC Relocation Soil Descriptions **Angela C. Whitehead**

Brown Farm North (Site 1)

September 29, 2022

1SB1D: (N36.7492110003°, W76.092049973°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 6 inches; dark grayish brown (10YR 4/2) loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg--6 to 30 inches; gray (10YR 5/1) clay; weak medium subangular blocky structure; very firm, slightly sticky, plastic; common medium faint yellowish brown (10YR 5/8) iron concentrations.

BCg--30 to 44 inches; gray (2.5Y 6/1) clay parting to very fine sandy clay; weak coarse subangular blocky structure; very firm, slightly sticky, plastic; common medium distinct strong brown (7.5YR 5/8) iron concentrations.

2Cg--44 to 60 inches; gray (2.5Y 6/1) very fine loamy sand; weak fine granular structure; friable, nonsticky, nonplastic; few fine mica flakes.

Notes: Increased soil moisture observed 44-60", no free water observed. Moderate shrink-swell potential in Btg.

1SB2P: (N36.7507500015°, W76.0921410006°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 6 inches; dark grayish brown (10YR 4/2) loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg--6 to 34 inches; gray (10YR 5/1) clay; weak medium subangular blocky structure; very firm, slightly sticky, plastic; common medium faint yellowish brown (10YR 5/8) iron concentrations.

2Cg1--34 to 52 inches; gray (2.5Y 6/1) very fine loamy sand; weak fine granular structure; friable, nonsticky, nonplastic; common medium distinct strong brown (7.5YR 5/8) iron concentrations.

2Cg2--52 to 60 inches; light brownish gray (2.5Y 6/2) sand; single grain; loose.

Notes: Increased soil moisture observed 34-60", no free water observed.

1SB3R: (N36.7544109654°, W76.0922720097°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 6 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg--6 to 32 inches; gray (10YR 5/1) sandy clay; weak medium subangular blocky structure; firm, slightly sticky, plastic; common medium faint yellowish brown (10YR 5/8) iron concentrations.

2Cg1--32 to 50 inches; gray (2.5Y 6/1) loamy fine sand; weak fine granular structure; friable, nonsticky, nonplastic; few medium distinct strong brown (7.5YR 5/8) iron concentrations.

2C2--50 to 60 inches; yellowish brown (10YR 5/8) sand; single grain; loose.

Notes: Increased soil moisture observed 32-60", no free water observed.

1SB3R Image

1SB4R: (N36.7528739758 °, W76.0921410006°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 8 inches; dark grayish brown (10YR 4/2) loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg--8 to 36 inches; gray (10YR 5/1) very fine sandy clay; weak medium subangular blocky structure; very firm, slightly sticky, plastic; few medium distinct yellowish brown (10YR 5/8) iron concentrations.

2Cg--36 to 60 inches; light brownish gray (2.5Y 6/2) loamy sand parting to sand; single grain; loose; common medium distinct yellowish brown (10YR 5/8) iron concentrations.

Notes: Increased soil moisture observed 36-60”, no free water observed.

1SB5R: (N36.7520999908°, W76.090391026°), terrace, cultivate field (cut corn). Colors are moist.

Ap--0 to 8 inches; dark grayish brown (10YR 4/2) loam; weak fine granular structure; friable, nonsticky, slightly plastic.

Btg--8 to 38 inches; gray (10YR 5/1) very fine sandy clay; weak medium subangular blocky structure; very firm, slightly sticky, plastic; few medium distinct yellowish brown (10YR 5/8) iron concentrations.

2Cg--38 to 60 inches; light brownish gray (2.5Y 6/2) loamy sand parting to sand; single grain; loose; common medium distinct yellowish brown (10YR 5/8) iron concentrations.

Notes: Increased soil moisture observed 38-60”, no free water observed.

1SB5R Image

VT AREC Relocation Soil Descriptions **Angela C. Whitehead**

Virginia Tech Hampton Roads AREC **October 6, 2022**

VTSB1: (N36.8925429694°, W76.1758580245°), terrace, turfgrass. Colors are moist.

Ap--0 to 14 inches; dark grayish brown 2.5Y 4/3) silt loam; moderate fine granular structure; very friable; many fine mica flakes; slightly compacted; clear boundary.

Bt--14 to 22 inches; dark yellowish brown (2.5Y 5/6) silty clay loam; weak fine subangular blocky structure; firm, slightly sticky, slightly plastic; few distinct clay films on faces of peds; 2 percent fine gravel; many very fine mica flakes; gradual boundary.

Btg--22 to 48 inches; gray (2.5Y 6/2) gravelly silty clay loam; many fine distinct strong brown (7.5YR 5/8) iron concentrations; weak medium subangular blocky structure; very firm, slightly sticky, slightly plastic; few faint clay films on faces of peds; 5 percent gravel; common fine mica flakes; clear smooth boundary.

2C--48 to 60 inches; gray (2.5Y 5/6) gravelly coarse sand; loose single grain; 5 percent gravel.

Notes: Increased soil moisture observed 38-60”, no free water observed. Moderate shrink swell potential in Btg.

VTSB2: (N 36.8939399812°, W76.1777570285°), terrace, turfgrass. Colors are moist.

Ap--0 to 10 inches; brown (2.5Y 4/4) gravelly silt loam; moderate fine granular structure; very friable; 5 percent fine gravel; common very fine mica flakes; clear boundary.

Bt--10 to 34 inches; yellowish brown (10YR 5/6) gravelly silty clay loam; weak fine subangular blocky structure; friable; 5 percent fine gravel; few fine mica flakes; clear boundary.

C--34 to 50 inches; very pale brown (7.5YR 4/6) gravelly loamy sand; weak fine granular structure; very friable; 5 percent gravel.

Notes: Increased soil moisture observed 34-50”, no free water observed.

VTSB3: (N36.8898979761°, W76.17977296°), terrace, turfgrass. Colors are moist.

Ap--0 to 14 inches; brown (10YR 4/4) gravelly silt loam; moderate fine granular structure; very friable; 5 percent fine gravel; clear boundary.

Bt--14 to 32 inches; yellowish brown (7.5YR 4/6) gravelly silty clay loam; weak fine subangular blocky structure; friable; 5 percent fine gravel; few very fine mica flakes; clear boundary.

C--32 to 56 inches; very pale brown (10YR 6/6) gravelly sand; single grain; loose; few medium distinct black (10YR 2/1) Mn coatings 54-56"; 5 percent gravel.

Notes: Increased soil moisture observed 32-56”, no free water observed.

Appendix C.5

Current NRCS Soil Series Typical Pedon and Range of Characteristics Sheets for Dominant Soils Observed

LOCATION ACREDALE VA+NC

Established Series
DRH, JHW, RLV Rev. PLT, GH
04/2004

ACREDALE SERIES

MLRA(s): 153A, 153B
MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina
Depth Class: Very Deep
Drainage Class: Poorly drained
Permeability: Slow
Surface Runoff: Slow
Parent Material: Formed in silty and loamy marine and fluvial sediments
Slope: 0 to 2 percent
Mean Annual Air Temperature (type location): 59 degrees F.
Mean Annual Precipitation (type location): 45 inches

TAXONOMIC CLASS: Fine-silty, mixed, active, thermic Typic Endoaqualfs

TYPICAL PEDON: Acredale silt loam - in a nearly level cultivated field. (Colors are for moist soil.)

Ap--0 to 7 inches; grayish brown (10YR 5/2) silt loam; weak fine granular structure; very friable, slightly sticky, slightly plastic; common fine and very fine roots; common fine and medium pores; strongly acid; clear smooth boundary. (6 to 12 inches thick)

Btg1--7 to 15 inches; light brownish gray (10YR 6/2) silt loam; few fine prominent yellowish brown (10YR 5/8) soft masses of iron accumulation; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; common fine and very fine roots; common very fine vesicular and few fine tubular pores; many very fine sand grains coated and bridged with clay; very strongly acid; abrupt smooth boundary. (0 to 10 inches thick)

Btg2--15 to 35 inches; gray (5Y 5/1) silty clay loam; common medium prominent yellowish brown (10YR 5/8) soft masses of iron accumulation; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; friable, sticky, plastic; common very fine roots; few fine vesicular and few fine tubular pores; many thin continuous clay films on faces of macro peds; many very fine sand grains coated and bridged with clay; pockets of silt from 1/2 to 3 inches in diameter that are white when dry; very strongly acid; clear smooth boundary.

Btg3--35 to 43 inches; light greenish gray (5GY 7/1)silt loam; common medium distinct dark gray (N 4/0) iron depletions, common medium prominent yellowish brown (10YR 5/8) soft masses of iron accumulation; moderate fine and medium subangular and angular blocky structure; friable, sticky, plastic; few very fine roots; few very fine vesicular pores; few thin discontinuous clay films on faces of peds; few very fine sand grains coated and bridged with clay; few fine prominent yellowish red colors along very fine root channels; very strongly acid; clear smooth boundary. (Combined thickness of Bt horizon is 14 to 43 inches.)

2BCg--43 to 50 inches; gray (10YR 6/1)sandy loam; common medium distinct light greenish gray (5GY 7/1) iron depletions and common medium prominent yellowish brown (10YR 5/8) soft masses of iron accumulation; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; few very fine roots; few fine vesicular pores; few sand grains coated and bridged with clay; many clean sand grains; common pockets of clean white sand up to 3 inches in diameter; strongly acid; clear wavy boundary. (0 to 10 inches thick)

2Cg--50 to 66 inches; gray (5Y 6/1) sandy loam; common medium faint light olive gray (5Y 6/2) iron depletions and common medium prominent yellowish brown (10YR 5/8) soft masses of iron accumulation; massive, very friable; nonsticky, nonplastic; few very fine vesicular pores; many fine flakes of mica; moderately acid.

TYPE LOCATION: City of Virginia Beach, Virginia; approximately 4.5 miles northwest of Princess Anne, 1,700 feet south southwest of intersection of Lynhaven Parkway and Princess Anne Road.

RANGE IN CHARACTERISTICS:
Solum Thickness: 40 to 60 inches
Depth to Bedrock: Greater than 60 inches
Depth to Seasonal High Water Table: 0 to 12 inches, December to April
Soil Reaction: The A horizon ranges from extremely acid through strongly acid unless limed. The B and C horizons range from very strongly acid through neutral.

A or AP horizon:
Color-- hue of 10YR or 2.5Y, value of 2 through 6, and chroma of 1 through 3. Horizons with value of 2 or 3 are less than 6 inches thick.
Texture--silt loam, loam, or very fine sandy loam.

BA horizon (where present):
Color--hue of 10YR through 5Y or is neutral, value of 4 through 7, and chroma of 0 through 2.
Texture--loam or silt loam.

Redoximorphic features (if they occur)--iron masses in shades of brown, yellow, or red and iron depletions in shades of olive or gray

Btg horizon:
Color--hue of 10YR through 5Y or is neutral, value of 4 through 7, and chroma of 0 through 2; also includes hue of 5GY and 5G, value of 4 through 6, and chroma of 1. When present, the greenish colors are generally in the lower part of the horizon.
Texture: upper Btg horizon is silty clay loam or silt loam, and texture of the lower Btg horizon has similar textures and ranges to loam, clay loam, or silty clay.
Redoximorphic features (if they occur)--iron masses in shades of brown, yellow, or red and iron depletions in shades of olive or gray

BCg horizon (where present):
Color--hue of 10YR through 5Y or is neutral, value of 4 through 7, and chroma of 0 through 2; also includes hue of 5GY and 5G, value of 4 through 6, and chroma of 1..
Texture--is loam, silt loam, silty clay loam, clay loam, or silty clay. Some pedon range to fine sandy loam, sandy loam or sandy clay loam in some pedons.
Redoximorphic features (if they occur)--iron masses in shades of brown, yellow, or red and iron depletions in shades of olive or gray

Cg horizon:
Color--hue of 10YR through 5Y or is neutral, value of 4 through 7, and chroma of 0 through 2; also includes hue of 5GY and 5G, value of 4 through 6, and chroma of 1.
Textureis dominantly sand, loamy sand, very fine sandy loam, fine sandy loam or sandy loam, but thin strata of finer texture are common in most pedons.

COMPETING SERIES:
Adaton soils--Adaton soils have dark concretions in the B horizon and solum thickness greater than 60 inches.
Amagons oils-- have a B horizon that contains dark concretions and a high content of very fine sand and solum thickness of 50 to 70 inches or more.
Dundeeare somewhat poorly drained and are limited to landscapes of MLRA 131.
Idee soils-- are somewhat poorly drained and thickness of solum is more than 60 inches
Tichnor soilshave solum thickness greater than 60 inches are limited to MLRA 134 and 131.

GEOGRAPHIC SETTING:
Lanscape: Coastal Plain
Landform: Terraces
Elevation: 5 to 100 feet above mean sea level
Parent Material: Formed in silty and loamy marine and fluvial sediments
Mean Annual Air Temperature: 59 degrees
Mean Annual Precipitation: 45 inches
Frost Free Period: 200 to 270 days

GEOGRAPHICALLY ASSOCIATED SOILS:
Argent soils--poorly drained soils (seasonal high water table 0 to 12 inches) in fine family on similar landscape
Arapahoe soils--very poorly drained soils (seasonal high water table 0 to 12 inches) in coarse-loamy family on similar landscapes
Cape Fear soils--very poorly drained soils (seasonal high water table 0 to 12 inches) in fine family on similar landscape
Chapanoke soils-- somewhat poorly drained soils (seasonal high water table 6 to 18 inches) in fine-silty family on slightly higher landscapes
Deloss soils--very poorly drained soils (seasonal high water table 0 to 12 inches) in fine-loamy family on similar landscapes
Gertie soils--poorly drained soils (seasonal high water table 0 to 12 inches) in fine family on similar landscape
Hydeland soils--very poorly drained soils (seasonal high water table 0 to 12 inches) in fine-silty family on similar landscapes
Nimmo soils--poorly drained soils (seasonal high water table 0 to 12 inches) in coarse-loamy family on similar landscapes
Pasquotank soils--poorly drained soils (seasonal high water table 0 to 12 inches) in coarse-silty family on similar landscapes
Perquimans soils--poorly drained soils (seasonal high water table 0 to 12 inches) in fine-silty family on similar landscapes
Portsmouth soils--very poorly drained soils (seasonal high water table 0 to 12 inches) with contrasting textures on similar landscapes

DRAINAGE AND PERMEABILITY:
Agricultural Drainage Class: Poorly drained
Permeability: Slow

USE AND VEGETATION:
Major Uses: Mostly cultivated
Dominant Vegetation: Where cultivated--corn, oats, soybeans, small grain, truck crops, and pasture. Where wooded--loblolly pine, willow oak, yellow poplar, red maple, water tupelo, sweetgum, blackgum, and water oak. Understory plants include inkberry, large gallberry, southern bayberry, switchcane, blueberry, sweetbay and American holly.

DISTRIBUTION AND EXTENT:
Distribution: Lower Coastal Plain of Virginia, North Carolina, and South Carolina
Extent: Moderate

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina

SERIES ESTABLISHED: City of Virginia Beach, Virginia, 1979. The name is from a small community.

REMARKS: Acredale soils have been included with Bladen and Roanoke soils in past mapping.

ADDITIONAL DATA: Virginia Polytechnic Institute and State University soil survey lab data shows the typical pedon of the Acredale series to have a base saturation of 74.67 percent at 50 inches below the top of the argillic. The particle-size control section has 26 percent clay, 55 percent silt, and 9 percent sand that is coarser than very fine sand as a weighted average, with 76 percent quartz and 20 percent weatherable minerals, mainly feldspar and mica, in the 20 to 2,000 micron fraction.

Sample Numbers: S77VA76-49-(1-6), S73VA76-3-(1-7), S75VA76-23-(1-6), S75VA-76-20-(1-5), S77VA-76-66-(1-7), S75-VA-76-29-(1-6), S78VA-76-62-(1-5), S73VA-76-1-(1-7).

TABULAR SERIES DATA:

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SOI-5  Soil Name   Slope Airtemp FrFr/Seas Precip Elevation
VA0160 ACREDALE    0-  2   59- 65  190-260  40- 56     1- 100


SOI-5  FloodL FloodH Watertable Kind   Months  Bedrock Hardness VA0160 NONE   RARE     0-1.0 APPARENT DEC-APR 60-60


SOI-5  Depth  Texture               3-Inch  No-10  Clay%   -CEC- VA0160  0- 7  SIL L VFSL             0-  0 100-100  8-15   3- 10 V


SOI-5  Depth    -pH-     O.M.  Salin  Permeab   Shnk-Swll
VA0160  0- 7  3.6- 5.5  2.-8.  0- 0   0.6- 2.0 LOW
VA0160  7-15  3.6- 5.5  .5-1.  0- 0   0.6- 2.0 LOW
VA0160 15-43 4.5- 7.3 0.-.5 0- 0 0.06- 0.2 MODERATE
VA0160 43-66  4.5- 7.3  0.-.5  0- 0   2.0- 20 LOW
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National Cooperative Soil Survey
U.S.A.

LOCATION TETOTUM VA+NC SC

Established Series
JHW-DLJ, Rev GH/PLT
05/2004

TETOTUM SERIES

MLRA(s): 133A, 152A, 153A, 153B, 153C
MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina
Depth Class: Very deep
Drainage Class: Moderately well drained
Permeability: Moderate in the B horizon and moderate to rapid in the C horizons
Surface Runoff: Slow on nearly level areas and medium to rapid on steeper areas
Parent Material: Moderately fine textured fluvial or marine sediments underlain by stratified coarse to medium textured sediments
Slope: 0 to 15 percent
Mean Annual Air Temperature (type location): 58 degrees F.
Mean Annual Precipitation (type location): 42 inches

TAXONOMIC CLASS: Fine-loamy, mixed, semiactive, thermic Aquic Hapludults

TYPICAL PEDON: Tetotum fine sandy loam, in a cultivated field. (Colors are for moist soil.)

Ap--0 to 9 inches; dark grayish brown (10YR 4/2) fine sandy loam; moderate fine granular structure; very friable; many fine roots; 2 percent fine gravel; moderately acid; clear smooth boundary. (0 to 12 inches thick)

Bt1--9 to 14 inches; dark yellowish brown (10YR 4/4) sandy clay loam; weak fine subangular blocky structure; friable, slightly sticky, slightly plastic; many fine roots; common fine pores; few distinct clay films on faces of peds; 2 percent fine gravel; strongly acid; clear smooth boundary.

Bt2--14 to 23 inches; yellowish brown (10YR 5/4) clay loam; moderate medium subangular blocky structure; firm, sticky, slightly plastic; common fine roots; common fine pores; few distinct clay films on faces of peds; 2 percent fine gravel; strongly acid; clear smooth boundary.

Bt3--23 to 30 inches; yellowish brown (10YR 5/8) clay loam; few fine distinct gray (10YR 6/1) iron depletions and strong brown (7.5YR 5/8) soft masses of iron accumulation; moderate fine subangular blocky structure; firm, sticky, slightly plastic; few fine roots; few fine pores; few distinct clay films on faces of peds; 2 percent fine gravel; strongly acid; clear smooth boundary.

Bt4--30 to 38 inches; varigated yellowish brown (10YR 5/8), gray (10YR 6/1), and red (2.5YR 4/8) clay loam; moderate fine angular blocky structure; firm, sticky, plastic; few fine roots; few fine pores; common distinct clay films on faces of peds; 10 percent fine gravel; very strongly acid; clear smooth boundary. (Combined thickness of the Bt horizon is 18 to 52 inches.)

Btg--38 to 48 inches; gray (10YR 6/1) sandy clay loam; many fine distinct strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) soft masses of iron accumulation; weak medium subangular blocky structure; firm, slightly sticky, slightly plastic; few fine roots; few fine pores; few faint clay films on faces of peds; 5 percent fine gravel; very strongly acid; gradual smooth boundary. (0 to 14 inches thick)

2Cg--48 to 72 inches; gray (10YR 6/1) stratified fine sandy loam and loamy fine sand; common medium distinct yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6) soft masses of iron accumulation; massive; friable; 2 percent fine gravel; very strongly acid.

TYPE LOCATION: King George County, Virginia; approximately 1 mile east of Tetotum Post Office at intersection of VA-619 and VA-218; 150 feet north of VA-619.

RANGE IN CHARACTERISTICS:
Solum Thickness: 40 to more than 60 inches
Depth to Bedrock: Greater than 60 inches
Depth to Seasonal High Water Table: 18 to 30 inches, December to April
Soil Reaction: extremely acid through strongly acid unless limed
Other Features: The upper 20 inches of the argillic horizon averages more than 30 percent silt or more than 40 percent silt plus very fine sand. Some pedons have few mica flakes

A or Ap horizon:
Color--hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 2 through 4
Texture--sandy loam, fine sandy loam, loam, or silt loam

E horizon:
Color--hue of 10YR or 2.5Y, value of 4 through 7, and chroma of 2 through 4
Texture--sandy loam, fine sandy loam, loam, or silt loam

BA or BE horizon, (where present):
Color--hue of 10YR or 2.5Y, value of 4 through 7, and chroma of 3 through 8 Texture--sandy loam, fine sandy loam, sandy clay loam, loam, or silt

loam

Bt horizon, (upper part):
Color--has hue of 7.5YR through 2.5Y, value of 4 through 7, and chroma of 4 through 8
Texture-- typically is clay loam or loam, but some pedons have subhorizons that are sandy clay loam, silt loam, or silty clay loam

Bt horizon, (lower part):
Color--hue of 7.5YR through 5Y, value of 5 through 7, and chroma of 3 through 8. In some pedons the lower part of the Bt horizon is mottled with these or other hue and does not have dominant matrix color.
Texture--typically is clay loam or loam, but some pedons have subhorizons that are sandy clay loam, silt loam, or silty clay loam
Redoximorphic Features--iron masses in shades of red and iron depletions in shades of gray are in some pedons

Btg horizon, (where present):
Color--hue of 7.5YR through 5Y, value of 4 through 7, and chroma of 1 or 2, or it is mottled with these or other hue and does not have dominant matrix color.
Texture--is clay loam or loam, but some pedons have subhorizons that are sandy clay loam, silt loam, or silty clay loam.
Redoximorphic Features--iron masses in shades of red and iron depletions in shades of gray are in some pedons

BC or CB horizon, (where present):
Color--hue of 7.5YR through 5Y, value of 5 through 7, and chroma of 3 through 8, or it is mottled with these or other hue without dominant matrix color.
Texture--sandy loam, fine sandy loam, very fine sandy loam, sandy clay loam, or loam.
Redoximorphic Features--iron masses in shades of red and iron depletions in shades of gray are in some pedons

BCg or CBg horizon, (where present):
Color--hue of 7.5YR through 5Y, value of 5 through 7, and chroma of 1 or 2, or it is mottled with these or other hue without dominant matrix color.
Texture--sandy loam, fine sandy loam, very fine sandy loam, sandy clay loam, or loam.
Redoximorphic Features--iron masses in shades of red and iron depletions in shades of gray are in some pedons

C or 2C horizon,:
Color--hue of 7.5YR through 5Y, value of 5 through 7, and chroma of 3 through 8. In some pedons the lower part of the Bt horizon is mottled with these or other hue and does not have dominant matrix color.
Texture--stratified sands to sandy clay loam. Strata of finer texture are in some pedons.
Redoximorphic Features--iron masses in shades of red and iron depletions in shades of gray are in some pedons

Cg or 2Cg horizon:
Color--hue of 7.5YR through 5Y, value of 5 through 7, and chroma of 3 through 8. In some pedons the lower part of the Bt horizon is mottled with these or other hue and does not have dominant matrix color.
Texture--stratified sands to sandy clay loam. Strata of finer texture are in some pedons.

COMPETING SERIES:
Abell soils--moderately well drained soils (seasonal high water table 24 to 42 inches) on similar landscapes but have less than 30 percent silt in the upper particle size control section. These soils also have a lithological discontinuity in the Bt horizon
Altavista soils--moderately well drained soils (seasonal high water table 18 to 30 inches) on similar landscapes but have less than 30 percent silt in the upper particle size control section.
Santuc soils--formed in residuum weathered from mixed acid crystalline rocks and have a perched water table
Winton soils--moderately well drained soils (perched water table at 24 to 42 inches) on long narrow bluffs that break sharply into rivers and their major tributaries that drain from the Piedmont and Coastal Plain. Have less than 30 percent silt in the upper particle size control section.

GEOGRAPHIC SETTING:
Landscape: Coastal Plain
Landform: Terraces
Elevation: 5 to 200 feet above mean sea level
Parent Material: Moderately fine textured fluvial or marine sediments underlain by stratified coarse to medium textured sediments
Mean Annual Air Temperature: 58 to 62 degrees
Mean Annual Precipitation: 40 to 48 inches
Frost Free Period: 195 to 240 days

GEOGRAPHICALLY ASSOCIATED SOILS:
Augusta soils--somewhat poorly drained soils (seasonal high water table 12 to 18 inches) on slightly lower landscapes
Bertie soils--somewhat poorly drained soils (seasonal high water table 12 to 18 inches) on slightly lower landscapes
Bojac soils--well drained soils (seasonal high water table 48 to 72 inches) in coarse-loamy family on similar landscapes
Chesapeake soils-- well drained soils (seasonal high water table 48 to 72 inches) on slightly higher landscapes
Dogue soils--moderately well drained soils (seasonal high water table 18 to 30 inches) in fine family on similar landscapes
Gertie soils--poorly drained soils (seasonal high water table 0 to 12 inches) in fine family on flats and in depressions
Roanoke soils--poorly drained soils (seasonal high water table 0 to 12 inches) in fine family on flats and in depressions
State soils--well drained soils (seasonal high water table 48 to 72 inches) on slightly higher landscapes
Tomotley soils--poorly drained soils (seasonal high water table 0 to 12 inches) in fine-loamy family on flats and in slight depressions
Wickham soils--well drained soils (seasonal high water table greater than 72 inches) on slightly higher landscapes

DRAINAGE AND PERMEABILITY:
Agricultural Drainage Class: Moderately well drained
Permeability: Moderate in the B horizon and moderate to rapid in the C horizon

USE AND VEGETATION:
Major Uses: Mostly cultivated
Dominant Vegetation: Where cultivated--corn, cotton, small grain, soybeans, and truck crops. Where woodland--loblolly, sweetgum, red maple, yellow-poplar, white oak, southern red oak, water oak, American beech, and hickory.

DISTRIBUTION AND EXTENT:
Distribution: Virginia, North Carolina, and possibly Alabama, and Georgia
Extent: Moderate

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina

SERIES ESTABLISHED: King George County, Virginia, 1970.

REMARKS:
Diagnostic horizons and features recognized in this pedon are:
1. ochric epipedon - the zone from 0 to 9 inches (Ap horizon).
2. argillic horizon - the zone from 9 to 48 inches (Bt and Btg horizons).

ADDITIONAL DATA:

TABULAR SERIES DATA:

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SOI-5  Soil Name   Slope Airtemp FrFr/Seas Precip Elevation
VA0033 TETOTUM     0- 50   58- 62  195-240  40- 48     5- 200


SOI-5  FloodL FloodH Watertable Kind   Months Bedrock Hardness
VA0033 NONE   RARE   1.5-2.5 APPARENT DEC-APR  60-60


SOI-5  Depth  Texture                3-Inch  No-10  Clay%   -CEC-
VA0033  0- 9  FSL SL                  0-  0  80-100  5-15    -
VA0033  0- 9  L SIL                   0-  0  80-100 10-22    -
VA0033  9-48  SCL CL SICL             0-  2  80-100 18-35    -
VA0033 48-72  SR SCL LFS              0-  2  75-100  5-30    -


SOI-5   Depth   -pH-   O.M.   Salin   Permeab   Shnk-Swll
VA0033 0- 9 3.6- 5.5 .5-2. 0- 0 2.0- 6.0  LOW
VA0033  0-  9  3.6-  5.5  .5-2.  0-  0  0.6-  2.0   LOW
VA0033  9-48  3.6-  5.5  0.-.5  0-  0  0.6-  2.0   LOW
VA0033 48-72  3.6- 5.5  0.-.5  0- 0   0.6-  20  LOW
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National Cooperative Soil Survey
U.S.A.

LOCATION MUNDEN VA+NC

Established Series
Rev. DRH-JHW-DLJ
05/2007

MUNDEN SERIES

MLRA(s): 153A, 153B
MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina
Depth Class: Very deep
Drainage Class: Moderately well drained
Permeability: Moderate to moderately rapid in the A and B horizon and moderately rapid in the C horizons
Surface Runoff: Slow
Parent Material: Loamy and sandy marine and fluvial sediments
Slope: 0 to 8 percent
Mean Annual Air Temperature (type location): 59 degrees F.
Mean Annual Precipitation (type location): 45 inches

TAXONOMIC CLASS: Coarse-loamy, mixed, semiactive, thermic Aquic Hapludults

TYPICAL PEDON: Munden fine sandy loam, cultivated. (Colors are for moist soil.)

Ap--0 to 8 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; very friable; common fine roots; slightly acid; abrupt smooth boundary. (5 to 10 inches thick)

Bt1--8 to 15 inches; yellowish brown (10YR 5/6) sandy loam; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; few fine roots; few faint clay films on faces of peds; many sand grains coated and bridged with clay; strongly acid; clear smooth boundary.

Bt2--15 to 25 inches; yellowish brown (10YR 5/6) loam; moderate medium subangular blocky structure; friable, slightly sticky, slightly plastic; few fine roots; common distinct clay films on faces of peds; many sand grains coated and bridged with clay; common medium faint light brown (7.5YR 6/4) soft masses of iron accumulation; very strongly acid; clear smooth boundary.

Bt3--25 to 32 inches; brown (10YR 5/3) and yellowish brown (10YR 5/8) sandy loam; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; few fine roots; common fine distinct light brownish gray (10YR 6/2) iron depletions; few faint clay films on faces of peds; many sand grains coated and bridged with clay; few small pockets of sand up to 1 1/2 inches in diameter; very strongly acid; clear smooth boundary. (Combined thickness of the Bt horizons ranges from 15 to 35 inches)

C--32 to 62 inches; yellowish brown (10YR 5/8), light brownish gray (10YR 6/2), and yellowish red (5YR 5/6) sand; single grain; loose; many stained sand grains; strongly acid.

TYPE LOCATION: City of Virginia Beach, Virginia; approximately 1.25 miles southwest of Princess Anne and 4.25 miles southeast of Stumpy Lake; 136 feet due south of North Landing Road and 100 feet southeast of small cemetery.

RANGE IN CHARACTERISTICS:
Solum Thickness: 25 to more than 50 inches
Depth to Bedrock: Greater than 60 inches
Depth to Seasonal High Water Table: 18 to 30 inches, December to April
Soil Reaction: very strongly acid to moderately acid, unless limed

Ap or A horizon:
Color--hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 to 4
Texture--loamy sand, loamy fine sand, sandy loam, fine sandy loam, or loam

E horizon (if it occurs):
Color--hue of 10YR to 5Y, value of 5 to 7, and chroma of 2 to 6
Texture--loamy sand, loamy fine sand, sandy loam, fine sandy loam, or loam

BA or BE horizon (if it occurs):
Color: hue of 10YR to 5Y, value of 5 or 6, and chroma of 3 to 6
Texture--sandy loam, fine sandy loam, or loam

Bt horizon--the upper part of the Bt horizon has hue of 7.5YR to 2.5Y, value of 3 to 6, and chroma of 4 to 8. The lower part of the Bt horizon has hue of 7.5YR to 2.5Y, value of 3 to 6, and chroma of 3 to 8, or it is multicolored in these and other hues without dominant matrix color
Texture--sandy loam, fine sandy loam, or loam. Subhorizons of some pedons range to sandy clay loam
Redoximorphic features--iron masses in shades of brown, red or yellow and iron depletions in shades of brown, olive and gray

Btg horizon (if it occurs):
Color--hue of 7.5YR to 2.5Y or is neutral, value of 3 to 6, and chroma of 0 to 2, or it is multicolored in these and other hue without dominant matrix color
Texture--sandy loam, fine sandy loam, or loam. Subhorizons of some pedons range to sandy clay loam
Redoximorphic features--iron masses in shades of brown, red or yellow and iron depletions in shades of brown, olive and gray

BC or CB horizon (if it occurs):
Color--hue of 7.5YR to 2.5Y, value of 3 to 6, and chroma of 3 to 8, or it is multicolored with these or other hue without dominant matrix color
Texture--loamy sand, sandy loam, fine sandy loam, or loam
Redoximorphic features--iron masses in shades of brown, red or yellow and iron depletions in shades of brown, olive and gray

BCg or CBg horizon (if it occurs):
Color--hue of 7.5YR to 2.5Y, value of 3 to 6, and chroma of 0 to 2, or it is multicolored with these or other hue without dominant matrix color
Texture--loamy sand, sandy loam, fine sandy loam, or loam
Redoximorphic features--iron masses in shades of brown, red or yellow and iron depletions in shades of brown, olive and gray

C horizon:
Color--hue of 7.5YR to 5Y, value of 5 to 7, and chroma of 3 to 8, or it is multicolored with these or other hue without dominant matrix color
Texture--sand, fine sand, loamy sand, loamy fine sand, sandy loam, or fine sandy loam. Some pedons have thin strata ranging from sandy clay loam to silty clay.
Redoximorphic features--iron masses in shades of brown, red or yellow and iron depletions in shades of brown, olive and gray

Cg horizon (if it occurs):
Color--has hue of 7.5YR to 5Y or is neutral, value of 5 to 7, and chroma of 0 to 2, or it is multicolored with these or other hue without dominant matrix color.
Texture--sand, fine sand, loamy sand, loamy fine sand, sandy loam, or fine sandy loam. Some pedons have thin strata ranging from sandy clay loam to silty clay.
Redoximorphic features--iron masses in shades of brown, red or yellow and iron depletions in shades of brown, olive and gray

COMPETING SERIES: There are no other series in this family.

GEOGRAPHIC SETTING:
Landscape: Coastal Plain
Landform: Terraces
Elevation: 5 to 100 feet above mean sea level
Parent Material: Loamy and sandy marine and fluvial sediments
Mean Annual Air Temperature: 59 to 64 degrees
Mean Annual Precipitation: 41 to 49 inches
Frost Free Period: 190 to 240 days

GEOGRAPHICALLY ASSOCIATED SOILS:
Augusta soils--somewhat poorly drained soils (seasonal high water table 12 to 18 inches) on slightly lower landscapes
Bertie soils--somewhat poorly drained soils (seasonal high water table 12 to 18 inches) on slightly lower landscapes
Bojac soils--well drained soils (seasonal high water table 48 to 72 inches) on similar landscapes
Dragston soils--somewhat poorly drained soils (seasonal high water table 12 to 18 inches) family on slightly lower or similar landscapes
Nimmo soils--poorly drained soils (seasonal high water table 0 to 12 inches) on flats and in slight depressions
Roanoke soils--poorly drained soils (seasonal high water table 0 to 12 inches) in fine family on flats and in slight depressions
State soils--well drained soils (seasonal high water table 48 to 72 inches) in fine-loamy family on slightly higher landscapes
Tetotum soils--moderately well drained soils (seasonal high water table 18 to 30 inches) in fine-loamy family on similar landscapes
Tomotley soils--poorly drained soils (seasonal high water table 0 to 12 inches) in fine-loamy family on flats and in slight depressions

DRAINAGE AND PERMEABILITY:
Agricultural Drainage Class: Moderately well drained
Permeability: Moderate to moderately rapid in the A and B horizon and moderately rapid in the C horizons

USE AND VEGETATION:
Major Uses: Mostly cultivated
Dominant Vegetation: Where cultivated--corn, cotton, small grain, soybeans, and peanuts. Where woodland --- loblolly, sweetgum, red maple, yellow-poplar, white oak, southern red oak, water oak, American beech, and hickory.

DISTRIBUTION AND EXTENT:
Distribution: Virginia, North Carolina, and possibly Alabama, and Georgia
Extent: Moderate

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina

SERIES ESTABLISHED: City of Virginia Beach, Virginia, 1980.

REMARKS:
1. In the past Munden soils have been included with the Altavista, Bertie, Dragston, and Tetotum soils. The May 2007 revision removes MLRA

regions 133A, 152A, and 153C.
2. Diagnostic horizons and features recognized in this pedon are:
a. Ochric epipedon -the zone from 0 to 8 inches (Ap horizon).
b. Argillic horizon -the zone between 8 and 32 inches (Bt horizon).
c. Aquic feature -low chroma Fe depletions in the upper 24 inches of the argillic horizon (Bt3 horizon).
SIR = VA0162
MLRA = 153A, 153B
REVISED = 2/7/96, MHC; 5/07, DTA

ADDITIONAL DATA: Virginia Polytechnic Institute and State University soil survey lab data shows the typical pedon of the Munden series to have a base saturation of 19.48 percent at a depth of 50 inches below the top of the argillic horizon.
The particle-size control section has 15.6 percent clay and 29.8 percent silt as a weighted average. Pedon sample numbers are: S74VA76-18(1-9), S76VA76-31(1-9), S77VA76-40(1-8), S77VA76-41(1-6).

TABULAR SERIES DATA:
SOI-5 Soil Name Slope Airtemp FrFr/Seas Precip Elevation
VA0162 MUNDEN 0-8 59-64 190-240 40-49 5-100

SOI-5	FloodL	FloodH	Watertable	Kind	Months	Bedrock
VA0162	NONE	RARE	1.5-2.5	APPARENT	DEC-APR	>60

SOI-5	Depth	Texture	3-Inch	No-10	Clay%	-CEC-
VA0162	0-8	LS LFS	0-0	90-100	3-10	-
VA0162	0-8	SL FSL L	0-0	90-100	4-16	-
VA0162	8-32	SL L FSL	0-0	90-100	8-18	-
VA0162	32-62	FSL LS S	0-0	90-100	2-12	-

SOI-5	Depth	-pH-	O.M.	Salin	Permeab	Shnk-Swll
VA0162	0-8	4.5-6.0	.5-1.	0-0	2.0-6.0	LOW
VA0162	0-8	4.5-6.0	1.-2.	0-0	2.0-6.0	LOW
VA0162	8-32	4.5-6.0	.5-1.	0-0	0.6-6.0	LOW
VA0162	32-62	4.5-6.0	0.-.5	0-0	2.0-20	LOW

National Cooperative Soil Survey
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LOCATION BOJAC VA+NC

Established Series
Rev. ACB-CDP-DLJ
10/2002

BOJAC SERIES

MLRA(s): 133A, 153A, 153B, 153C
MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina
Depth Class: Very deep
Drainage Class: Well drained
Permeability: Moderately rapid
Surface Runoff: Slow to medium
Parent Material: Loamy and sandy fluvial and marine sediments
Slope: 0 to 10 percent
Mean Annual Air Temperature (type location): 59 degrees F.
Mean Annual Precipitation (type location): 48 inches

TAXONOMIC CLASS: Coarse-loamy, mixed, semiactive, thermic Typic Hapludults

TYPICAL PEDON: Bojac loamy fine sand-cultivated. (Colors are for moist soil.)

Ap--0 to 8 inches; brown (10YR 4/3) loamy fine sand; single grain; loose; many fine roots; neutral; abrupt smooth boundary. (6 to 12 inches thick)

Bt1--8 to 13 inches; yellowish brown (10YR 5/6) fine sandy loam; many medium distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; very friable; common fine roots; sand grains bridged and coated with clay; strongly acid; diffuse smooth boundary.

Bt2--13 to 25 inches; yellowish brown (10YR 5/6) fine sandy loam; weak medium subangular blocky structure; very friable; few fine roots; sand grains bridged and coated with clay; very strongly acid; diffuse smooth boundary.

Bt3--25 to 37 inches; strong brown (7.5YR 5/6) fine sandy loam; weak medium subangular blocky structure; very friable; few fine roots; sand grains bridged and coated with clay; strongly acid; diffuse smooth boundary.

Bt4--37 to 47 inches; yellowish brown (10YR 5/8) fine sandy loam; weak medium subangular blocky structure; very friable; sand grains bridged and coated with clay; many medium prominent very pale brown (10YR 7/4) soft masses of iron accumulation; very strongly acid; diffuse smooth boundary. (Combined thickness of the Bt horizon is 15 to 70 inches.)

C1--47 to 70 inches; very pale brown (10YR 7/3) loamy fine sand; single grain; loose; very strongly acid; diffuse smooth boundary. (0 to 40 inches thick)

C2--70 to 85 inches; yellow (10YR 7/6) coarse sand; single grain; loose; 2 percent gravel; common medium faint yellowish brown (10YR 5/6) soft masses of iron accumulation; very strongly acid.

TYPE LOCATION: Greensville County, Virginia; about 1.34 miles west southwest (250 degrees) of the junction of VA-625 and VA-622 and about 0.47 miles south of VA-625.

RANGE IN CHARACTERISTICS:
Solum Thickness: 30 to 65 inches
Depth to Bedrock: Greater than 60 inches
Depth to Seasonal High Water Table: 48 to 72 inches, November to April
Soil Reaction: extremely acid to slightly acid except where the surface has been limed
Gravel Content: Quartz gravel make up 0 to 5 percent of the solum and 0 to 15 percent of the C horizon in the non-flooded phase; 0 to 35 percent in the solum and 0 to 50 percent of the C horizon in the flooded phase

A or Ap horizon:
Color--hue of 7.5YR to 2.5Y, value of 3 to 6, and chroma of 1 to 4. Where the value is 3 and the chroma is 1 or 2, the A horizon is less than 6 inches thick. Texture--loamy sand, loamy fine sand, sandy loam, fine sandy loam, or loam

E horizon (if it occurs)
Color--has hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 4 or 6
Texture--loamy sand, loamy fine sand, sandy loam, fine sandy loam, or loam

BA or BE horizon (if it occurs)
Color--hue of 5YR to 2.5Y, value of 4 to 7, and chroma of 3 to 6
Texture--sandy loam, fine sandy loam, or loam

Bt horizon:

Color--hue of 5YR to 10YR, value of 4 to 6, and chroma of 4 to 8
Texture--sandy loam, fine sandy loam, or loam. Some pedons may have a thin subhorizon that is sandy clay loam or clay loam. The lower boundary is gradual or diffuse or there is more than 50 percent fine and coarser sand in the B horizon.
Redoximorphic features--iron depletions with chroma of 2 or less are in some pedons below a depth of 40 inches.

BC or CB horizon (if it occurs)
Color--hue of 5YR to 10YR, value of 4 to 6, and chroma of 4 to 8
Texture--loamy sand or loamy fine sand
Redoximorphic features--iron masses in shades of brown, yellow, or red and iron depletions in shades of olive or gray

C horizon:
Color--hue of 7.5YR to 2.5Y, value of 4 to 7, and chroma of 3 to 8
Texture--usually stratified and in the fine-earth portion, ranges from coarse sand to loamy fine sand
Redoximorphic features--iron masses in shades of brown, yellow, or red and iron depletions in shades of olive or gray

COMPETING SERIES:
Louisburg soils--On summits and side slopes of Piedmont uplands that are underlain by saprolite at 20 to 40 inches

GEOGRAPHIC SETTING:
Landscape: Coastal Plain
Landform: Stream terraces and flood plains
Elevation: 10 to 250 feet above mean sea level
Parent Material: Loamy and sandy fluvial sediments and marine sediments
Mean Annual Air Temperature: 58 to 60 degrees
Mean Annual Precipitation: 40 to 50 inches
Frost Free Period: 190 to 220 days

GEOGRAPHICALLY ASSOCIATED SOILS:
Altavista soils--Moderately well drained soils (seasonal high water table 18 to 30 inches) in fine-loamy family on slightly lower landscapes
Augusta soils--Somewhat poorly drained soils (seasonal high water table 12 to 18 inches) in fine-loamy family on lower landscapes
Bertie soils--Somewhat poorly drained soils (seasonal high water table 12 to 18 inches) in fine-loamy family on lower landscapes
Catpoint soils--Somewhat excessively drained soils (seasonal high water table 48 to 72 inches) with sandy textures throughout on higher landscapes
Conetoe soils--Well drained soils (seasonal high water table below 72 inches) in loamy family on similar landscapes
Dogue soils--moderately well drained soils (seasonal high water table 18 to 30 inches) in fine family on slightly lower landscapes
Dragston soils--somewhat poorly drained soils (seasonal high water table 12 to 30 inches) on lower landscapes
Munden soils--moderately well drained soils (seasonal high water table 18 to 30 inches)in on slightly lower landscapes
Nimmo soils--poorly drained soils (seasonal high water table 0 to 12 inches) in coarse-loamy family on flats and in slight depressions
Pamunkey soils--well drained soils (seasonal high water table 48 to 72 inches) in fine-loamy family on similar landscapes
State soils--well drained soils (seasonal high water table 48 to 72 inches) in fine-loamy family on similar landscapes
Tarboro soils--somewhat excessively drained soils (seasonal high water table is below 6 feet) with sandy textures throughout on higher landscapes
Wickham soils--well drained soils (seasonal high water table is below 6 feet) in fine-loamy family on similar landscapes

DRAINAGE AND PERMEABILITY:
Agricultural Drainage Class: Well drained
Permeability: Moderately rapid

USE AND VEGETATION:
Major Uses: Mostly cultivated
Dominant Vegetation: Where cultivated--peanuts, soybeans, and corn. Where wooded--loblolly pine, sweet gum, oak, hickory, and maple

DISTRIBUTION AND EXTENT:
Distribution: Atlantic Coastal Plain of Virginia, North Carolina, and possibly Georgia, Florida, and Alabama
Extent: Moderate

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina

SERIES ESTABLISHED: Greensville County, Virginia, 1979.

REMARKS:
Diagnostic horizons and other features recognized in this pedon are:
a. Ochric epipedon -the zone between 0 and 8 inches (Aphorizon).
b. Argillic horizon -the zone between 8 and 47 inches (Bthorizon).

SIR=VA0127, VA0137 (FLOODED)
MLRA=133A, 153A, 153B, 153C
REVISED=7/9/96, MHC

ADDITIONAL DATA: Laboratory data from typical pedon and 8 supporting pedons (S73VA31-78(1-7), S73VA41-76(1-7), S73VA41-(1-8), S74VA41-97(1-4), S74VA41-92(1-7), S74VA41-92(1-7), S74VA41-101(1-5)) may be obtained from Virginia Polytechnic Institute and State

University Soil Survey Laboratory.

TABULAR SERIES DATA:

SOI-5	Soil Name	Slope	Airtemp	FrFr/Seas	Precip	Elevation
VA0127	BOJAC	0-10	58-60	190-220	40-50	10-250
VA0137	BOJAC	0-10	58-60	185-225	40-50	25-200

SOI-5	FloodL	FloodH	Watertable	Kind	Months	Bedrock
VA0127	NONE		4.0-6.0	APPARENT	NOV-APR	60-60
VA0137	RARE/COMMON		4.0-6.0	APPARENT	NOV-APR	60-60

SOI-5	Depth	Texture	3-Inch	No-10	Clay%	-CEC-
VA0127	0-8	SL FSL L	0-0	95-100	3-8	
VA0127	0-8	LFS LS	0-0	95-100	3-8	
VA0127	8-47	FSL L SL	0-0	95-100	11-16	
VA0127	47-85	SR LFS COS	0-0	75-100	1-8	
VA0137	0-8	SL FSL L	0-0	75-100	3-8	
VA0137	0-8	LFS LS	0-0	75-100	3-8	
VA0137	0-8	GR-S GR-LS GR-LFS	0-0	50-75	3-8	
VA0137	8-47	FSL L SL	0-0	50-100	11-16	
VA0137	47-85	SR LS G	0-15	25-100	1-6	

SOI-5	Depth	-pH-	O.M.	Salin	Permeab	Shnk-Swll
VA0127	0-8	3.6-6.5	.5-2.	0-0	2.0-6.0	LOW
VA0127	0-8	3.6-6.5	.5-1.	0-0	6.0-20	LOW
VA0127	8-47	3.6-6.5	0.-.5	0-0	2.0-6.0	LOW
VA0127	47-85	4.5-6.0	0.-.5	0-0	6.0-20	LOW
VA0137	0-8	3.5-6.5	.5-2.	0-0	2.0-6.0	LOW
VA0137	0-8	3.5-6.5	.5-1.	0-0	6.0-20	LOW
VA0137	0-8	3.5-6.5	.5-1.	0-0	6.0-20	LOW
VA0137	8-47	3.5-6.5	0.-.5	0-0	2.0-6.0	LOW
VA0137	47-85	3.5-6.5	0.-.5	0-0	6.0-20	LOW

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Appendix C.6

Soil Fertility, pH, Soluble Salts and Organic Matter Lab Data for Three Proposed Locations.

Fertility Data only for VT AREC.

Sample IDs		Particle Size Analysis				Saturated Paste		P	K	Ca	Mg	Zn	Mn	Cu	Fe	B	Soil Testing Lab	
Methods Section Label	Lab/Sample Code	Textural Class	% Sand	% Silt	% Clay	pH	SC dS/m	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	% Organic Matter	CEC meq/100g
D1-Brown S	AREC-1	SIL	22.5	57.7	19.8	6.16	0.263	99	106	952	129	2.6	6.9	0.6	44	0.3	2.7	8.4
D2-Brown S	AREC-2	SIL	21.3	57.3	21.4	5.38	0.302	75	93	828	131	1.4	5.2	0.5	36.3	0.2	3.6	8.8
R1-Brown S	AREC-3	SIL	25.2	54.8	20	5.62	0.389	55	41	620	105	2.8	3.6	1.1	64.8	0.1	2.7	6.9
R2-Brown S	AREC-4	SIL	29	60	11	5.02	0.155	7	41	286	112	1.8	10.3	0.4	56	0.1	4	7.1
R3-Brown S	AREC-5	SIL	23.3	58.6	18.1	6.15	0.313	40	42	732	131	1.6	3.2	0.8	39.2	0.2	2.9	6.9
D1-Brenneman	AREC-6	SIL	27.1	54.4	18.5	5.66	0.471	18	43	736	168	0.9	2.9	0.4	42.4	0.2	2.8	7.1
D2-Brenneman	AREC-7	SIL	25.2	56.6	18.2	6.2	0.334	13	43	768	199	0.9	3.5	0.3	35.6	0.2	2.6	7
R1-Brenneman	AREC-8	SIL	29.9	53.9	16.2	5.8	0.424	13	43	652	163	1	3.7	0.3	37.2	0.2	2.5	6.8
R2-Brenneman	AREC-9	SL	56.5	32.2	11.3	5.93	0.415	121	49	664	125	1.6	3.9	0.6	42.4	0.2	3.1	6.2
R3-Brenneman	AREC-10	L	35.3	47.9	16.9	6.08	0.354	52	57	680	138	1.1	3.6	0.7	67.2	0.2	3	6.6
D1-Brown N	AREC-11	SIL	23.2	57.9	19	6.07	0.261	42	57	844	182	1.3	3.5	0.9	52.4	0.2	3.7	7.9
D2-Brown N	AREC-12	SIL	22.9	58	19.1	6.04	0.22	33	43	736	171	1.5	3	0.8	48.8	0.2		7.8
R1-Brown N	AREC-13	L	44.8	41.8	13.5	5.91	0.291	133	49	724	131	5.9	4.3	2	103.6	0.2	2.7	6.7
R2-Brown N	AREC-14	L	35.2	48	16.8	6.09	0.183	122	45	852	135	5.8	4.1	2	88.4	0.2	2.9	7.5
R3-Brown N	AREC-15	L	34.5	47.8	17.7	5.92	0.242	90	45	728	121	5	3.1	1.4	70.8	0.2	3.3	7.5

B-2 Soil Test Results (Virginia Tech Lab) and Lime Recommendations

*VH - No phosphorus should be applied

** No soil test because the pots are placed on gravel and individually fertilized.

Area	Mixed Landscape	Acre	Date	P Level	P lb/Acre	K Level	K lb/Acre	Soil pH	Soil BpH	rec. lime target soil 6.2 pH tons/Ac
1	Arboretum	1.2	2021-Sp	VH	152	H-	194	6.69	6.27	0.75
2	Bermuda & Zoysia	0.6	2021-Sp	VH	160	M+	156	6.42	6.29	0.75
3	Arboretum	2.2	2021-Sp	H+	98	H-	190	5.61	6.03	2.00
4	Arboretum	4.0	2021-Sp	M	30	H-	178	5.37	5.98	2.25
5	Bluegrass & Tall Fescue	1.5	2021-Sp	H+	110	M	140	6.27	6.27	0.75
6	Cool Season Fescue	7.3	2021-Sp	VH	164	M-	100	5.96	6.17	1.25
7	Shrubs & Annual Weeds	0.6	2021-Sp	VH	130	M	112	6.41	6.26	0.75
8	Bluegrass & Tall Fescue	1.3	2021-Sp	VH	160	M+	174	6.27	6.24	0.75
9	Saint Augustine	0.6	2021-Sp	VH	202	M	118	6.67	6.31	0.50
10	Mix of St Augustine & Cool Season	0.6	2021-Sp	VH	120	M+	172	6.13	6.2	1.00
11	Tall Fescue	1.0	2021-Sp	VH	164	M+	166	6.47	6.28	0.75
12	Gravel Container Research Pad	0.6								
13	Golf Fairway Research	2.5	2021-Sp	H+	94	M+	170	6.29	6.25	0.75
14	Organic Strawberry/Broccoli Research	1.8	2021-Sp	H (Optimum, High)	68	M+ (Deficient, Medium)	170	6.09	6.15	1.50*
15	Fruit & Woody Ornamental	3.7	2021-Sp	VH	162	M	110	5.81	6.13	1.50
16	Arboretum	1.5	2021-Sp	VH	242	M-	96	5.54	6	2.00
18	Strawberry	3.6	2021-Sp	H- (Optimum, High)	38	M- (Deficient, Medium)	84	5.95	6.23	1.00
19	Woody Nursery Plants	4.3	2021-Sp	VH	116	H-	192	5.6	6.08	1.75
	Total Acres	38.90								
* same amount of lime for 6.2 and 6.5 soil pH target. Broccoli requires 6.5 target										