Virginia Tech Hampton Roads Agricultural Research and Extension Center

Relocation Planning Study

15 December 2022

VIRGINIA TECH

AECOM

Virginia Tech Hampton Roads AREC

Executive Summary

Background

In collaboration with Virginia Tech, AECOM conducted a planning study to evaluate the feasibility of relocating the Hampton Roads Agricultural Research and Extension Center (HR AREC) to alternative sites currently owned by the City of Virginia Beach. The study provides guidance on the time and cost required to create an equivalent replacement of the existing facility at a new location that would be developed according to current regulatory requirements.

Key to the study is an assessment of the specific soil, landmass, and infrastructure characteristics necessary to support the unique types of nursery crop and turf grass research currently conducted at the existing HR AREC campus.

Existing Facilities

The HR AREC consists of 16 buildings comprising approximately 59,000 gross square feet of built space as well as numerous constructed site support elements. The facility types include a large multi- story building (that contains labs, classrooms and office spaces), greenhouses, and small agricultural sheds. The basis of analysis for this study assumes a 'like-in-kind' replacement of all the buildings and structures.

Existing Site Conditions

The HR AREC currently utilizes approximately 71 acres in Virginia Beach; 58 acres have been leased from the City of Virginia Beach since 1920. The land is comprised of high-quality soil with excellent drainage and irrigation characteristics. Due to its average elevation of 25 feet above mean sea level and relatively flat topography with low water table, it is not subject to rain-event flooding or sea level rise. The soil quality, elevation, drainage, and irrigation infrastructure are key to successful research activities at the existing site.

Site Options Process

Due to time constraints, this study was limited to sites currently owned by Virginia Beach that provide a minimum of 71 contiguous acres. Three potential sites were identified at the beginning of the study; however, one site was quickly eliminated as it was in the process of being contracted for sale.

The two remaining sites are the Brown Farm and the Brenneman Farm, both located along North Landing Road. The Brown Farm was studied as two distinct parcels because future extension of the Nimmo Parkway is expected to bifurcate the farm. The report labels these as Brown Farm North and Brown Farm South. Thus, three sites were evaluated as part of this study to develop an understanding of the requirements and costs to relocate HR AREC.

Land Development Considerations

To ensure a comprehensive review of soil and regulatory requirements, AECOM obtained the services of a nationally renowned soils scientist who conducted a preliminary soils analysis of the existing and alternate sites.

Two critical land development components identified by the soils consultant and AECOM are (1) the establishment of the appropriate soil drainage, and (2) an engineered buffer zone.

Drainage

Soils are arrayed into seven classifications for drainage adequacy. The soils at the existing HR AREC are classified as "well-drained," typical of upland soils with deep water tables which are ideal for the growth of turf grass and nursery crops.

The Brennemen Farm and Brown Farm primarily grow soybean and corn crops. The soils at both farms have water near or at the surface year-round and as such are classified as "poorly-drained."

While the three alternate sites are currently well-suited for corn and soybean production given the high moisture content of their existing soil, those soil conditions would be harmful to the types of research plants grown at HR AREC.

The soil conditions at the alternate sites would require significant enhancements to establish the drainage characteristics necessary to support the HR AREC's research activities. The essential enhancements would include (1) construction of drainage and irrigation infrastructure and (2) addition of significant engineered soil material (ranging from 1 to 4 feet deep) to elevate plant roots above the water table.

Engineered Buffer Zone

The existing site has been developed over an approximately 100 year period and operates under grandfathered regulatory requirements. Current permitting and land use requirements dictate the need for a separation zone between the research center and adjacent parcels. The construction of a new AREC at an alternate site will require establishment of an engineered buffer zone surrounding its entire perimeter to meet current regulatory requirements. This 100-ft wide area would be based on National Forest Services guidance for width and composition and would contain features established under Virginia stormwater best management practices.

The engineered buffer zone serves three required functions:

1. Compliance with current stormwater management regulations,
2. Ensure rainwater and irrigation run-off is retained on site to preclude infiltration of research-related spillover onto adjacent non-HR AREC parcels, and
3. Preclude infiltration of surface/groundwater from adjacent parcels onto the HR AREC property that could negatively influence research efforts.

The existing AREC encompasses 71 acres of used land but does not include an engineered buffer zone. Establishment of a new AREC will require a larger area to accommodate the engineered buffer zone while maintaining an equivalent program acreage. The additional land area required for the three sites studied varies between 7 to 15 percent dependent upon configuration and natural assets of a particular site.

Timeline

Based upon the following assumptions, the total anticipated time to relocate the HR AREC would not exceed 66 months (approximately five and one-half years):

- Project effective date of July 1, 2023
- "Non-pool" capital funding
- Site approval and acquisition from the City completed within one year of project effective date
- Design duration of eighteen months
- Construction contract procurement and permitting duration of six months
- Total construction duration of thirty-six months

Under these assumptions, the HR AREC would vacate the current site by December 31, 2028.

The timeline has the potential to be reduced depending on (1) the actual time to acquire the property, (2) the actual construction procurement method, and (3) the actual intensity of land development required to achieve the necessary soil drainage and buffer zone.

The timeline includes a transition period for the research program which would begin one year into the three-year construction period and would conclude upon completion of construction. Because of the nature of the soil-based research, projects would not transplant to the new location. Rather, research activity will terminate over a two-year period at the existing site while new research is initiated at a new site.

A brief list of key schedule points for the capital project and the transition of the research program are shown below and shown graphically in Table 1.

Capital Project Timeline:

1. July 1, 2023 - Project effective date
2. July 2024 - Site acquisition complete
3. July 2025 - Design complete
4. December 2025 - Construction contract procurement complete
5. July 2027 - Construction of buildings complete
6. December 2028 - Land development complete

Research Program Transition Timeline:

1. December 2026 - Research begins transition to new site.
2. December 2028 - Program terminates at existing site.

Cost

Total project costs for each site evaluated are shown below in Table 2: Cost Evaluation of the Three Sites. These cost are not based on a design but are parametric estimates which provide reasonable rough order of magnitude (ROM) costs for buildings, land development, and transitioning the research program to a new location. A dedicated cost narrative is provided later in this report detailing how anticipated costs were developed and estimated.

A list of key assumptions and considerations related to costs are shown below:

1. The report reflects 2022 Q4 dollars and would need to escalated.
2. The report assumes the City of Virginia Beach will provide the required infrastructure services (road network, power, water, sewer, data, etc.) to a selected site. Thus, these costs are not included in the report.
3. The land development costs reflect establishing soil drainage and buffer zone requirements for the entire acreage of each alternative site, and each site is larger than the existing HR AREC location. Once a site is selected and the actual buffer zone requirements are known, the costs for the land development could be controlled by developing only what is necessary to support the existing 71-acre program. This would leave some acreage undeveloped and available for the future.

Limitations of this Study

1. **Extent of Soil Analyses:** The soil analysis conducted was sufficient for the purposes of this study in determining approximate time and cost that would be required to relocate the HR AREC. However, this preliminary soil analysis and other contents in this study should be considered a preliminary due diligence effort and not the final analysis for the purposes of selecting the optimal new site for the HR AREC. The next stage of work should carefully define the site's drainage and soil hydrologic conditions and any regulatory complications from potential wetland jurisdictional questions. During the final due diligence effort, it will be necessary to engage the City of Virginia Beach and other stakeholders prior to finalization of site selection.
2. **Groundwater Level Analyses:** Groundwater levels were reported per available GIS data. Groundwater data should be validated using onsite testing as part of the final due diligence at the next stage.
3. **Using 1:1 Replacements for Existing Buildings:** The like-in-kind basis for this analysis provided an appropriately conservative assessment of the facilities required to support the program activities. During a formal design process, programming effort would likely identify opportunities for efficiencies that may improve operations and the scope of buildings required for the operations.

Additional Alternative Site Locations

Additional time for a more exhaustive search for potential parcels, either commercially available or owned by Virginia Beach, may realize cost avoidance opportunities. These alternatives would still include the need for buildings (estimated at approximately $32M), and possible acquisition costs, however, savings may be generated if other locations would require less intense soil improvements and infrastructure requirements. For example, golf courses may have the type of soil, improved drainage requirements, stormwater collection, and some of the irrigation that would optimize a newly established HR AREC.

Conclusion

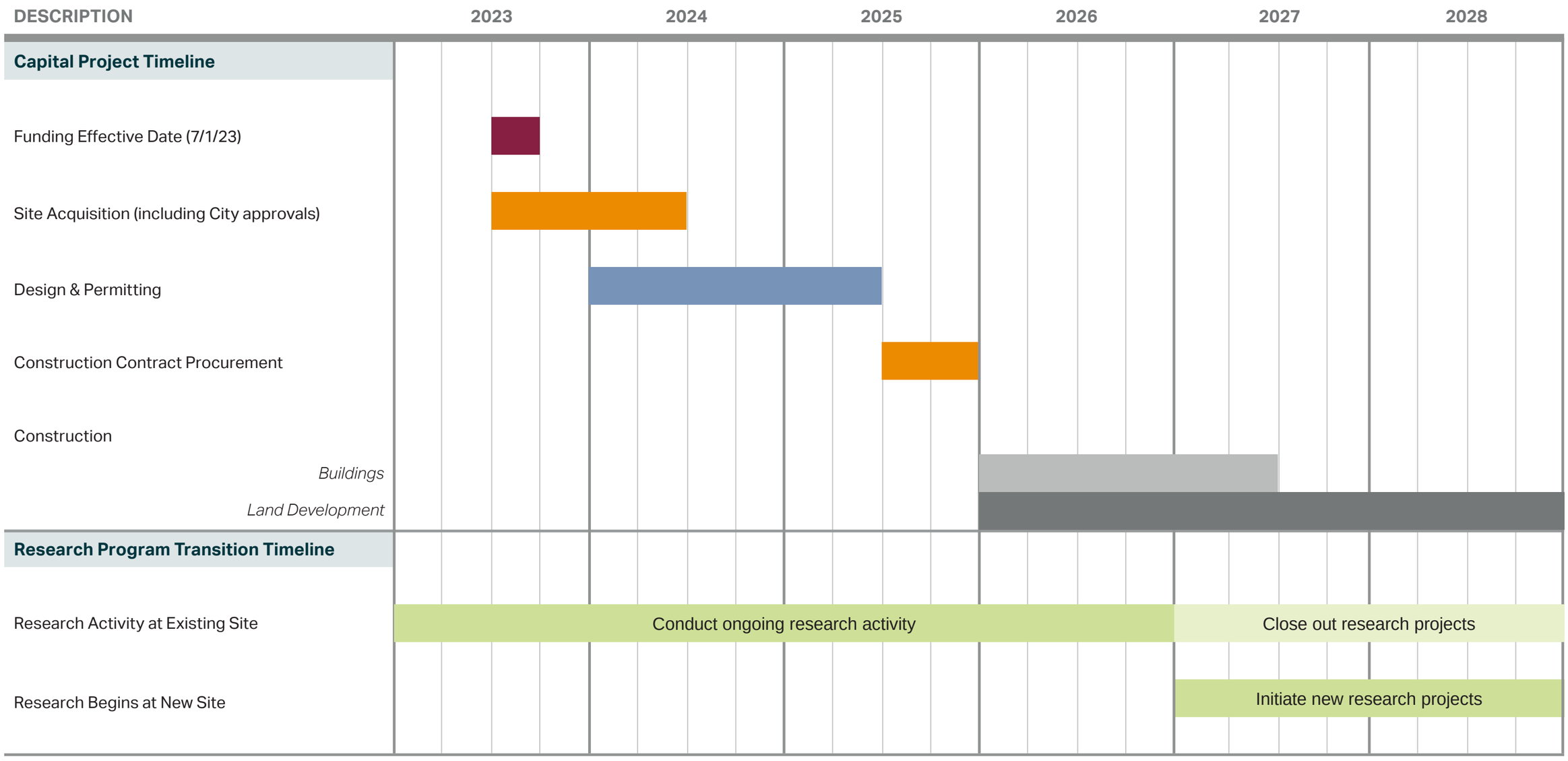
This study demonstrates the requirements and costs to effectually relocate the HR AREC to alternate sites owned by the City of Virginia Beach, and it highlights two material considerations.

First, the study shows the significant work and costs that would be required to replicate the soil conditions and to establish a buffer zone in accordance with regulatory requirements for a new site.

Second, the study shows that active ground soil research projects are generally not transferable to a new location. Rather, ongoing projects will need to be phased out and terminated while simultaneously initiating new research work at a new location. Thus, the HR AREC would temporarily require some redundant equipment and labor during an approximately two-year transition period, which is included in the total project costs for land development.

Hampton Roads Agricultural Research and Extension Center

Table 1. Project Schedule



Hampton Roads Agricultural Research and Extension Center

Table 2. Cost Evaluation of the Three Sites

Parametric Cost Estimates

Costs in 2022 Q4 Dollars

(Dollars in Millions)

	Site 1 **Brenneman Farm**	**Site 2** **Brown Farm North**	**Site 3** **Brown Farm South**
	88.5 acres	**109.00 acres**	**118.00 acres**
			
Capital Projects Costs [1]:			
Buildings	$32	$32	$32
Land Development[2]	$74	$70	$87
Total Capital Project Costs	**$106**	**$102**	**$119**

NOTES:

(1) The costs assume the City of Virginia Beach will provide the required infrastructure services (road network, power, water, sewer, data, etc.) to a selected site.

(2) The land development costs reflect establishing soil drainage and buffer zone requirements for the entire acreage of each alternative site, and each site is larger than the existing HR AREC location. Once a site is selected and the actual buffer zone requirements are known, the costs for the land development could be controlled by developing only what is necessary to support the existing 71-acre program. This would leave some acreage undeveloped and available for the future.

Contents

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Current Assets and Existing Criteria

01

Introduction

Project Overview

This study fulfills the request from the Virginia General Assembly to "prepare a plan to relocate the Hampton Roads Agricultural Research and Extension Center including timeline, suitable location requirements, and building and moving costs." The full text is included below.

2022 Session

Budget Amendments - HB30 (Floor Approved)

Bill Order » Item C-25.10 #3h

VT Ext - Planning to Relocate the Hampton Roads AREC

Item C-25.10 #3h

First Year - FY2023

Education: Higher Education

Virginia Cooperative Extension and Agricultural Experiment Station $500,000

Language

Page 533, after line 19, insert:

"C-25.10 Planning: Relocate Hampton Roads Agricultural Research and Extension Cente $500,000

Fund Sources: Dedicated Special Revenue $500,000

Page 533, after line 19, insert:

"A. Out of this appropriation, $500,000 the first year from nongeneral fund sources is designated to begin planning the relocation of the Hampton Roads Agricultural Research and Extension Center. The Virginia Cooperative Extension and Agricultural Experiment Station shall report to the Chairs of the House Appropriations and Senate Finance and Appropriations Committees by December 15, 2022 on a plan to relocate the Hampton Roads Agricultural Research and Extension Center including timeline, suitable location requirements, and building and moving costs.

B. This project shall be funded for detailed planning from amounts in the Central Capital Planning Fund (09650), established under the authority of § 2.2-1520, Code of Virginia."

Explanation

(This amendment provides nongeneral fund appropriation in the first year for the Virginia Cooperative Extension and Agricultural Experiment Station to initiate planning to relocate the Hampton Roads Agricultural Research and Extension Center.)

After receiving the directive from the Commonwealth of Virginia, Virginia Polytechnic Institute and State University (Virginia Tech) commissioned AECOM to perform an analysis of the existing conditions at the Virginia Tech Hampton Roads Agricultural Research and Extension Center (HR AREC) including a complete review of existing research initiatives, built environment, current operations, and future capital improvement projects. AECOM also performed a city-wide investigation for potentially suitable areas where the HR AREC could relocate and engaged the services of a soil science expert, TerraScience, to provide additional context for relocation viability and costs. The results of the study are presented here in three sections.

Section One presents the existing conditions of the HR AREC, including site history, context, and current operations. Section Two presents the criteria for potentially suitable areas for relocation, the selection process for the chosen potential sites, and the results of three "test fits." Test fits apply the current assets and operational needs of the HR AREC to potential future sites to ensure there is an appropriate amount of space and suitable arrangement of assets for the HR AREC to successfully carry out its mission in a new location. Section Two also presents a cost model narrative (the full cost model provided in in Appendix E) and the project schedule. Section Three outlines possible additional benefits and opportunities for relocation, beyond achieving a one-to-one replacement.

Due to the fast-paced nature of the study – the directive was issued by the Virginia State Legislature in July 2022 with a deadline of December 2022 – the findings presented here represent a high-level analysis of the HR AREC and the potential future sites. Before final decisions are issued, additional studies including detailed water quality and water table analyses and soil amendment processes should be performed to ensure appropriate due diligence.

Intent of Brief

It is important to note that this brief is intended only as a preliminary investigation into the viability of relocation. The City of Virginia Beach was not engaged during this process and may possess or be aware of additional information or context that is contrary to the findings presented here. Geographic Information Systems (GIS) data was limited and, apart from TerraScience's report, all site analyses were performed digitally using publicly available data. As noted previously, additional studies should be conducted before action is taken on relocation to ensure a mutually beneficial outcome for the City of Virginia Beach and Virginia Tech.

AREC History and Existing Conditions

Figure 1. Virginia Truck Experiment Station c. 1915. Image Credit: Sargeant Memorial Collection Norfolk Public Library

History

The HR AREC originated in 1907 as the Virginia Truck Experiment Station with a focus on vegetable production in Virginia Beach, then Princess Anne County, Virginia (Figure 1). By the mid-twentieth century the site shifted toward nursery and landscape industry research, as reflected in its new name, Virginia Truck and Ornamentals Research Station. In the late 1980s the site changed names once again to the Hampton Roads Agricultural Experiment Station before becoming the Hampton Roads Agricultural Research and Extension Center in the early 1990s, although its research focus remained on the nursery and landscape industries. Today, the HR AREC also performs annual bedding plant trials, disease and insect research, and outreach services for the Commonwealth of Virginia.

The HR AREC is one of 11 Virginia Agricultural Experiment Stations (VAES) across the state and is within Virginia Tech's College of Agricultural and Life Sciences, College of Natural Resources and Environment, and the Virginia-Maryland College of Medicine. The VAES perform critical field research for Virginia industries in addition to offering important outreach and extension services.

Existing Conditions

The HR AREC currently uses approximately 71 acres on three adjacent parcels in the heavily developed northern area of Virginia Beach. The largest parcel (58 acres) is leased from the City of Virginia Beach to Virginia Tech (Figure 2). The site is roughly triangular and is bounded by Diamond Springs Road on the west, Bayside Road on the east, and Northampton Boulevard on the south side of the property. It is less than two miles and approximately six minutes away from the Interstate 64 interchange and is less than five miles and approximately 10 minutes away from Norfolk International Airport. The proximity to major transportation networks aids in the extension's mission to provide educational resources to the entire Commonwealth of Virginia, including presenting research at statewide events and inviting the public and special interest groups to the HR AREC. In addition to research, the HR AREC also performs free testing of seeds and plants for Virginia farmers and often employs interns from nearby Virginia Weslyan University. Figures 3 through 9 provide a summary of the HR AREC's existing conditions and assets.

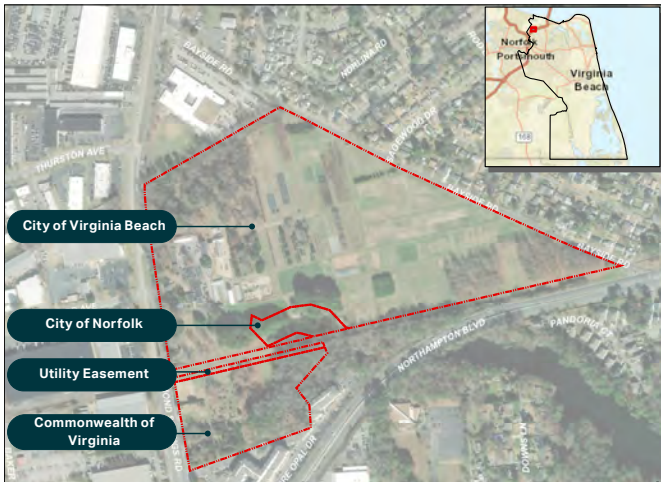
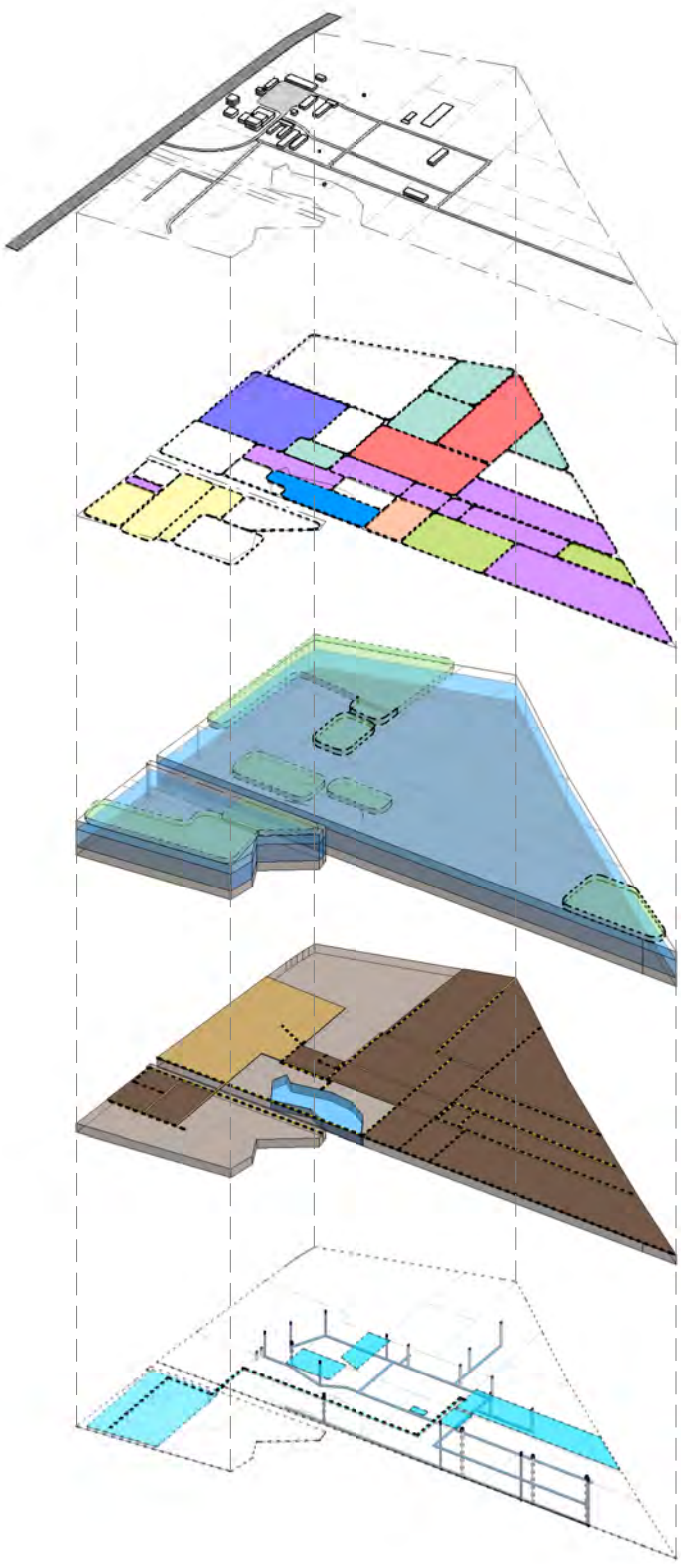


Figure 2. Parcel Ownership - The three parcels that compose the site's 70+ acres are owned by three separate entities.

Figure 3. Existing Site - Axonometric



BUILT ENVIRONMENT

TOTAL BUILDING GSF: 58,594 SF
PAVED ROAD AREA: 52,453 SF
DIRT/GRAVEL ROAD AREA: 101,210 SF

RESEARCH PLATS

TOTAL RESEARCH AREA: 44.84 acres
TOTAL SITE AREA: 71.29 acres

NATURAL ASSETS

FOREST AREA: 20.91 acres
WATER TABLE LEVEL: 5-10'

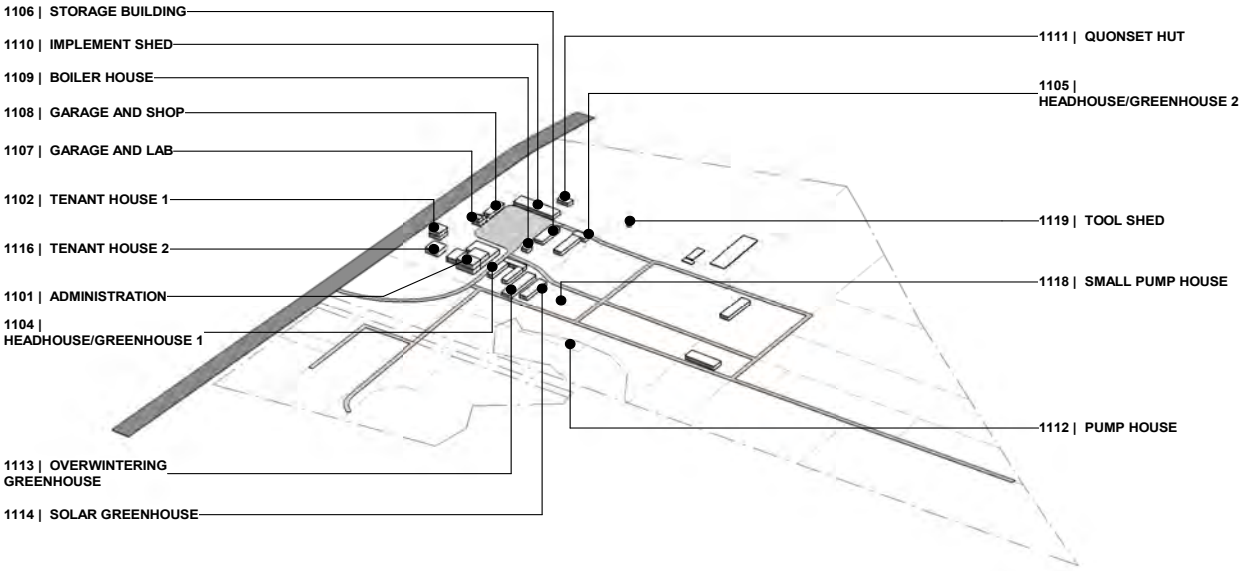
SOIL & DRAINAGE

SOIL TYPES: TETOTUM, BOJAK
ESTIMATED DITCH LENGTH: 12,186 FT
POND AREA: 2.09 acres

IRRIGATION

SYSTEMS: 3
PUMPS: 10
HYDRANTS: 15
ESTIMATED PIPE LENGTH: 9,538 FT
UNDERGROUND IRRIGATION AREA: 10.01 acres

Figure 4. Existing Site - Built Environment



MAIN ROAD (ACCESS TO SITE)

PAVED ROAD (ON SITE)

DIRT/GRAVEL ROAD (ON SITE)

HARDSCAPE AREA

DIRT/GRAVEL	2.32 acres	101,210 SF
PAVED	1.20 acres	52,453 SF
NET AREA =	3.53 acres	153,662 SF

EXISTING BUILDING AREAS

BUILDING NUMBER	BUILDING NAME	GSF
ADMINISTRATION		
1101	ADMINISTRATION	19,217.00 SF
		19,217.00 SF
GREENHOUSE		
1104	HEADHOUSE/GREENHOUSE 1	5,865.00 SF
1105	HEADHOUSE/GREENHOUSE 2	4,607.00 SF
1113	OVERWINTERING GREENHOUSE	2,890.00 SF
1114	SOLAR GREENHOUSE	2,700.00 SF
		16,062.00 SF
RESIDENTIAL		
1102	TENANT HOUSE 1	3,178.00 SF
1116	TENANT HOUSE 2	1,920.00 SF
		5,098.00 SF
SUPPORT		
1109	BOILER HOUSE	645.00 SF
1112	PUMP HOUSE	160.00 SF
1118	SMALL PUMP HOUSE	55.00 SF
		860.00 SF
WAREHOUSES AND SHOPS		
1106	STORAGE BUILDING	3,824.00 SF
1107	GARAGE AND LAB	1,980.00 SF
1108	GARAGE AND SHOP	2,268.00 SF
1110	IMPLEMENT SHED	8,000.00 SF
1111	QUONSET HUT	1,150.00 SF
1119	TOOL SHED	135.00 SF
		17,357.00 SF
GROSS BUILDING GSF =		58,594.00 SF

Figure 5. Existing Site - Research Plats

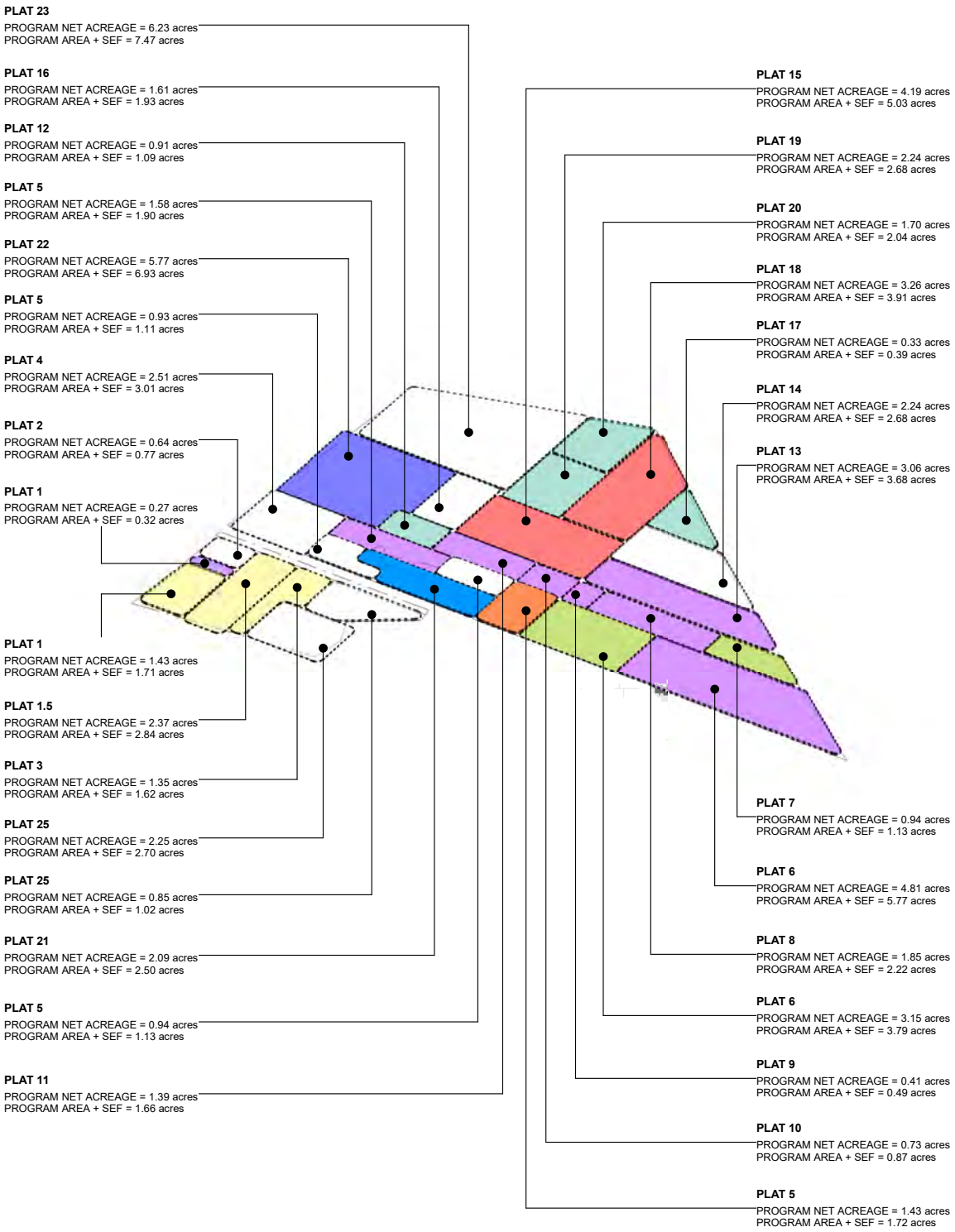


Figure 6. Existing Site - Research Plats

NET ACREAGE - EXISTING SITE		
PLAT	PROGRAM AREA	PROGRAM AREA + 20% SITE ENGINEERING FACTOR (SEF)
DEMONSTRATION AREAS		
PLAT 1	1.43 acres	1.71 acres
PLAT 1.5	2.37 acres	2.84 acres
PLAT 3	1.35 acres	1.62 acres
	5.14 acres	6.17 acres
ENTOMOLOGY (FUTURE)		
PLAT 5	1.43 acres	1.72 acres
	1.43 acres	1.72 acres
EXTENSION		
PLAT 4	2.51 acres	3.01 acres
PLAT 5	1.87 acres	2.25 acres
	4.38 acres	5.26 acres
HORTICULTURE		
PLAT 12	0.91 acres	1.09 acres
PLAT 17	0.33 acres	0.39 acres
PLAT 19	2.24 acres	2.68 acres
PLAT 20	1.70 acres	2.04 acres
	5.17 acres	6.20 acres
ORGANIC		
PLAT 14	2.24 acres	2.68 acres
	2.24 acres	2.68 acres
POND		
PLAT 21	2.09 acres	2.50 acres
	2.09 acres	2.50 acres
SITE SUPPORT		
PLAT 16	1.61 acres	1.93 acres
PLAT 22	5.77 acres	6.93 acres
PLAT 23	6.23 acres	7.47 acres
PLAT 25	3.10 acres	3.72 acres
	16.71 acres	20.05 acres
SMALL FRUIT		
PLAT 15	4.19 acres	5.03 acres
PLAT 18	3.26 acres	3.91 acres
	7.45 acres	8.94 acres
TURFGRASS		
PLAT 1	0.27 acres	0.32 acres
PLAT 2	0.64 acres	0.77 acres
PLAT 5	1.58 acres	1.90 acres
PLAT 6	4.81 acres	5.77 acres
PLAT 8	1.85 acres	2.22 acres
PLAT 9	0.41 acres	0.49 acres
PLAT 10	0.73 acres	0.87 acres
PLAT 11	1.39 acres	1.66 acres
PLAT 13	3.06 acres	3.68 acres
	14.73 acres	17.68 acres
WEED CONTROL		
PLAT 6	3.15 acres	3.79 acres
PLAT 7	0.94 acres	1.13 acres
	4.10 acres	4.92 acres
ESTIMATED NET ACREAGE =	63.44 acres	76.13 acres

Figure 7. Existing Site - Natural Assets

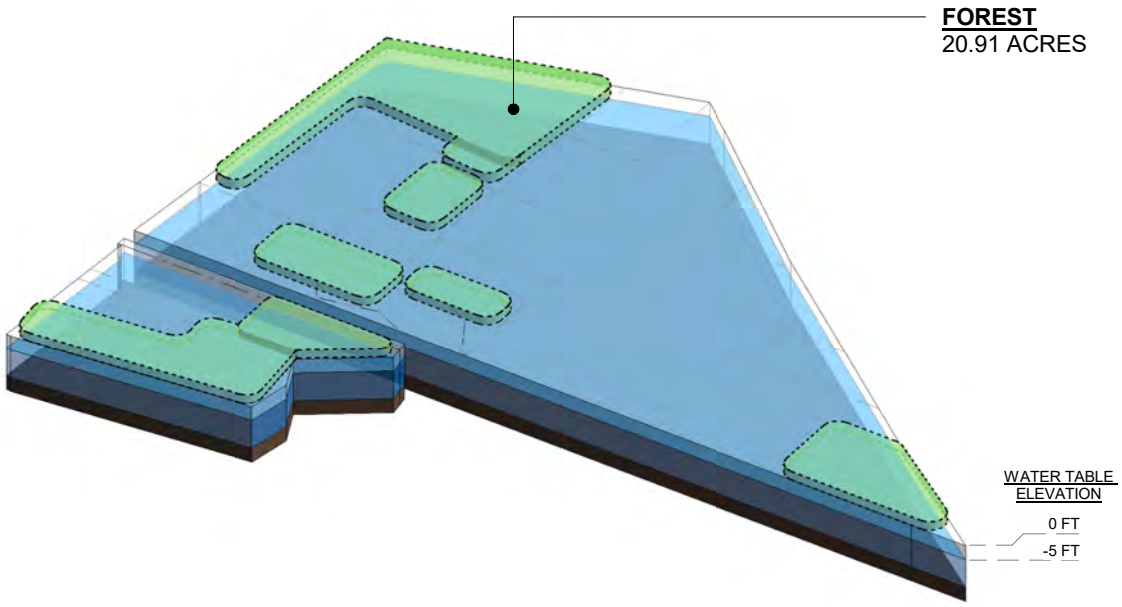
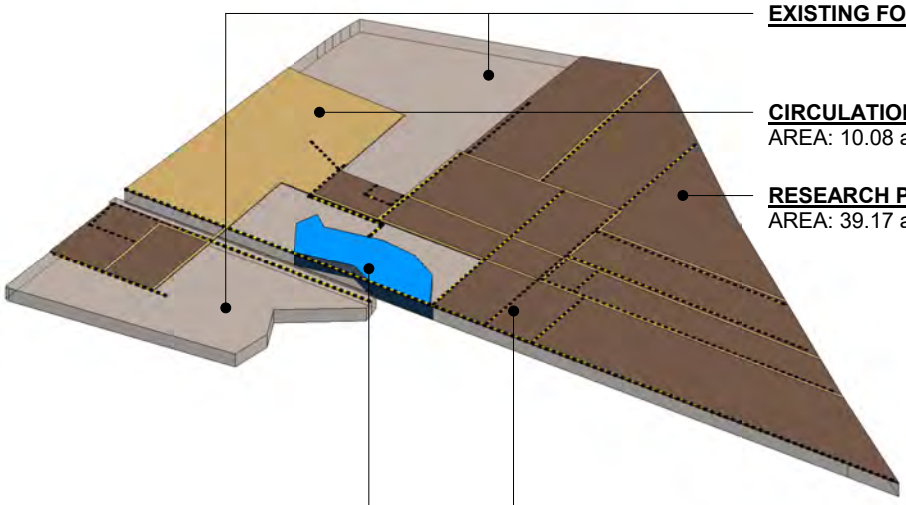


Figure 8. Existing Site - Soil Amendment and Drainage



EXISTING FOREST

CIRCULATION & HARDSCAPE
AREA: 10.08 acres

RESEARCH PLATS
AREA: 39.17 acres

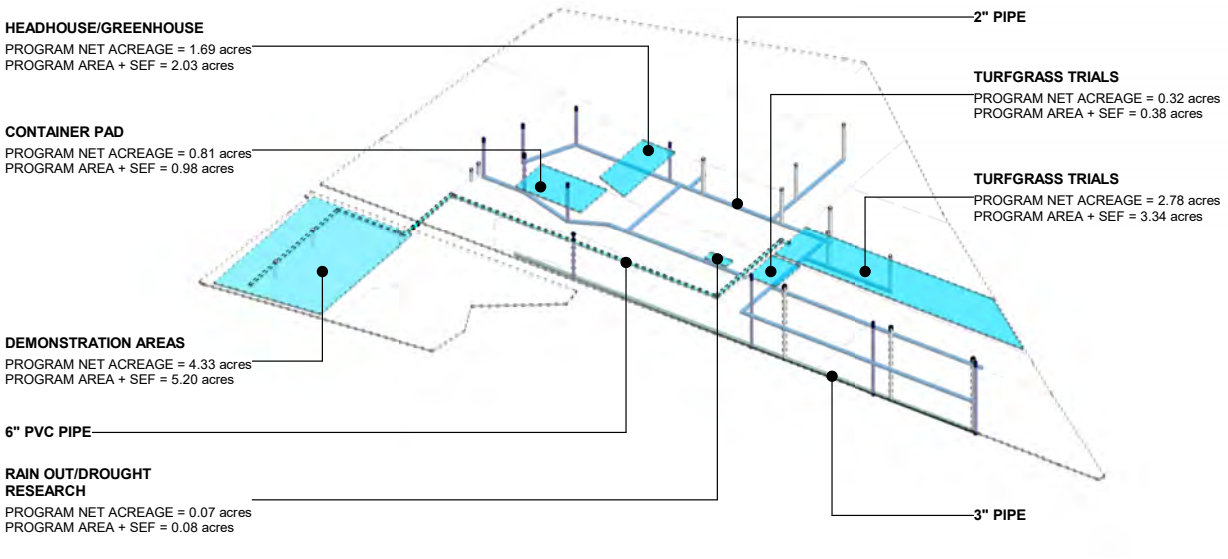
DRAINAGE DITCH
ESTIMATED LENGTH: 12,186 FT

POND
ESTIMATED AREA: 2.09 acres

SOIL DISTRIBUTION				
SOIL TYPE	**PLAT TYPE**	**SOIL DEPTH**	**AREA**	**VOLUME**
CIRCULATION & HARDSCAPE				
CIRCULATION & HARDSCAPE	RESEARCH PLATS	4' - 0"	10.08 acres	65,048 CY
			10.08 acres	65,048 CY
RESEARCH PLATS				
RESEARCH PLATS	RESEARCH PLATS	4' - 0"	39.17 acres	252,787 CY
			39.17 acres	252,787 CY
NET ACREAGE =			49.25 acres	317,836 CY

PLAT DRAINAGE DITCH LENGTH
12186'
12186'

Figure 9. Existing Site - Irrigation



- UNDERGROUND IRRIGATION
- SYSTEM 1
- SYSTEM 2
- SYSTEM 3
- HYDRANTS
- PUMPS

PUMPS & HYDRANTS

HYDRANT	15
PUMP	10

PIPE SYSTEM LENGTH

SYSTEM	PIPE LENGTH
SYSTEM 1	
2" PIPE	5423'
	5423'
SYSTEM 2	
3" PIPE	1731'
	1731'
SYSTEM 3	
6" PVC PIPE	2383'
	2383'
TOTAL PIPE LENGTH =	9538'

UNDERGROUD IRRIGATION ACREAGE

PROGRAM	TOTAL AREA	TARGET AREA (TOTAL AREA + 20%)
UNDERGROUND IRRIGATION		
CONTAINER PAD	0.81 acres	0.98 acres
DEMONSTRATION AREAS	4.33 acres	5.20 acres
HEADHOUSE/GREENHOUSE	1.69 acres	2.03 acres
RAIN OUT/DROUGHT RESEARCH	0.07 acres	0.08 acres
TURFGRASS TRIALS	0.32 acres	0.38 acres
TURFGRASS TRIALS	2.78 acres	3.34 acres
IRRIGATION NET ACREAGE =	10.01 acres	12.01 acres

Site Context

Topography

The City of Virginia Beach falls within the Tidewater area of the Atlantic Coastal Plain. It is characterized by generally flat topography that can have well-drained ridges or wide, poorly drained flat areas. Of the city's 310 square miles, over 50 acres of that area is water. The northern part of the city is on the Oceana Ridge, making it higher than the southern part of the city, on the Pungo Ridge, by 9 to 12 feet.

The HR AREC is located in northern Virginia Beach (Figure 10) on Oceana Ridge and has a high point of 25 feet above mean sea level (Figure 11). The site has very little slope but is graded to the pond on the southern side of the site to collect stormwater runoff.

Soil

The HR AREC site sits on four soil types: State, Bojac, Tetotum, and Augusta (Figure 12). Most of the site is Tetotum soil, which is deep and moderately well drained. Moderately well drained soils typically remain wet for a short time following a rain event, but occasionally can remain wet for longer periods following a major rain event. Bojac and State soils are both well drained and associated with higher elevations than Tetotum. Tetotum is moderately to rapidly permeable with slow surface runoff and a deep root zone. The moderately well and well drained soils and slow runoff rates protect plant material from 'wet feet' and subsequent root rot, which occurs when roots of plants not suited to wet conditions are exposed to water for extended periods. The soil conditions help the HR AREC grow and maintain their turfgrass and small fruit experiments without intensive intervention such as soil amendments or large raised beds.

For additional details, see Appendix C.

Flooding

The HR AREC is less than three miles away from Chesapeake Bay and is separated from Lake Lawson by Northampton Boulevard. Despite its proximity to large waterways and water bodies, the site currently is not susceptible to flooding and is not projected to be impacted by major storm events even in the event of 3 feet of sea level rise (Figures 13, 14, and 15). The major roadways connecting the site to the city also are not expected to be impacted during a major flood event with three feet of sea level rise, indicating that the site could continue to be accessed and maintained immediately following a significant storm. Freeboard, an additional amount of height above the base flood elevation required for health and safety, is not required in this area because storm surge and projected flood waters do not impact the parcel. The water table is estimated to be between five and ten feet deep and there are no issues with saltwater intrusion (Figure 16).

Zoning

The largest portion of the HR AREC is zoned R7.5 – medium density single-family residential development and the southern portion of the site that contains demonstration areas is zoned B2 – community business district, intended for general application (Figure 17). The R7.5 zoning supports tenant housing on site.

Tree Canopy Cover

The site benefits from a moderate level of tree cover, averaging about 35 percent of the site across all parcels (Figure 18). The value of all trees on site was estimated to be $6.725 million by an independent arborist. The tree canopy establishes a buffer between the busy surrounding roads and the research and provides a visual buffer between the site and Northampton Boulevard and Diamond Springs Road. The woods are used for shade-dependent research as well as for organic material storage such as mulch and tree debris piles. The site has a more robust tree canopy than many of the surrounding parcels and helps contribute to the city's initiative for a goal of an urban tree canopy cover of 45 percent by 2034.

Stormwater Utilities

The HR AREC is in the highly populated northern half of the city and benefits from robust utility systems connections, including a well-connected stormwater utility system (Figure 19). The site is graded to the on-site pond, which collects runoff during storm events and is then used to irrigate the site.

Air Installations Compatible Use Zone Impacts

Despite the site's proximity to Norfolk International Airport, there are no Air Installations Compatible Use Zone (AICUZ) impacts (Figure 20). Air traffic is almost exclusively commercial flights into and out of Norfolk International Airport, which keeps noise and accidental potential zones to a minimum compared to the AICUZ impacts of Naval Air Stations. Additionally, there are drone flying limitations at the HR AREC. Researchers use drones flown at low altitudes to monitor data, and they currently must request permission from the Federal Aviation Administration (FAA) or the airport air traffic control before running drone flight paths. The FAA requires notification to the FAA Norfolk Tower prior to operating drones within five miles of the airport. The FAA Norfolk Tower assesses the activity and provides feedback on where the intended activity is allowed based on the location with respect to controlled airspace. The assessment does not include any feedback for potential nuisance or privacy issues.

Hampton Roads Agricultural Research and Extension Center

Figure 10. Existing Site - Aerial Map

Data Sources: Esri, VGIN, City of Virginia Beach

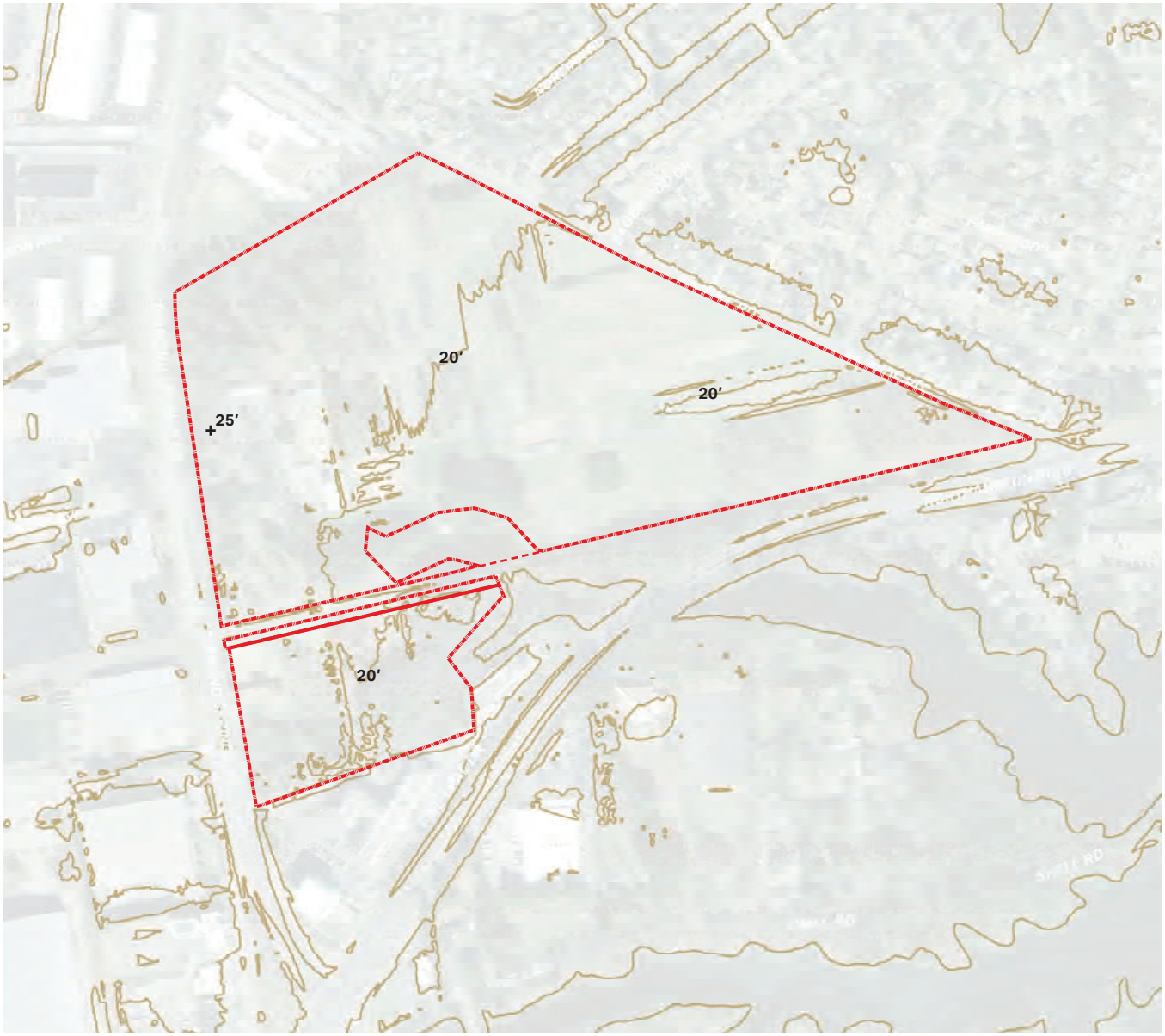
0 100 200 400 600 800 Feet N

Legend

Site Boundary

Hampton Roads Agricultural Research and Extension Center

Figure 11. Existing Site - Topography Map



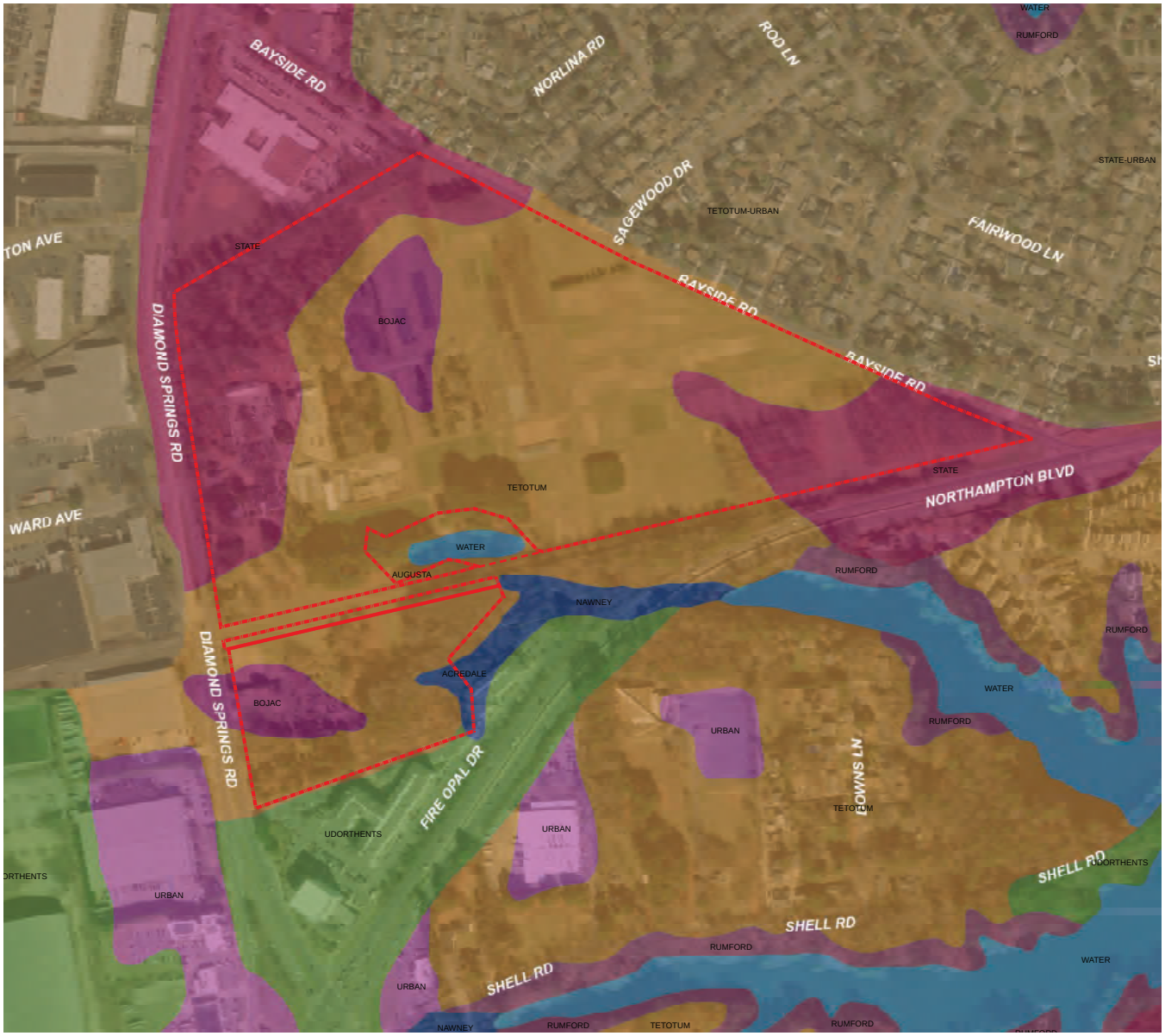
Data Sources: Esri, VGIN, City of Virginia Beach

Legend

- Site Boundary
- Spot Elevation
- Intermediate 2-Ft
- Index Contour

Hampton Roads Agricultural Research and Extension Center

Figure 12. Existing Site - Soils Map



Data Sources: Esri, VGIN, City of Virginia Beach

0 100 200 400 600 800 Feet

N

Legend

Site Boundary

Soil Types

- Tetotum
- Augusta
- Bojac
- State
- Urban
- Rumford
- Acredale
- Tetotum-Urban
- Water

Hampton Roads Agricultural Research and Extension Center

Figure 13. Existing Site - Flood Map

Data Sources: Esri, VGIN, City of Virginia Beach

0 100 200 400 600 800 Feet

N

Legend

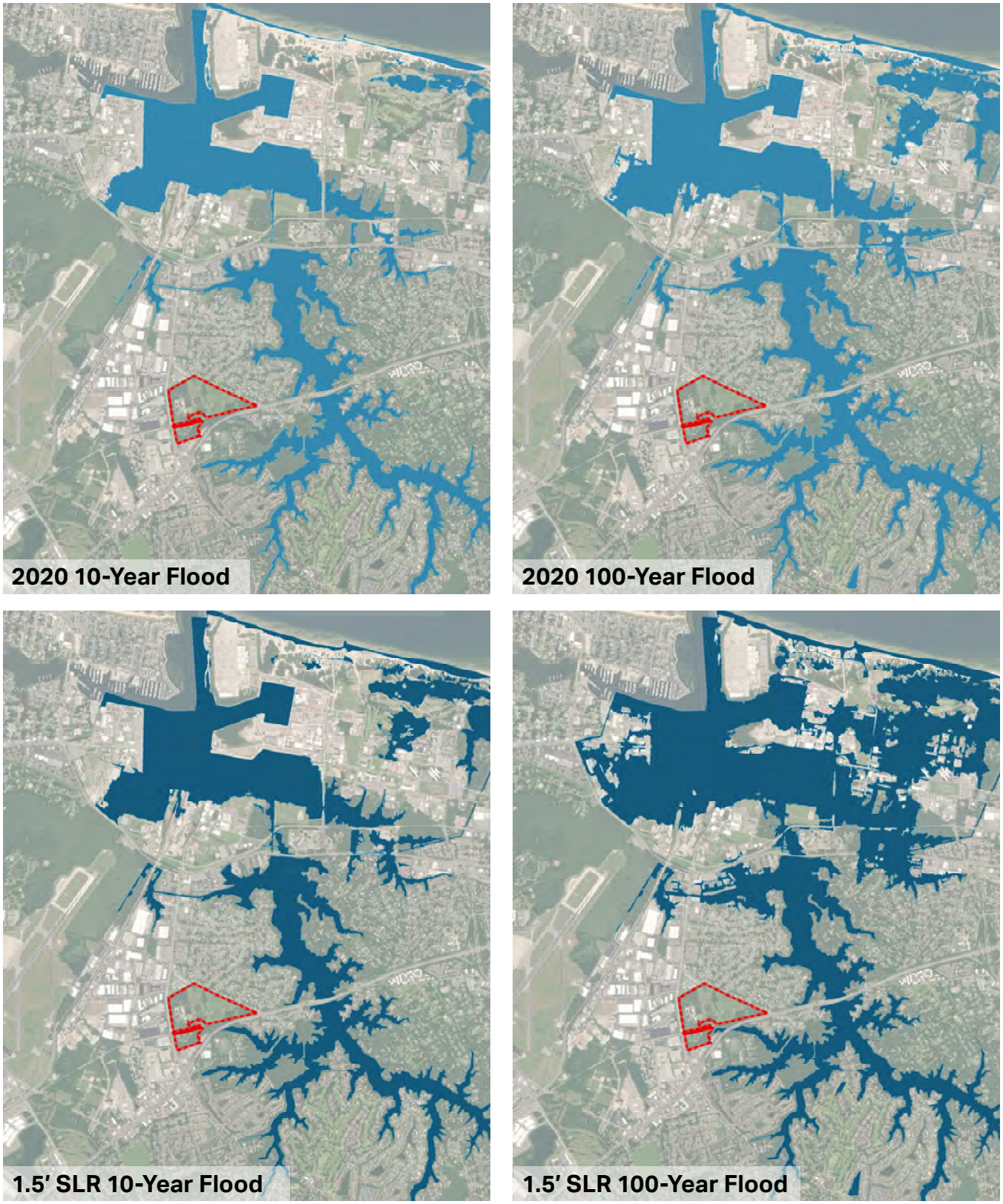
Site Boundary

Flood Zones

AE - Base Floodplain

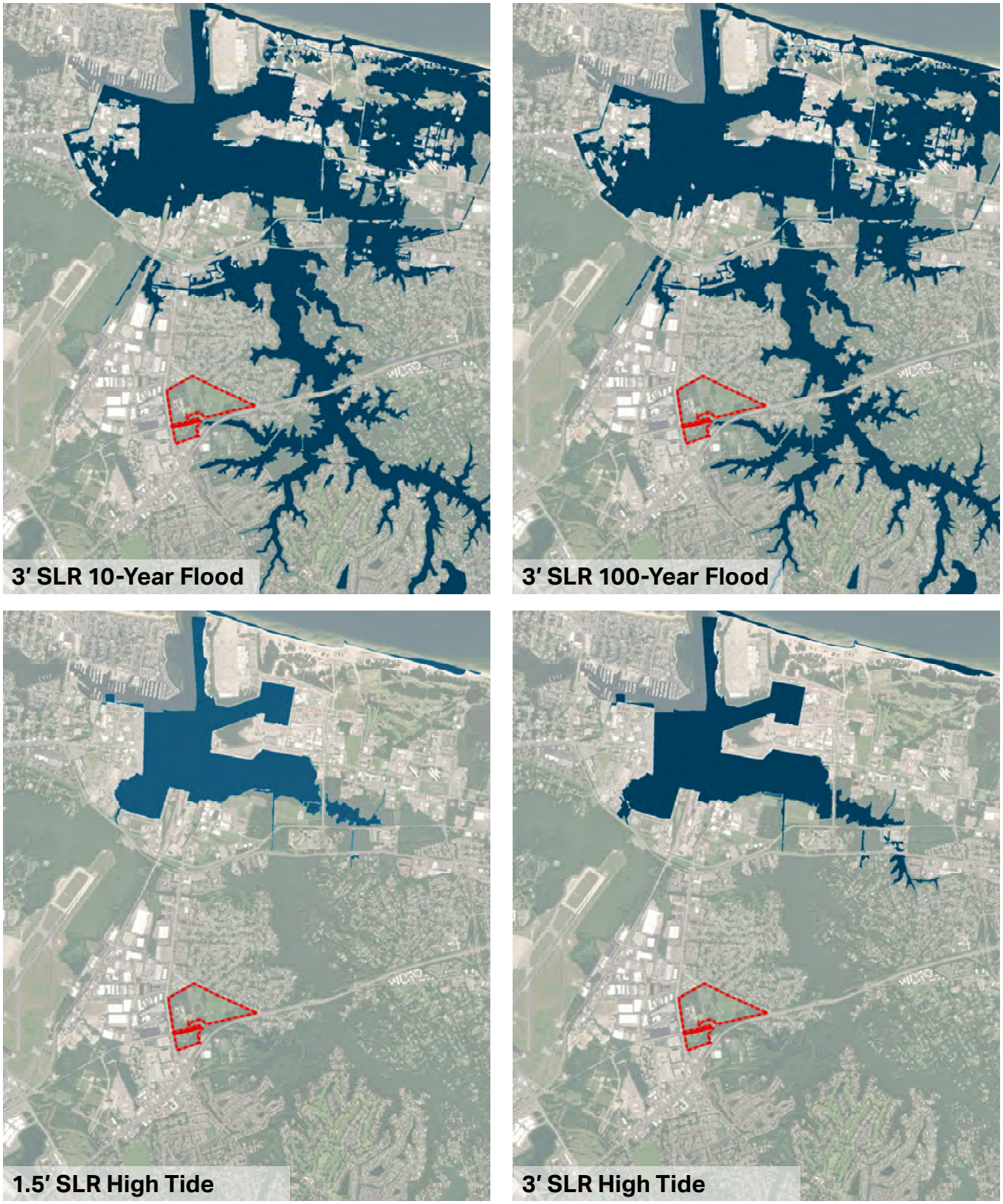
Hampton Roads Agricultural Research and Extension Center

Figure 14. Existing Site - Sea Level Rise Scenarios



Hampton Roads Agricultural Research and Extension Center

Figure 15. Existing Site - Sea Level Rise Scenarios



Hampton Roads Agricultural Research and Extension Center

Figure 16. Existing Site - Estimated Water Table Depth

Data Sources: Esri, VGIN, City of Virginia Beach

Legend

Site Boundary

Estimated Water Table

- Less than 1 foot
- 1 to 3 feet
- 3 to 5 feet
- 5 to 10 feet
- Greater than 10 feet

Hampton Roads Agricultural Research and Extension Center

Figure 17. Existing Site - Zoning Map

Data Sources: Esri, VGIN, City of Virginia Beach

0 100 200 400 600 800 Feet

Legend

Site Boundary

Zoning

A12	Apartment District
A18	Apartment District
A36	Apartment District
B2	Community Business District
H1	Hotel District
I1	Light Industrial
O1	Office District (small scale)
O2	Office District (large scale)
P1	Preservation District
R5D	Residential Duplex District
R7.5	Residential District
R20	Residential District
R40	Residential District

Hampton Roads Agricultural Research and Extension Center

Figure 18. Existing Site - Urban Tree Canopy Cover

Data Sources: Esri, VGIN, City of Virginia Beach

Legend

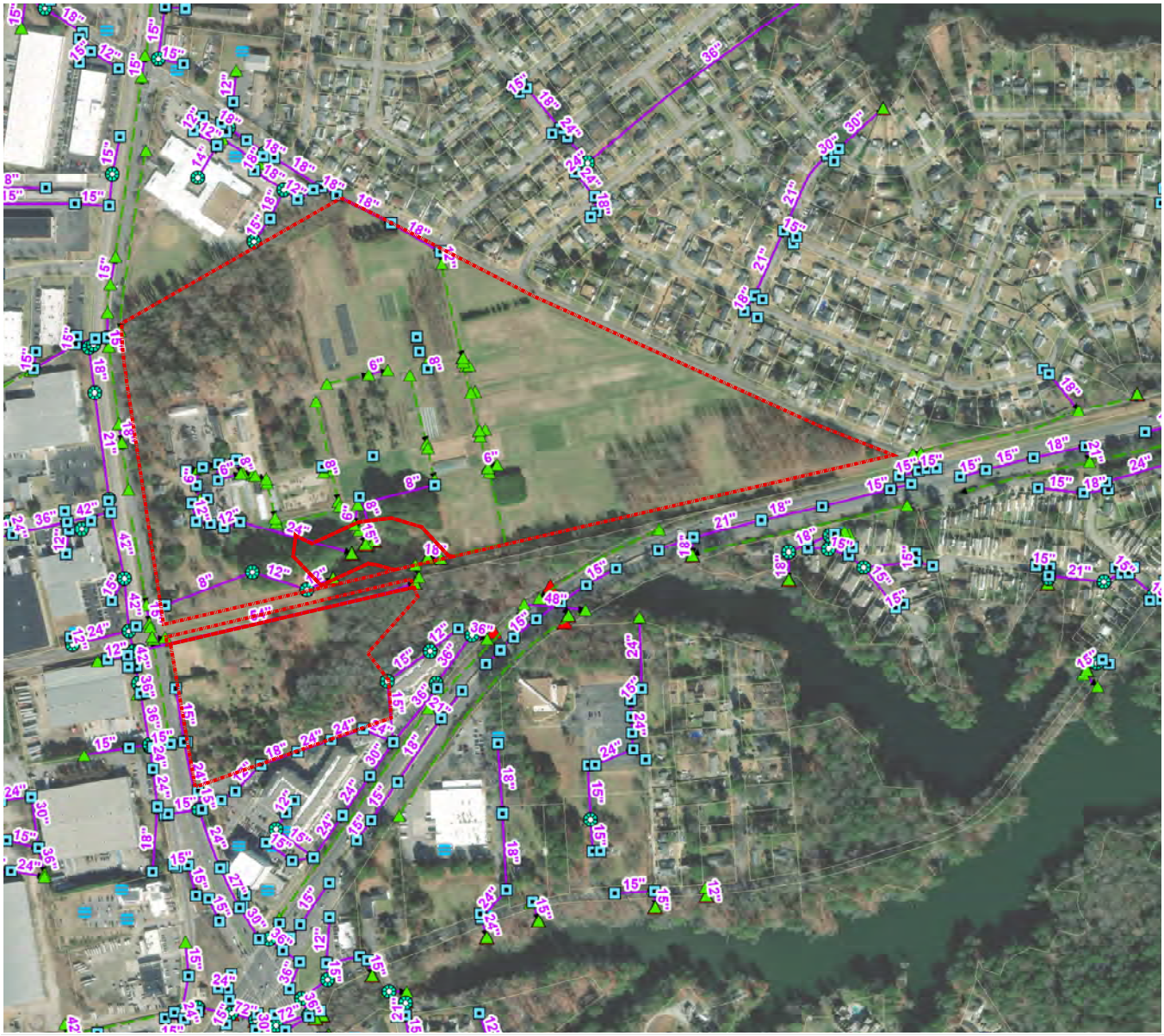
Site Boundary

Tree Canopy Coverage Percentage

- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 30
- 30 - 40
- 40 - 60
- 60 - 80
- 80 - 100

Hampton Roads Agricultural Research and Extension Center

Figure 19. Existing Site - Stormwater Utilities Map



Data Sources: Esri, VGIN, City of Virginia Beach

0 100 200 400 600 800 Feet

N

Legend

- Site Boundary
- Storm Main
- Storm Pump Station
- Ditch
- SWMF Point
- Stormwater Drainage Basin

Hampton Roads Agricultural Research and Extension Center

Figure 20. Existing Site - AICUZ Impacts

Data Sources: Esri, VGIN, City of Virginia Beach

0 100 200 400 600 800 Feet

N

Legend

Site Boundary

Data Sources: Esri, VGIN, City of Virginia Beach

Site Facilities

The HR AREC utilizes roughly six acres of the site for its facility operations center, and has approximately 59,000 square feet (SF) of built space. The facility generally prioritizes main research programs, designating about 28 percent of these buildings for greenhouses and high tunnels, 30 percent for storage, 23 percent for lab and research, and the remainder for general administration and utilities (Figure 21).

There are a total of 16 structures on the site, ranging from a large multistory building to small sheds. The majority of activity occurs in the administration building, which houses the facility's labs, classrooms, and offices. The original building is more than 60 years old and the most recent partial renovation was in 2003. For its age, the building is in good condition. Of note is a tunnel located in the basement that leads to a fallout shelter beneath the adjacent greenhouses.

There are five greenhouses on site: three general greenhouses, an overwintering greenhouse, and a solar greenhouse. These are of typical aluminum frame with glass or plastic construction with two shared concrete masonry headhouses. Each greenhouse is equipped with a shared heating, cooling, and irrigation system. This system is not automized and all temperature or water adjustments affect all connected buildings. There are two high tunnels located near the turfgrass plats that do not need controls.

The HR AREC provides on site housing for graduate students employed at the facility. There are two tenant houses that typically house four personnel each. One house predates the HR AREC and is likely close to a century old. The second house is a recent 2012 construction with modern utilities.

A variety of storage buildings and warehouses are accessible from the main parking lot. These store all tools, equipment, vehicles, and hazardous chemicals used by the HR AREC. There are also multiple workshops available for equipment maintenance. The majority of these buildings were likely constructed in the 1950s and 1960s.

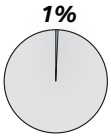
The site has 46 parking spaces with one accessible space. About ten of these are reserved for facility vehicles.

For additional details, see Appendix A.

Hampton Roads Agricultural Research and Extension Center

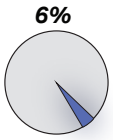
Figure 21. Program Areas

Site Utilities



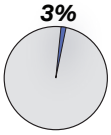
860 SF

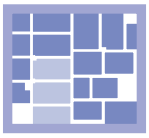
Classrooms



3,300 SF

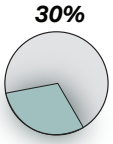
Office / Administration

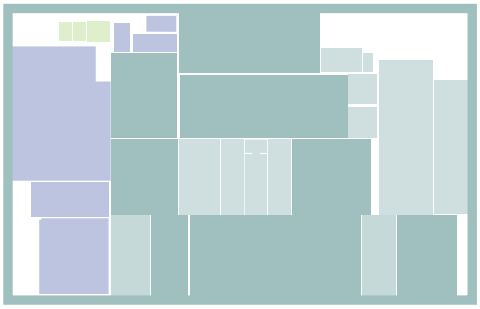




1,895 SF

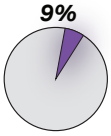
Warehouses, Shops, Hazardous Storage





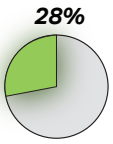
17,325 SF

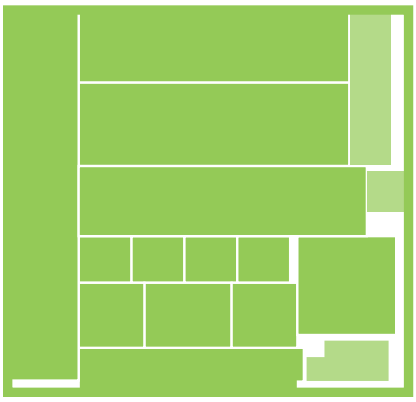
Residential



5,098 SF

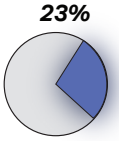
Greenhouses

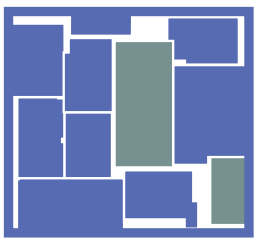




16,012 SF

Lab / Research





15,999 SF

TOTAL = 58,594 SF

1 5 10 20 40 80

Existing Research

The HR AREC focuses on five major research topics: nursery crops, pest management, small fruit production, stormwater management, and turfgrass maintenance. As Smart Farm technology advances, the HR AREC is integrating innovative technologies on site including stormwater modeling, the use of drones to monitor research, and a solar-heated greenhouse. Most of the site's acreage is devoted to turfgrass research because of the inherently large footprint such research requires (Figure 22). The next largest acreage consists of dense woods. The wooded areas are used for equipment and organic material storage, as well as for research that requires shade and significant canopy cover.

Turf Research

The largest research group by land area, the HR AREC grows several types of turfgrass including Bermuda, St. Augustine, Tall Fescue, and Zoysia. Virginia Beach is in the 8A growing zone, providing a unique environment for turfgrass tests that are unachievable in other areas such as Blacksburg, Virginia, where the main Virginia Tech campus is located, or in Florida, where there is a concentration of turfgrass research. The HR AREC participates in the National Turfgrass Evaluation Program (NTEP), a national organization that works to identify turfgrass cultivars and care regimens for regions across the United States and Canada. NTEP trials typically operate on a five-year schedule, requiring the same conditions and maintenance consistently across a five-year timeline. The HR AREC's acreage allows it to run several trials over five-year spans. The HR AREC regularly performs work with the Virginia Turfgrass Council and hosts turfgrass conference sessions and NTEP educational classes.

Weed Research

The HR AREC focuses on weed management especially in nursery crop environments. Research topics include investigating alternatives to chemicals such as mulches and landscape fabrics for weed control, evaluating control mechanisms for weeds in a lawn care scenario, and managing weeds in a tree and small fruit production environment. Weed research trials take advantage of many of the site conditions at the HR AREC, including the shaded wood edge and open grass fields.

Small Fruit Research

Blackberries, raspberries, kiwi, and strawberries are all components of the HR AREC's small fruit production research area. Most of the small fruit is grown in raised beds and requires well drained soils; the root systems of small fruit are especially sensitive to extended exposure to wet soils.

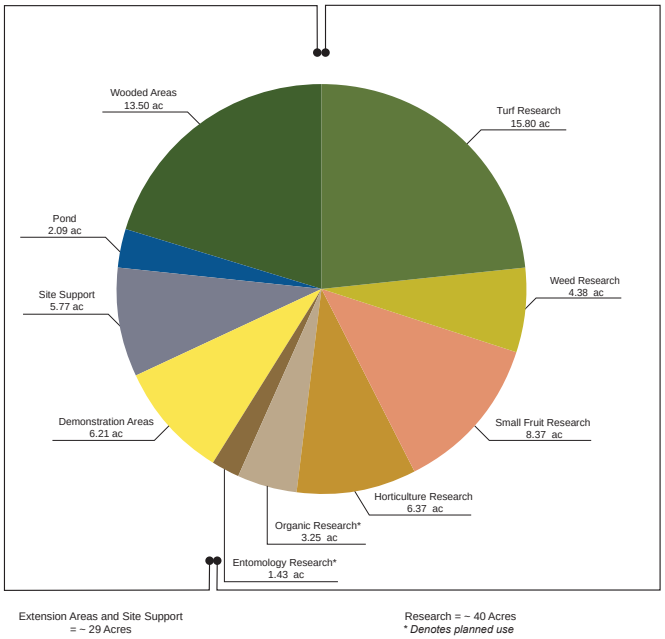


Figure 22. Acreage Breakdown - Over half of the site's acreage is dedicated to research trials. Of the remaining nearly 30 acres, most of the land falls within a wooded area and serves multiple purposes.

Boxwood research currently is performed in the same area as the small fruit research and requires strict maintenance and care due to the threat of 'boxwood blight'. The research trials vary in length from one year for strawberries to five or more years for blackberries and boxwoods.

Horticulture Research

Separate from the extension areas such as the demonstration areas and the riparian buffer display, horticulture research focuses on nursery industry research topics. There are several container pads on site used to simulate a nursery environment for potted plants. Irrigation trials are performed to test the differences between well water and pond irrigation on nutrient absorption and plant health in potted plants.

Organic Research

Currently, the HR AREC does not perform any organic research on site; however, just over three acres of land is designated for future organic research use. As part of the certified organic process, any land used to perform organic research must be intervention-free for at least three years and must have a buffer around the site to ensure there is no chemical infiltration. The HR AREC is currently working toward achieving these requirements.

Entomology Research

New entomology research is coming to the HR AREC in the next academic year and will include an isolated research environment in which to study pests. Studies include threat and management of arthropods such as beetles, mites, and centipedes, as well as beneficial insect research. As part of the research, the development of a sustainable integrated management program for ambrosia beetles as pests of woody ornamentals, tactics for control of flea beetles in nurseries, and management of soft scales in southern landscapes will be included.

Demonstration Areas

The HR AREC has several extension and demonstration areas around the site, totaling over six acres and concentrated in the demonstration garden area, which features over 1,400 species in its annual and perennial gardens. Regional Master Gardeners use the gardens to perform perennial plant tests to understand what cultivars perform well in this area. The gardens also include the arboretum, which is just under two acres and includes several Champion Trees – trees that are the largest and healthiest of its species in the state of Virginia. Other demonstration areas include the riparian buffer display that identifies plant species well suited for borders between land and water, the utility line display in partnership with Dominion Energy that identifies species well suited for planting near live power lines, and a tree trail that identifies 19 trees and provides educational materials for tree identification.

Site Support

The site support area is the main core of the HR AREC and includes the administrative building, classrooms, laboratories, and equipment and material storage. All the buildings and greenhouses, except for the solar greenhouse, are heated using a boiler steam system, restricting the ability to individually control the heat in a single area. In addition to the HR AREC's closed storage areas such as the pole barn and the garages, large equipment also is stored in the nearby field either uncovered or covered with temporary structures.

See Appendix A for a complete assessment of existing site assets.

Partnerships and Collaborations

Most of the research performed at the HR AREC is funded through grant programs. Many different organizations are associated with the HR AREC including:

- 4-H (Head, Heart, Hands, and Health)
- American Horticultural Research Institute (funding)
- Environmental Protection Agency
- Extension Agents
- IR-4 Program (pest management) (funding)
- NTEP
- Turfgrass Water Conservation Alliance (funding)
- Virginia Beach Master Gardeners Association
- Virginia Cooperative Extension
- Virginia Horticultural Foundation
- Virginia Nursery and Landscape Association (funding)
- Virginia Strawberry Growers Association
- Virginia Turfgrass Council (funding)
- Virginia Turfgrass Foundation (funding)

The HR AREC frequently collaborates with other Extension offices in the state to mutually support research and extension initiatives. Most recently, the HR AREC provided space in its horticultural research plots for the Eastern Shore AREC to use for its own commercial vegetable research due to lack of space at the Eastern Shore site. The site's current location off of U.S. Route 13, the area's only connection to the Eastern Shore, is a critical component of that partnership. Partnerships and shared initiatives also occur between the HR AREC and the Virginia Cooperative Extension to provide educational materials and events for Virginia homeowners and farmers. Activities with the Virginia Cooperative Extension include plant disease identification, insect identification, community resiliency planning aid, and certification classes.

The HR AREC benefits from a robust Master Gardener volunteer group who maintain the demonstration areas and the arboretum. The Master Gardeners are responsible for the garden trials held in the annual and perennial gardens, including growing and maintaining the cultivars. Based on zip code information provided by volunteers, most Master Gardeners are in the northern half of the city of Virginia Beach and the current location of the HR AREC is a significant factor in frequency and duration of volunteer hours (Figure 23).

In addition to robust partnerships, the HR AREC also hosts several events throughout the year for a variety of stakeholders. The HR AREC uses indoor and outdoor space for outreach and extension activities and accommodates parking for large events by using the open fields adjacent to the demonstration areas for temporary overflow parking. Private and community events such as weddings, birdwatching groups, and photography sessions regularly occur at the site. See page 72 for further discussion regarding the impact of a potential move on current site users and partnerships.

See Appendix B for a complete list of users.

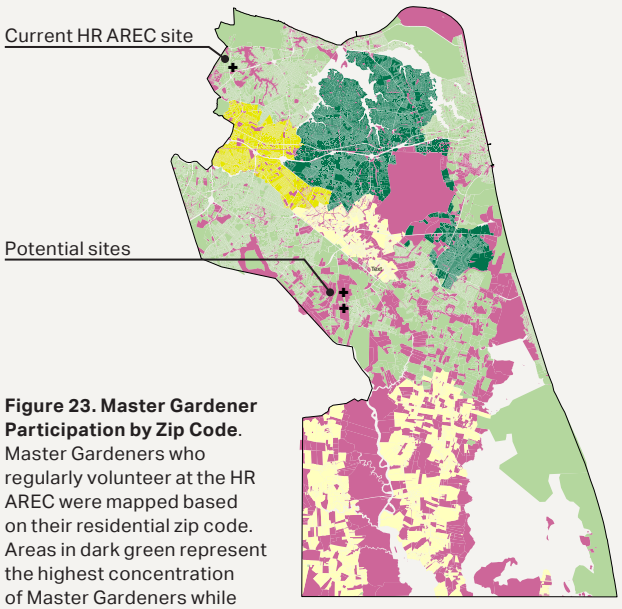


Figure 23. Master Gardener Participation by Zip Code. Master Gardeners who regularly volunteer at the HR AREC were mapped based on their residential zip code. Areas in dark green represent the highest concentration of Master Gardeners while areas in pink represent low concentration.

Event	Average Attendees	Frequency per Year
Turfgrass Field Day	150	1
Fall Garden Festival	1,500 – 2,000	1
School Tours	300 – 800	15 – 35
Spring Plant Sale	800 – 1,000	1
VT Alumni Association Meeting	50 – 100	1
Virginia Wesleyan Soils Lab	20 – 30	1
Tidewater Community College Classes	100 – 200	7
Outreach/Continuing Education	Varies	50 (held weekly)

Cultural Value

Beyond research and community support, the HR AREC provides cultural services that are difficult to quantify. The site has been in operation as an agricultural research facility since the early 1900s, a rare example of continuing operation in Virginia Beach, especially considering the area's rapid urbanization beginning in the 1960s when the city was officially established. In its nearly 120-year history, the HR AREC has contributed critical agricultural research and products to both World War I and World War II efforts, and participated in New Deal-era initiatives to help the region survive and recover from Great Depression impacts. The legacy of providing aid on a regional and national level is tied to the site's location, which has always been easily accessible whether by rail or by car.

The site also has significant tree coverage, as indicated in Figure 18. Such coverage provides physical benefits including reduced energy demands for cooling buildings and improved stormwater management due to canopy interception and uptake, but there are many intangible benefits as well. The canopy provides shade and shelter for visitors, the allée of trees along the entrance path offers a sense of arrival to the facilities, and the Champion Trees on site present a rare opportunity to experience specimen of such size and health. Independent arborists assessed the total tree canopy at the HR AREC at a value of over six million dollars, but the cultural impact of the canopy is more difficult to quantify. It is suggested that if the site of the existing HR AREC is redeveloped that Virginia Beach consider developing a plan to preserve the existing arboretum and Champion Trees in situ to maintain or further enhance the community benefit.

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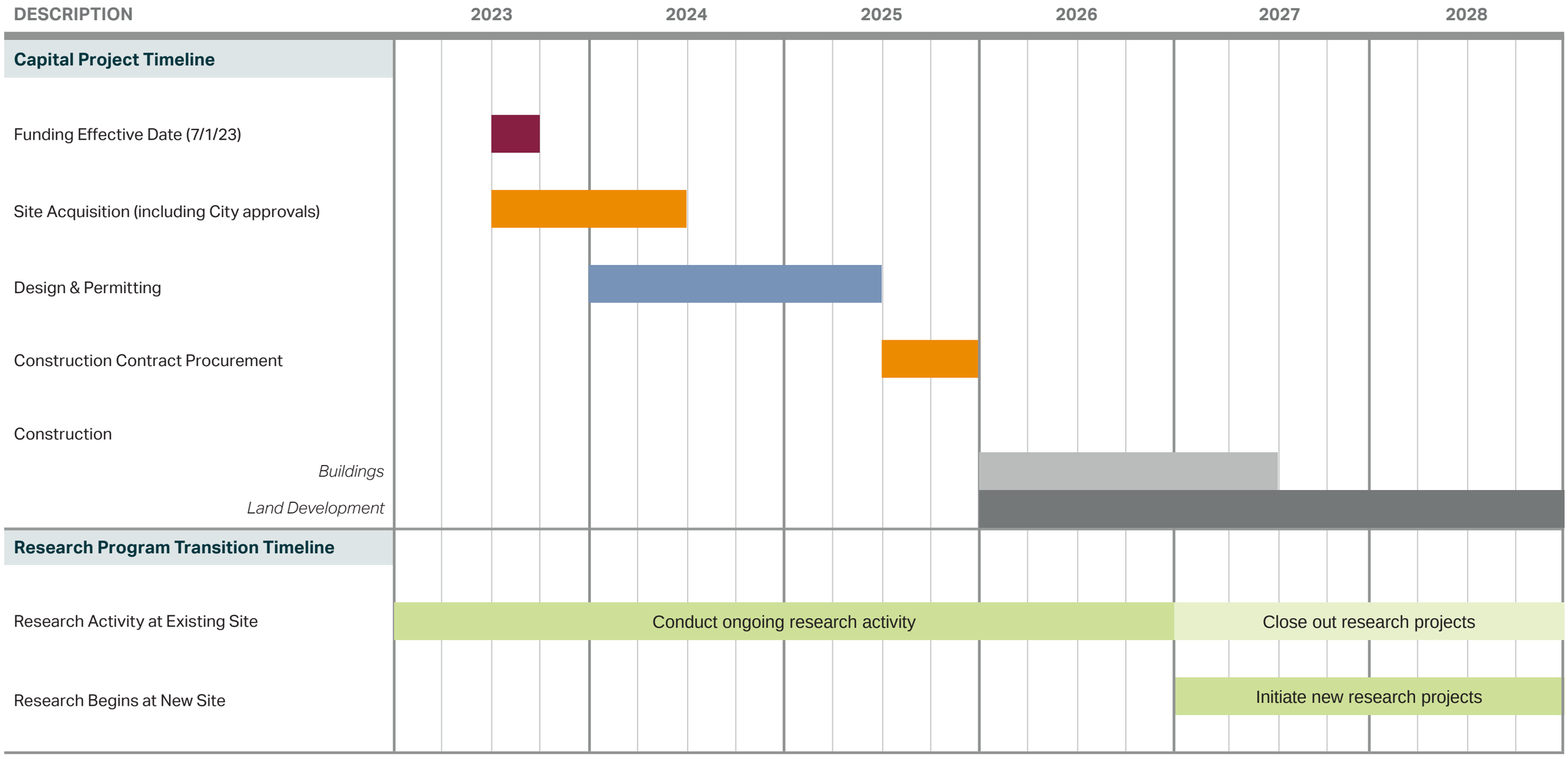
1:1 Replacement

02

Moving to a New Site

Project Schedule



Site Selection Process

GIS software was used in the first stage of the site selection process using data available on the City of Virginia Beach's Open GIS Portal. Not all relevant data was able to be collected, including the location of power utilities and complete easement information. When considering possible future sites for the AREC, several parameters were used to cull potential parcels:

Parcel Ownership – Only parcels owned by the City of Virginia Beach were considered for the initial parcel analysis.

Parcel Size – The existing site is approximately 71 acres. In a one-to-one replacement strategy, a parcel of similar or larger size is required, dependent upon additional site drainage required in order make the site usable. During the site selection process, if adjacent parcels were owned by the City, those parcels were considered one single parcel for the purposes of acreage. For example, if the City owned a 30-acre parcel that shared a parcel line with a 40-acre parcel, those two parcels were considered a potentially suitable site based on acreage and ownership alone.

Flood Plain – Potential parcels were required to be outside the current Federal Emergency Management Agency (FEMA) 500-year floodplain. After selection, further flooding scenarios were considered, including using the City's Sea Level Wise data to analyze future flooding events.

Compatible Use – After reducing the number of potential parcels using the above GIS parameters, existing land use was compared to potential future use and incompatible parcels were removed from consideration. For example, when analyzed using only GIS criteria (owned by the City, at least 70 acres, outside the floodplain), Mt. Trashmore is returned as a potential site, but clearly cannot be considered as a potentially suitable parcel due to several factors including its topography, the site's history as a landfill, and its current function as a major community asset.

After running the initial analysis, four sites were identified and a fifth site, Cockrell Farm, was presented by the City of Virginia Beach (Figure 24). Cockrell Farm was incompatible due to size, as the parcel is only about 46 acres. The four remaining sites were parcels in Corporate Landing, Brenneman and Brown Farms off North Landing Road, and a parcel off Princess Anne Road near the Sportsplex. After further research, it was discovered that the Department of Economic Development has tentative plans for a medical park at the Princess Anne site, and nearly all available land within the Corporate Landing parcels is already under agreement for development. Only two parcels remained – the Brenneman Farm and Brown Farm parcels – but their significant size allowed for several test fits to be conducted (Figure 25).

Further impacting the test fitting process were plans presented in City of Virginia Beach's 2017 Comprehensive Plan in the Interfacility Traffic Area and Vicinity Master Plan amendment. In that plan, the City proposed extensions of both Nimmo Parkway and Landstown Road. The Nimmo Parkway extension would bisect the Brown Farm site, while the Landstown Road extension cuts through its westernmost edge. Included in the plan was a potential bicycle path that would run across the southern end of the Brown Farm site, approximately one-third of the way between North Landing Road and the proposed Nimmo Parkway extension. That potential development provided spatial parameters for the test fitting process.

Site Criteria Development

A series of site criteria were developed to aid in prioritization of a single site using the existing HR AREC conditions as a baseline. Factors such as length of contiguous street frontage, proximity to major transportation connections, proximity to partner organizations, and percentage of tree canopy coverage were evaluated and assigned weights based on potential impact to site suitability. After using GIS to narrow the list of potential parcels as presented in the Site Selection Process section, the resulting parcels were in the same geographic area, minimizing the usefulness of site criteria for prioritization in this study. A complete list of site criteria and rankings is included in Appendix D for use in later site investigations if other locations are considered.

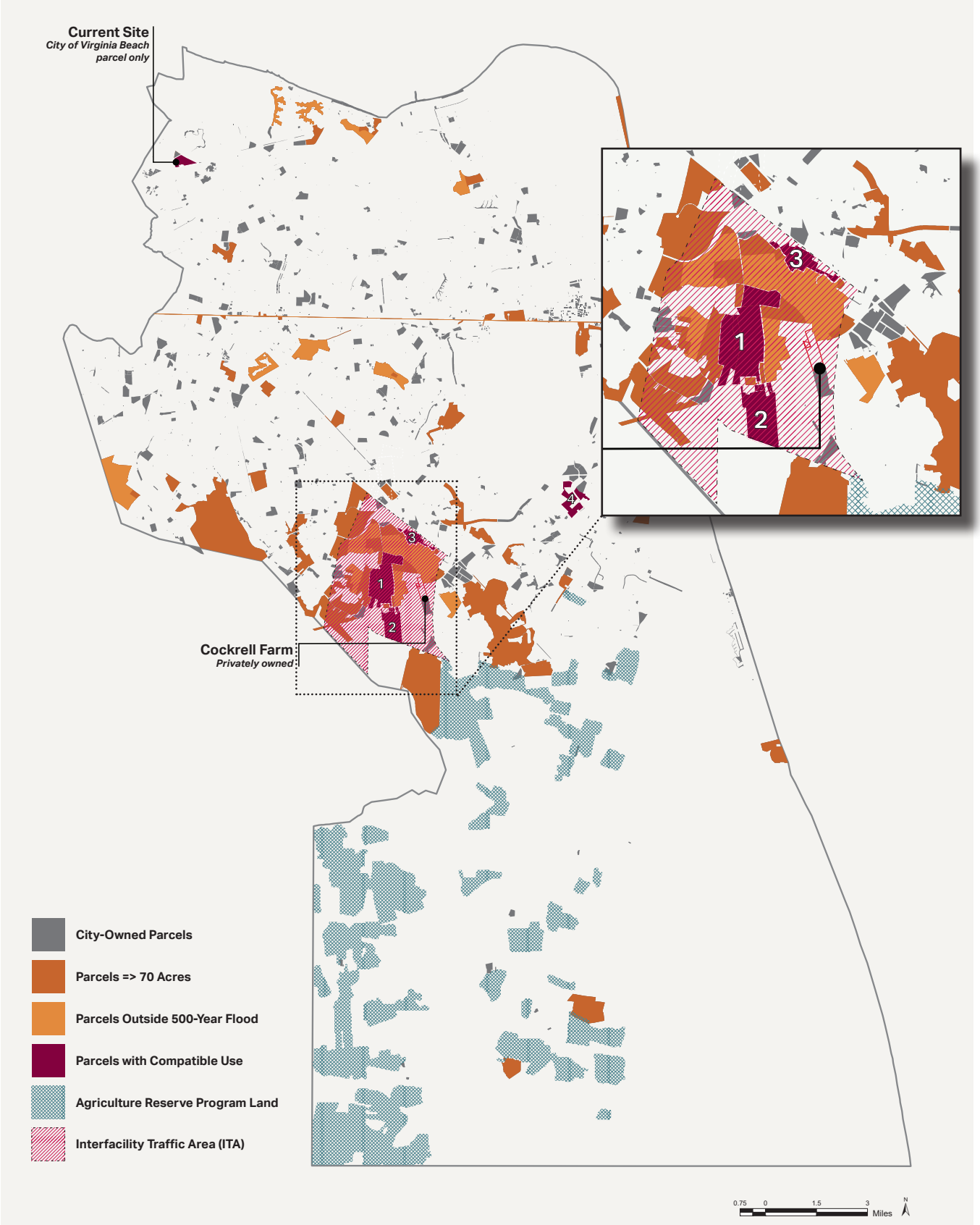
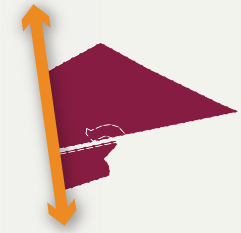
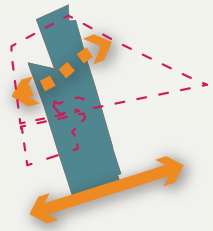


Figure 24. Site Selection. Parcels shown in gray are City of Virginia Beach-owned parcels. Using the defined parameters, four sites, indicated in maroon, were identified for additional analysis.



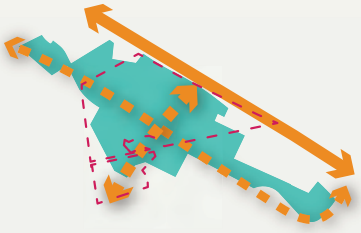
VT AREC Existing Site
with existing Diamond Springs Road

71.29 Acres



Cockrell Farm
with Nimmo Parkway extension and existing North Landing Road

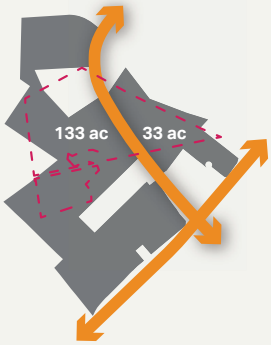
46.39 Acres



Princess Anne Road Parcel
with existing Princess Anne Road and proposed roads for Biomedical Park and sports fields

92.89 Acres

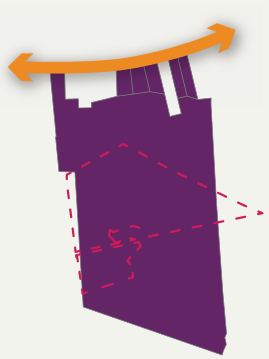
(Parcel 3 on previous page)



Corporate Landing Parcel
with existing Corporate Landing Parkway and General Booth Boulevard

166.58 Acres

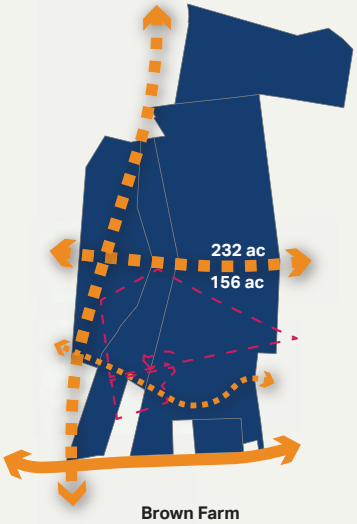
(Parcel 4 on previous page)



Brennamen Farm
with existing North Landing Road

207.44 Acres

(Parcel 2 on previous page)



Brown Farm
with existing North Landing Road, Nimmo Parkway and Landstown Road extensions, and proposed trail

400.37 Acres

(Parcel 1 on previous page)

Figure 25. Selected Parcels Diagram. Four parcel options were returned via GIS analysis and a fifth, Cockrell Farm, was suggested by the City of Virginia Beach.

Potential Site Existing Conditions

Topography

Brenneman Farm and Brown Farm are in southern Virginia Beach, just above the Green Line, a line instated by the City of Virginia Beach to combat urban sprawl into the traditionally agricultural areas of the city (Figure 26). The sites are relatively flat with high points of 14 feet above mean sea level (Figure 27). The sites have a long history of crop farming, and there are existing open drainage ditch systems that were dug and maintained to help drain the soil.

The soil report indicated that the water table likely rises to less than one foot beneath the surface each winter, which has implications for plant and tree species with non-shallow root systems. Many small fruit and boxwood species require dry roots and would need a raised bed or similar intervention to prevent the water table from saturating the root systems. City of Virginia Beach GIS data estimates the water table fluctuates between 5 and 10 feet. Additional boring tests are required to fully understand the existing water table levels and how seasonal fluctuation may impact the land.

Soil

Both Brenneman Farm and Brown Farm are almost exclusively Acredale soil, a deep and poorly drained soil (Figure 28). Infiltration is slow due to the high silt and clay content of the surface soils. Surface runoff can be very slow, causing ponding after a rain. During the wet season the soil remains saturated, causing rapid runoff during rain events. The soil can be well suited to cultivated crops such as soybeans and corn with the use of drainage ditches like those on site, but crops are occasionally damaged after heavy or long periods of rain. See Appendix C for additional soil data.

Flooding

There are several wetland areas around the sites, and many branches of nearby North Landing River extend near the sites. The sites currently are not susceptible to flooding and are outside the FEMA 500-year floodplain, also known as the 0.2 percent floodplain. When analyzing the sites under the City of Virginia Beach Sea Level Wise plan's sea level rise data, Brenneman and Brown Farms are less accessible in the event of a 10-year storm with 1.5 feet of sea level rise. Many roads leading to the sites are completely inundated in that scenario and the condition worsens under the three feet of sea level rise scenario. The site itself would remain only minorly impacted; however, it will be challenging to access the site in those scenarios (Figures 29 through 32). Freeboard is not necessary.

Zoning

Both Brenneman Farm and Brown Farm are zoned AG-1 – agricultural district (Figures 33 and 34). The intent of AG zoning is "to protect and preserve agricultural lands for agricultural functions and to protect and preserve agricultural lands and activities in the rural areas of the city…" (Virginia Beach Zoning Districts – General Description and Purpose p.1). Agricultural districts allow for "reasonable levels of rural residential development" (ibid) that would not prohibit tenant housing on site; however, the desired rural character of the area as indicated by its zoning should be considered due to the inherent public nature of the extension function of the HR AREC.

Tree Canopy Cover

Brenneman and Brown Farms were historically and continue to be used for farm crops such as soybeans and corn. These practices have limited overall site canopy cover despite their proximity to wetland areas; the average canopy coverage for Brenneman Farm is approximately 5 percent. Brown Farm has a slightly higher canopy coverage of about 10 percent because of a nearby wetland area (Figure 35).

Air Installations Compatible Use Zone

The potential sites are located between Naval Air Station Oceana and Naval Auxiliary Landing Field Fentress, two Navy installations with significant aircraft activity. The sites are outside of the accident potential zone but are well within the decibel impact zone (Figure 36). Most of Brenneman and Brown Farms are in the 70 to 75 decibel level; the southwest corner of Brown Farm falls within the 75 and greater decibel level and the southeast edge of Brenneman Farm falls within the 65 to 70 decibel level. Loud noise levels such as those generated by jets and aircraft can cause increased stress levels to people living and working in the area, and sustained noise above 70 decibels can damage hearing, according to the Center for Disease Control. Possible impacts to scientific equipment due to vibrations caused by overhead aircraft are uncertain. Additional architectural support to mitigate noise and vibrations such as insulated windows were not analyzed under this study.

Although the potential sites are located within the AICUZ, there are no flight restrictions for drone activity below 200 feet. The nature of the HR AREC's site work does not necessitate high altitude surveys; therefore, drone activity would not be impacted at Brenneman or Brown Farm.

Hampton Roads Agricultural Research and Extension Center

Figure 26. Potential Sites - Aerial Map

Data Sources: Esri, VGIN, City of Virginia Beach

500 250 0 500 1,000 1,500 2,000 Feet

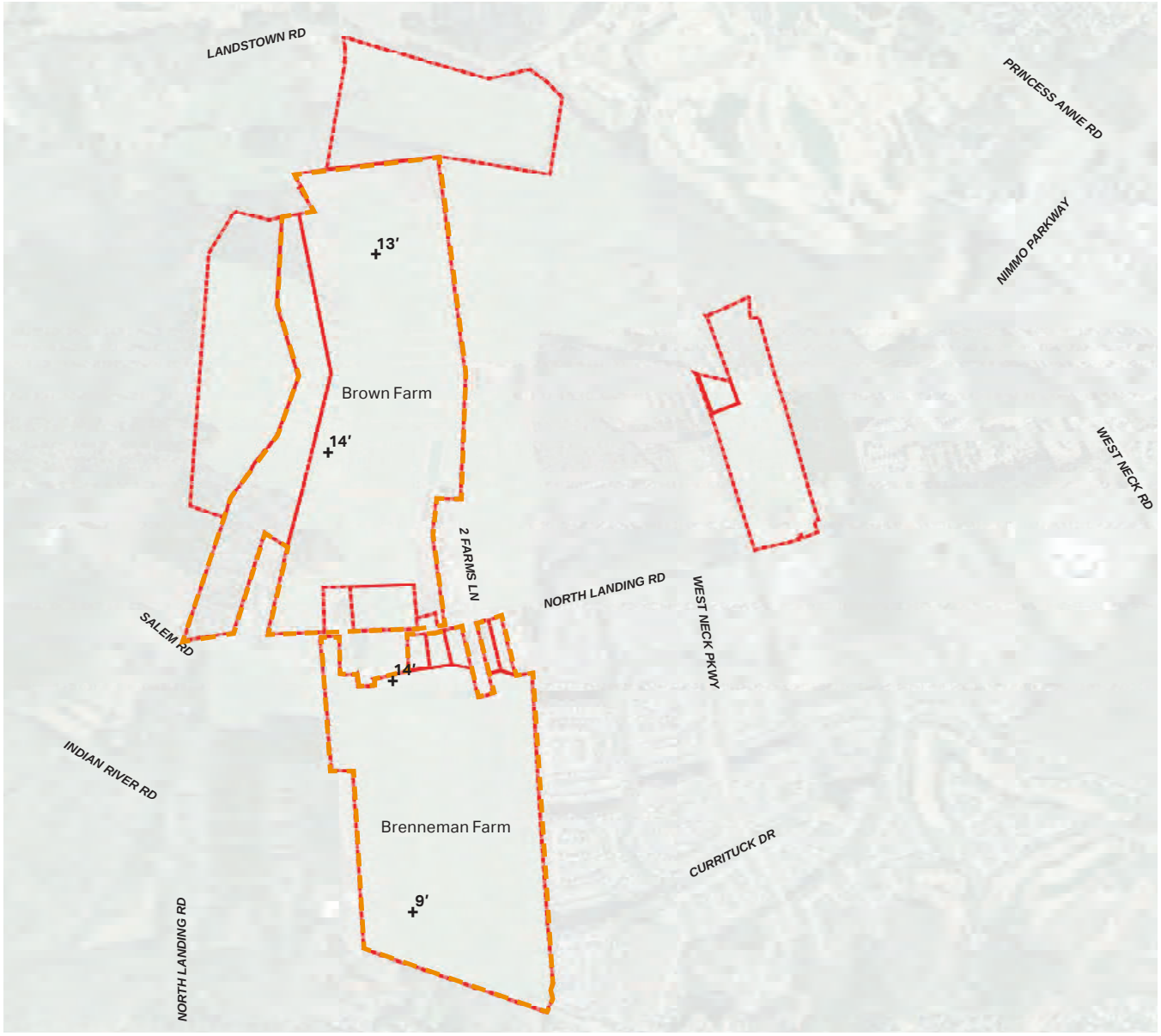
N

Legend

- Identified Parcels
- Potential Site Test Fit Areas

Hampton Roads Agricultural Research and Extension Center

Figure 27. Potential Sites - Topographic Map



Data Sources: Esri, VGIN, City of Virginia Beach

500 250 0 500 1,000 1,500 2,000 Feet

Legend

- Identified Parcels
- Potential Site Test Fit Areas
- \+ Spot Elevation

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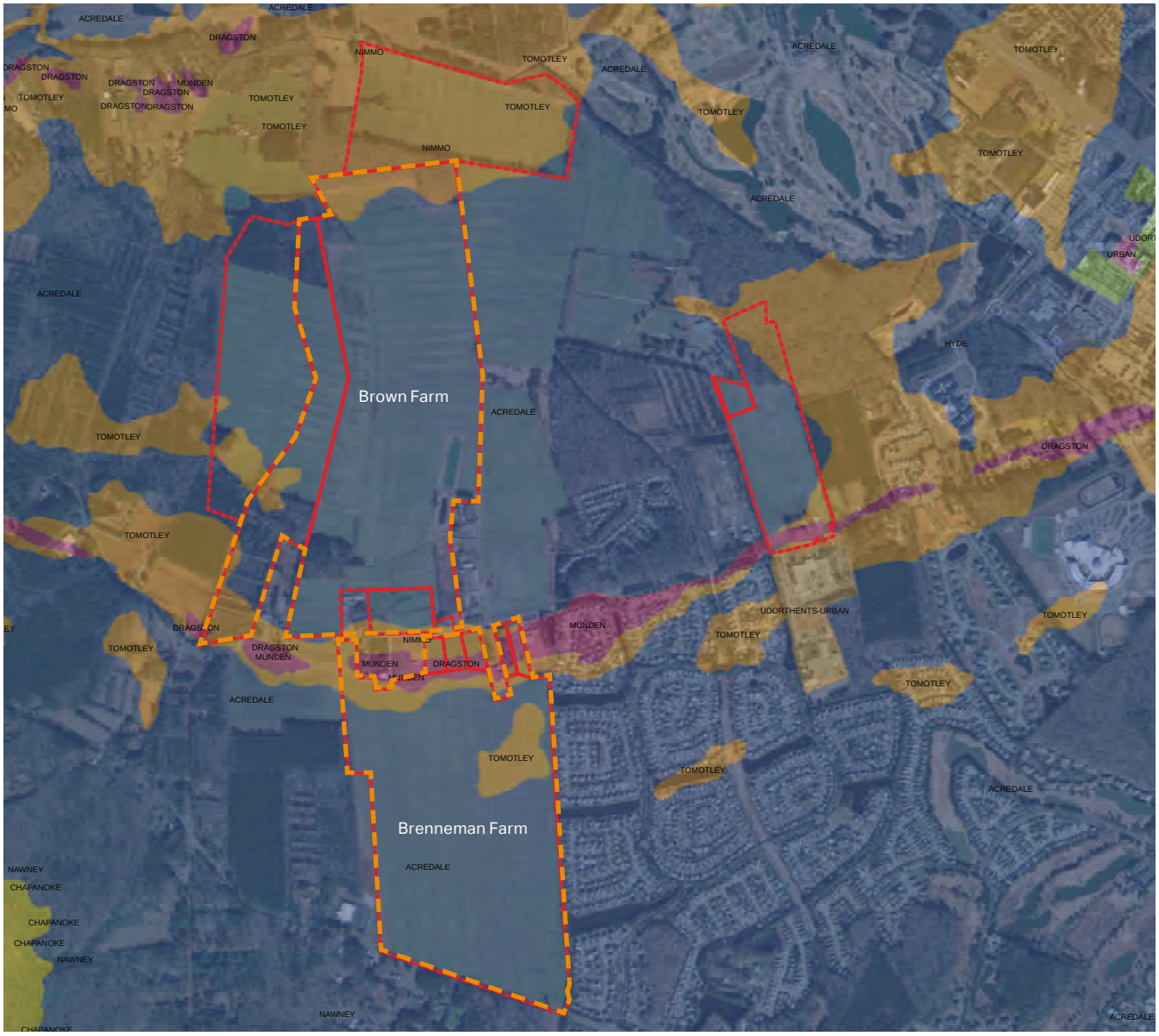
Figure 28. Potential Sites - Soils Map



Data Sources: Esri, VGIN, City of Virginia Beach

500 250 0 500 1,000 1,500 2,000 Feet

N

Legend

- Identified Parcels
- Potential Site Test Fit Areas

Soil Types

- Acredale
- Tomotley
- Dragston
- Munden
- Udorthents - Urban
- Udorthents
- Chapanoke

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Figure 29. Potential Sites - Flood Hazard Map

Data Sources: Esri, VGIN, City of Virginia Beach

500 250 0 500 1,000 1,500 2,000 Feet

N

Legend

- Identified Parcels
- Potential Site Test Fit Areas

Flood Zones

- Floodway
- AE - Base Floodplain
- .2% - 500-year Floodplain

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Figure 30. Potential Sites - Sea Level Rise Scenarios

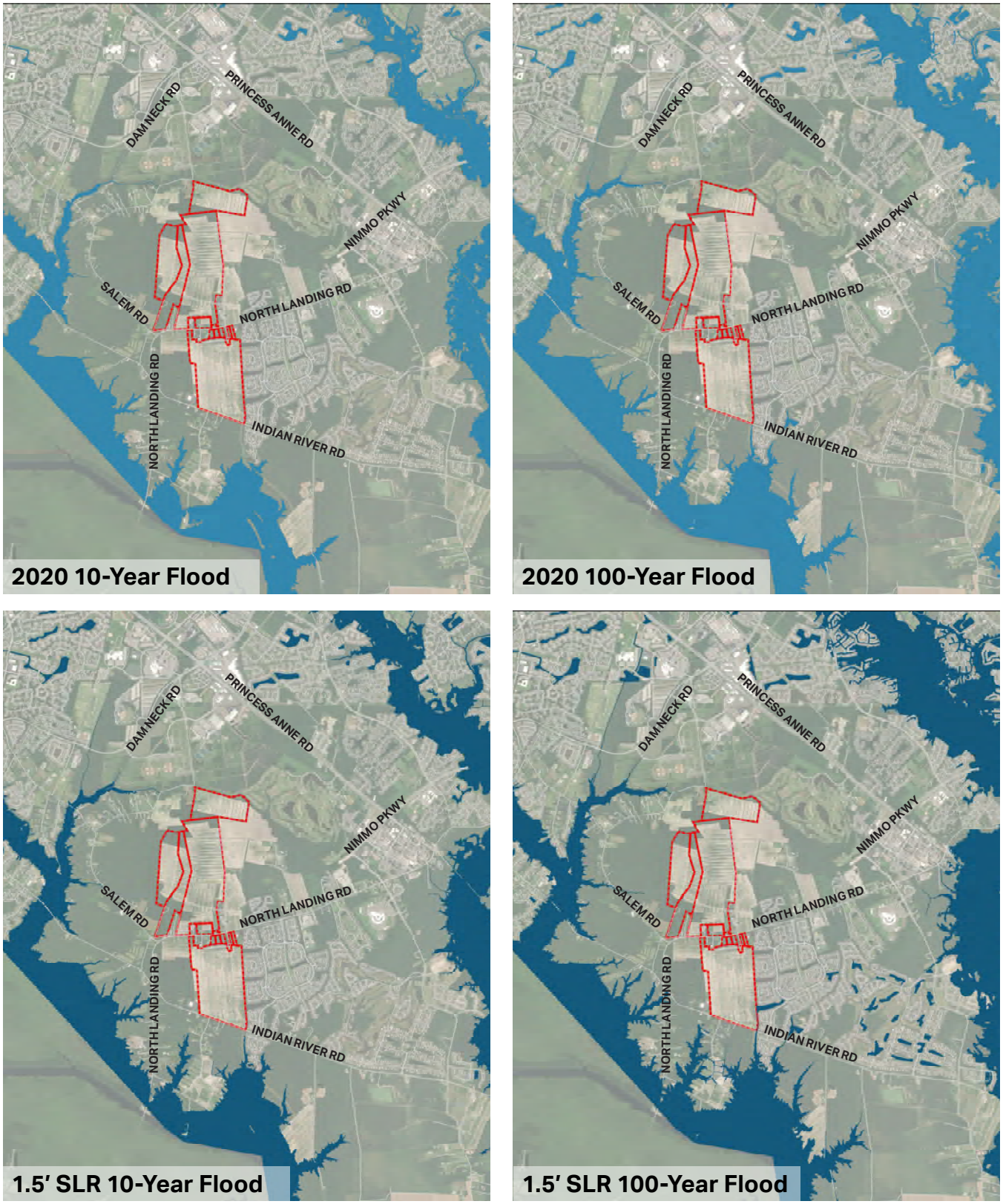

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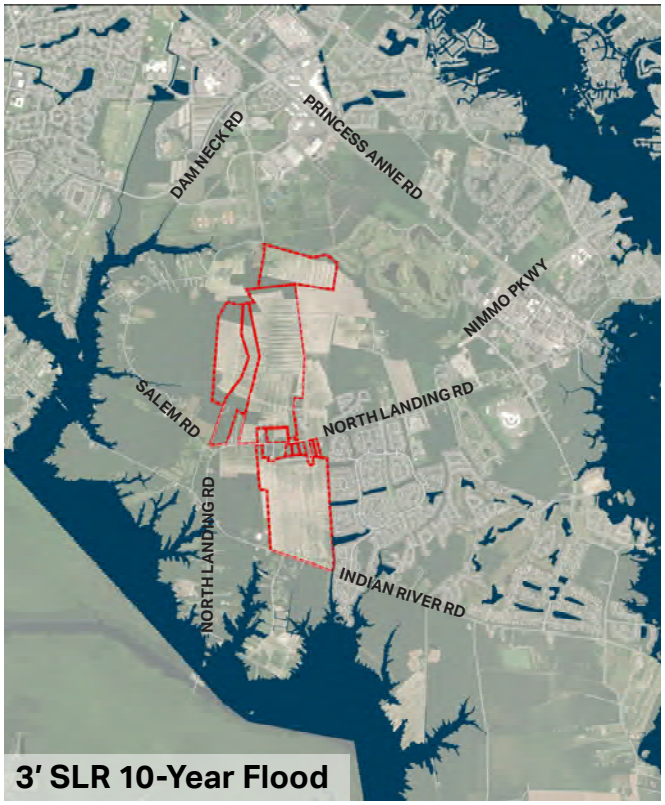
Figure 31. Potential Sites - Sea Level Rise Scenarios



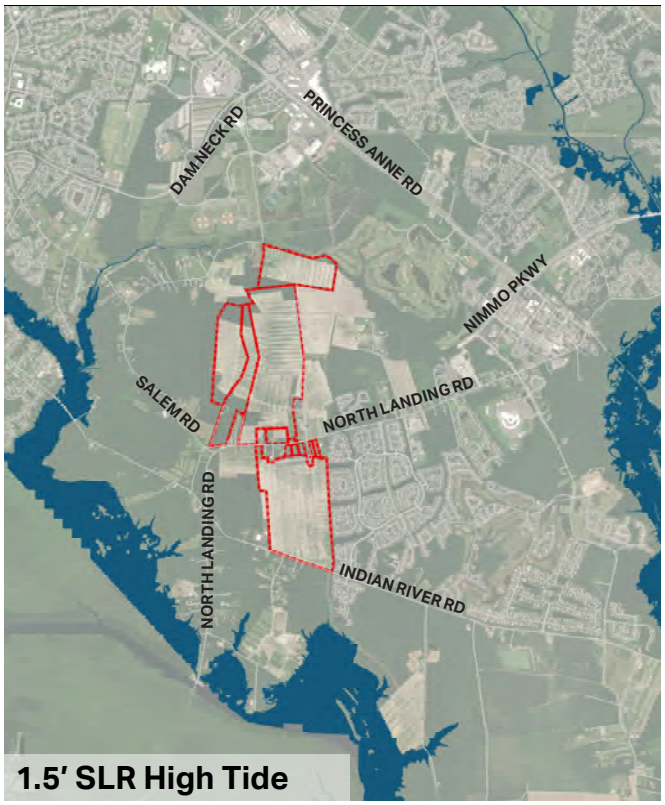


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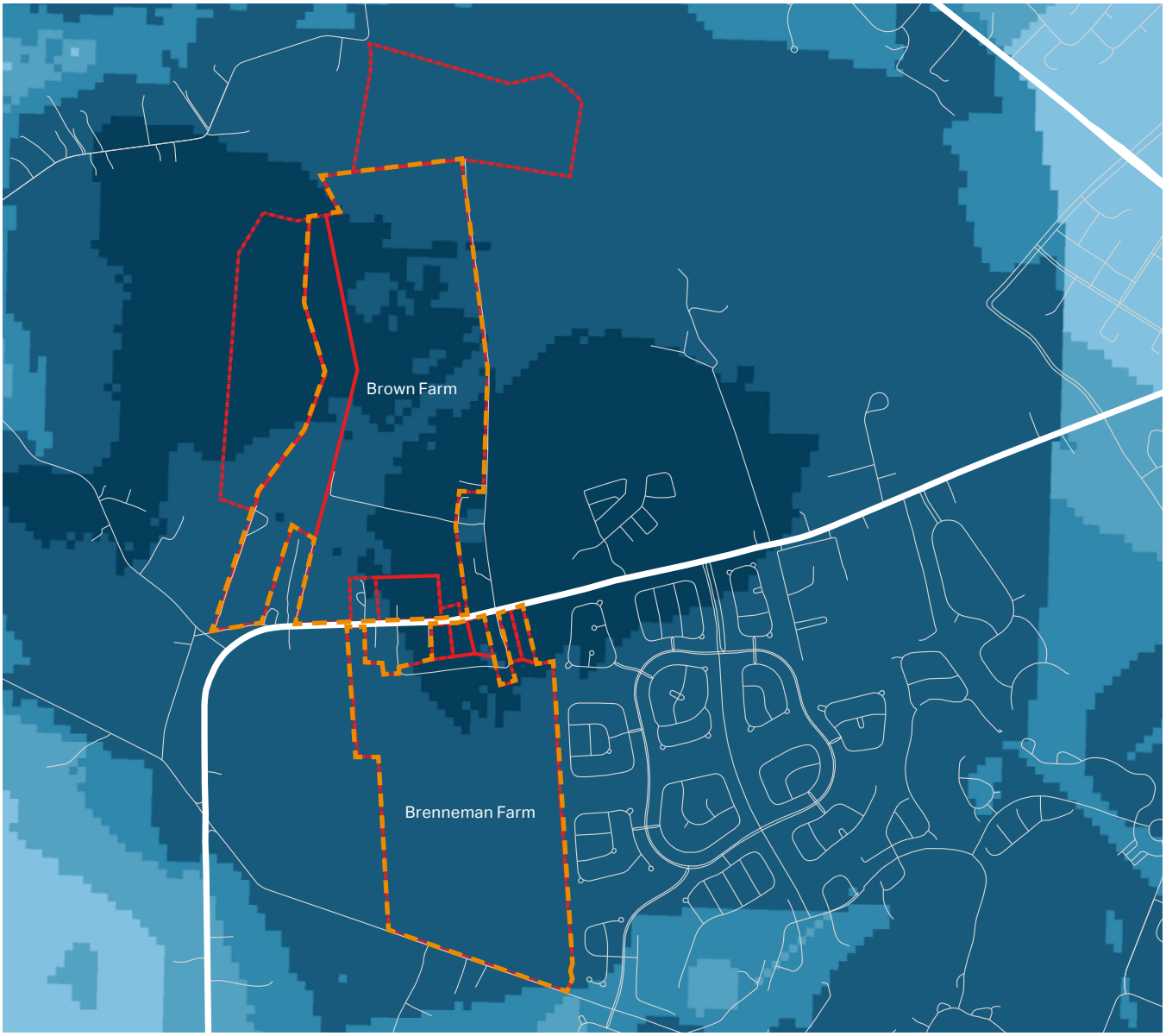
Figure 32. Potential Sites - Estimated Water Table Depth



Data Sources: Esri, VGIN, City of Virginia Beach

Legend

- Identified Parcels
- Potential Site Test Fit Areas

Estimated Water Table

- Less than 1 foot
- 1 to 3 feet
- 3 to 5 feet
- 5 to 10 feet
- Greater than 10 feet

Hampton Roads Agricultural Research and Extension Center

Figure 33. Brown Farm - Zoning Map

Data Sources: Esri, VGIN, City of Virginia Beach

500 250 0 500 1,000 1,500 2,000 Feet

N

Legend

- Identified Parcels
- Potential Site Test Fit Areas
- Interfacility Traffic Area

Zoning

AG1	Agricultural District
AG2	Agricultural District
PDH1	Planned Unit Development District
R7.5	Residential District

Hampton Roads Agricultural Research and Extension Center

Figure 34. Brenneman Farm - Zoning Map

Data Sources: Esri, VGIN, City of Virginia Beach

500 250 0 500 1,000 1,500 2,000 Feet

N

Legend

- Identified Parcels
- Potential Site Test Fit Areas
- Interfacility Traffic Area

Zoning

AG1	Agricultural District
AG2	Agricultural District
PDH1	Planned Unit Development District

Hampton Roads Agricultural Research and Extension Center

Figure 35. Potential Sites - Urban Tree Canopy Cover

Data Sources: Esri, VGIN, City of Virginia Beach

500 250 0 500 1,000 1,500 2,000 Feet N

Legend

- Identified Parcels
- Potential Site Test Fit Areas

Tree Canopy Coverage Percentage

- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 30
- 30 - 40
- 40 - 60
- 60 - 80
- 80 - 100

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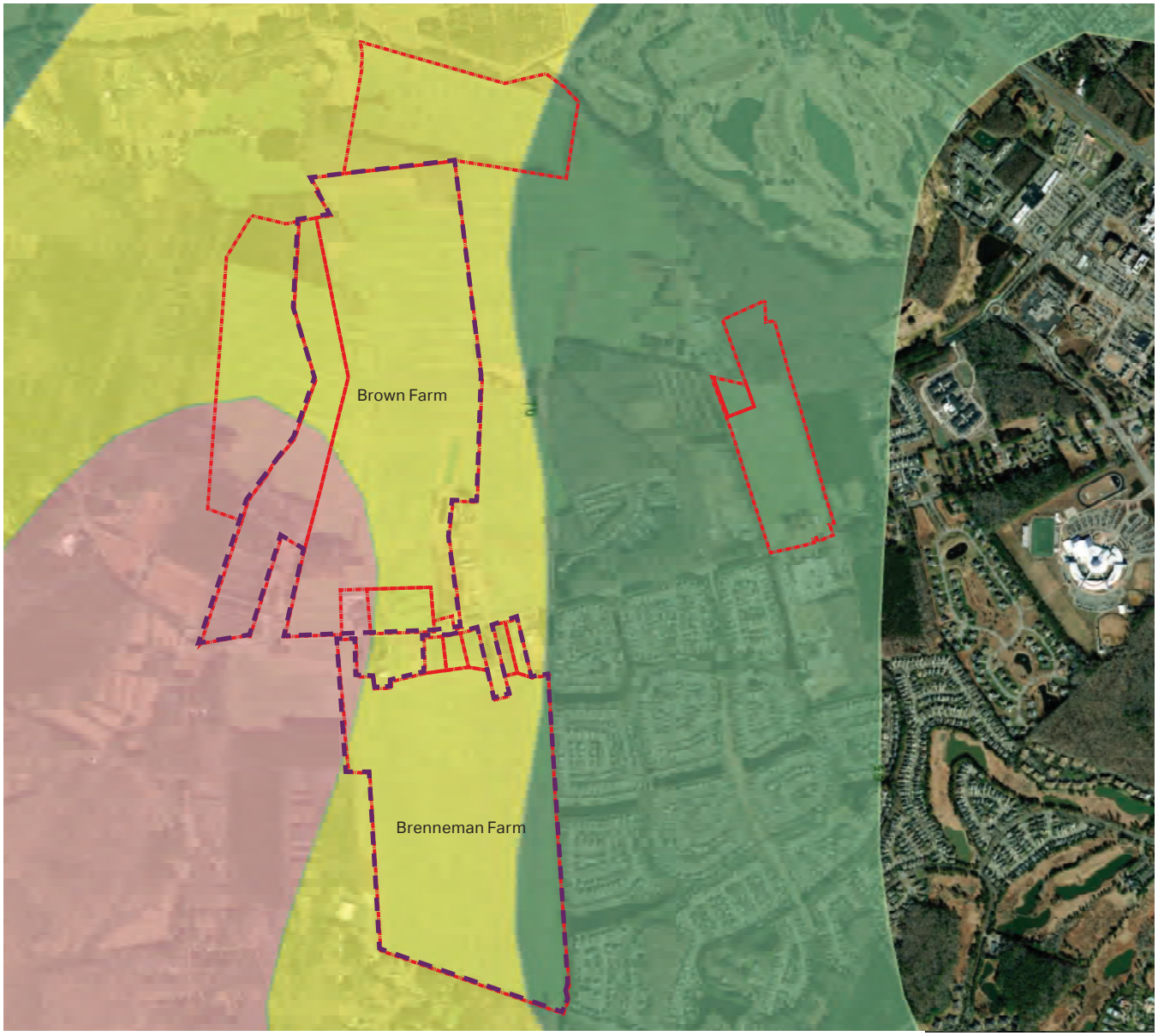
Figure 36. Potential Sites - AICUZ Map



Data Sources: Esri, VGIN, City of Virginia Beach

Legend

- Identified Parcels
- Potential Site Test Fit Areas

Decibel Levels

- 65 - 70 dB
- 70 - 75 dB
- > 75 dB

Tracking the Unknowns and Risks

This study was performed on an accelerated timeline and additional design and planning is required to define the unknowns and mitigate risks where possible. Refer to for a summary of risks and impacts.

Additional Site Options

As described in the site selection section of this report, only sites currently owned by the City of Virginia Beach were considered for this study. There may be additional suitable options that currently are on privately owned land.

Water Quality

A water quality and water table survey were unable to be performed during this study period. Water quality has a significant impact on research and should be thoroughly understood before a site selection is made. The current site has high-quality water from a well system and a water table unimpeded by saltwater intrusion. The potential future sites are at a lower elevation than the existing site and are closer to wetland areas, which may impact the water table and water quality.

Contaminant Infiltration

The current site is well buffered by trees and low intensity surrounding uses including utility easements, an elementary school, and multi-family residential. The potential future sites are adjacent to active farmland and single-family residential areas, which may contain fertilizers and chemicals that could impact research. A wooded buffer and stormwater management best management practices are included in the test fits to ensure no contaminants reach the research areas and no research interventions cross the property lines.

Utility Capacity and Condition

Only City-managed utility infrastructure - stormwater and water - was analyzed for this report. Power, cable, and, fiber information was not ascertained for this study. It is assumed City-managed utility infrastructure will be available at the property line, enabling the AREC site to connect to these services. The cost estimate only includes on-site utility networks that connect to an assumed City node along the major roads.

Proposed Area Buildout

The 2017 Interfacility Traffic Area and Vicinity Master Plan, an amendment to the City's comprehensive plan, identifies both Brown and Brenneman farms as sites of future development (Figure 37). The plan calls for an extension of Landstown Road and Nimmo Parkway, both of which bisect the Brown Farm parcel and have implications for accessibility to the Brenneman Farm site. The test fits account for this potential development and in some instances are organized in a manner dependent on the roadway extensions. According to the 2023 - 2028 Capital Improvement Programs document, these extensions are not on the five-year project list, but their construction would be critical to the planning and design of a future AREC site in this area. A better understanding of the potential timeline of these projects should be achieved before additional planning resumes.

The 2017 Interfacility Traffic Area and Vicinity Master Plan also identified the northern section of Brown Farm as the site for a potential new municipal service facility. The same area was identified as a potential site for a new AREC. Another alternative was identified across the proposed extended Nimmo Parkway from the proposed municipal service facility, but site adjacencies and land use compatibilities should be firmly understood before planning progresses.

Private Ownership Parcels

The existing ownership for parcels in the Brenneman and Brown Farms area is not contiguous. To maximize site organization, some test fit scenarios show the acquisition of private parcels while others show extant ownership. Use of private parcels helps create a unified site with a higher concentration of activity areas, which benefits overall operation of the AREC.

Wildlife

Current wildlife hazards are unknown; therefore, wildlife management infrastructure is not fully understood. It is assumed that significant deer fencing and deterrence will be required in addition to small mammal fencing (e.g., fox and raccoon deterrence) and bird deterrence (e.g., geese). Additional intervention may be required for nuisances unknown at this time.

Endangered Species

A flora and fauna survey was not conducted as part of this study. It is unknown if there are threatened or endangered animal or plant species on site that may impact development or site organization. The wetland area in the southwest corner of Brown Farm is a jurisdictional zone.

Figure 37. Proposed Landstown Road and Nimmo Parkway Extensions. Developed as an amendment to the 2017 Comprehensive Plan, this graphic shows the path of the proposed extensions and provides a typical section of the roadways. Image Credit: Interfacility Traffic Area and Vicinity Master Plan: Virginia Beach, Virginia. 2017.

Test Fits

Five test fits were generated between the Brenneman and Brown Farm parcels and three were visualized in accordance with the project scope. Each test fit took advantage of the existing parcel lines and the existing and proposed road networks to create the most logical layout and use of the site. All five test fits are larger than the HR AREC's existing 71 acres to accommodate a buffer along the perimeter that manages all stormwater on site and protects research areas from potential contaminant intrusion. The 100-foot buffer around each site was designed using National Forest Service recommendations for width and composition and contains two stormwater best management practices (BMPs) as defined by the Virginia Stormwater BMP Clearinghouse; a grassy channel and a bioswale **(Figure 38)**. The outermost edge of the buffer contains a 15-foot-wide wooded edge and a 21-foot-wide grassy channel to provide visual screening between the site and its surroundings, contribute to stormwater uptake, and reduce contaminant intrusion. A 30-foot-wide grassy channel separates the wooded edge from the site's service road, helping to prevent off-site contaminants from reaching the research areas and providing a catchment area to ensure the HR AREC's stormwater runoff remains on site. A 14-foot-wide service road provides perimeter access for maintenance and farm vehicles and serves as a berm around the site. On the other side of the service road is a 10-foot-wide bioswale planted with native species to aid in capturing and treating runoff from the HR AREC. An underdrain beneath the bioswale captures the filtered water and returns it to the site's stormwater pond for later use in site irrigation. The bioswale is flanked by a 10-foot-wide planted edge that separates the open research area from the overall buffer zone and provides additional stormwater uptake services. The entire site is enclosed with a fence to keep wildlife out.

Site Engineering Strategy

As discussed on page 36 and detailed in Appendix C, the existing soil conditions at Brenneman and Brown Farm are not suitable to the HR AREC's needs. The soil composition does not support the varied plant material studied and the soil stays much wetter than the existing HR AREC conditions. Most of the research plant material would not survive directly in the ground at the Brenneman and

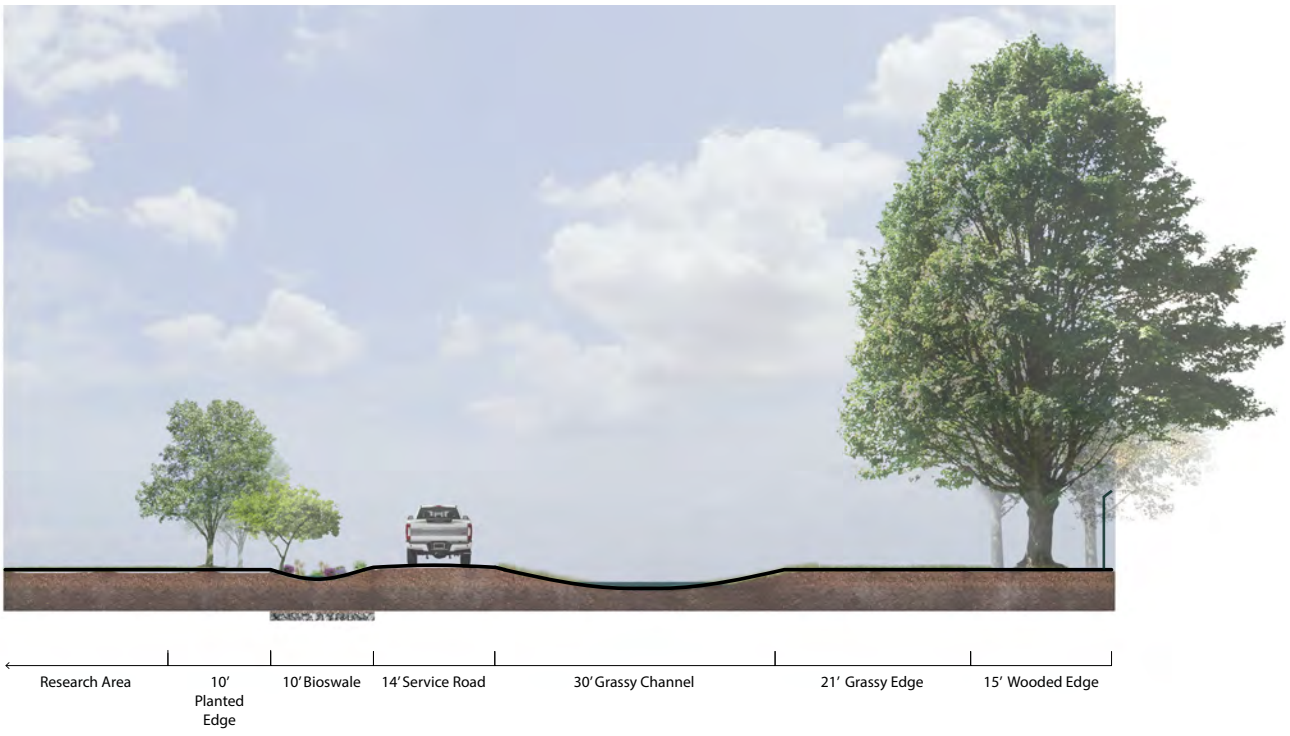


Figure 38. Typical Perimeter Buffer Section.

Brown Farm sites because the poor drainage and extended wetness of the soil would damage or destroy the plants. To recreate the conditions at the current HR AREC and to build an environment in which the research grants could be carried out without damage or loss requires significant site engineering. The soil conditions on site necessitate the addition of thousands of cubic yards of engineered and construction-grade soil.

Estimated soil quantities were generated for each site based on research type and the size of the research plats. In these scenarios, small fruit and organic research plats received four feet of engineered soil; turfgrass, the demonstration garden, and container pads received two feet of engineered soil; entomology and horticulture plats received three feet of engineered soil; and weed plats received one foot of engineered soil. The site support, storage, and pond areas received one foot of construction fill; and the buffer areas received two feet of soil, 90% of which is construction fill and 10% of which is engineered. These amounts are estimates of what is required based on estimated root depth, estimated water table, and projected drainage infrastructure. According to the soil survey, there may be jurisdictional wetlands in the area, which would require extra permitting permissions and would have design implications for the placement and management of soil and drainage systems.

Site Drainage Infrastructure

Brenneman and Brown Farms currently use an at-grade drainage ditch system typical of crop farms. The ditches vary in width and depth across the site; it is unknown if there is a tile drainage system on site. The existing drainage system is not suitable for the level of drainage required for HR AREC research. In addition to adding engineered soil, an extensive drainage system is required to ensure root systems are protected from sustained exposure to water (Figures 39 - 41). A tile drainage system is required, estimated in the following scenarios to be installed at 50-foot intervals across the research areas of the site. At-grade drainage ditches will also be installed along either side of the access roads, following the organization of the research plats. Additional studies are required to determine the design of the tile drainage and ditch drainage to ensure research areas are protected.

Site Engineering Factor (SEF)

To capture the additional land area required to engineer the land to make it useful for research, AECOM has estimated that approximately 20 percent of additional area beyond a one-to-one scenario may be required. This is a conceptual estimate based upon preliminary sketches and site appraisal. It includes the area in the this document referred to as “buffer zone”, but is also intended to account for the spatial requirements of the intensive drainage system infrastructure, which will utilize land area and render it unavailable for research.

Maintenance Impacts

The soil content (Acredale) at Brenneman and Brown Farms necessitates significant soil amendment and drainage construction. The soil amendment includes adding one to four feet of new soil depending on consultant recommendations across the site, amounting to thousands of cubic yards in addition to construction of tile drainage and extending existing open drainage ditches. The cost for this intervention was estimated at a high level but will require more detailed planning to provide an accurate budget.

Political Impacts

The current construction market is difficult to predict and complicates cost estimation, especially over a 5 to 6-year timeline. During the estimated five and half years of the project schedule, several election cycles will occur which may shift political leadership and therefore city- and state-wide initiatives.

A Planned Unit Development (PUD) is adjacent to Brenneman Farm. PUDs are highly designed single-family residential areas that have Homeowner Association dues attached because of the level of community amenities provided within the development. PUD residents may be more invested in surrounding development and could potentially be vocal about new uses abutting the neighborhood.

Field Crop Focus

A move to the southern side of Virginia Beach in a traditional farming area presents concerns the HR AREC will be asked to modify, expand, or shift their mission from a nursery and landscape industry focus to a crop focus. The HR AREC is intent on continuing its current mission.

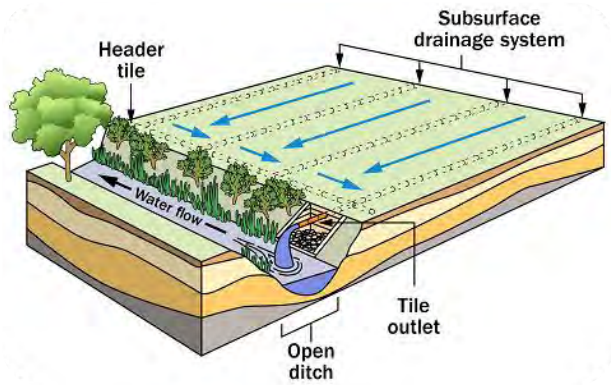


Figure 39. Tile Drainage System. Tile drainage is installed underground with outlets to perpendicular ditches. This approach is common in crop fields. Image credit: Ontario Ministry of Agriculture, Food and Rural Affairs.

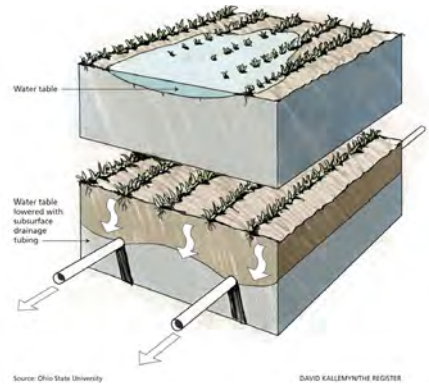


Figure 40. Tile Drainage Impact. Tile drainage lowers the water table, protecting roots from extended exposure to wet soil. Image credit: Ohio State University and David Kallemyn - The Register.

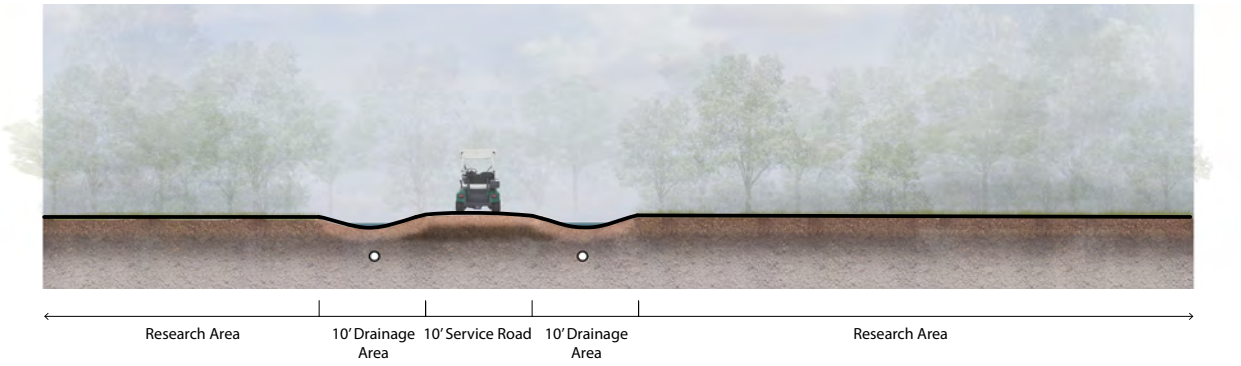


Figure 41. Research Field Cross Section. The proposed research plat configurations include drainage ditches on either side of the dirt access roads to accomodate a robust drainage tile system.

Research Phasing

Some research areas require consistent periods of time to complete a trial, such as turfgrass and blackberry research. The proposed project schedule (page 32) demonstrates a period of time where existing, or "legacy research," will continue on the existing site until the completion of the research trial, while new research begins at the new site. At that transition point, or beginning of period of overlap, no new research will begin at the existing site. This approach will have to be carefully planned to manage partner relationships and research commitments.

Proposed Buildings

In order to move, the research center requires the same facilities and site support structures to operate at full capacity. It is expected that each new potential site would require a full design period to construct these new facilities.

Following the 1:1 replacement strategy, all rooms and buildings at the existing HR AREC were assessed and important assets identified to ensure that the required buildings on the potential new sites would be sufficient. These spaces were then regrouped into similar typologies that represent an example future "building" and it's area requirements. These groups are documented in Table 3.1 and Table 3.2.

Portable or deconstructable site support assets, including high tunnels, storage containers, and surplus equipment, were separated from these groups. These structures are thought to be able to be transferred between sites and would not require additional construction, although they will require adequate space and potentially some additional infrastructure.

See Appendix A for more detailed analysis of buildings and spaces.

Note: The Rain Out / Drought Tunnel and High Tunnel are considered site support structures for the purpose of this study and cost estimation.

Proposed Buildings			
Number	**Name**	**NSF**	**GSF**
1	Administration, Classrooms, Research, Outreach	12372	19299
2	Greenhouses and Headhouses	15460	16012
3	Warehouses and Shops	12677	14986
4	Hazardous Storage	1735	2339
5	Support Building - Energy Center	775	860
6	Residential	4650	5098
Total Proposed Building GSF			**58594**

Table 3.1. Proposed Buildings

Site Support Structures		
Number	**Name**	**GSF**
1115	Rain Out/Drought Tunnel	4690
1117	High Tunnel	4320
A	Solar Panels	600
B	Netted High Tunnel	1600
C	Boiler Tanks	320
D	Potting Yard	4675
E	Mulch and Bark Supply Bays	1200
F	Military Surplus Tent	715
G	Shipping Containers (2)	700
H	Government Surplus Equipment Storage	450
Total Site Support GSF		**19270**

Table 3.2. Site Support Structures

Brenneman Farm

The Brenneman Farm option is 88.5 acres and uses the existing two-lane North Landing Road for access. The demonstration areas take a prominent position at the north end of the site, and one of the two access roads takes advantage of the existing tree cover to create an allée entrance to the main administrative, research, and classroom hub. The extension and demonstration areas are concentrated at the northern end of the site to facilitate outreach events that require indoor and outdoor spaces.

The greenhouses are located behind the demonstration areas and next to the main hub to allow easy access for researchers and Master Gardeners. The maintenance and storage area is adjacent to the greenhouses and the demonstration garden to maximize connectivity between the maintenance hub and all site areas. The plan uses the site's natural topography and places the stormwater and irrigation pond at the southeastern corner of the site.

Research zones are created using a simple irregular grid with a main spine stemming from the stormwater pond to simplify site irrigation. The 100-foot buffer follows the perimeter of the site beginning on the western edge, extending around the southern end of the parcel, and ending on the eastern edge where the farm parcel abuts a privately owned parcel. The northern edge of the parcel along North Landing Road does not have a buffer (Figures 42 through 47).

Site Strengths

- The existing open layout is a blank slate for site design.
- The existing topography is conducive to an irrigation pond in an area protected from the public.
- There are no restrictions on drone use at the HR AREC's level of use.
- The site is not predicted to be directly impacted by flooding even in the most extreme scenario.

Brenneman Farm North HR AREC Concept Development Visualization

Site Opportunities

- All new construction would significantly improve the overall condition and technological capabilities of HR AREC facilities.
- The demonstration areas and main hubs could be located on a main road.

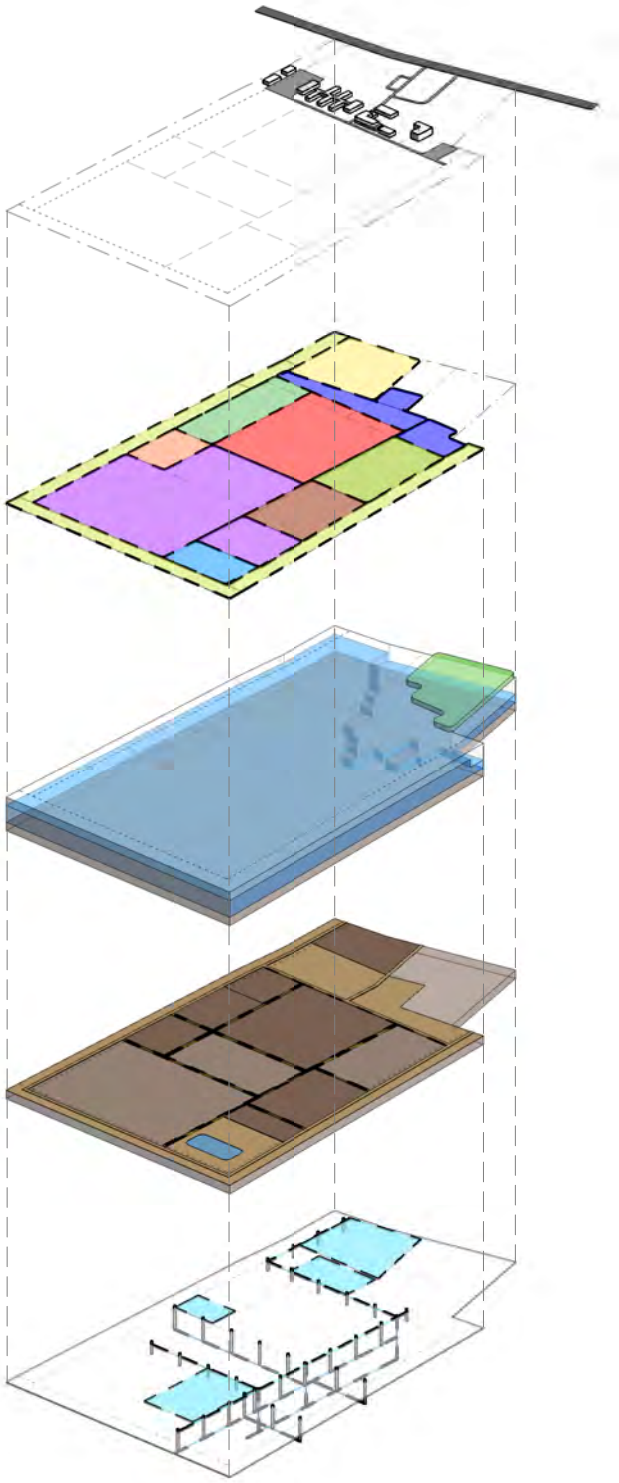
Site Weaknesses

- North Landing Road is a two-lane, infrequently traveled road compared to Diamond Springs Road. The site will be less visible and less accessible than the current location.
- The main entrance and maintenance entrance are close together, which may impede traffic and circulation on North Landing Road.
- The Acredale soil on site requires intensive and costly soil amendment.
- Additional infrastructure will be required to manage stormwater and wildlife.
- There is limited tree cover on site, restricting the amount of shade-dependent research that can be performed.
- The decibel impact of aircraft flightpaths will disturb lectures and events and may cause physical stress to staff and visitors.
- The VAES standard for internet is 1 gigabit speed. It is unknown if the potential site has this capacity.
- An arboretum, demonstration garden, riparian buffer display, and utility line display would need to be planted in their entirety. A mature arboretum would not exist for public education and benefit for at least 50 years.

Site Threats

- The move from northern Virginia Beach near major roads and institutions, including the City of Norfolk and the Peninsula, to more rural southern Virginia Beach will likely impact visitation numbers, volunteer hours, funding partners, and outreach opportunities.
- Flood projections that account for 1.5 feet of sea level rise indicate the site will be isolated and inaccessible during flooding events due to flooding of access roads.
- The site is directly adjacent to a neighborhood and a church. These groups may be vocal about neighboring uses, and fertilizers and chemicals may be used in the residential area that could interfere with research.

Figure 42. Brenneman Farm - Axonometric



BUILT ENVIRONMENT

TOTAL BUILDING GSF: 55,954 SF
PAVED ROAD AREA: 106,914 SF

RESEARCH PLATS

TOTAL RESEARCH AREA: 66.24 acres
TOTAL SITE AREA: 88.50 acres
BUFFER AREA: 14.19 acres

NATURAL ASSETS

FOREST AREA: 5.76 acres
WATER TABLE LEVEL: 5 FT - 10+ FT

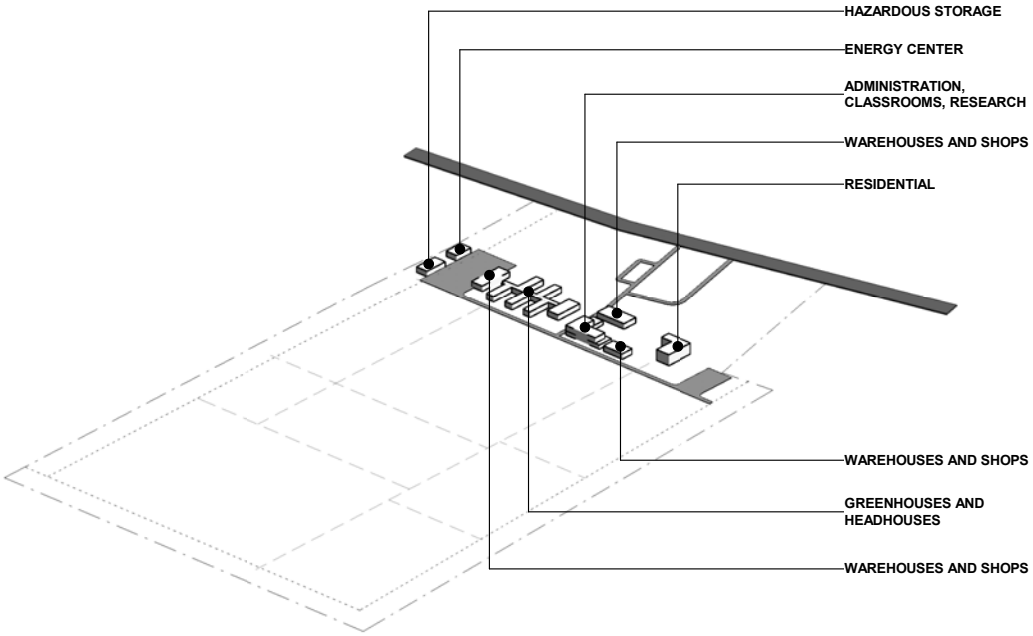
SOIL AMENDMENT & DRAINAGE

SOIL TYPES: ACREDALE, MUNDEN, DRAGSTON
ENGINEERED SOIL REQUIRED: 231,992 CY
CONSTRUCTION SOIL REQUIRED: 77,837 CY
ESTIMATED DITCH LENGTH: 12,119 FT
POND AREA: 1.00 acres
POND VOLUME: 1,304,018 gal

IRRIGATION

SYSTEMS: 3
PUMPS: 3
HYDRANTS: 32
ESTIMATED PIPE LENGTH: 8,757 FT
UNDERGROUND IRRIGATION AREA: 12.22 acres

Figure 43. Brenneman Farm - Built Environment



MAIN ROAD (ACCESS TO SITE)

PAVED ROAD (ON SITE)

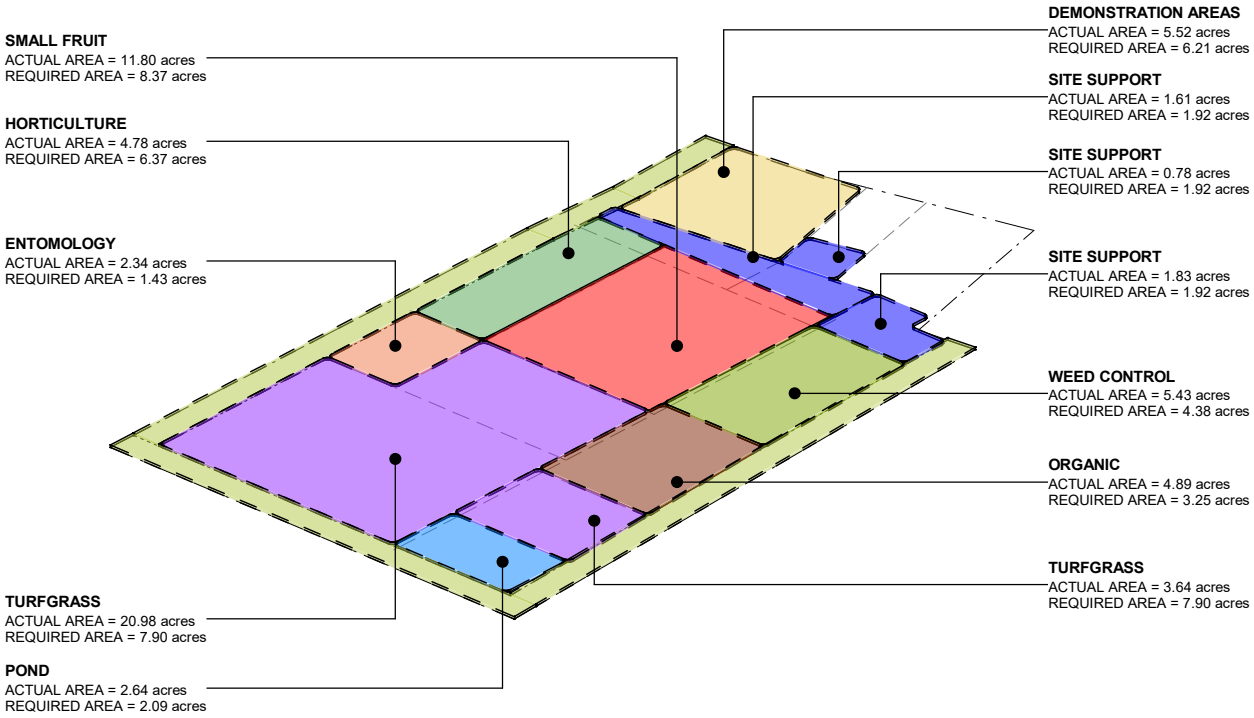
HARDSCAPE AREA

PAVED	2.45 acres	106,914 SF
NET AREA =	2.45 acres	106,914 SF

BUILDING AREAS BY SF

PROGRAM	TARGET AREA
ADMINISTRATION, CLASSROOMS, RESEARCH	16,659 SF
ENERGY CENTER	860 SF
GREENHOUSES AND HEADHOUSES	16,012 SF
HAZARDOUS STORAGE	2,339 SF
RESIDENTIAL	5,098 SF
WAREHOUSES AND SHOPS	14,986 SF
GROSS BUILT AREA =	55,954 SF

Figure 44. Brenneman Farm - Research Plats



BUFFER AREA - BRENNEMEN FARM

100' BUFFER	14.19 acres
	14.19 acres

NET PROGRAM ACREAGE - BRENNEMEN FARM

PLAT	REQUIRED AREA	SITE ENGINEERING FACTOR (SEF)	TARGET AREA	SHOWN AREA
DEMONSTRATION AREAS	6.21 acres	20%	7.45 acres	5.52 acres
ENTOMOLOGY	1.43 acres	20%	1.72 acres	2.34 acres
HORTICULTURE	6.37 acres	20%	7.64 acres	4.78 acres
ORGANIC	3.25 acres	20%	3.90 acres	4.89 acres
POND	2.09 acres	20%	2.51 acres	2.64 acres
SITE SUPPORT	5.77 acres	20%	6.92 acres	4.23 acres
SMALL FRUIT RESEARCH	8.37 acres	20%	10.04 acres	11.80 acres
TURF RESEARCH	15.80 acres	20%	18.96 acres	24.62 acres
WEED CONTROL	4.38 acres	20%	5.26 acres	5.43 acres
NET PROGRAM ACREAGE =	53.67 acres		64.40 acres	66.24 acres

Figure 45. Brenneman Farm - Natural Assets

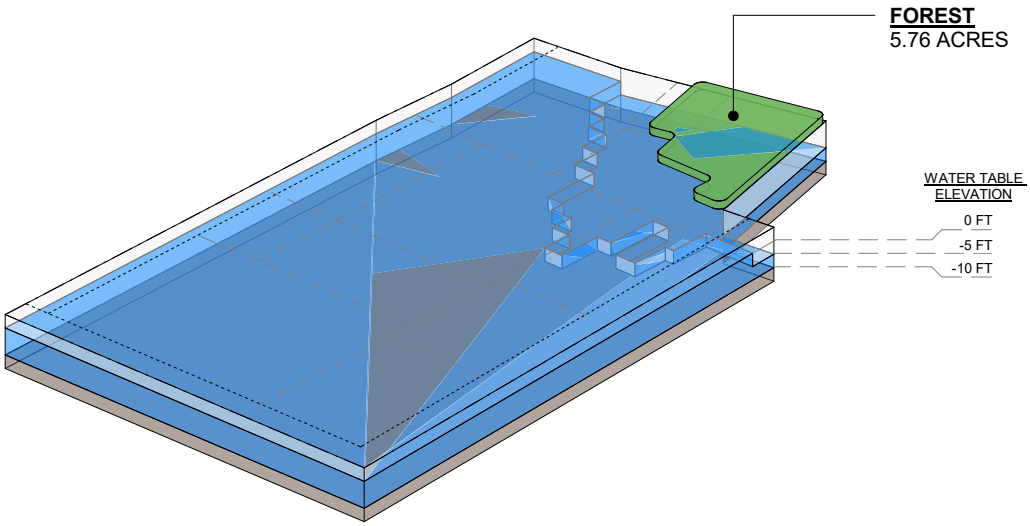
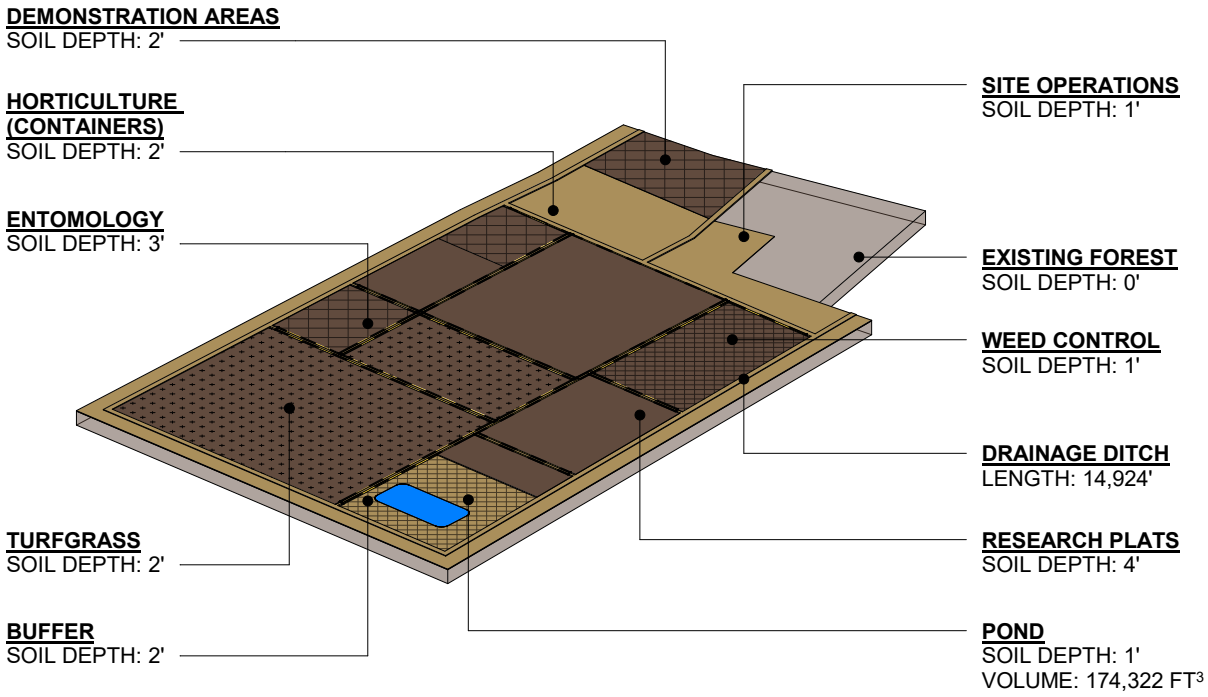


Figure 46. Brenneman Farm - Soil Amendment and Drainage

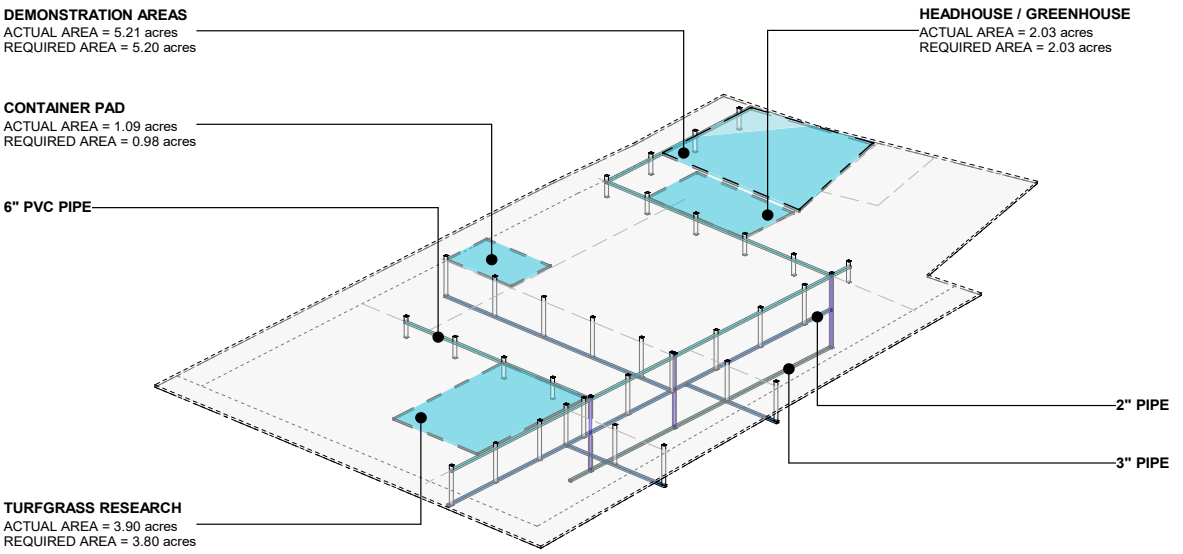


SOIL DISTRIBUTION			
PLAT TYPE	SOIL DEPTH	AREA	VOLUME
CONSTRUCTED SOIL			
POND	1' - 0"	3.67 acres	5,918 CY
SITE OPERATIONS	1' - 0"	8.17 acres	13,181 CY
BUFFER	2' - 0"	8.49 acres	27,408 CY
ROADS	4' - 0"	4.85 acres	31,331 CY
		25.19 acres	77,837 CY
ENGINEERED SOIL			
WEED CONTROL	1' - 0"	5.35 acres	8,625 CY
DEMONSTRATION AREAS	2' - 0"	3.69 acres	11,909 CY
HORTICULTURE (CONTAINERS)	2' - 0"	1.91 acres	6,169 CY
TURFGRASS RESEARCH	2' - 0"	21.41 acres	69,074 CY
ENTOMOLOGY	3' - 0"	2.31 acres	11,181 CY
RESEARCH PLATS	4' - 0"	19.37 acres	125,033 CY
		54.04 acres	231,992 CY
NET ACREAGE =		79.23 acres	309,829 CY

PROPOSED POND		
AREA	DEPTH	VOLUME
1.00 acres	4' - 0"	1,304,018 gal
1.00 acres		1,304,018 gal

PLAT DRAINAGE DITCH LENGTH
12119'
12119'

Figure 47. Brenneman Farm - Irrigation



- UNDERGROUND IRRIGATION
- SYSTEM 1
- SYSTEM 2
- SYSTEM 3
- HYDRANTS
- PUMPS

PUMPS & HYDRANTS

HYDRANTS	32
PUMPS	3

PIPE SYSTEM LENGTH

SYSTEM	PIPE LENGTH
SYSTEM 1	
2" PIPE	3440'
	3440'
SYSTEM 2	
3" PIPE	1183'
	1183'
SYSTEM 3	
6" PVC PIPE	4134'
	4134'
TOTAL PIPE LENGTH =	8757'

UNDERGROUND IRRIGATION ACREAGE

PROGRAM	TOTAL ACRES
UNDERGROUND IRRIGATION	
CONTAINER PAD	1.09 acres
DEMONSTRATION AREAS	5.21 acres
HEADHOUSE / GREENHOUSE	2.03 acres
TURFGRASS RESEARCH	3.90 acres
IRRIGATION NET ACREAGE =	12.22 acres

Brown Farm North

The Brown Farm North option is 109 acres and assumes the construction of both the Nimmo Parkway and Landstown Road extensions. The site is oriented so its main entrance faces the Nimmo Parkway extension, which is proposed to have two lanes in either direction as well as a pedestrian and bicycle path. The demonstration area takes a prominent position at the corner of Landstown Road and Nimmo Parkway extensions, maximizing visibility and creating a landmark corner for the community. The extension and demonstration areas are concentrated at the southern end of the site to facilitate outreach events that require indoor and outdoor spaces.

There are two entrances to the site off the Nimmo Parkway extension. A maintenance entrance is on the far eastern side of the parcel, minimizing heavy vehicle traffic through the public spaces and providing direct access to the maintenance and storage area of the site. The main entrance separates the demonstration garden from the more private areas for the administrative, classroom, and laboratory hub, placing the outreach and education components of the site in a prominent position.

The greenhouses are integrated into the administrative and classroom hub, creating a learning and research campus at the main entrance of the site. The demonstration areas are located opposite the main entrance from the greenhouses, facilitating shared greenhouse use between researchers and Master Gardeners. The maintenance and storage area is on the eastern side of the parcel, adjacent to the maintenance entrance. This location accommodates simple site access while restricting visibility of the maintenance area.

The research areas are organized off a main spine in a staggered ladder pattern. The existing trees are concentrated at the northern end of the site; therefore, there are no significant shade impacts on site. The turfgrass research areas are located adjacent to the tree covered areas to facilitate possible shade research under the canopy.

Brown Farm North HR AREC Concept Development Visualization

The stormwater and irrigation pond is placed in the northeastern corner of the site to use the natural topography of the parcel to help collect stormwater runoff. The 100-foot buffer runs the length of the parcel on its western and eastern edges, joining into the existing tree canopy coverage on the northern end. Additional planting runs along the southern end of the parcel parallel to the proposed Nimmo Parkway Extension but is not a part of the buffer system (Figures 48 through 53).

Site Strengths

- The existing wooded areas help protect the site from potential contaminant infiltration and manage stormwater.
- The existing topography is conducive to an irrigation pond in an area protected from the public.
- There are no restrictions on drone use at the HR AREC's level of use.
- The site is not predicted to be directly impacted by flooding even in the most extreme scenario.

Site Opportunities

- All new construction would significantly improve the overall condition and technological capabilities of HR AREC facilities.
- The demonstration areas and main hubs could be located on the corner of two major thoroughfares if the extensions are constructed.

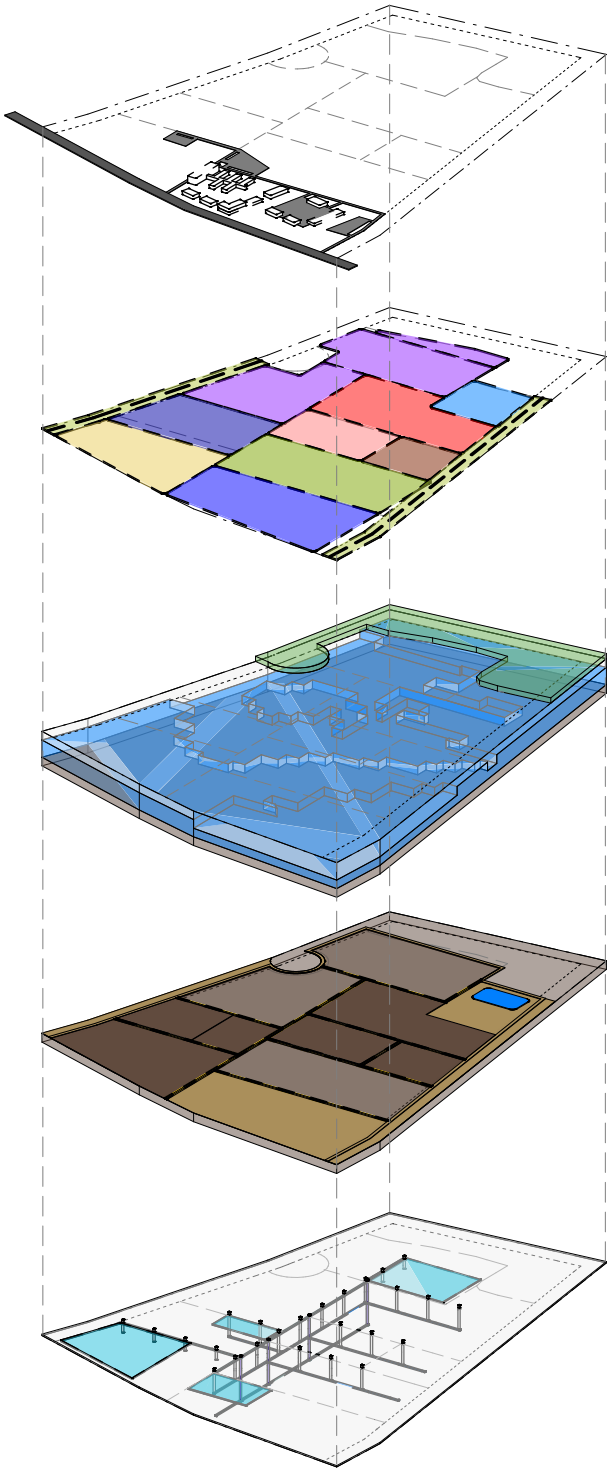
Site Weaknesses

- The move from northern Virginia Beach near major roads and institutions to more rural southern Virginia Beach will likely impact visitation numbers, volunteer hours, funding partners, and outreach opportunities.
- The option shows acquisition of a small triangle of land at the corner of the Landstown Road and Nimmo Parkway extensions that currently is not owned by the City.
- The Acredale soil on site requires intensive and costly soil amendment.
- The decibel impact of aircraft flight paths will disturb lectures and events and may cause physical stress to staff and visitors.
- The VAES standard for internet is 1 gigabit speed. It is unknown if the potential site has this capacity.
- A section of the existing woods in the northwestern corner of the lot is a woody wetland, likely subject to wetlands jurisdiction.
- An arboretum, demonstration areas garden, riparian buffer display, and utility line display would need to be planted in their entirety. A mature arboretum would not exist for public education and benefit for at least 50 years.

Site Threats

- Flood projections that account for 1.5 feet of sea level rise indicate the site will be isolated and inaccessible during flooding events due to flooding of access roads.
- Currently, it is uncertain if the road extensions will be constructed or what the road extension project timeline may be. This option is dependent on the road extensions.
- Additional infrastructure will be required to manage stormwater and wildlife.
- The site is potentially allocated for a municipal service facility, as indicated in the 2017 Interfacility Traffic Area and Vicinity Master Plan.

Figure 48. Brown Farm North - Axonometric



BUILT ENVIRONMENT

TOTAL BUILDING GSF: 55,954 SF
PAVED ROAD AREA: 186,098 SF

RESEARCH PLATS

TOTAL RESEARCH AREA: 76.61 acres
TOTAL SITE AREA: 109.00 acres
BUFFER AREA: 8.73 acres

NATURAL ASSETS

FOREST AREA: 14.99 acres
WATER TABLE LEVEL: 5 FT - 10+ FT

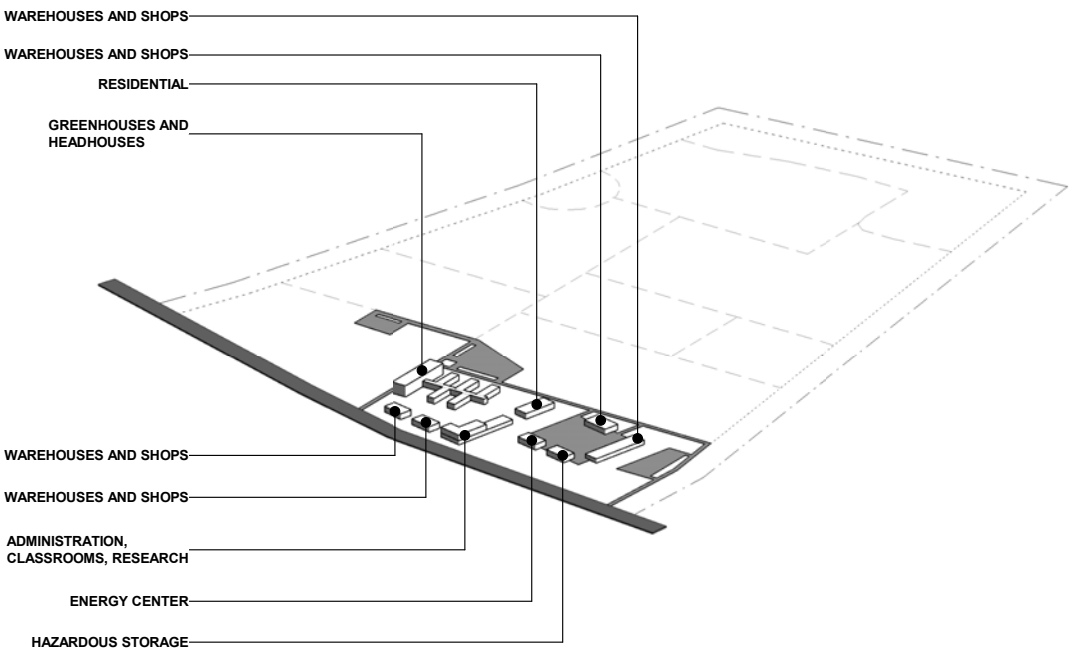
SOIL AMENDMENT & DRAINAGE

SOIL TYPES: ACREDALE
ENGINEERED SOIL REQUIRED: 256,327 CY
CONSTRUCTION SOIL REQUIRED: 77,090 CY
ESTIMATED DITCH LENGTH: 15,743 FT
POND AREA: 1.00 acres
POND VOLUME: 1,308,056 gal

IRRIGATION

SYSTEMS: 3
PUMPS: 4
HYDRANTS: 25
ESTIMATED PIPE LENGTH: 7,834 FT
UNDERGROUND IRRIGATION AREA: 12.78 acres

Figure 49. Brown Farm North - Built Environment



MAIN ROAD (ACCESS TO SITE)

PAVED ROAD (ON SITE)

GRAVEL MAINTENANCE ROAD

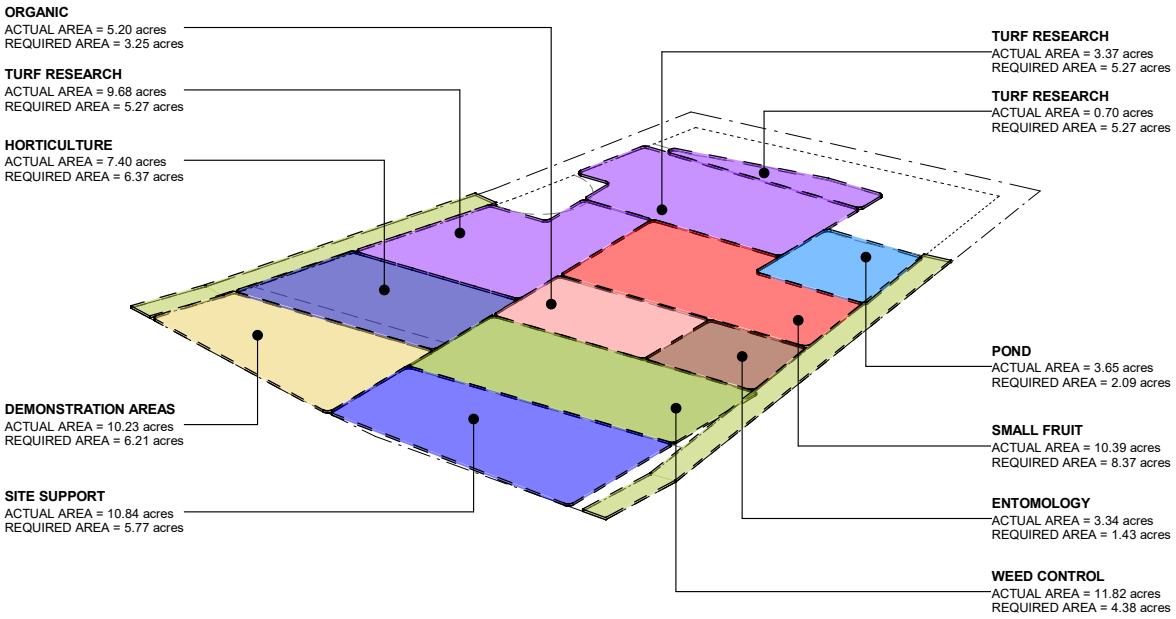
HARDSCAPE AREA

PAVED	4.27 acres	186,098 SF

BUILDING GSF

BUILDING	TARGET AREA
ADMINISTRATION, CLASSROOMS, RESEARCH	16,659 SF
ENERGY CENTER	860 SF
GREENHOUSES AND HEADHOUSES	16,012 SF
HAZARDOUS STORAGE	2,339 SF
RESIDENTIAL	5,098 SF
WAREHOUSES AND SHOPS	14,986 SF
GROSS BUILT AREA =	55,954 SF

Figure 50. Brown Farm North - Research Plats



BUFFER AREA - BROWN FARM NORTH

100' BUFFER	8.73 acres
	8.73 acres

NET PROGRAM ACREAGE - BROWN FARM NORTH

PLAT	REQUIRED AREA	SITE ENGINEERING FACTOR (SEF)	TARGET AREA	SHOWN AREA
DEMONSTRATION AREAS	6.21 acres	20%	7.45 acres	10.23 acres
ENTOMOLOGY	1.43 acres	20%	1.72 acres	3.34 acres
HORTICULTURE	6.37 acres	20%	7.64 acres	7.40 acres
ORGANIC	3.25 acres	20%	3.90 acres	5.20 acres
POND	2.09 acres	20%	2.51 acres	3.65 acres
SITE SUPPORT	5.77 acres	20%	6.92 acres	10.84 acres
SMALL FRUIT	8.37 acres	20%	10.04 acres	10.39 acres
TURF RESEARCH	15.80 acres	20%	18.96 acres	13.75 acres
WEED CONTROL	4.38 acres	20%	5.26 acres	11.82 acres
NET PROGRAM ACREAGE =	53.67 acres		64.40 acres	76.61 acres

Figure 51. Brown Farm North - Natural Assets

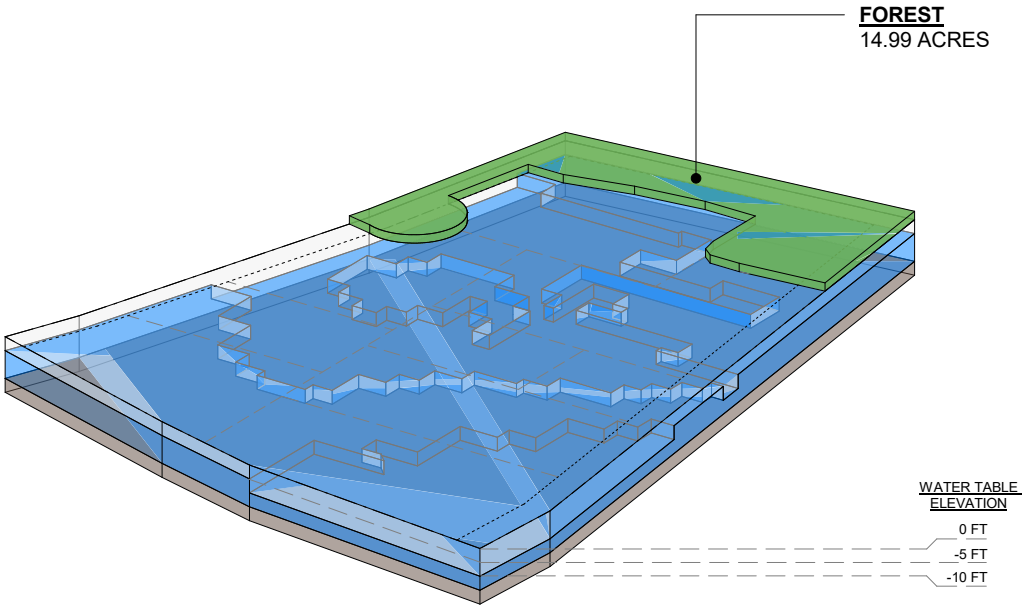
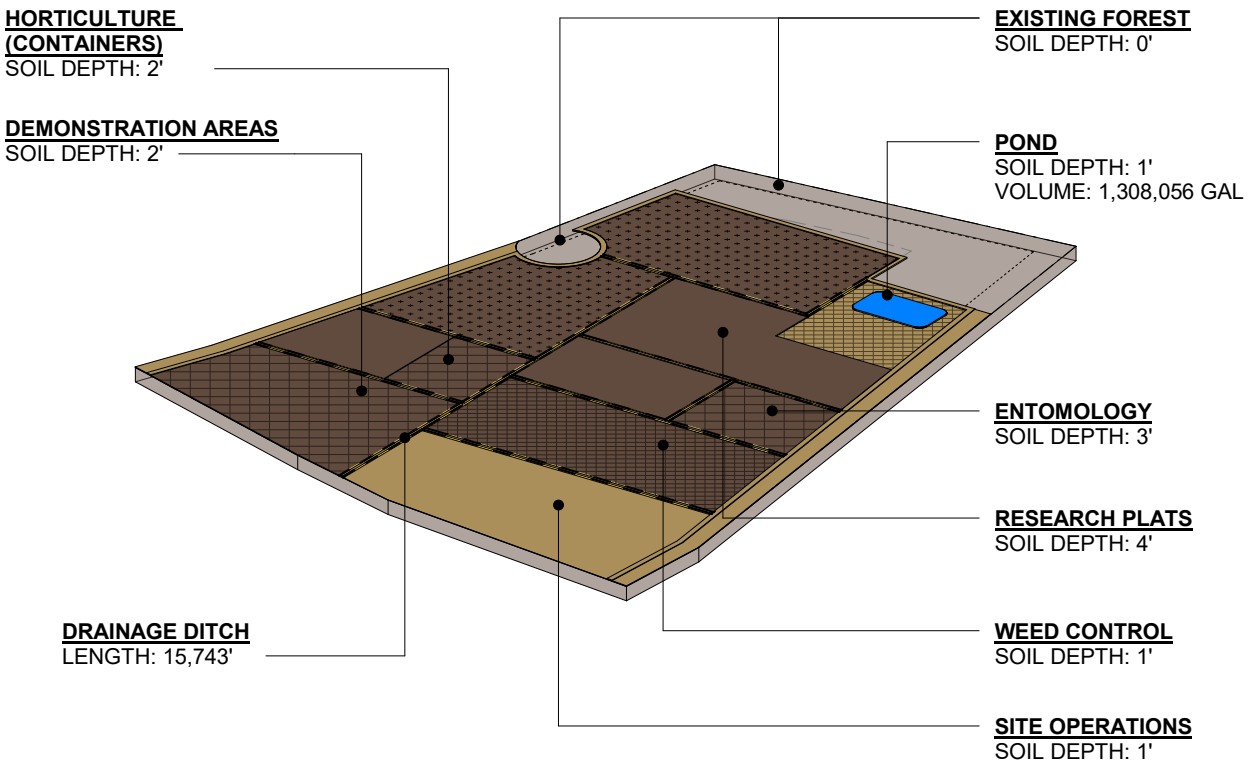


Figure 52. Brown Farm North - Soil Amendment and Drainage

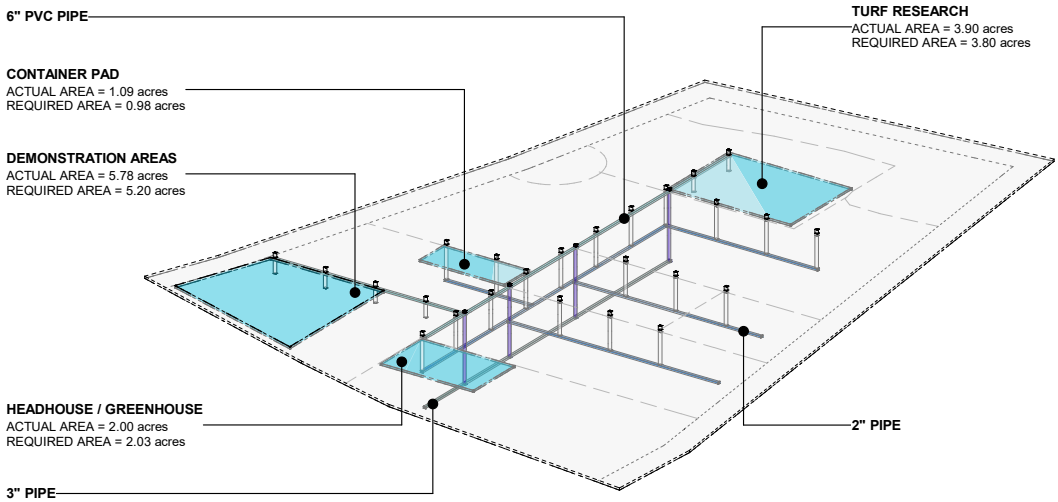


SOIL DISTRIBUTION			
PLAT TYPE	SOIL DEPTH	AREA	VOLUME
CONSTRUCTION FILL			
POND	1' - 0"	4.83 acres	7,787 CY
SITE OPERATIONS	1' - 0"	13.60 acres	21,939 CY
BUFFER	2' - 0"	5.32 acres	17,178 CY
ROADS	4' - 0"	4.68 acres	30,186 CY
		28.43 acres	77,090 CY
ENGINEERED SOIL			
WEED CONTROL	1' - 0"	11.55 acres	18,632 CY
DEMONSTRATION AREAS	2' - 0"	10.43 acres	33,663 CY
HORTICULTURE (CONTAINERS)	2' - 0"	2.64 acres	8,533 CY
TURFGRASS RESEARCH	2' - 0"	19.09 acres	61,585 CY
ENTOMOLOGY	3' - 0"	3.44 acres	16,672 CY
RESEARCH PLATS	4' - 0"	18.17 acres	117,243 CY
		65.32 acres	256,327 CY
NET ACREAGE =		93.75 acres	333,418 CY

PROPOSED POND		
AREA	DEPTH	VOLUME
1.00 acres	4' - 0"	1,308,056 gal
1.00 acres		1,308,056 gal

PLAT DRAINAGE DITCH LENGTH
15743'
15743'

Figure 53. Brown Farm North - Irrigation



- UNDERGROUND IRRIGATION
- SYSTEM 1
- SYSTEM 2
- SYSTEM 3
- HYDRANTS
- PUMPS

PUMPS & HYDRANTS

HYDRANT	25
PUMP	4

PIPE SYSTEM LENGTH

SYSTEM	PIPE LENGTH
SYSTEM 1	
2" PIPE	3935'
	3935'
SYSTEM 2	
3" PIPE	1402'
	1402'
SYSTEM 3	
6" PVC PIPE	2497'
	2497'
TOTAL PIPE LENGTH =	7834'

UNDERGROUND IRRIGATION ACREAGE

PROGRAM	TOTAL ACRES
UNDERGROUND IRRIGATION	
CONTAINER PAD	1.09 acres
DEMONSTRATION AREAS	5.78 acres
HEADHOUSE / GREENHOUSE	2.00 acres
TURF RESEARCH	3.90 acres
IRRIGATION NET ACREAGE =	12.78 acres

Brown Farm South

Three separate scenarios were developed for the Brown Farm South parcel. The first scenario is presented as a rendered model while options 1A and 1B are presented as sketches in Appendix F. The first scenario is 118 acres and provides a main entrance and a maintenance entrance from North Landing Road. The demonstration garden and the administrative, classroom, and laboratory hub are located prominently along North Landing Road to maximize visibility.

The administrative hub is located across the access road from the demonstration garden to facilitate use of classrooms and outdoor space for outreach and extension events. In this scenario, the greenhouses are located off a main headhouse attached to the laboratory building, creating a gap between the greenhouses and the Master Gardener area. The maintenance and storage area is directly behind the laboratory and greenhouse building, next to the stormwater irrigation pond that is in the southeastern corner of the lot to accommodate the site's natural topography.

The existing wooded edge, a section of which is part of a woody wetland, separates the demonstration garden from the research area and casts minor shadows across the site, informing how research type is organized. Research plats are laid out in a quilted pattern to capture the optimal location for each research requirement. The turfgrass research areas are placed adjacent to the wooded edge and along the border to optimize potential shade tolerance research. The entomology research plat is framed by the existing woods because shade does not influence research factors for entomology.

The 100-foot buffer extends around the eastern and northern edges of the parcel and partway along the western edge, until reaching the existing tree cover. The existing tree cover and the southwestern corner of the parcel are part of a woody wetland; therefore, developing stormwater BMPs in this area would be inappropriate. The southern edge of the parcel is planted parallel to North Landing Road but is not part of the buffer system.

Brown Farm South HR AREC Concept Development Visualization

This scenario reroutes the proposed bicycle trail depicted in the 2017 Interfacility Traffic Area and Vicinity Master Plan to North Landing Road to prevent the path from bisecting the site and creating security concerns (Figures 54 through 59).

Site Strengths

- The demonstration areas and main hubs are located on a main road.
- The existing wooded areas help protect the site from potential contaminant infiltration and manage stormwater.
- There are no restrictions on drone use at the HR AREC's level of use.
- The site is not predicted to be directly impacted by flooding even in the most extreme scenario.

Site Opportunities

- All new construction would significantly improve the overall condition and technological capabilities of the HR AREC facilities.
- The existing wooded areas create a shady environment for research.

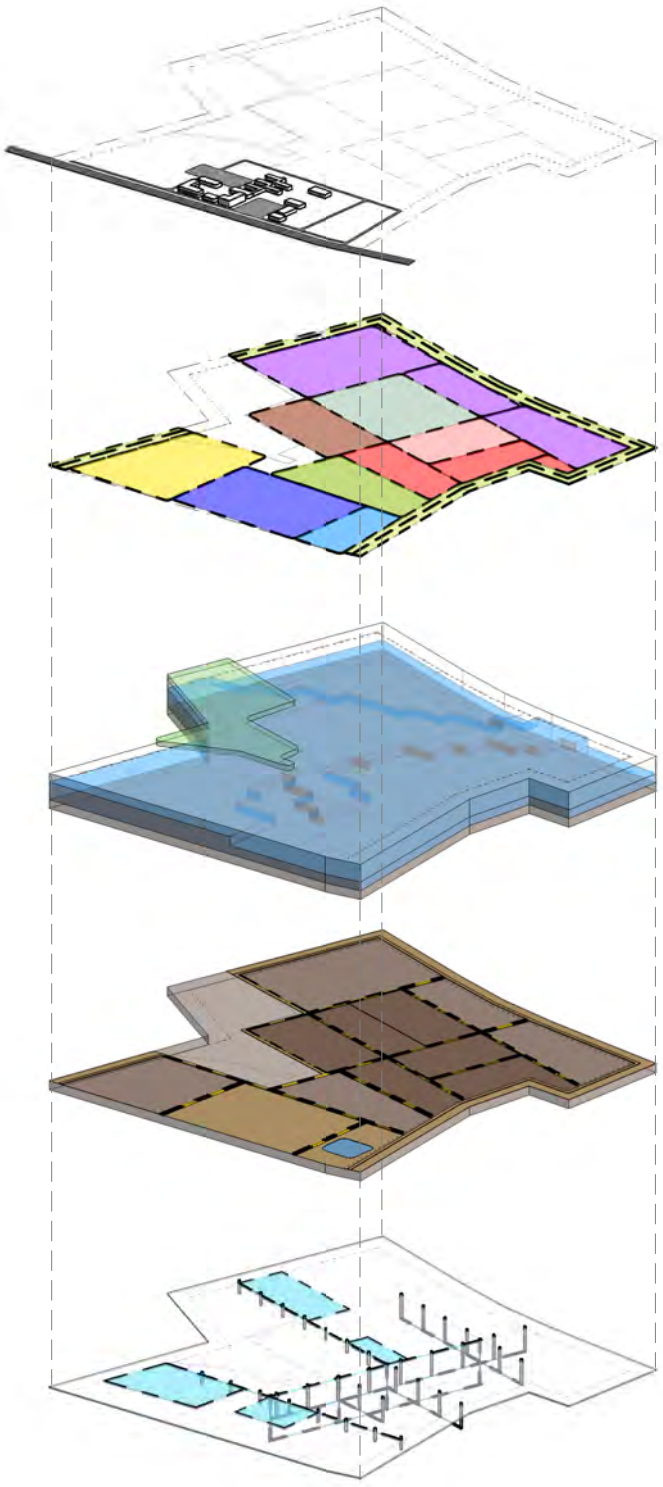
Site Weaknesses

- The move from northern Virginia Beach near major roads and institutions to more rural southern Virginia Beach will likely impact visitation numbers, volunteer hours, funding partners, and outreach opportunities.
- This option shows acquisition of privately owned parcels along North Landing Road to provide a contiguous edge on the south side of the site.
- The Acredale soil on site requires intensive and costly soil amendment.
- The decibel impact of aircraft flight paths will disturb lectures and events and may cause physical stress to staff and visitors.
- The VAES standard for internet is 1 gigabit speed. It is unknown if the potential site has this capacity.
- A section of the existing woods in the southwestern corner of the lot is a woody wetland, likely subject to wetland jurisdiction.
- The pond is in the southeastern corner of the lot to utilize the site's natural topography; however, it is close to the road in this scenario and more prone to interference from the public.
- Additional infrastructure will be required to manage stormwater and wildlife.
- An arboretum, demonstration garden, riparian buffer display, and utility line display would need to be planted in their entirety. A mature arboretum would not exist for public education and benefit for at least 50 years.

Site Threats

- Flood projections that account for 1.5 feet of sea level rise indicate the site will be isolated and inaccessible during flooding events due to flooding of access roads.
- This scenario assumes the proposed bicycle path can be rerouted south of the site to North Landing Road.
- If the Nimmo Parkway extension is complete, this scenario will not have valuable frontage and access from Nimmo Parkway.
- If the municipal service facility is built on the north side of the site as indicated in the 2017 Interfacility Traffic Area and Vicinity Master Plan, potential traffic and compatible use impacts may not coincide with the HR AREC needs.

Figure 54. Brown Farm South Axonometric



BUILT ENVIRONMENT

TOTAL BUILDING GSF: 55,954 SF
PAVED ROAD AREA: 162,196 SF

RESEARCH PLATS

TOTAL RESEARCH AREA: 88.58 acres
TOTAL SITE AREA: 118 acres
BUFFER AREA: 15.30 acres

NATURAL ASSETS

FORESTED AREA: 12.83 acres
WATER TABLE LEVEL: 5 FT - 10+ FT

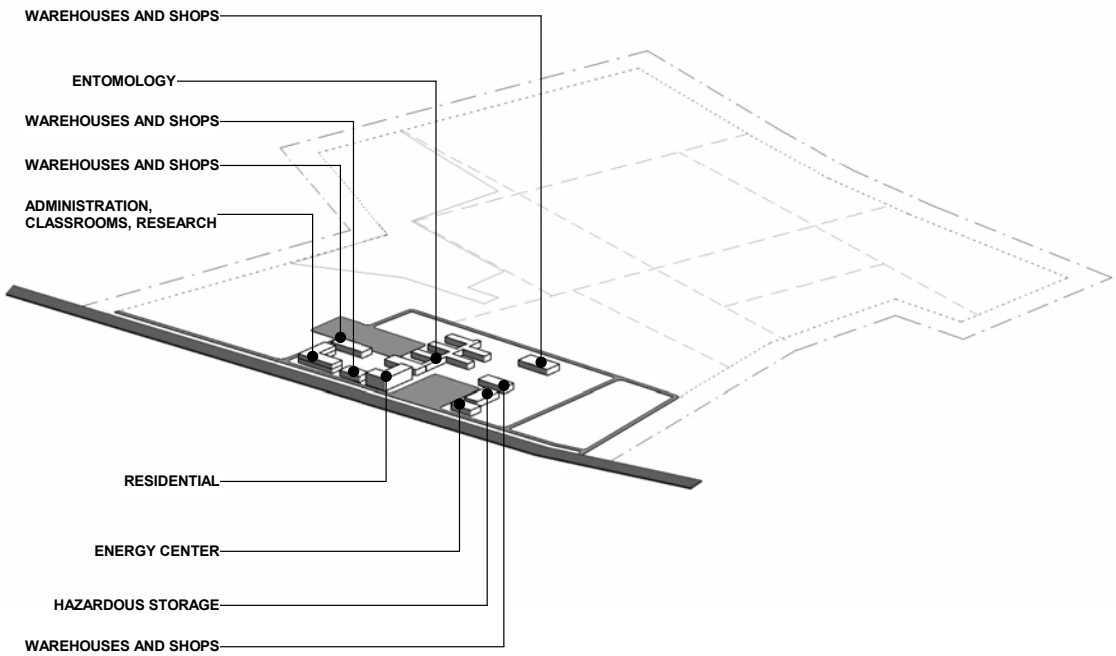
SOIL AMENDMENT AND DRAINAGE

SOIL TYPES: ACREDALE
ENGINEERED SOIL REQUIRED: 287,123 CY
CONSTRUCTION SOIL REQUIRED: 91,920 CY
ESTIMATED DITCH LENGTH: 19,954 FT
POND AREA: 1 acre
POND VOLUME: 1,309,183 gal

IRRIGATION

SYSTEMS: 3
PUMPS: 4
HYDRANTS: 36
ESTIMATED PIPE LENGTH: 9,569 FT
UNDERGROUND IRRIGATION AREA: 12.86 acres

Figure 55. Brown Farm South - Built Environment



MAIN ROAD (ACCESS TO SITE)

PAVED ROAD (ON SITE)

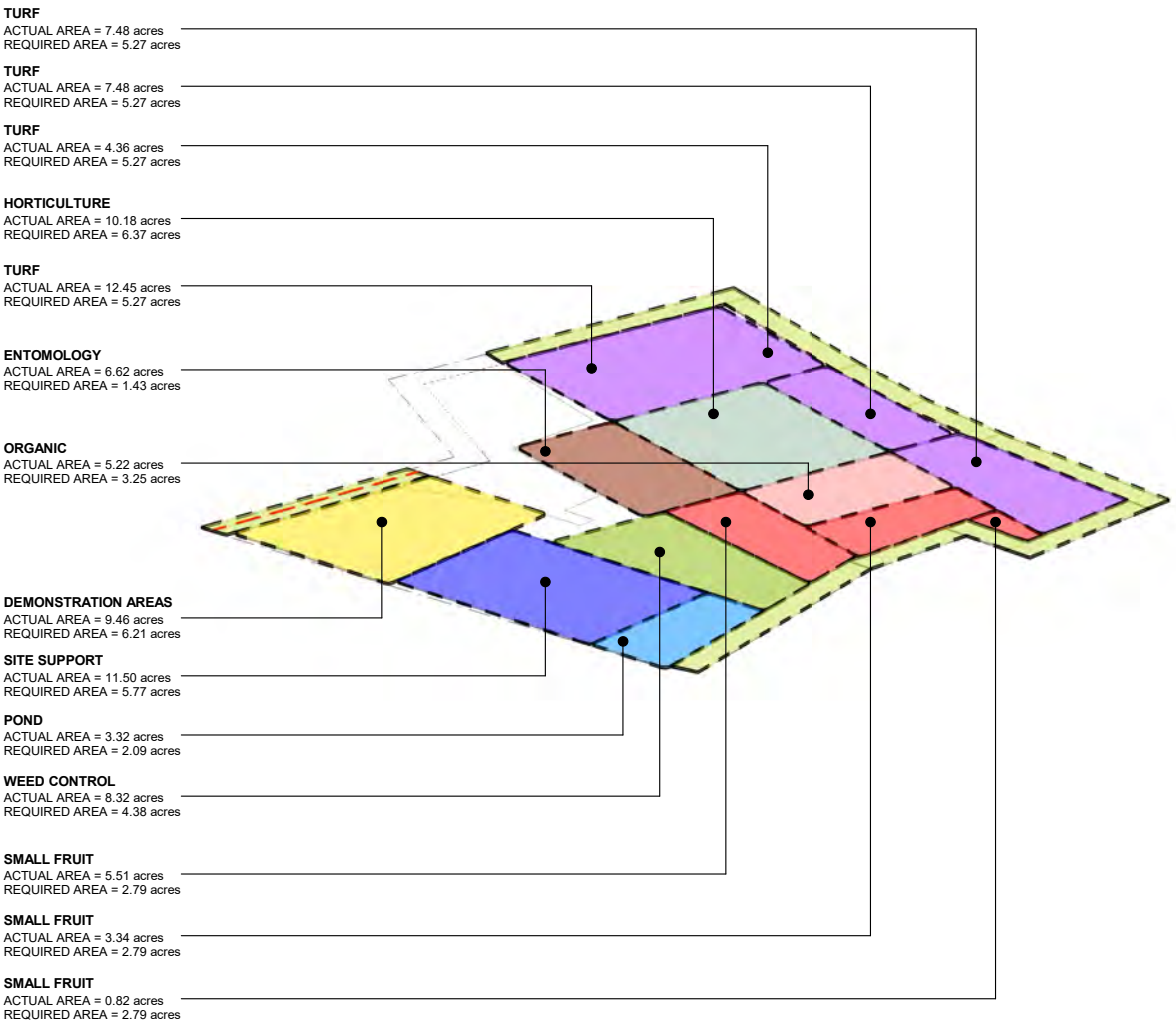
HARDSCAPE AREA

PAVED	3.72 acres	162,196 SF
NET AREA =	3.72 acres	162,196 SF

PROPOSED BUILDING GSF

BUILDING	TARGET AREA
ADMINISTRATION, CLASSROOMS, RESEARCH	16,659 SF
ENERGY CENTER	860 SF
ENTOMOLOGY	16,012 SF
HAZARDOUS STORAGE	2,339 SF
RESIDENTIAL	5,098 SF
WAREHOUSES AND SHOPS	14,986 SF
GROSS BUILT AREA =	55,954 SF

Figure 56. Brown Farm South - Research Plats



BUFFER AREA - BROWN FARM SOUTH

BUFFER	15.30 acres
	15.30 acres

NET PROGRAM ACREAGE - BROWN FARM SOUTH

SPACE NAME	REQUIRED AREA	SITE ENGINEERING FACTOR (SEF)	TARGET AREA	SHOWN AREA
DEMONSTRATION AREAS	6.21 acres	20%	7.45 acres	9.46 acres
ENTOMOLOGY	1.43 acres	20%	1.72 acres	6.62 acres
HORTICULTURE	6.37 acres	20%	7.64 acres	10.18 acres
ORGANIC	3.25 acres	20%	3.90 acres	5.22 acres
POND	2.09 acres	20%	2.51 acres	3.32 acres
SITE SUPPORT	5.77 acres	20%	6.92 acres	11.50 acres
SMALL FRUIT	8.37 acres	20%	10.04 acres	9.68 acres
TURF	15.80 acres	20%	18.96 acres	24.29 acres
WEED CONTROL	4.38 acres	20%	5.26 acres	8.32 acres
	53.67 acres		64.40 acres	88.58 acres
NET PROGRAM ACREAGE =	53.67 acres		64.40 acres	88.58 acres

Figure 57. Brown Farm South - Natural Assets

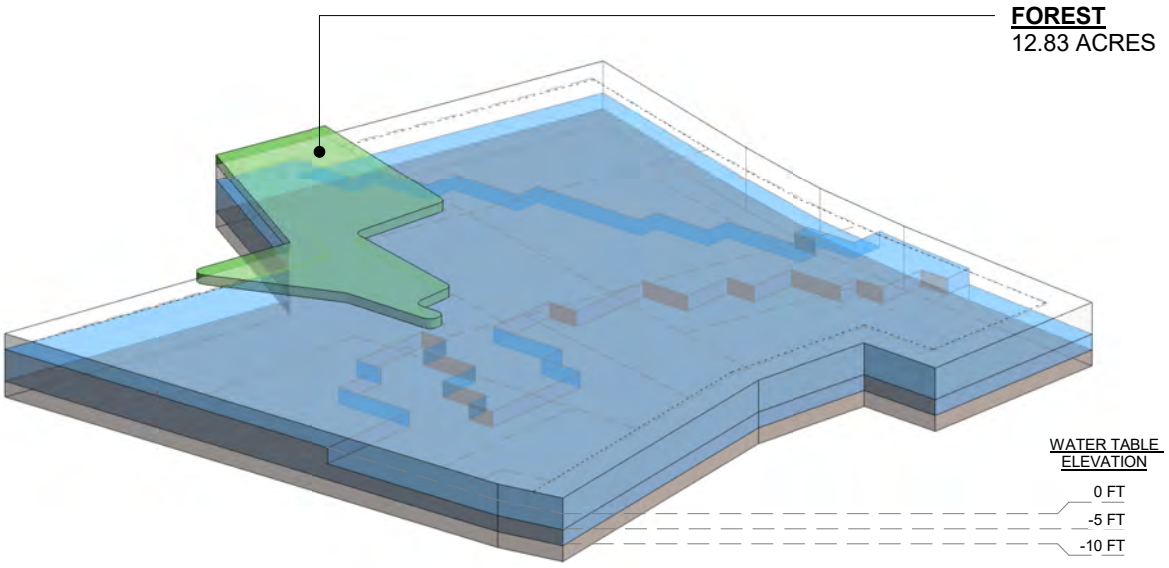
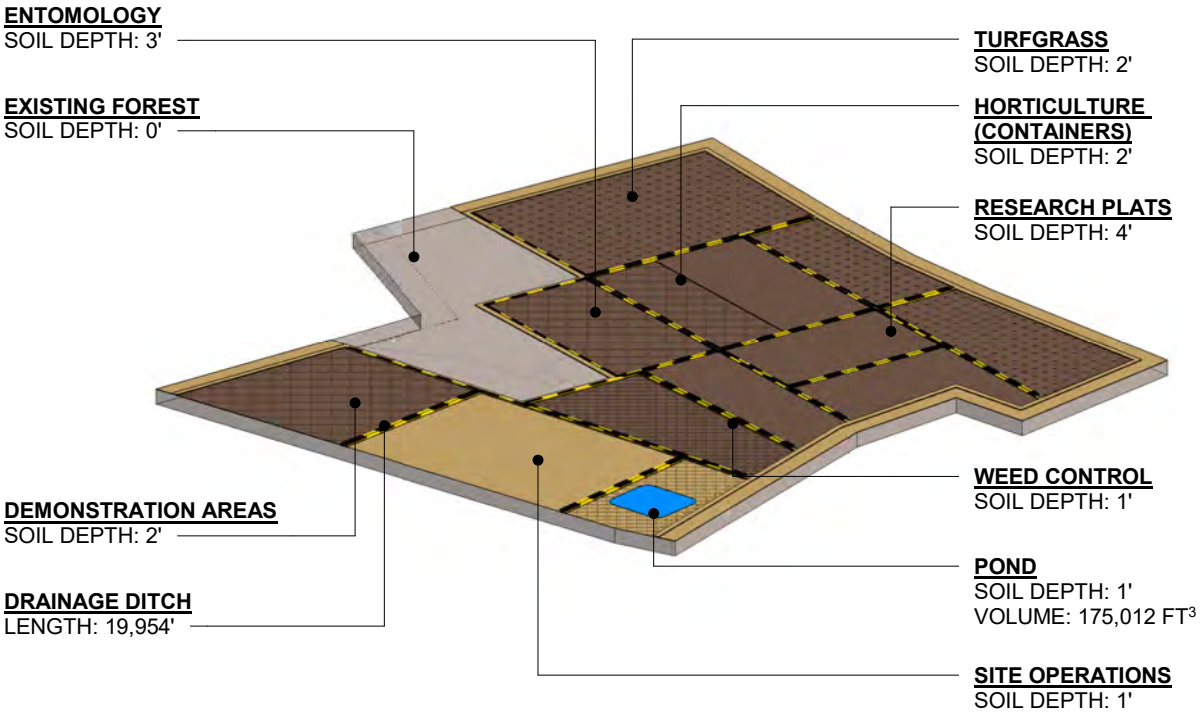


Figure 58. Brown Farm South - Soil Amendment and Drainage

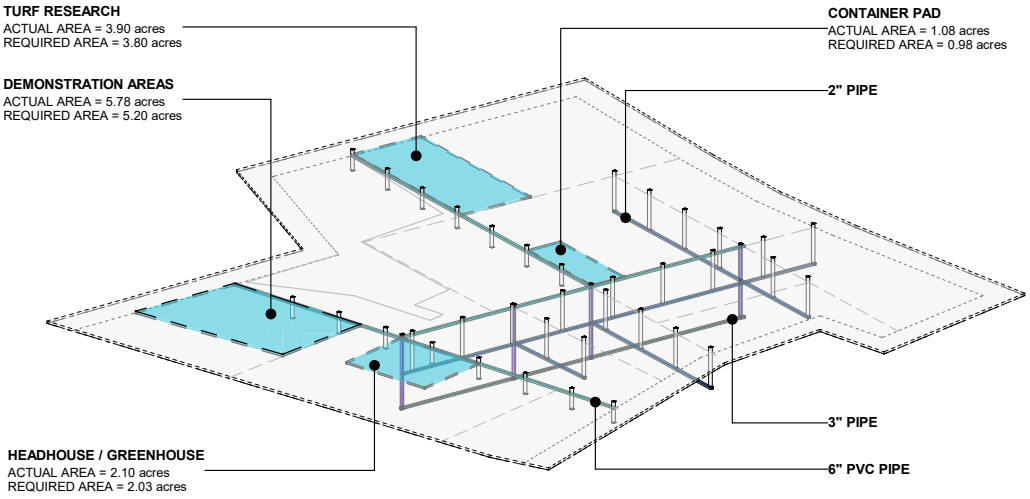


SOIL DISTRIBUTION			
PLAT TYPE	**SOIL DEPTH**	**AREA**	**VOLUME**
CONSTRUCTION FILL			
POND	1' - 0"	2.92 acres	4,718 CY
SITE OPERATIONS	1' - 0"	11.62 acres	18,754 CY
BUFFER	2' - 0"	8.80 acres	28,379 CY
ROADS	4' - 0"	6.21 acres	40,069 CY
		29.55 acres	91,920 CY
ENGINEERED SOIL			
WEED CONTROL	1' - 0"	6.73 acres	10,854 CY
DEMONSTRATION AREAS	2' - 0"	8.73 acres	28,185 CY
HORTICULTURE (CONTAINERS)	2' - 0"	4.13 acres	13,317 CY
RESEARCH PLATS	2' - 0"	24.43 acres	78,842 CY
ENTOMOLOGY	3' - 0"	6.27 acres	30,363 CY
RESEARCH PLATS	4' - 0"	19.46 acres	125,562 CY
		69.75 acres	287,123 CY
NET ACREAGE =		99.31 acres	379,042 CY

PROPOSED POND		
AREA	**DEPTH**	**VOLUME**
1.00 acres	4' - 0"	1,309,183 gal
1.00 acres		1,309,183 gal

PLAT DRAINAGE DITCH LENGTH
19954'
19954'

Figure 59. Brown Farm South - Irrigation



- UNDERGROUND IRRIGATION
- SYSTEM 1
- SYSTEM 2
- SYSTEM 3
- HYDRANTS
- PUMPS

PUMPS & HYDRANTS

HYDRANT	36
PUMP	4

PIPE SYSTEM LENGTH

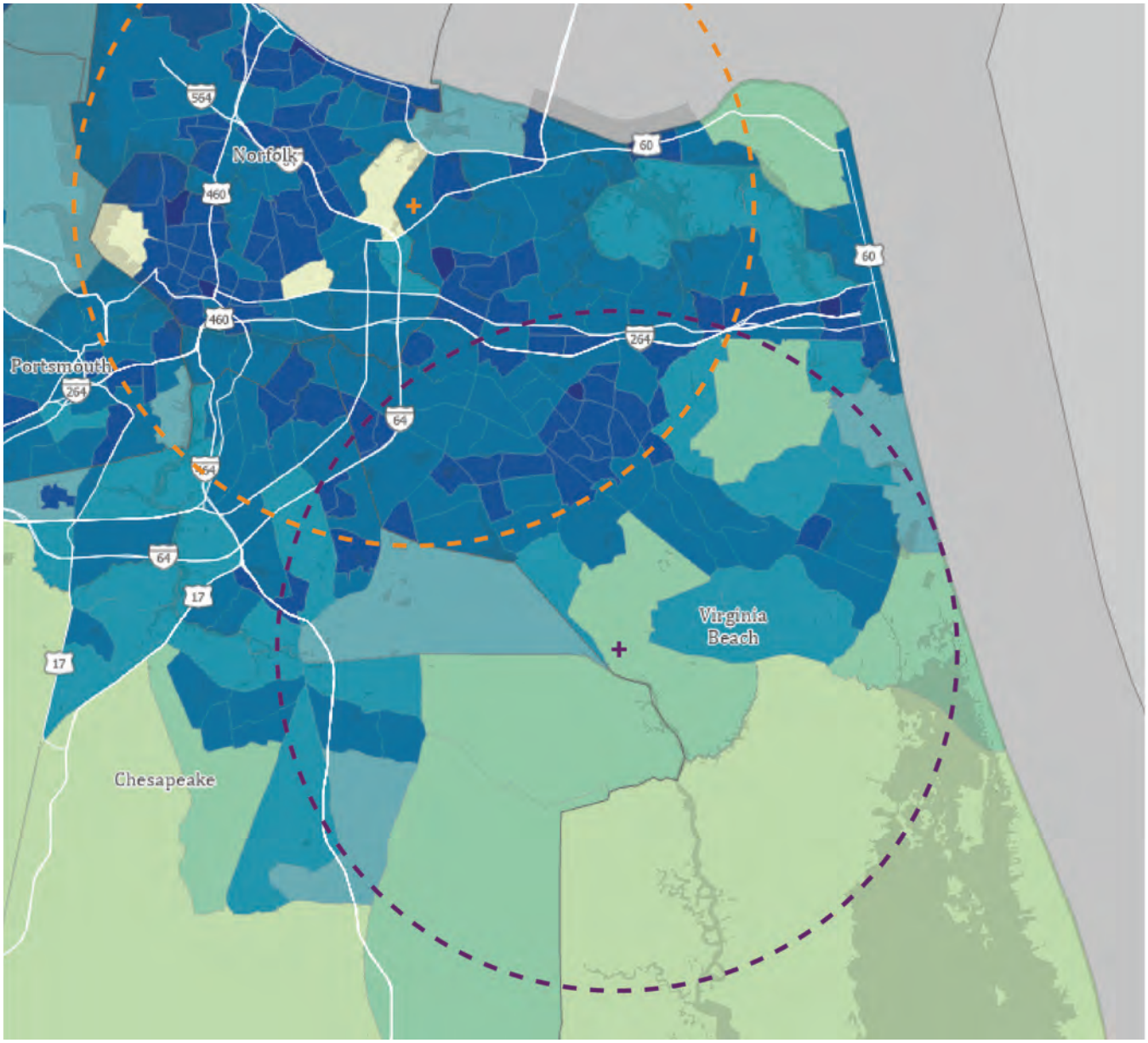
SYSTEM	PIPE LENGTH
SYSTEM 1	
2" PIPE	3819'
	3819'
SYSTEM 2	
3" PIPE	1371'
	1371'
SYSTEM 3	
6" PVC PIPE	4378'
	4378'
TOTAL PIPE LENGTH =	9569'

UNDERGROUD IRRIGATION ACREAGE

PROGRAM	TOTAL ACRES
UNDERGROUND IRRIGATION	
CONTAINER PAD	1.08 acres
DEMONSTRATION AREAS	5.78 acres
HEADHOUSE / GREENHOUSE	2.10 acres
TURF RESEARCH	3.90 acres
IRRIGATION NET ACREAGE =	12.86 acres

Hampton Roads Agricultural Research and Extension Center

Figure 60. Site Distance and Population Density



Data source: United States Census
2020 Census Demographic Data Map Viewer

Legend

- Existing AREC Site
- Potential Sites
- 10-mile Buffer from AREC
- 10-mile Buffer from Potential Sites

Persons per Square Mile

- 10,000+
- 5,000 to 9,999.9
- 2,000 to 4,999.9
- 1,000.0 to 1,999.9
- 500.0 to 999.9
- 100.0 to 499.9
- 50.0 to 99.9
- Less than 50.0
- Water

Cost Model Methodology and Narrative

Objective
To establish an Order-of-Magnitude forecast of the probable construction costs to relocate the existing AREC program to a new site.

Cost Model Methodology / Approach

- The cost model(s) reflect the specific optimized requirements necessary to create a "research-ready" environment for each of the new sites.
- We organized the Cost Model into the following categories:
  - Buildings
    - New (replacement) buildings (including fueling station, fuel tanks and dedicated emergency generator)
  - Site Development
    - Site preparation
    - Drainage
    - Irrigation
    - Soil amendments
    - Buffer
    - Pond
    - Hardscape (roads / circulation)

Replacement Buildings / Program

- New Buildings / Capital Improvements:
  - The basis of model is that all existing assets will be replicated as new ground-up construction.
  - The cost carried for the buildings includes both Core & Shell and Fit-Out based on $/SF allocations.
  - The replacement buildings have been grouped as six separate buildings, as follows:
    - Admin / Education / Research
    - Greenhouses
    - Residential
    - Warehouse / Storage / Shops
    - Hazardous Storage
    - Site Support (shops and solar)
  - The basis of the building cost model assumes that the new building will be designed to present standards and codes and will reflect future-proof higher education design specifications.
- The cost model is built up from separate rates for core & shell and fit-out of new spaces, but for general reference, it includes the following aggregate direct cost rates:
  - Admin / Education / Research / Outreach: $497/GSF
  - Greenhouses: $298/GSF
  - Residential: $342/GSF
  - General Storage: $255/GSF
  - Hazardous Storage: $369/GSF
  - Site Support: $345/GSF
- These direct rates include mark-ups associated with the costs of a General Contractor or Construction Manager (general conditions, general requirements, overhead, profit, insurances, bonds, etc.)
- The cost model does not suppose specific programmatic adjacencies but assumes future design strategies would aim to create possible colocation and other adjacency efficiencies.
- The cost model assumes that massing & stacking of the building(s) would be single story.

Site Development / Amendments:

- Drainage:
  - There are two types of drainage systems in the Cost Model:
    - An above ground drainage system consisting of drainage ditches, culverts, and outfall structures
    - A below ground piped tile drainage system.
  - The above ground drainage system was based on:
    - The linear footage(s) for each site are based on preliminary quantity estimates as provided by the planning team.
    - While the specific construction make up / specification for the drainage trenches is not yet designed, we assumed they consisted of sloped excavation, geogrid / geofabric, and erosion control mesh / hydroseed for the trench embankments.
  - The below ground piped tile drainage system was based on:
    - An assumed linear footage(s) for each site as roughly based on a 2:1 ratio to the above ground trenches.
    - While the specific construction make up / specification for the tile drainage trenches is not yet designed, we assumed they consisted of an

underground pipe infrastructure system of 4", 5" and 6" pipe, gravel bedding, and outfall structures.
Irrigation

– Irrigation
  - The cost of irrigation for each site was calculated based on the axonometric diagrams, descriptions and quantities provided by the planning team.
  - There are two types of irrigation in the Cost Model
    - A dedicated underground commercial-grade system with pop-up heads for the following areas:
      - Demonstration gardens
      - Headhouse / greenhouse
      - Container pad
      - Turf Research
  - An underground infrastructure system comprised of above grade pumps, underground 2", 3" and 6" pipe and strategically located hose bib / hydrants.

– Soils / Soil Amendments:
  - The cost of soil(s) for each site is based on the quantities of soil types (Construction Fill and Engineered Soil) as provided by the planning team.
  - Engineered Soil assumed an indicative mixture of the following:
    - Sand / Clay (30%)
    - Topsoil (40%)
    - Other Soil Additives (30%)
  - *The actual specification / composition of the mix will be determined at a later date by the researchers and detailed soil & water analysis of the existing sites. We do not anticipate the final specification will change the overall costs appreciably.*

– Buffer:
  - The scope and cost of the buffer for each site based on the typical cross section sketch provided by the planning team.
  - While the width / depth of the buffer remained constant (at a total of 100 feet), the planning team provided the specific quantity area / acreage of the buffer for each site.
  - As per the sketch provided, the makeup of this buffer was comprised of the following:
    - 10' shrub and small plantings buffer
    - 10' bioswale
    - 14' service road
    - 30' Grassy channels (trench drain)
    - 21' turf edge
    - 15' woodland edge

– Pond:
  - The cost of the new ponds for each site is assessed based on the quantities provided by the planning team, including both pond surface area and pond perimeter.
  - While the design of the ponds are not yet specified, based on discussion with the planning team, we modeled the cost based on the following:
    - For the pond we assumed excavation (to an average depth of 8 feet), gravel underlayment, and a geofabric lining.
    - For the pond perimeter we assumed a mix of riprap, bedding stone, geo-grid / fabric, small shrubs, and edge and aquatic plantings.

– Hardscape (Roads and Circulation)
  - The cost model includes paved roads and circulation based on the quantities for each site as provided by the planning team.

– A Two Pump Fueling Station consisting of:
  - Above 200-gallon above ground double lined fuel tank
  - Direct burial (double lined) fuel line to the fuel pumps
  - Concrete pad for the fuel pumps (including foundations)
  - Fueling pumps (2 each)
  - Roof canopy (including a fire suppression system)
  - Double sided concrete vehicular access (truck loading capacity)
  - Signage

– As part of the overall cost of the replacement buildings, we have included the following site "support" elements':
  - Netted high tunnel
  - Solar panels
  - Potting yard / paved area
  - Rain out / drought research
  - High tunnel
  - Mulch / bark storage area (excludes stockpile)
  - Above-ground double lined fuel tanks (200-gallon serving fueling station described above, plus 1,000-gallon gasoline and 550 gallon diesel to replace existing in kind)

- Dedicated backup generator for low-temperature freezers

Cost Model Qualifications:

- All costs include indirect costs associated with construction delivery:
  - General Conditions
  - General Requirements
  - Sub-guard and other insurances
  - CM overhead and profit / fee
  - Allowance for design contingency
- Project Cost is derived by a soft cost multiplier on both buildings and land development, as provided by the client:
  - 28% for Buildings and Site Development
- Escalation:
  - The base cost model was based on today's costs (Q4 2022)
  - While escalation to a future start date is excluded from the base Cost Model, we recommend the following markup for escalation based on and anticipated construction start date of Q4 2025:
    - 5% per annum for Plat / Site Development
    - 6.5% per annum for New Building Construction

Major Exclusions

- Land acquisition
- Temporary facilities (including off site tree farms)
- Perimeter and access road realignments and other traffic improvements
- Incoming utility services beyond the limits-of-work
- Costs associated with interim educational and/or research programs
- Demolition of existing buildings and other assets
- Existing utility relocations (including pipelines)
- Wetland mitigation and/or replacement requirements
- Stormwater retention and/or detention requirements (other than the new ponds)
- Soil batch plants
- Contaminated materials handling
- Owner Force Account work (during construction)
- Maintenance of work-in-place or the existing site during construction / relocation
- Supplemental Owner's Project Contingencies
- Escalation to a future start date (cost model is based on today's Q4 2022 costs)
- Cost associated with additional above-grade distribution from the underground pipe infrastructure / hose bib / hydrants to accommodate other forms of irrigation extensions (funded by an owner's operational budget)

Opportunities

03

Opportunities

Beyond a one-to-one replacement value, the potential move presents opportunities for growth and technological advancement for the HR AREC. The most recent construction at the HR AREC was the renovation of the main administrative building in 2007, and most of the site has organized itself organically over time. Components of the laboratories and administrative spaces are outdated, especially site-wide utilities such as the boiler heating system. A move to a new location would provide the opportunity to create state-of-the-art spaces for faculty, staff, students, and outreach participants designed and organized for optimal performance.

The identified potential sites also present an opportunity for growth. The current HR AREC site is bounded by roadways, residential areas, and a public school, eliminating the possibility for additional land acquisition and physical expansion. The potential parcels are all large enough to support a 20 percent growth across all research areas, including the site support areas that provide labs and classrooms.

The Future of Research

The Agricultural Research and Extension Center currently uses a variety of practices that manage the overall research projects. The land use and management is informed by the environmental conditions, size of the research project, availability, and management of resources. Relocation and a new build presents the opportunity for advancement of Smart Farm initiatives at a faster pace than the current site could adapt. Such elements include increased digital management of and use and the implication of that on research, robotics development, and increased drone use.

The sites for relocation have been analyzed environmentally. The current HR AREC site has a highly-tailored irrigation system that provides multiple redundancies and will need to be replicated in an appropriate manner, along with control systems that use a digital platform. It is clear from the existing conditions on the potential sites identified in this report that intensive drainage systems will need to be designed and are dependent on the site and the land management strategies selected.

Sustainable power sources should be considered to provide power to the fields, in addition to a connection with a wide power network that would provide redundant networks for the site.

The outreach component of the HR AREC includes hands-on volunteers and events for the general public. The HR AREC has included technology such as QR codes at its existing site; however, the construction of a cutting-edge farm technology campus could lead to opportunities for continued progress through digital outreach and could extend outreach services using digital citizen participation.

The Built Environment

The existing research labs are well used and, in many cases, demonstrate needs that are being accommodated in a make-shift manner. As the site evolved over more than a century, new research projects and technology often moved into extant spaces, leading to an ad hoc assortment of assets rather than an agile, leading edge research facility. A relocation presents the opportunity to construct state-of-the-art facilities complete with vital capital improvements already slated for funding and with the ability to flex with technology and research needs as they continue to advance in the next century.

Scientific Equipment

Growth Chambers may require stand-by power. Freezer and refrigerators for specimen storage may also require standby power.

Greenhouses

Incorporating greenhouses with digital monitoring and control of temperature, humidity, shade devices, watering, and research tracking is a standard in new greenhouses. The HR AREC currently has two smart greenhouses listed in the capital improvements project list; constructing a new campus would provide seven smart greenhouses, a leap in technological capabilities compared to its current boiler-heated greenhouses.

As with all research programs, the stakeholders doing the research will guide and inform the outcomes. The research needs along with a flexible design can serve the evolving research overtime.

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Appendices

04

Appendix A - HR AREC Existing Assets

Building Key

Virginia Tech Buildings

1101. Administration
1102. Tenant Housing
1104. Headhouse / Greenhouse
1105. Headhouse / Greenhouse
1106. Storage Building
1107. Garage and Lab
1108. Garage and Shop
1109. Boiler House
1110. Implement Shed
1111. Quonset Hut
1112. Pump House
1113. Overwintering Greenhouse
1114. Solar Greenhouse
1115. Rain Out / Drought Tunnel*
1116. Tenant House
1117. High Tunnel*
1118. Small Pump House**
1119. Tool Shed**

Site Support Structures

A. Solar Panels
B. Netted High Tunnel
C. Boiler Tanks
D. Potting Yard
E. Mulch and Bark Supply Bays
F. Military Surplus Tent
G. Shipping Containers (2)
H. Government Surplus Equipment Storage
I. Parking Lot

**Temporary/Portable structure; Considered a Site Support Structure for the purpose of cost estimation*

***Not included in Virginia Tech Building List*

Existing Site - Building Areas

Existing Buildings			
Number	**Name**	**NSF**	**GSF**
1101	Administration	12325	19217
1102	Tenant House	2960	3178
1104	Headhouse/Greenhouse	5325	5865
1105	Headhouse/Greenhouse	4595	4607
1106	Storage Building	3220	3824
1107	Garage and Lab	1764	1980
1108	Garage and Shop	1775	2268
1109	Boiler House	560	645
1110	Implement Shed	6400	8000
1111	Quonset Hut	1150	1150
1112	Pump House	160	160
1113	Overwintering Greenhouse	2890	2890
1114	Solar Greenhouse	2700	2700
1116	Tenant House	1690	1920
1118	Small Pump House*	55	55
1119	Tool Shed*	135	135
Total Building GSF			**58594**

**Not included in Virginia Tech Building List*

Existing Site - Site Support Structures

Site Support Structures		
Number	**Name**	**GSF**
1115	Rain Out/Drought Tunnel	4690
1117	High Tunnel	4320
A	Solar Panels	600
B	Netted High Tunnel	1600
C	Boiler Tanks	320
D	Potting Yard	4675
E	Mulch and Bark Supply Bays	1200
F	Military Surplus Tent	715
G	Shipping Containers (2)	700
H	Government Surplus Equipment Storage	450
Total Site Support GSF		**19270**
I	Parking Lot	46850
Total Site Support GSF + Parking		**66120**

Total Building GSF	58594
Total Site Support GSF	19270
Parking GSF	46850
Total Required Built Area	**124714**

Proposed Buildings and Areas

Proposed Buildings			
Number	**Name**	**NSF**	**GSF**
1	Administration, Classrooms, Research, Outreach	12372	19299
2	Greenhouses and Headhouses	15460	16012
3	Warehouses and Shops	12677	14986
4	Hazardous Storage	1735	2339
5	Support Building - Energy Center	775	860
6	Residential	4650	5098
Total Proposed Building GSF			**58594**

Total Proposed Building GSF	58559
Total Site Support GSF	19270
Parking GSF	46850
Total Required Built Area	**124714**

1101 Administration | Plat 22

12,325 NSF | 19,217 GSF

Located in the southwest corner of Plat 22, the Administration building is the center of most operations for the site. It contains the primary lab and research spaces for students and faculty. Virgina Tech, Master Gardeners, and other outreach programs share the classroom spaces for educational classes and events throughout the year. The building is relatively recent construction with three floors. The structure appears to be concrete masonry with a brick facade and aluminum frame storefront windows. A tunnel in the basement level connects the building to the fallout shelter beneath the adjacent greenhouse.

Primary Uses: Administration / Labs and Research / Education / Outreach

Outreach Areas:

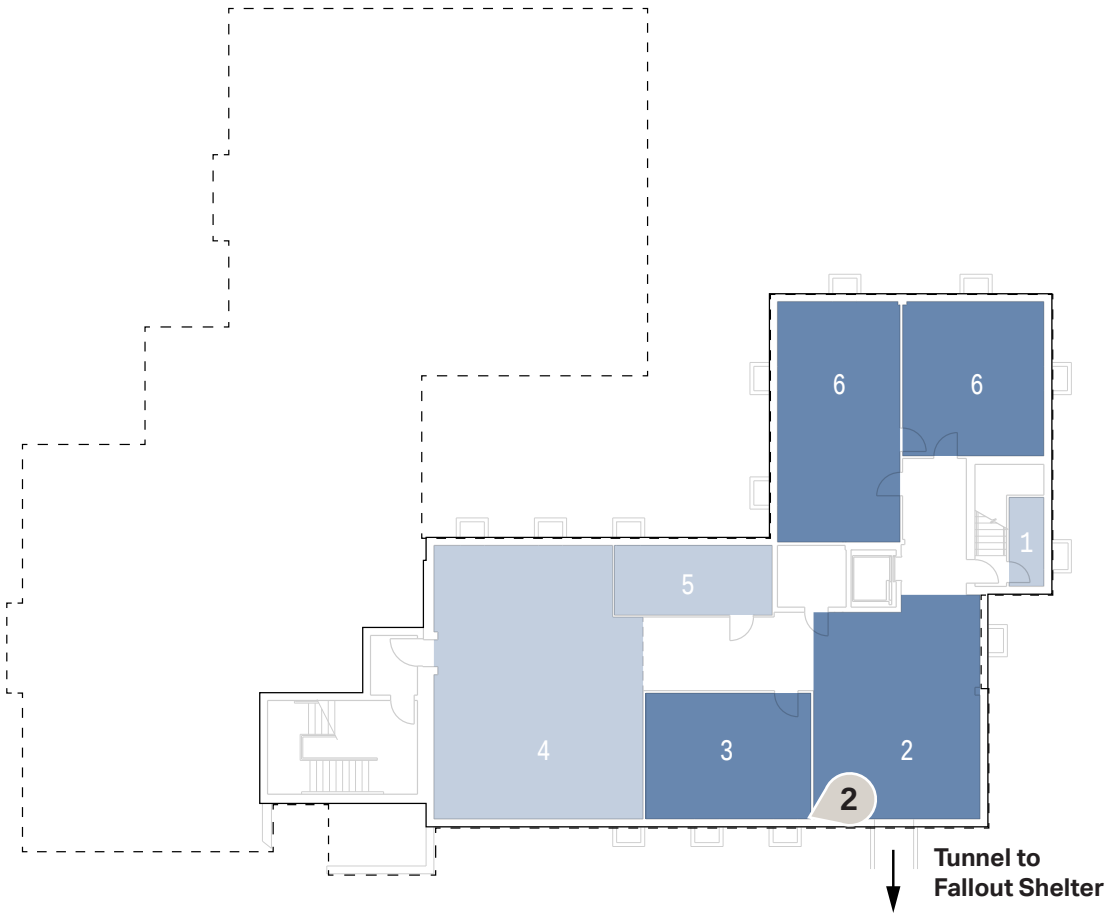
- 5 Outreach offices
- 2 Outreach classrooms

Assets & Equipment:

- 15 Offices
- 1 Large Classroom with Moveable Partition
- 3 Small Classrooms with 20 student desks
- 7 Labs
- 1 BSL2 Lab
- 2 Industrial Walk-In Coolers
- Growth Chambers

1101 Administration | Plat 22

12,325 NSF | 19,217 GSF



Legend

1. Storage
2. Growth Chambers
3. Stormwater Management Lab
4. Utilities / Storage / Coolers
5. Storage
6. Pathology Lab

Lab

Support

1 5 10 20 40 80

1101 Administration | Plat 22

12,325 NSF | 19,217 GSF

Legend

1. Outreach Office
2. Entomology Office
3. Horticulture Office
4. Graduate Student Desks
5. Horticulture Lab
6. Lab Support
7. Entomology Lab
8. Director's Office
9. Large Classroom
10. Mail
11. Reception
12. Administration Office
13. Safety Manager Office
14. Entomology Office
15. Horticulture Office
16. Server Room
17. Staff Office
18. Farm Manager Office
19. Stormwater Office
20. Horticulture Lab

- Lab
- Offices
- Classrooms / Meeting
- Support

1 5 10 20 40 80

1101 Administration | Plat 22

12,325 NSF | 19,217 GSF

1

Legend

1. Outreach Classroom
2. Pathology Office
3. Outreach Classroom
4. Pathology Lab (BSL2)
5. Lab Support
6. Turfgrass Lab
7. Small Classroom
8. Post-Doc Office
9. Outreach Office
10. Lounge
11. Outreach Office
12. Graduate Student Desks
13. Board Room

- Lab
- Offices
- Classrooms / Meeting
- Support

1 5 10 20 40 80

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Administration	Support	Mail	65	-	-
Administration	Office	Safety Manager Office	70	-	-
Administration	Office	Reception	75	-	-
Administration	Office	Horticulture Office	85	-	-
Administration	Support	Server Room	95	-	-
Administration	Office	Staff Office	95	-	-
Administration	Office	Farm Manager Office	95	-	-
Administration	Office	Post-Doc Office	100	-	-
Administration	Office	Administration Office	105	-	-
Administration	Office	Entomology Office	130	-	-

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Administration	Office	Pathology Office	160	-	-
Administration	Office	Horticulture Office	160	-	-
Administration	Office	Director's Office	160	-	-
Administration	Office	Stormwater Office	175	-	-
Administration	Support	Lounge	325	-	Couches, TV, kitchenette
Classroom	Classrooms / Meeting	Small Classroom	115	-	More akin to a small study space
Classroom	Classrooms / Meeting	Board Room	260	-	Primary meeting space for administration functions
Classroom	Classrooms / Meeting	Graduate Student Desks	315	-	-
Classroom	Classrooms / Meeting	Graduate Student Desks	400	-	-
Classroom	Classrooms / Meeting	Large Classroom	1215	Room divider	Classrooms are used for outreach events and grad-student lectures

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Lab / Research	Lab	Entomology Lab	160	-	-
Lab / Research	Lab	Lab Support	235	Growth Chambers	-
Lab / Research	Lab	Lab Support	240	Growth Chambers	-
Lab / Research	Lab	Stormwater Management Lab	335	-	-
Lab / Research	Lab	Entomology Lab	530	-	-
Lab / Research	Lab	Horticulture Lab	560	-	-
Lab / Research	Lab	Lab Support	575	Growth Chambers	Adjacent tunnel connects to fallout shelter below double greenhouse
Lab / Research	Lab	Pathology Lab	575	-	Restricted Access, BSL2
Lab / Research	Lab	Turfgrass Lab	580	-	-
Lab / Research	Lab	Horticulture Lab	650	-	-

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Lab / Research	Lab	Pathology Lab	825	-	-
Lab / Research	Equipment Storage	Coolers and Utilities	890	(2) Industrial Walk-In Coolers	-
Outreach	Office	Outreach Office	115	-	-
Outreach	Office	Outreach Office	180	-	-
Outreach	Office	Outreach Office	450	(3) Offices	Hardly used
Outreach	Classrooms / Meeting	Outreach Classroom	475	Graduate Student Desks	Hardly used
Outreach	Classrooms / Meeting	Outreach Classroom	520	-	Hardly used
Storage	General Storage	General Storage	50	-	-
Storage	General Storage	General Storage	180	-	IT and electronic storage

1102 Tenant House | Plat 22

2,960 NSF | 3,178 GSF

The first Tenant House is located behind the Administration building (1101). The house is tucked in the midst of a small grove to limit sightlines to the adjacent street. The house is designed in the traditional four square style, with the main shared living spaces on the ground level and bedrooms on the upper level. There are two large bedrooms which are often shared. It is typical wood frame construction suitable for residential use. Graduate students and facility employees live here throughout the year.

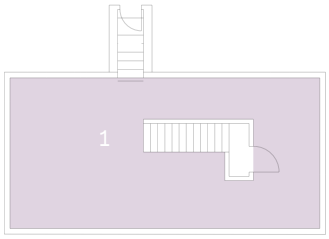
Primary Use: Residential

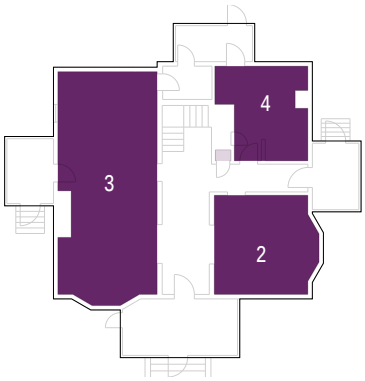
Assets & Equipment:

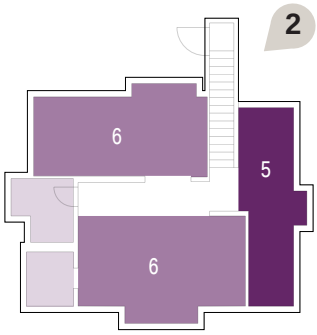
- 2 shared bedrooms
- Shared kitchen, dining, living rooms
- Basement

1102 Tenant House | Plat 22 - *Continued*

2,960 NSF | 3,178 GSF







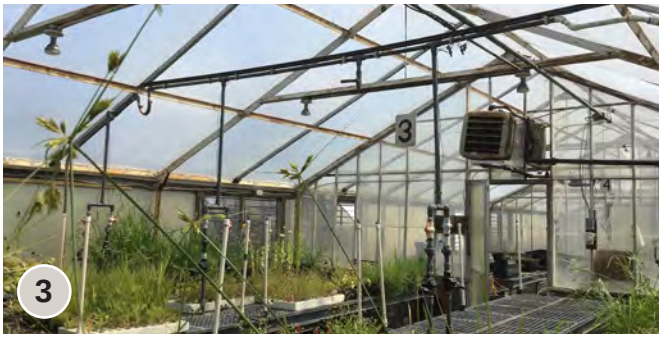
Legend

1. Basement
2. Dining Room
3. Living Room
4. Kitchen
5. Shared Space
6. Shared Bedroom

Shared Space
Bedroom
Storage / Utilities

1 5 10 20 40 80

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Residential	Shared Living	Kitchen	170	-	-
Residential	Shared Living	Dining Room	225	-	-
Residential	Shared Living	Shared	240	-	-
Residential	Bedroom	Shared Bedroom	335	-	-
Residential	Bedroom	Shared Bedroom	430	60 SF closet	-
Residential	Shared Living	Living Room	500	-	-
Residential	General Storage	Basement	1060	-	-



1104 Headhouse / Greenhouse | Plat 22 - *Continued* *5,325 NSF | 5,865 GSF*

Building 1104 comprises of two greenhouses attached via a shared headhouse. The headhouse is primarily used for potting, tool and equipment storage, and flexible workspace for researchers. A small room with lockers is provided for users. The greenhouses are designated for general use and do not utilize any automated heating, irrigation, or air systems. A stair leads to a basement level where there is an old fallout shelter that has been converted into a temporary lab space. The lab is currently being utilized for specialized pathology studies requiring cold, dark, isolated spaces. Two tunnels also connect the fallout shelter to the Administration Building (1101) and the Boiler House (1109). The building is primarily used by HR AREC researchers and students, although the Master Gardeners are permitted to use the open space if available. The main structure of the headhouse and basement is concrete masonry with a plaster finish. The greenhouses have an aluminum frame glass system on top of a concrete curb.

Primary Use: Greenhouse / Lab and Research / Outreach

Outreach Areas:

Master Gardeners: Greenhouse

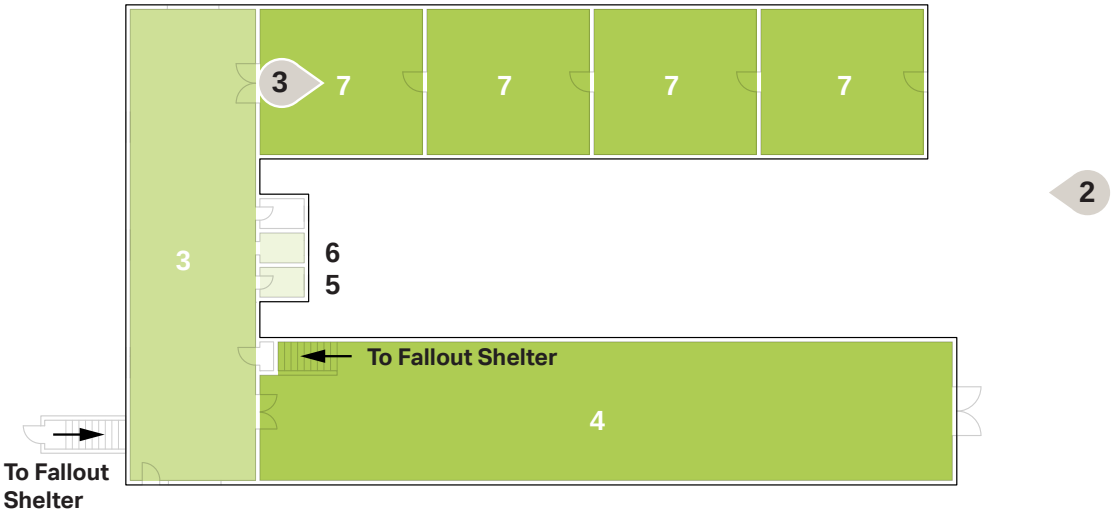
Assets & Equipment:

2 large greenhouses

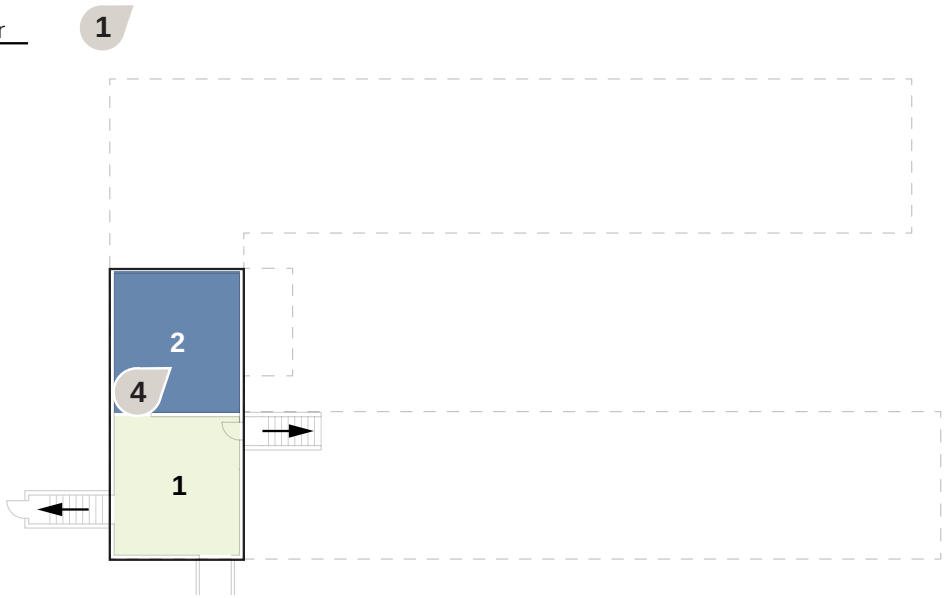
1 headhouse

1 fallout shelter / temporary lab space

1 personal locker room



First Floor



Basement

Legend

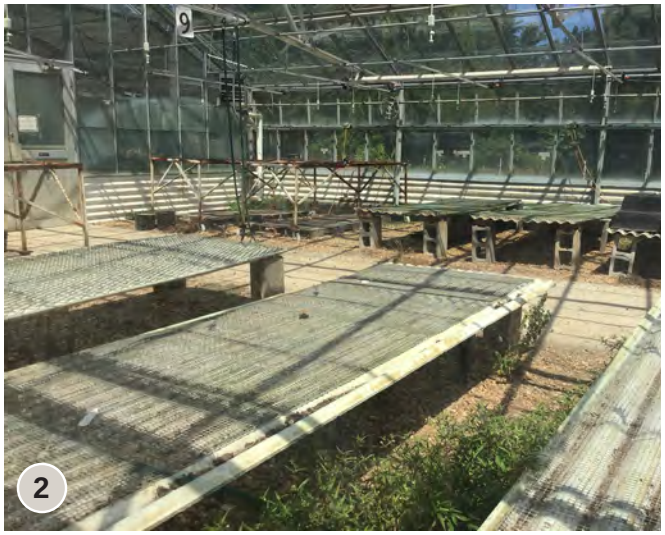
1. Storage
2. Fallout Shelter / Temporary Lab
3. Headhouse
4. Greenhouse
5. Storage
6. Lockers
7. Greenhouse

Greenhouse
Headhouse
Support / Storage
Lab

1 5 10 20 40 80

1104 Headhouse / Greenhouse | Plat 22 - *Continued* *5,325 NSF | 5,865 GSF*

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Greenhouse	Headhouse	Headhouse	1090	-	Seasonally shared with Master Gardeners if space allows
Greenhouse	Greenhouse	Greenhouse	1765	-	Seasonally shared with Master Gardeners if space allows
Greenhouse	Greenhouse	Greenhouse	1780	(4) 445 SF separate greenhouses	Seasonally shared with Master Gardeners if space allows
Lab / Research	Lab	Fallout Shelter / Temporary Lab	320	-	Adjacent tunnel connects to Offices and Lab Basement; Adjacent tunnel connects to Boiler House; Used by Pathologist for protected experiments in cool/ damp locations
Storage	General Storage	Storage	25	-	-
Storage	General Storage	Lockers	25	-	-
Storage	General Storage	Storage	320	-	-



1105 Headhouse / Greenhouse | Plat 22

4,595 NSF | 4,607 GSF

This general greenhouse is used by researchers, students, and master gardeners. It is the primary greenhouse utilized for horticulture and the master gardeners and includes a large container pad with an adjacent potting yard. Used and new pots are stored inside and outside of the headhouse. In front of the headhouse, a large area is designated by large concrete blocks for mulch and bark storage. The main structure of the headhouse is concrete masonry with a plaster finish. The greenhouse is an aluminum frame system with a glass gable roof and walls.

Primary Use: Greenhouse / Outreach

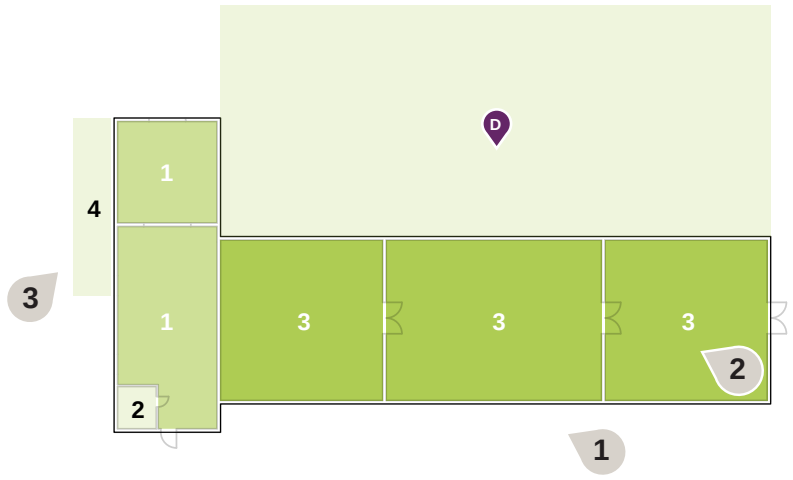
Outreach Areas:

Master Gardeners: Greenhouse / Headhouse, Potting Yard and Storage, Mulch and Bark Supply Bays

Assets & Equipment:

- Potting Yard and Storage (Site Support Area D)
- Mulch and Bark Supply (Site Support Area E)
- 1 Greenhouse

1105 Headhouse / Greenhouse | Plat 22 - *Continued* *4,595 NSF | 4,607 GSF*



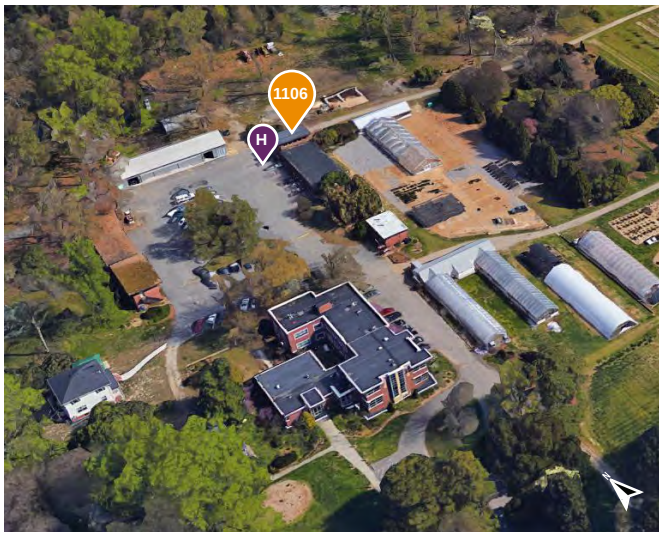
Legend

1. Headhouse
2. Potting Storage
3. Greenhouse
4. Master Gardener Pots
5. Potting Yard

Greenhouse
Headhouse
Support / Storage

1 5 10 20 40 80

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Greenhouse	Equipment Storage	Potting Storage	60	-	Seasonally shared with Master Gardeners if space allows
Greenhouse	Headhouse	Headhouse	1060	-	Seasonally shared with Master Gardeners if space allows
Greenhouse	Greenhouse	Greenhouse	3225	(3) separate greenhouses: (2) 960 SF, (1) 1270 SF	Seasonally shared with Master Gardeners if space allows
Storage	Equipment Storage	Master Gardener Storage	250	-	Seasonally shared with Master Gardeners if space allows



1106 Storage Building | Plat 22

3,220 NSF | 3,824 GSF

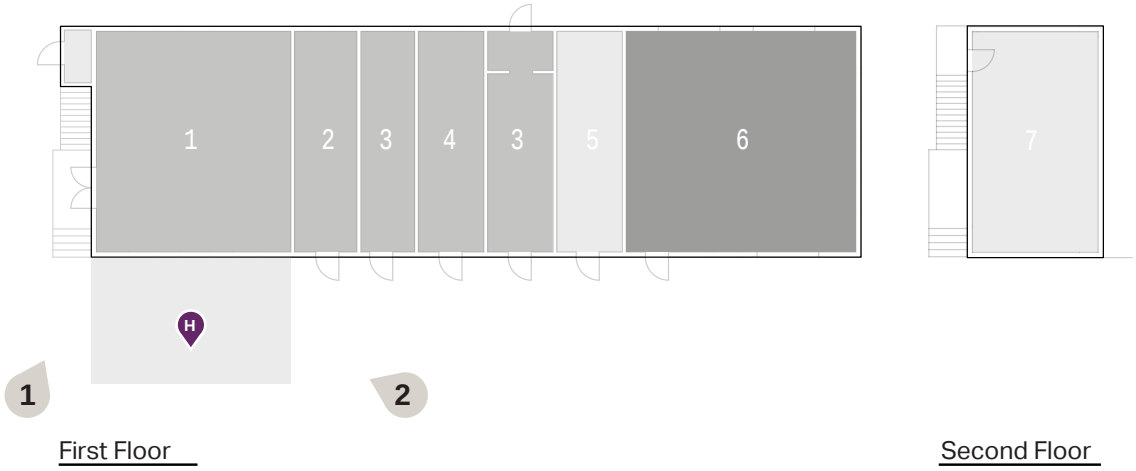
The Storage Buildng is the main facility for hazardous materials storage, including pesticides and fertilizers. Each researcher is assigned a storage room for their personal supplies and equipment. At the far end of the building, a garage provides space for turfgrass specific tools, equipment, and maintenance. Above the primary fertilizer storage room is another general storage room. Currently, the open space in front of the fertilizer room is designated for government surplus equipment.
The building is concrete masonry with brick cladding. Access to the storage rooms is restricted to assigned researchers.

Primary Use: Storage

Assets & Equipment:

- 1 shop
- 5 hazardous storage rooms
- 2 general storage rooms
- 4 backup generators (Site Support Area H)

1106 Storage Building | Plat 22 - *Continued* *3,220 NSF | 3,824 GSF*



Legend

1. Fertilizer Storage
2. Small Fruit Pesticide Storage
3. Turfgrass Pesticide Storage
4. Entomology Pesticide Storage
5. Tool Storage
6. Turfgrass Garage / Workshop
7. Entomology Storage
8. Government Surplus Equipment

Garage / Shop
Hazardous Materials Storage
Tools / Storage

1 5 10 20 40 80

1106 Storage Building | Plat 22 - *Continued* *3,220 NSF | 3,824 GSF*

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Hazardous Storage	Hazardous Storage	Small Fruit Pesticide Storage	230	-	Restricted Access to assigned researcher only
Hazardous Storage	Hazardous Storage	Entomology Pesticide Storage	245	-	Restricted Access to assigned researcher only
Hazardous Storage	Hazardous Storage	Turfgrass Pesticide Storage	445	(2) Storage units	Restricted Access to assigned researcher only
Hazardous Storage	Hazardous Storage	Fertilizer Storage	725	-	Restricted Access
Shop	Shop	Turfgrass Garage / Workshop	860	-	-
Storage	Equipment Storage	Tool Storage	245	-	-
Storage	Equipment Storage	Entomology Storage	470	-	-

1107 Garage and Lab | Plat 22

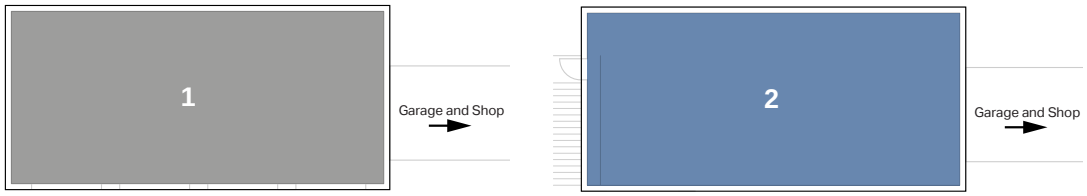
1,764 NSF | 1,980 GSF

Located in the main site support area, the Garage and Lab houses the shared vehicles that employees use on the site. There are a total of 13 shared vehicles on site and four are stored in the garage. The second floor is currently set up as a temporary lab space for small fruit research. The structure is concrete masonry with a brick facade. While anyone working on site has access to the garages, graduate students and researchers are the primary users of the lab space above.

Primary Use: Storage / Lab and Research

Assets & Equipment:

- 4 garage spaces
- 4 shared vehicles
- 1 lab



First Floor

Second Floor

Legend

1 Vehicle Garage
2 Small Fruit Lab

Lab
Garage

1 5 10 20 40 80

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Lab / Research	Lab	Small Fruit Lab	882	-	-
Storage	Equipment Storage	Vehicle Garage	882	-	(13) total vehicles on site, (4) housed in garage

1108 Garage and Shop | Plat 22

1,775 NSF | 2,268 GSF

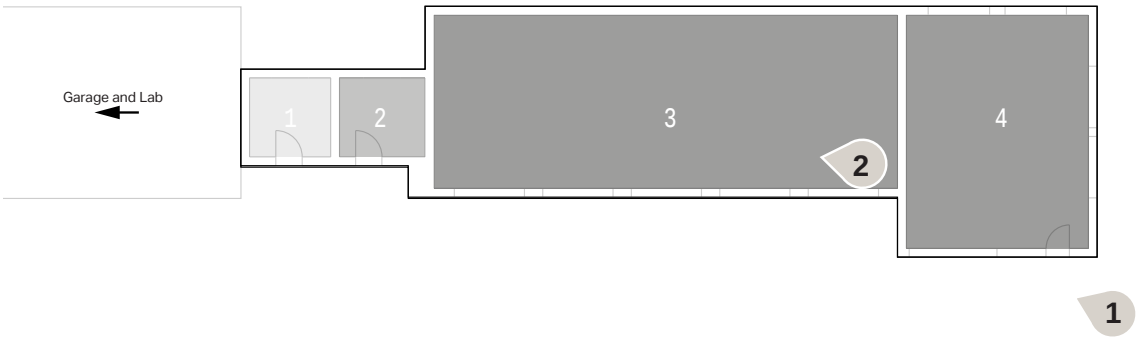
Directly adjacent to the Garage and Lab (1107), the Garage and Shop building contains additional garages for mowers and golf carts as well as wall space for general tool storage. Between the Garage and Building 1107 are two small storage rooms that store hazardous materials such as oils and fuels. These materials require additional caution and have restricted access to qualified employees only to protect employees from toxic fumes and fire hazards. On the far end is the main mechanic shop where vehicles, tools, and equipment are maintained. The structure is concrete masonry with a brick facade. All on-site workers have access to the garages and shop.

Primary Use: Storage / Site Support

Assets & Equipment:

- 2 storage rooms
- 4 garage spaces
- Lawn mowers
- Golf carts
- 1 shop

1108 Garage and Shop | Plat 22 - *Continued* *1,775 NSF | 2,268 GSF*



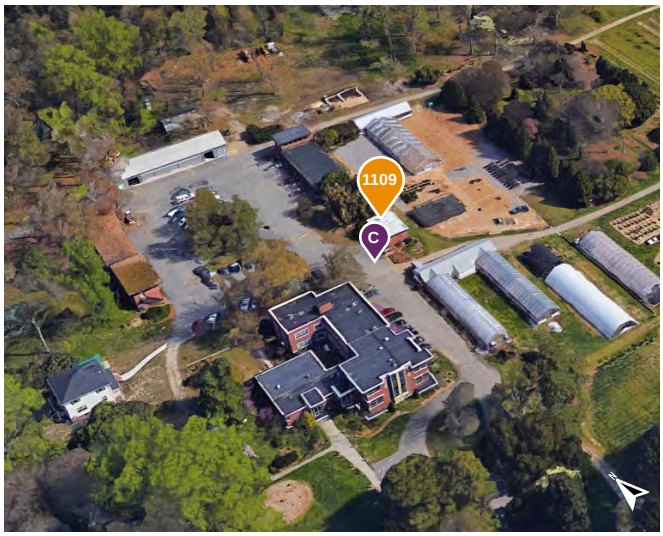
Legend

1. Storage
2. Hazardous Materials Storage
3. Golf Cart and Mower Garage
4. Mechanic Shop

Garage / Shop
Hazardous Materials Storage
Tools / Storage

1 5 10 20 40 80

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Hazardous Storage	Hazardous Storage	Hazardous Materials Storage	90	-	Restricted Access
Shop	Shop	Mechanic Shop	550	-	-
Storage	General Storage	Storage	85	-	-
Storage	Equipment Storage	Golf Cart and Mower Garage	1050	-	-



1109 Boiler House | Plat 22

560 NSF | 645 GSF

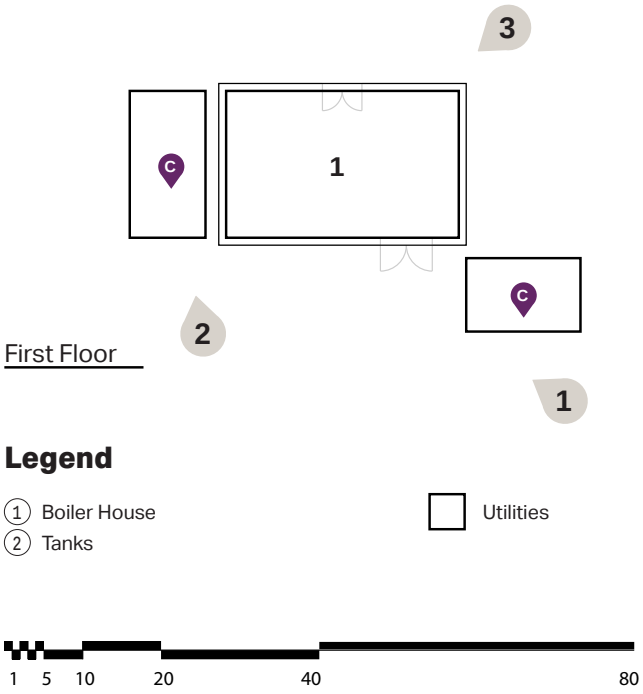
The Boiler House is the central heating and cooling facility for the entire site. The building houses two electric boilers which rotate use throughout the year for maintenance and upkeep. In the event of a failure, there is an additional natural gas with diesel backup boiler system. Three large tanks are located on the sides of the building and feed into the system. The space is also being used for storage of small miscellaneous tools. Under a grate in the center of the building, a tunnel leads to the fallout shelter under the double greenhouse and headhouse building. The building is concrete masonry with brick cladding. Access is restricted to building maintenance personnel.

Primary Use: Utilities

Assets & Equipment:

- 2 electric boilers
- 1 natural gas/diesel boiler
- 3 tanks (Site Support Structure C)

1109 Boiler House | Plat 22 - *Continued* *560 NSF | 645 GSF*



DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Energy	Utilities	Boiler House	560	-	Adjacent tunnel connects to fallout shelter below double greenhouse; currently (2) boilers which rotate use although only one is necessary

1110 Implement Shed | Plat 22

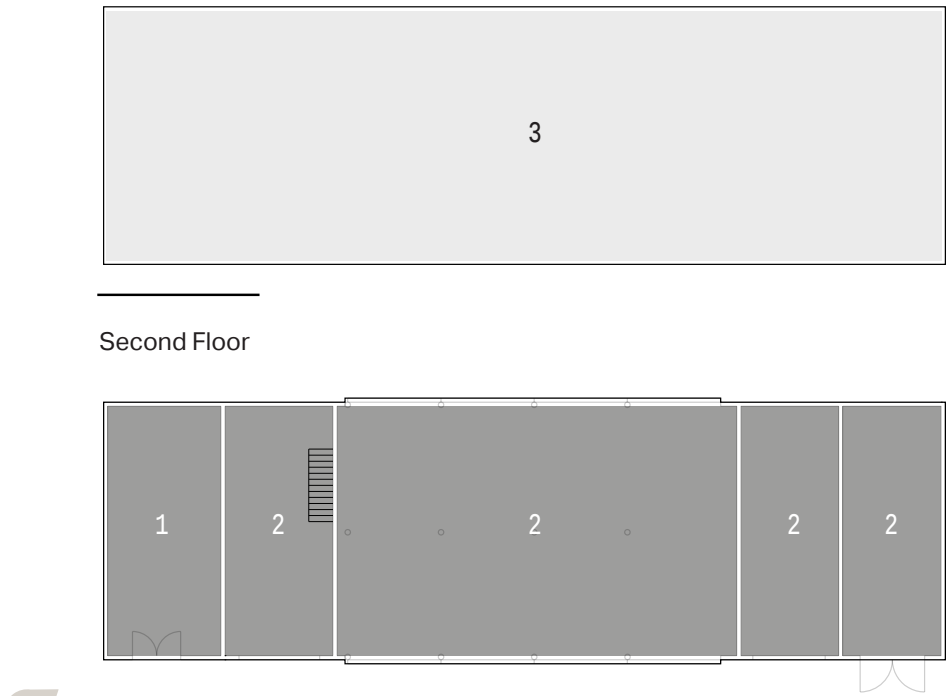
6,400 NSF | 8,000 GSF

Across the main site support area from the Administration Building (1101), the Implement Shed is the main storage facility for tractors and other large equipment. It is wood construction with exterior metal sheathing and roof. At the west end is a wood shop for site equipment maintenance. A large attic is above the entire first floor and serves as a miscellaneous storage area. Only qualified site employees have access to the building and equipment for safety.

Primary Use: Storage / Site Support

Assets & Equipment:

- 1 shop
- 3 small garages
- 1 large garage
- Tractors
- 1 attic



Legend

1. Wood Shop
2. Tractor Garage
3. Attic Storage

Garage / Shop

Tools / Storage

1 5 10 20 40 80

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Shop	Shop	Wood Shop	440	-	-
Storage	Equipment Storage	Tractor Garage	2730	-	-
Storage	General Storage	Attic	3230	-	-

1

Legend

① Quonset Hut

Tools / Storage

1 5 10 20 40 80

1111 Quonset Hut | Plat 23

1,150 GSF

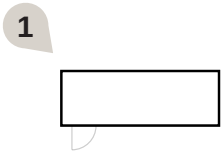
The Quonset Hut provides extra storage for stormwater management research equipment and tools. It is a semi-cylindrical prefabricated metal structure.

Primary Use: Storage

Assets & Equipment:

- Shipping Containers (Site Support Area G)
- Military Surplus Tent (Site Support Area F)

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Storage	Equipment Storage	Quonset Hut	1150	-	-



Legend

1 Pump House (Pond)

Utilities

1 5 10 20 40 80

1112 Pump House | Plat 21

160 GSF

The Pump House supplies pond water when necessary throughout the site. It connects via a 3" pipe to a series of pumps that run along the main turfgrass plats. Connecting metal piping to these pumps allows for irrigation to every area of the site.

Primary Use: Utilities

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Storage	Equipment Storage	Quonset Hut	1150	-	-

1113 Overwintering Greenhouse | Plat 22 *2,890 GSF*

The Overwintering Greenhouse is used for studies on growing plants and crops in colder temperatures and winter conditions. This requires the greenhouse to be heated throughout the year. A small high tunnel with insect netting is located directly adjacent, serving as a temporary headhouse. The greenhouse is primarily used by researchers, students, and the occasional master gardener if space permits. The structure is a semi-circular aluminum frame covered with plastic film.

Primary Use: Greenhouse / Outreach

Outreach Areas:

Master Gardeners: Greenhouse

Assets & Equipment:

- 1 heated greenhouse
- 1 netted high tunnel (Site Support Area B)

Legend

1 Netted High Tunnel
2 Overwintering Greenhouse

Greenhouse

1 5 10 20 40 80

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Greenhouse	Greenhouse	Overwintering Greenhouse	2890	-	-

1114 Solar Greenhouse | Plat 12

2,700 GSF

The Solar Greenhouse is used for studies on growing plants and crops using passive heating strategies. Similar to the Overwintering Greenhouse, the structure has the potential to be illuminated and air conditioned throughout the year. It is powered by 3 large solar panels which are located directly behind. The greenhouse is primarily used by researchers, students, and the occasional master gardener if space permits. The structure is an arched aluminum frame covered with plastic film.

Primary Use: Greenhouse / Outreach

Outreach Areas:

Master Gardeners: Greenhouse

Assets & Equipment:

- 1 solar powered greenhouse
- Solar panels (Site Support Area A)

1114 Solar Greenhouse | Plat 12 - *Continued* *2,700 GSF*

Legend

1 Solar Greenhouse
2 Solar Panels

Greenhouse
Support / Storage

1 5 10 20 40 80

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Greenhouse	Greenhouse	Solar Greenhouse	2700	-	-

1115 Rain Out / Drought Tunnel | Plat 10 *4,690 GSF*

This high tunnel is designated for rain out and drought research. The structure is a semi-circular aluminum frame covered with plastic film.

Primary Use: Greenhouse

1115 Rain Out / Drought Tunnel | Plat 10 - *Continued* *4,690 GSF*

Legend

1 Rain Out / Drought Research Tunnel

Greenhouse

1 5 10 20 40 80

DEPARTMENT	PLAT	SPACE NAME	GSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Site Support	10	Rain Out / Drought Research Tunnel	4690	-	-

1116 Tenant House | Plat 22

1,690 GSF | 1,920 GSF

The second Tenant House was constructed in 2012 and is located adjacent to the other Tenant House (1102). Like the first residence, it is surrounded by trees for privacy and planned in the traditional four square style with main living areas on the first floor and bedrooms on the second. There are three bedrooms; however, the rooms are large enough for two people to share each if necessary. It is typical wood frame construction suitable for residential use. Graduate students employed by Virginia Tech and performing research at the HR AREC live here throughout the year.

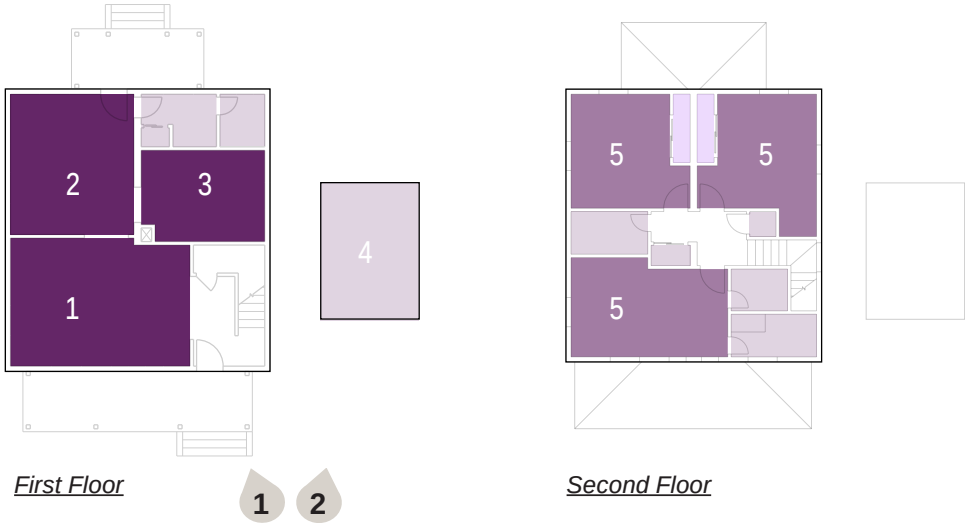
Primary Use: Residential

Assets & Equipment:

- 3 bedrooms
- Shared kitchen, dining, living rooms
- Garage

1116 Tenant House | Plat 22 - *Continued*

1,690 GSF | 1,920 GSF



First Floor **1** **2** *Second Floor*

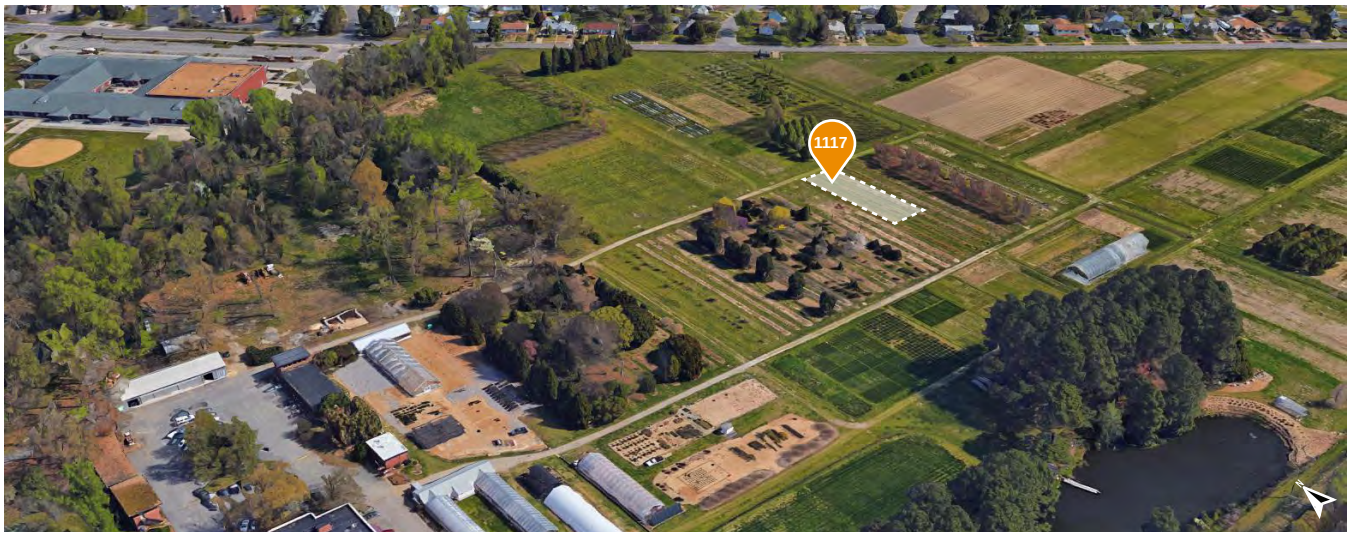
Legend

- Shared Space
- Bedroom
- Storage / Utilities

1. Living Room
2. Dining Room
3. Kitchen
4. Garage
5. Bedroom

1 5 10 20 40 80

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Residential	Shared Living	Kitchen	170	-	-
Residential	General Storage	Garage	200	-	Storage specific to grad students
Residential	Shared Living	Dining Room	270	-	-
Residential	Shared Living	Living Room	350	-	-
Residential	Bedroom	Bedroom	700	(3) Bedrooms with closets	-



1117 High Tunnel | Plat 15 *4,320 GSF*

The High Tunnel provides protection from harsh weather conditions. The structure is aluminum frame with a plastic film cover (temporarily removed). The tunnel is not currently being used for research.

Primary Use: Greenhouse

1117 High Tunnel | Plat 15 - *Continued* *4,320 GSF*

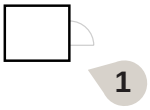
Legend

1 High Tunnel

Greenhouse

1 5 10 20 40 80

DEPARTMENT	PLAT	SPACE NAME	GSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Site Support	15	High Tunnel	4320	-	-



Legend

Utilities

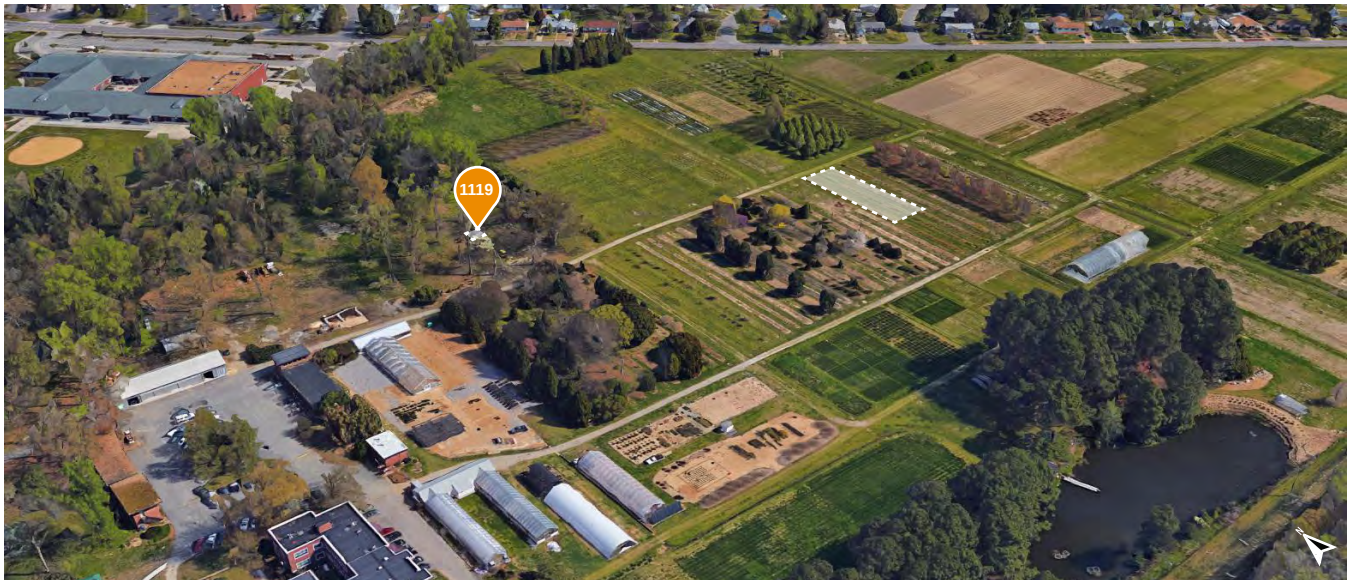
1 5 10 20 40 80

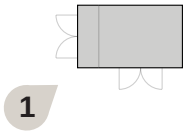
1118 Small Pump House | Plat 12 *55 GSF*

The Small Pump House services the immediate underground irrigation area around the container pad. It is a part of the primary 2" pipe system that spans from the administration area throughout the majority of the research plats.

Primary Use: Utilities

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Energy	Utilities	Small Pump House	55	-	-





Legend

Tools / Storage

1 5 10 20 40 80

1119 Tool Shed | Plat 23 *135 GSF*

The Tool Shed is located on the edge of the woods on Plat 23. It stores tools and equipment.

Primary Use: Storage

DEPARTMENT	SPACE TYPE	SPACE NAME	NSF	ASSETS AND EQUIPMENT	GENERAL COMMENTS
Storage	General Storage	Tool Shed	135	-	-

Site Support

19,270 GSF

LABEL	NAME	PLAT	SPACE TYPE	GSF	ASSETS AND EQUIPMENT	IMAGE
A	Solar Panels	12	Solar Panels	600	-	-
B	Netted High Tunnel	22	Netted High Tunnel	1600	-	
C	Boiler Tanks	22	Boiler Tanks	320	-	
D	Potting Yard	22	Potting Yard	4675	-	
E	Mulch and Bark Supply Bays	22	Mulch and Bark Supply Bays	1200	-	
F	Military Surplus Tent	23	Military Surplus Tent	715	Vehicle Garage - dump truck and fork lift	
G	Shipping Containers (2)	23	Shipping Containers	700	(2) 40' Shipping containers	
H	Government Surplus Equipment Storage	22	Government Surplus Equipment	450	(4) Mobile backup generators	

Existing Conditions

Data Sources: Esri, VGIN, City of Virginia Beach

VT AREC Research Plats
Existing Conditions

Legend

- Site Boundary
- (#) AREC Research Plat Number
- Planned Research Plats
- Fenceline

Turf Research

The AREC performs turf research on several different types of turfgrass including Fescue, Bermuda, Zoysia, and St. Augustine. Research for the National Turfgrass Evaluation Program occurs on 5 year cycles. Just over 15.5 acres are used for turf research.

Site Support

All labs, classrooms, and offices are located on the western edge of the campus. Additional site support elements include equipment garages, a boiler room, a pole barn, a workshop, and pesticide and fertilizer storage. Just over 2 acres of the site is used for support purposes.

Weed Control Research

Weed control research has two designated plats, but also occurs in opportunistic places around the campus including in shaded areas under the dense tree canopies. Weed control research uses just under 4.5 acres of the site.

Horticultural Research

Horticultural research is focused on nursery and greenhouse production questions. Research topics include Methyl Bromide alternatives, phytophthora in irrigation, and nutrient runoff in nursery lots. Horticultural research uses about 6.3 acres of the site.

Organic Material Storage

The debris pile on the north end is older, well broken down, and used for planting media. The piles at the southern end are separated for mulch and large organic debris such as large fallen trees.

Small Fruit Research

Blackberries, strawberries, and kiwi are all part of the small fruit research initiative at the AREC. In addition to the allocated plats, the small fruit research group has its own lab on the second floor of the equipment garage. About 8.3 acres of the site is used for small fruit research.

Demonstration Gardens

The display gardens are managed largely by Master Gardener volunteers and include annual and perennial displays, the arboretum, a riparian buffer exhibit, and a utility line planting exhibit. The public display gardens receive thousands of visitors every year. The display gardens are about 5.25 acres.

Outdoor Storage

Large equipment and materials outdoor storage, including trucks, irrigation pipes, and heavy machinery.

PLAT NUMBER	PRIMARY USE	ADDITIONAL USES	SUMMARY	TOTAL SIZE (ACRES)	ESTIMATED ACREAGE ALLOCATION
1	Public Demonstration	• Annual plants research	Annual garden and woody arboretum	1.76	• 1.76 acres research and demonstration
1.5	Public Demonstration	• None	Perennial Garden	2.37	• 2.37 acres research and demonstration
2	Open	• None	Open turfgrass field	0.64	• 0.64 acres open field
3	Public Demonstration	• Utility line planting research	Utility line planting exhibit	1.35	• 1.35 acres research
4	Public Demonstration	• Education and amenities	Tree trail - 19 mature trees with tree identification educational materials	2.51	• 2.51 acres site approach and tree trail
5	Turfgrass	• Riparian buffer exhibit and research • Apiculture • Entomology (Future)	Shady turfgrass research and the study of insects and pests	4.89	• 1.18 acres Turfgrass • 1.4 acres Entomology • 1.63 acres Riparian Buffer Exhibit (Including Plat 21 area) • 0.03 acres beehives

PLAT NUMBER	BUILT ASSETS	NATURAL ASSETS	UNDER-GROUND IRRIGATION (Y/N)	PUBLIC (Y/N)	GENERAL COMMENTS
1	• 2 benches • Raised drought garden • Plant identification plaques	• 7 Champion Trees • Mature, diverse arboretum ~1.8 ac • Together with Perennial Garden, over 1400 species	Y	Y	Maintenance and care performed by Master Gardeners
1.5	• 1 bench • 1 gazebo • 1 Japanese bridge • 4 compost bins • 8 mailboxes (estimate) • 1 garden arch • 1 port-a-john	• Together with Annual garden, over 1400 species	Y	Y	Plat is unnumbered on VT resources. Individual demonstration areas have their own characteristics such as scarecrows, mailboxes, pergolas, etc.
2	• None	• Turfgrass • Tree buffer between Plats 1 and 2	Y	Y	Open field is not used for parking during events
3	• Mock utility line	• Understory trees and shrubs	N	Y	The mock utility line is a partnership with Dominion Energy to research and demonstrate appropriate planting near above ground utility lines
4	• ~16 picnic tables • 19 tree identification plaques	• 19 trees in tree trail	N	Y*	This plat is within the locked area of the site, but is used during outreach/alumni events
5	• 2 benches • Plant identification plaques • VT Memorial • Beehives • Septic tanks	• Native riparian buffer exhibit • Mature tree cover	N	Y*	This plat is within the locked area of the site, but has a riparian buffer exhibit, a memorial garden for the 2007 Virginia Tech shooting, master gardener beehives, and is the site of the future entomology research plat

PLAT NUMBER	PRIMARY USE	ADDITIONAL USES	SUMMARY	TOTAL SIZE (ACRES)	ESTIMATED ACREAGE ALLOCATION
6	Turfgrass	• Weed control research	Shady turfgrass, annual weed control trials, bamboo control	9.17	• 6 acres Turfgrass • 3.15 acres Weed Control Trials
7	Weed Control	• None	Full plat dedicated to weed control trials	1.23	• 1.23 acres Weed Control
8	Turfgrass	• None	Performance of NTEP trials. Trials last 5 years	1.85	• 1.8 acres Turfgrass
9	Turfgrass	• None	St. Augustine turfgrass research	0.41	• 0.41 acres Turfgrass
10	Turfgrass	• Covered and outdoor turf research	St. Augustine and Fescue turfgrass and drought-tolerant turfgrass research	0.73	• 0.73 acres Turfgrass
11	Turfgrass	• None	Long-term turfgrass research	1.39	• 1.39 acres Turfgrass
12	Horticulture	• None	Nursery replication research and container plant research	0.91	• 0.91 acres Horticulture
13	Turfgrass	• None	Permanent Bermuda grass research	3.55	• 3.55 acres Turfgrass

PLAT NUMBER	BUILT ASSETS	NATURAL ASSETS	UNDER-GROUND IRRIGATION (Y/N)	PUBLIC (Y/N)	GENERAL COMMENTS
6	• None	• Planted grove ~ 4.13 acres • Bamboo stand ~0.17 acres	N	N	Approximately 1/3 of the plat is dedicated to annual weed control trials. The remaining 2/3 of the plat focuses on turfgrass research, including shade tolerant turfgrass
7	• 1 Utility Box	• Turfgrass	N	N	
8	• None	• Turfgrass	N	N	Plat currently used for 3 separate NTEP trials. Local turfgrass professionals visit the site for conferences/ events regarding research results.
9	• None	• Turfgrass	Y	N	
10	• Rainout building • Weather station	• Turfgrass	N	N	The rainout building allows drought-tolerant research to be performed in the same plat as the exposed St. Augustine and Fescue research
11	• None	• Turfgrass	N	N	Long-term turfgrass research - Tall Fescue and Bermuda
12	• Solar greenhouse with panels • 2 container pads • Pump house	• Container plants, i.e. grasses, hydrangea	Y	N	
13	• None	• Turfgrass	Y	N	Fully underground irrigated turfgrass field dedicated permanently to Bermuda turfgrass research

PLAT NUMBER	PRIMARY USE	ADDITIONAL USES	SUMMARY	TOTAL SIZE (ACRES)	ESTIMATED ACREAGE ALLOCATION
14	Horticulture (Future)		Organic Research	3.25	• 3.25 acres Horticulture
15	Small Fruit	• Boxwood research integrated in traditional small fruit research	Kiwi, Boxwood, and Blackberry research	4.19	• 4.19 acres Small Fruit
16	Open		Old woody arboretum	1.61	• 1.61 acres old woody arboretum • Capacity for new Smart Greenhouse
17	Horticulture		Currently inactive	1.26	• 1.26 acres Horticulture
18	Small Fruit		Strawberry research	4.18	• 4.18 acres Small Fruit
19	Horticulture		Simulated container nursery	2.24	• 2.24 acres Horticulture

PLAT NUMBER	BUILT ASSETS	NATURAL ASSETS	UNDER-GROUND IRRIGATION (Y/N)	PUBLIC (Y/N)	GENERAL COMMENTS
14	• Weather station • Seismograph	• Open field	N	N	Currently unused, the field has to be intervention-free for three years before receiving organic certification. The AREC is in the process of applying for organic research certification.
15	• Vine/Tree trellises • Small mammal fencing • High tunnel	• Boxwood plants • Kiwi stands • Blackberry bushes	N	N	The boxwoods require special care due to the threat of 'boxwood blight'. Boxwood cultivation requires well-drained soil.
16	• None	• Mature tree cover, ~ 1ac	N	N	Older woody arboretum. The westernmost portion of the plat is designated for a new greenhouse, if funding is received.
17	• None	• Open field • Tree buffer	N	N	Plat is dedicated to Horticultural research and was used as such before the horitculture specialist retired. The plat is currently unused but remains available for horticultural research. If other research needs arise, the plat could change use.
18	• 2 strawberry patches	• Mature tree buffer	N	N	Strawberry cultivation requires well-drained soil.
19	• Container pad • Irrigation runoff catchment • Raised beds • Irrigation tanks	• Open field	N	N	

PLAT NUMBER	PRIMARY USE	ADDITIONAL USES	SUMMARY	TOTAL SIZE (ACRES)	ESTIMATED ACREAGE ALLOCATION
20	Horticulture	• Currently collaborating with Eastern Shore AREC. Typically fully horticultural research.	Collaboration with Eastern Shore AREC	1.96	• 1.96 acres Horticulture
21	Irrigation	• Stormwater catchment and water-based research	Pond research includes floating wetlands, stormwater, and waterborne fungi	2.09	• 1 acres stormwater/ irrigation pond
22	Site Support	• Labs, housing, administrative offices, garages, and storage	The main activity center for the AREC	5.77	• 5.77 acres site support
23	Storage	• Buffer	Areas of this plat are used for organic material storage and large equipment storage	7.93	• 0.3 acres organic material storage • 0.66 acres large equipment storage • 6 acres dense woods • 1 acres canopy coverage
24	Buffer		The narrow point of the plat contains the eastern VT AREC sign	.08	• 0.08 acres open
25	Storage	• Buffer	Areas of this plat are used for organic material storage	3.96	• 0.26 acres organic material storage • 3.5 acres dense woods • 0.2 acres open field

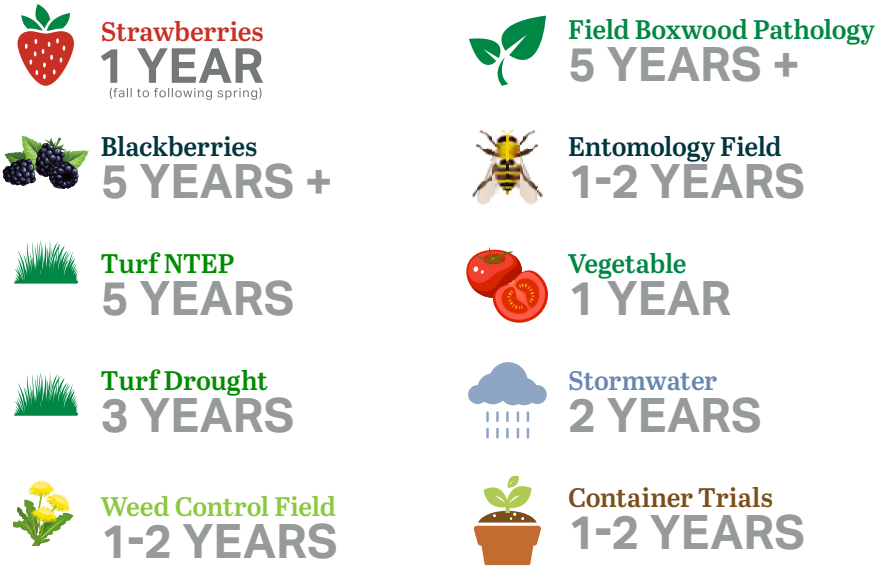
PLAT NUMBER	BUILT ASSETS	NATURAL ASSETS	UNDER-GROUND IRRIGATION (Y/N)	PUBLIC (Y/N)	GENERAL COMMENTS
20	• None	• Open field	N	N	The plat is typically dedicated to horticultural research but is currently being shared with the Virginia Tech Eastern Shore Extension for an experiment.
21	• Pump house and pier	• Stormwater/ irrigation pond • Buffer woods	N	N	Pond research: Comparing pond water to well water; floating wetlands; stormwater catchment; fungal research; irrigation testing
22	• Office and administrative building • 2 graduate houses • 2 garages • 3 storage buildings • 2 headhouses • 4 greenhouses • 2 boilers	• Rain garden • Mature trees • Educational gardens	N	Y*	The Site Support area is gated and not open 24/7, however there are several public amenities in this area. The classrooms and gardens are all used for outreach events.
23	• 1 quanset hut • 1 large storage tent • 2 shipping containers	• Dense woods	N	N	The plat is used for informal storage of large equipment and organic material such as tree debris. The shaded areas provided by the dense woods have been used to perform shade-dependent research in the past.
24	• 1 VT AREC sign	• Light canopy coverage	N	N	
25	• None	• Organic material storage	N	N	

Virginia Tech Hampton Roads AREC
Grant Funding – Fiscal years 2019-2022

	FY 2019	FY 2020	FY 2021	FY 2022
Del Pozo-Valdivia, Alejandro* **Entomology**	-	-	$39,638.00	$341,323.23
Derr, Jeffrey F. **Weed Science/Turf**	$254,313.66	$232,358.30	$132,934.72	$128,147.91
Fox, Laurie J. **Landscape**	$12429.45	$8,209.00	-	-
Hong, Chuanxue **Plant Pathology**	$5,966.25	$92,251.00	$4,299,148.68	$247.50
Kong, Ping **Plant Pathology**	$53,696.27	$108,780.20	$149,292.82	-
Owen, James S.** **Nursery Production**	$29,000.00	$45446.5	-	-
Sample, David J. **Stormwater Management**	$230,993.64	$22630.67	$40,400.00	$124,973.70
Samtani, Jayesh B. **Small Fruit Production**	$10,391.00	$148238	$60,236.23	$135,800.00
Schultz, Peter B.*** **Entomology**	$46,990.00	$33,915.00	-	-
TOTAL	$643,779.87	$692,732.67	$4,721,650.45	$730,492.34

*Alejandro Del Pozo-Valdivia joined the HRAREC in August 2020 ** James Owen left employment at HRAREC in January 2020. *** Peter Schultz retired in February, 2020.

Virginia Tech Hampton Roads AREC
HRAREC Field and Container Research Trials
(Length of trials)



1.

Located in the southwest corner of the parcel, Plat 1 contains the annual trial garden and part of the woody arboretum. Master Gardeners grow and test annual specimen seeds every year for major seed suppliers; Plat 1 is used as a testing ground as well as an advertising arena for successful annuals due to its public nature. The majority of maintenance and care for this plat, as well as the unnumbered plat adjacent to it, is performed by the Master Gardener volunteer groups. Plat 1 is open to the public 24/7.

Research Type: Public Demonstration

Size: 1.76 acres

Built Assets:

- 2 benches
- Raised xeriscape garden
- Plant identification plaques

Natural Assets:

- 7 Champion Trees
- Mature, diverse arboretum, approximately 1.8 acres
- Together with Perennial garden, over 1400 plant species

1.5

Located between Plats 1 and 3, this unnumbered plat contains the perennial garden and part of the woody arboretum. Master Gardeners grow and tend perennial gardens year-round with themes such as Peter Rabbit's Garden and a Japanese Garden, complete with garden structures. The unnumbered plat is open to the public 24/7.

Research Type: Public Demonstration

Size: 2.37 acres

Built Assets:

- 1 Bench
- 1 Gazebo
- 1 Japanese Bridge
- 4 Compost Bins
- 1 Pergola
- 8 Mailboxes (estimate)
- 1 Port-a-John

Natural Assets:
Together with the Annual garden, over 1400 plant species

2

Located in the southwest corner of the parcel adjacent to Diamond Springs Road and the utility easement corridor, Plat 2 is an open turfgrass field not currently used for research. During events, cars do not park in the field.

Research Type: Open

Size: 0.64 acres

Built Assets:

- None, open field
- Natural Assets:
- Turfgrass
- Tree buffer between Plats 1 and 2

3

Plat 3 is on the southern end of the site within the state-owned parcel, along with Plats 1 and 2. AREC partnered with Dominion Energy to construct a Utility Line Planting Display that uses a mock utility line to exhibit appropriate tree and shrub plantings near live wires. The southernmost end of Plat 3 abuts one of the dense wooded areas on site that contains a mulch pile and organic dump pile.

Research Type: Public Demonstration

Size: 1.35 acres

Built Assets:

- Mock utility line

Natural Assets:

- Understory trees and shrubs

4

Located at the main entrance of the AREC, Plat 4 has a tree trail of approximately 15 different mature trees with identification plaques that educate visitors about tree identification techniques. There is also a picnic area under the canopy on the upper right side of the plat. This is the main approach to the site and provides a welcoming sense of arrival for staff and guests.

Research Type: Public Demonstration

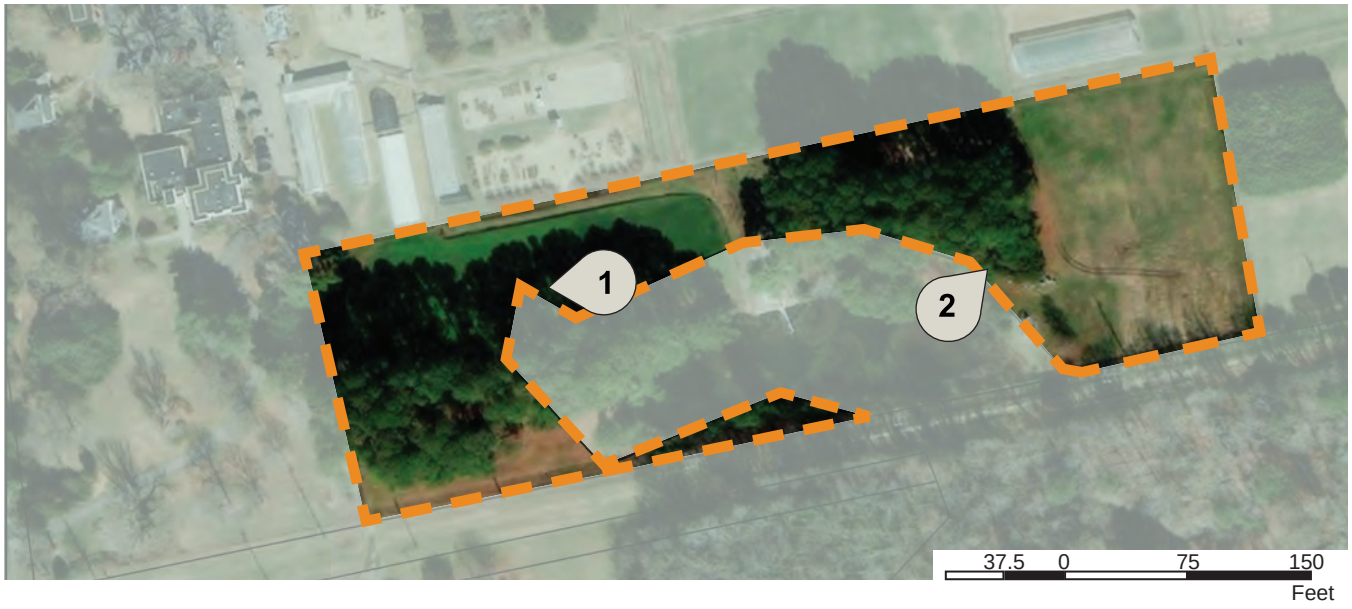
Size: 2.51 acres

Built Assets:

- 16 picnic tables (estimate)
- 15 tree identification plaques

Natural Assets:

- Turfgrass
- Mature trees



5

Plat 5 runs along the southern border of the western side of the site, parallel to the former Norfolk Southern railroad tracks. Plat 5 contains several different assets, including a pond that is used for stormwater collection and site irrigation. The parcel containing the pond is owned by the City of Norfolk; the parcel north of the pond is owned by the City of Virginia Beach. Plat 5 has beehives maintained by the Master Gardeners, a memorial to the victims and survivors of the 2007 Virginia Tech shooting, and a native riparian buffer exhibit. The plat is not always publicly accessible. The open field on the right hand side of the plat will host entomology research in the future.

Research Type: Shaded turfgrass and an education display for a native riparian buffer.

Size: 4.89 acres

Built Assets:

- 2 Benches
- Beehives
- Memorial
- Septic Tanks
- Plant identification plaques

Natural Assets:

- Mature tree cover
- Riparian buffer area, 1 acre (estimate)

6

Plat 6 is in the southeastern-most corner of the parcel and focuses on both turgrass and weed control research. Weed control trials are conducted annually and the planted groves of trees help create an shady environment for shaded turfgrass research.

Research Type: Turfgrass and Weed Control

Size: 9.17 acres

Built Assets:

- None, open field

Natural Assets:

- 2 Planted Groves, 4.13 acres (estimate)
- Bamboo Stand, 0.17 acres (estimate)
- Open turfgrass field

7

Plat 7 is on the southeastern side of the site and is adjacent to Bayside Road. Primarily used for weed control trials, the plat is bordered on three sides by turfgrass research plats. A mounted utility box stands between the border of Plat 7 and Plat 6.

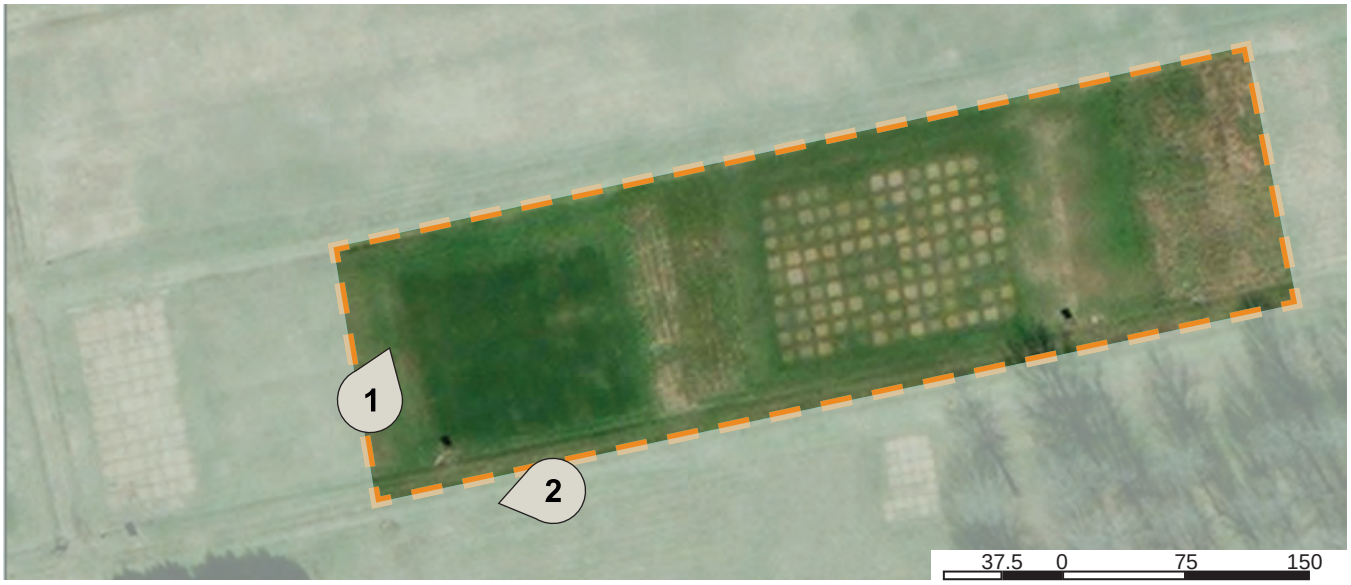
Research Type: Weed Control

Size: 1.23 acres

Built Assets:

- Mounted Utility Box

Natural Assets:
Open field



8

Plat 8 is divided into 5-feet by 5-feet grids for National Turfgrass Evaluation Program (NTEP) trials. NTEP research lasts for five years per trial. The AREC hosts local turfgrass experts and clients every year to demonstrate research results and to discuss turfgrass management. Current research is testing three different turfgrasses.

Research Type: Turfgrass

Size: 1.85 acres

Built Assets:

- None, open field

Natural Assets:

- Open turfgrass field
- 3 turfgrass trials

9

Plat 9 is dedicated to St. Augustine turfgrass research. It is one of the five areas on site that is irrigated via underground irrigation.

Research Type: Turfgrass - St. Augustine

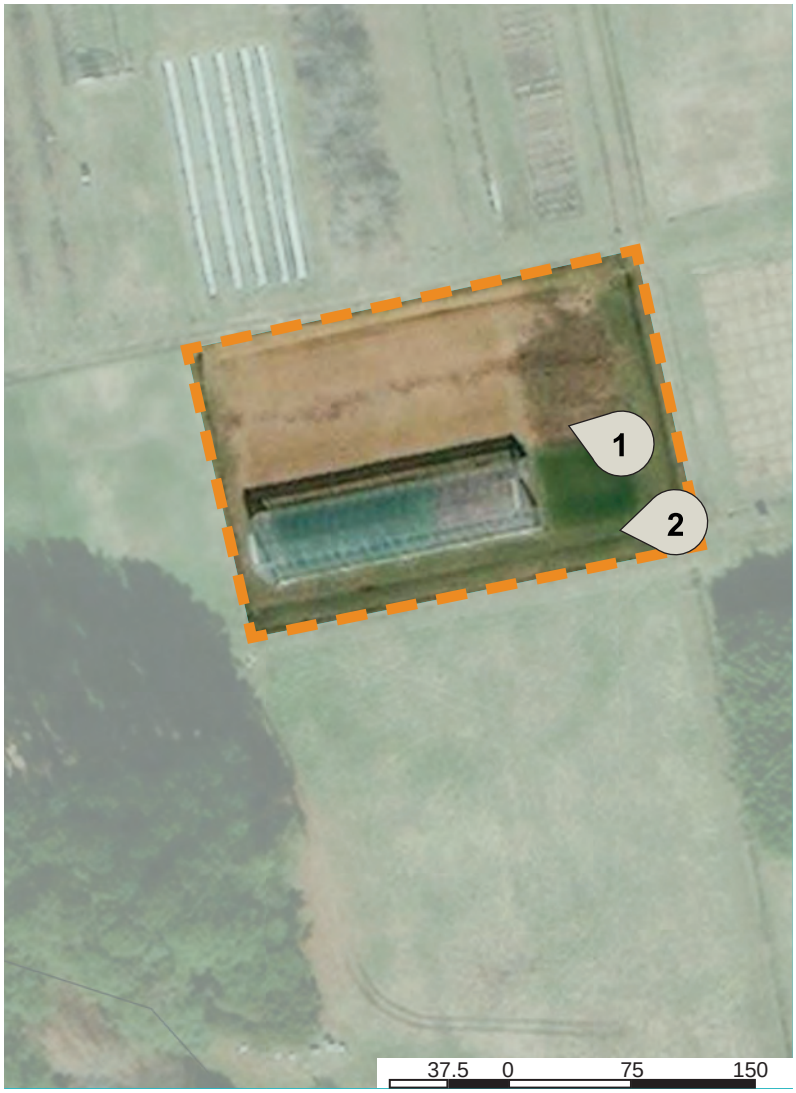
Size: 0.41 acres

Built Assets:

- None, open field

Natural Assets:

- Turfgrass



10

Plat 10 is dedicated to turfgrass research, including drought tolerance. The rain-out shelter creates drought conditions on site, allowing half the plat to be used for water-scarce treatment and the other half to receive field treatment.

Research Type: Turfgrass - Tall Fescue and St. Augustine

Size: 0.73 acres

Built Assets:

- Rain-out Shelter
- Weather Station

Natural Assets:

- Open turfgrass field

11

Plat 11 is used for long-term turfgrass research for Tall Fescue and Bermuda grass research. While this is long-term research, it does not follow the same timeline as the five-year cycle National Turfgrass Evaluation Program (NTEP) trial research plat.

Research Type: Turfgrass

Size: 1.39 acres

Built Assets:

- None, open field

Natural Assets:

- Open turfgrass field

12

Plat 12 is located adjacent to the main site support area and is used for nursery replication research and container plant research. The plat has the only solar-heated greenhouse on the property.

Research Type: Horticulture

Size: 0.91 acres

Built Assets:

- Solar greenhouse with panels
- 2 container pads
- Pump house

Natural Assets:

- Container plants such as grasses and hydrangeas

13

Plat 13 is dedicated to permanent Bermuda grass research. One of the largest research plats on site, it has full underground irrigation. There is a weather station and seismograph between the border of Plats 13 and 14.

Research Type: Turfgrass

Size: 3.55 acres

Built Assets:

- None, open field

Natural Assets:

- Open turfgrass field

14

The AREC is in the process of applying for organic research certification for Plat 14. Currently unused, Plat 14 has to be intervention-free for three years before receiving organic certification.

Research Type: Horticulture

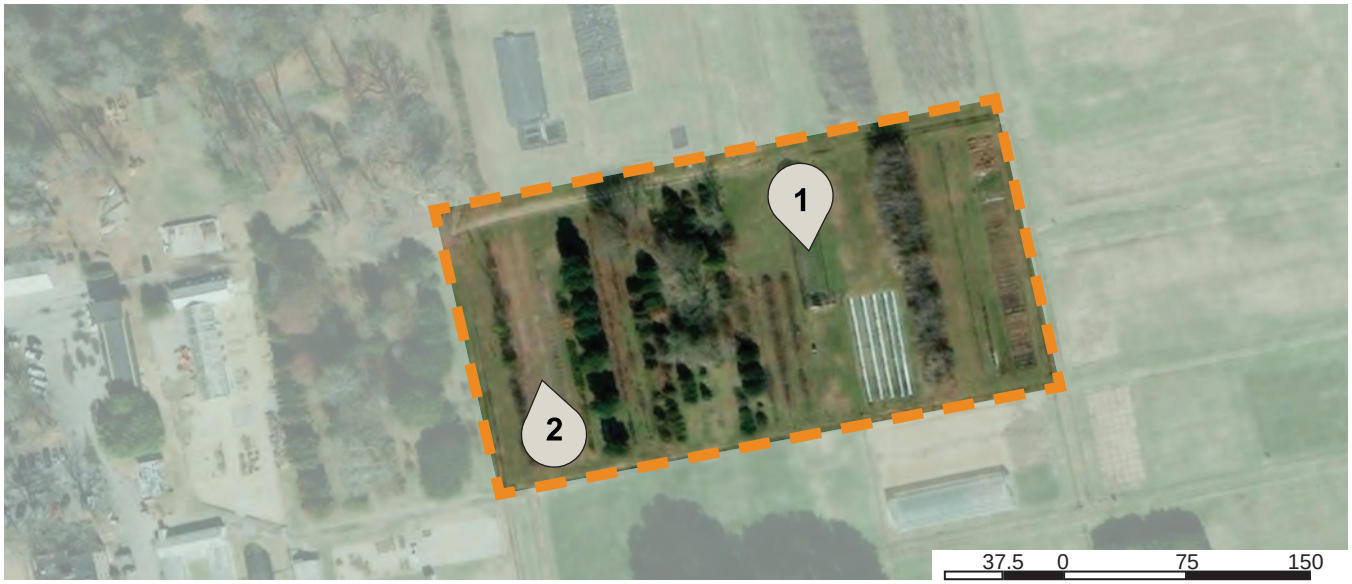
Size: 3.25 acres

Built Assets:

- Weather station
- Seismograph

Natural Assets:

- Open field



15

Plat 15 has a mix of small fruit research including kiwi and blackberry research. The kiwi are grown on metal and wire trellises. The blackberries require protective small mammal fencing and bird deterrence. There is a designated area for boxwood research. The boxwoods require special care due to the threat of 'boxwood blight'.

Research Type: Small Fruit

Size: 4.19

Built Assets:

- Vine and tree trellises
- Small mammal fencing
- High tunnel (uncovered)

Natural Assets:

- Boxwoods
- Kiwi
- Blackberries

16

Plat 16 is the old woody arboretum located adjacent to the main building area. Should the HR AREC receive funding for a new greenhouse and if they stay at the existing site, the greenhouse would be constructed on the eastern portion of Plat 16.

Research Type: Open

Size: 1.61 acres

Built Assets:

- None, tree canopy cover

Natural Assets:

- Tree canopy, 1.5 acres (estimate)

17

Plat 17 is dedicated to horticultural research and was used as such before the horticulture specialist retired. The plat is currently unused but remains available for horticultural research. If other research needs arise, the plat could change use. There is a city-owned building on the plat that is fenced off with access only via Bayside Road.

Research Type: Horticulture

Size: 1.26 acres

Built Assets:

- None, open turfgrass field

Natural Assets:

- Turfgrass field
- Tree buffer between Plats 17 and 14

18

Plat 18 is a large plat dedicated to small fruit research, especially strawberries. The strawberries require well-drained soils because strawberry plants suffer in standing water or with wet roots.

Research Type: Small Fruit

Size: 4.18 acres

Built Assets:

- None, open field

Natural Assets:

- 2 Strawberry patches

19

Plat 19 contains two simulated nursery environments. There is a container pad that supports potted trees and plants with two contained ponds at the southern end of the pad. The ponds are used to determine nutrient runoff from container irrigation. There are also constructed raised beds with underground irrigation tanks.

Research Type: Horticulture

Size: 2.24 acres

Built Assets:

- Container pad
- Irrigation runoff catchment
- Raised beds
- Irrigation tanks

Natural Assets:

- Open field

20

Plat 20 is currently being used in part by the Eastern Shore extension office for zucchini and entomology research, and the remainder of the plat is used to grow seasonal fruits and vegetables by staff. The plat is designated for horticultural research.

Research Type: Horticulture

Size: 1.93 acres

Built Assets:

- None, open field

Natural Assets:

- Zucchini plat
- Fruit and vegetable plat

21

Plat 21 is a parcel owned by the City of Norfolk that contains a pond and a pump house. The AREC graded the property to drain to the pond and operates a pump house that uses the pond to irrigate approximately three acres of the site. The pond is also used for water-based research such as floating wetlands and irrigation research.

Research Type: Irrigation and Stormwater

Size: 2.09

Built Assets:

- Pump house
- Pier

Natural Assets:

- Irrigation pond
- Buffer woods

22

Plat 22 is the site support center for the AREC. It contains the administrative building, labs, classrooms, graduate student housing, garages, and storage that all help serve the site. It is the main activity center for the AREC.

Research Type: Site Support

Size: 5.77 acres

Built Assets:

- Office and administrative building
- 2 graduate houses
- 2 garages
- 3 storage buildings
- 2 headhouses
- 5 greenhouses
- 2 boilers

Natural Assets:

- Rain garden
- Mature trees
- Educational gardens

23

Plat 23 is largely dense woods which have been on site since the plat's original acquisition in 1907. The wood edge was used in the past to conduct shade tolerant research but is not currently used for research purposes. Several types of storage are located in Plat 23 including shipping containers, a quonset hut, a military surplus tent, and uncovered organic storage for materials such as tree debris.

Research Type: Site Support

Size: 7.93 acres

Built Assets:

- 1 quonset hut
- 1 large storage tent
- 2 shipping containers

Natural Assets:

- Dense woods

24

Plat 24 is a small area at the corner of the lot where Bayside Road and Northampton Boulevard intersect. This area is not used for research but it does have light to moderate tree canopy coverage and a sign advertising the AREC.

Research Type: Site Support

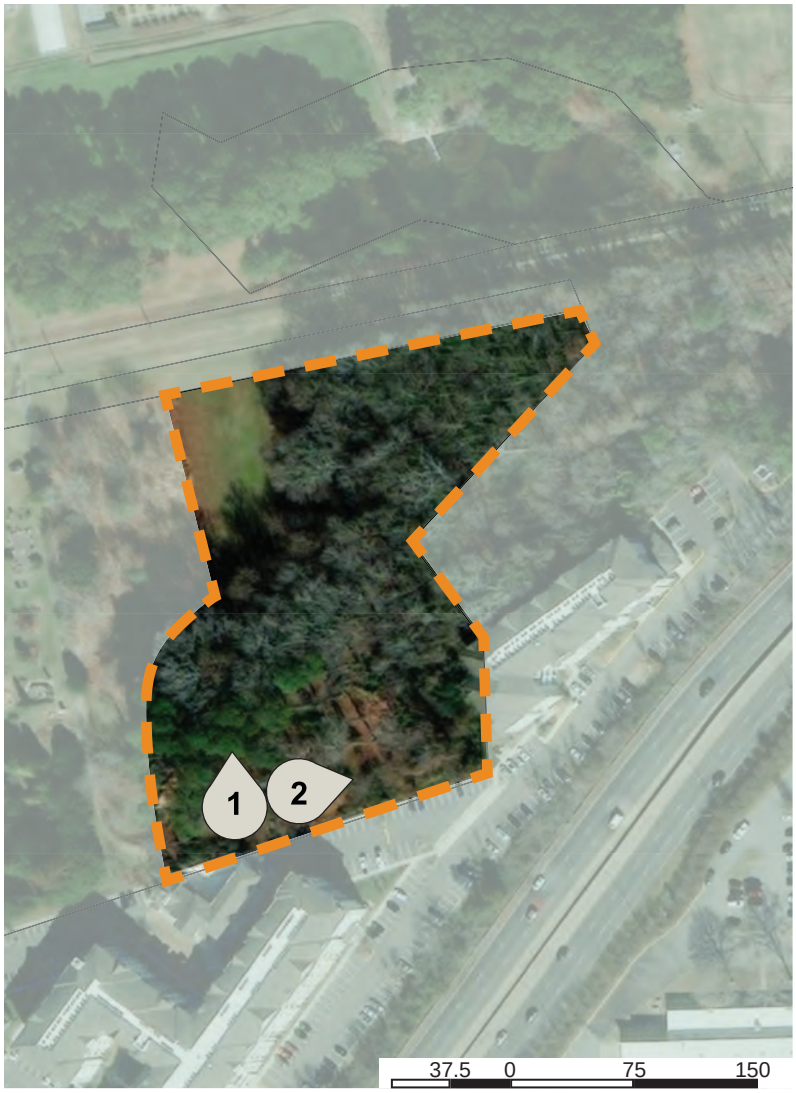
Size: 0.08 acres

Built Assets:

- 1 HR AREC sign

Natural Assets:

- Canopy coverage



25

Plat 25 is mostly dense woods that help buffer the site from the adjacent apartment complex. There are two areas for organic storage in Plat 25. One debris pile is established as a mulch compost area and will provide potting material in time. The second area is designated for large organic material storage and is accessible by large trucks that drop off fallen trees and other similarly scaled organic materials.

Research Type: Site Support

Size: 3.96 acres

Built Assets:

- None, dense woods

Natural Assets:

- Dense woods
- Organic material for potting

Appendix B - AREC User Groups

The Hampton Roads Agricultural Research and Extension Center interacts with dozens of groups and thousands of individuals every year. Individuals and groups visit the HR AREC for educational events such as tours or horticultural classes as well as for recreational activities including the seasonal plant sale and to visit the gardens. The HR AREC compiled a list of all groups and programs that use the HR AREC facilities during any given year, presented below.

Groups/Programs that Utilize the HR AREC

- Virginia Cooperative Extension
- School tours
- Master Gardeners
  - VBMG propagation workshop – hands-on lab demonstration
  - VBMG pollinator/habitat workshop – training
  - VBMG Tree Talks workshop – classes, training, and hands-on demonstrations
  - VBMG Intern training – classroom training
  - VBMG Water Steward garden tours – outdoor tours/ discussion
  - VBMG garden volunteers – 100+ volunteers who devote time to tending the HR AREC gardens
  - VBMG Jr. MG program – classroom training
  - Norfolk MG intern training - classroom training
  - Norfolk MG intern water quality class & tour – classes and tours
  - Portsmouth MG training - classroom training
  - Chesapeake MG training - classroom training
  - Suffolk MG training - classroom training
  - James City/Williamsburg MG intern water quality class & tour – classes and tours
  - Eastern Shore MG intern water quality class & tour – classes and tours
  - Peninsula MG intern landscape design & water quality classes & tour – classes and tours
  - Green Thumb garden talks - meetings
- 4-H
  - Classroom training
  - Shooting Club – use of property
  - Guardians of the Planet – meetings
  - Foragers & Beekeeping Club – meetings
- Educational Activities (Cooperating with area universities and colleges on research projects, assisting with classes, and providing meeting space and tours.)
  - Tidewater Community College – six horticulture classes/labs – outdoor classes
  - Norfolk State University - tours
  - Virginia Wesleyan University (interns, tours, Girls in Science) – source of hourly employees, station tours, meetings
  - Hampton University - tours
  - Old Dominion University – soils class, on-site research
  - Hampton Roads elementary, middle, and high schools - tours
  - Local Vocational Technical programs - tours
  - Local home school programs – tours
  - Virginia Cooperative Extension Master Gardeners - tours
  - Virginia Master Naturalists - tours
  - Norfolk Botanical Garden – sharing information
  - Barry Robinson Center Horticulture Instructors – tours, training
  - Virginia Tech – various researchers (transportation, vegetable, wildlife, forestry, stormwater design)- transportation has used our garages for a research project, seismic monitoring research for HRSD, research on wildlife/game cameras, cooperative stormwater research
  - National Landscape Design School - training
  - Institute for Learning in Retirement - meetings
  - Norfolk Police department – training of dogs
- Non-profits/Non-Governmental Organizations
  - Wetlands Watch – meetings, provide information
  - Lynnhaven River NOW – meetings, provide information
  - Elizabeth River Project – meetings, provide information

- Public (the public utilizes classrooms and demonstration areas)
  - Garden Club of Norfolk - meetings
  - Chesapeake Garden Club - meetings
  - Princess Anne Garden Club - meetings
  - Larkspur Garden Club - meetings
  - Virginia Federation of Garden Clubs Tidewater District - meetings
  - Council of Garden Clubs Virginia Beach - meetings
  - Photographers (hobby & professional) – general public visits
  - Bird watchers (clubs & photography) – general public visits
  - Geocaching – general public visits
  - Dog walkers and trainers – general public visits
  - Scouts – girl, boy, cub - meetings
  - State Fair youth plant ID team - training
  - Hampton Roads Hikers - meetings
  - Virginia Flower & Garden Expo - meetings
  - Family picnics– general public visits
  - Tai Chi exercise – general public visits
  - Plein air painting – general public visits
  - Weddings – general public visits
  - Diamond North apartment residents – general public visits
  - Transitional Housing residents – general public visits

- Funding sources
  - USDA (Specialty Crop Research Initiative, Animal and Plant Health Inspection Service)
  - Federal IR-4 Program (Interregional Research Project Number 4)
  - North American Strawberry Growers Association
  - Horticultural Research Institute (national)
  - Turfgrass Water Conservation Alliance
  - National Turfgrass Evaluation Program (NTEP)
  - Southern Region Small Fruit Consortium
  - Chesapeake Bay Trust
  - Northeast SARE (Sustainable Agriculture Research and Education), Southern SARE
  - Virginia Department of Agriculture and Consumer Services
  - Virginia Specialty Crop Block Grants
  - Virginia Turfgrass Foundation

- Grower organizations HR AREC works with:
  - Virginia Nursery and Landscape Association
  - Virginia Horticultural Foundation
  - AmericanHort
  - Virginia Turfgrass Council
  - Virginia Turfgrass Foundation
  - Virginia Strawberry Growers Association
  - North American Strawberry Growers Association

Appendix C - Soil Report

Hampton Roads AREC Soils Suitability Study

Draft Report – October 10, 2022

W. Lee Daniels, TerraScience LLC

Angela Whitehead, Soil Horizons LLC

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.

Specific Potential Limitations at Brown North

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

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Appendix C.1

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


76° 6' 36" W
76° 3' 57" W
36° 45' 58" N
36° 43' 8" N
401100
401700
402300
402900
403500
404100
404700
4069300
4068700
4068100
4067500
4066900
4066300
4065700
4065100
4064500
Brown Farm
Brenneman Farm
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

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.

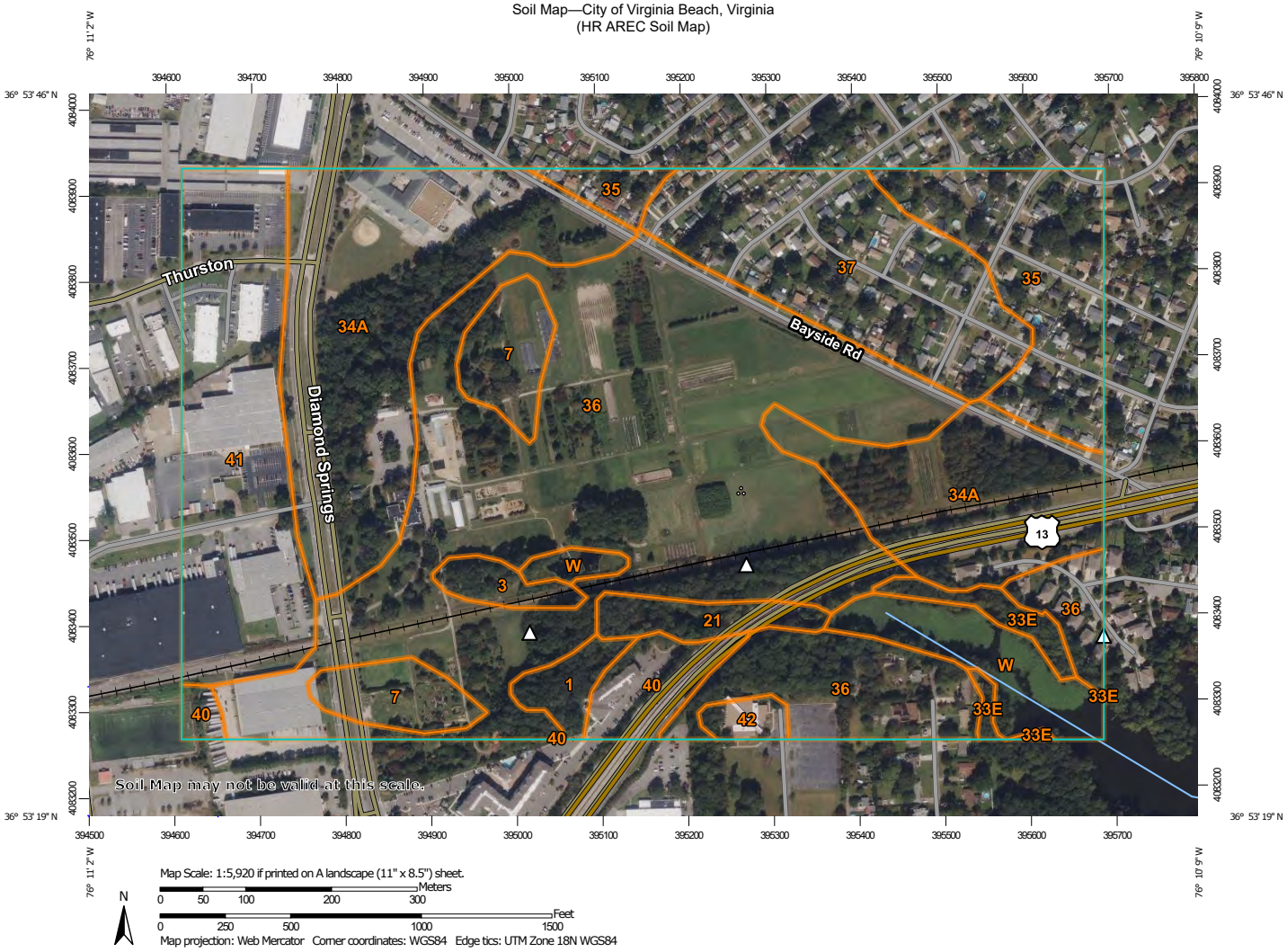
Date(s) aerial images were photographed: Jul 1, 2018—Aug 1, 2018

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 Scale: 1:5,920 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 250 500 1000 1500

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

10/1/2022
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.

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

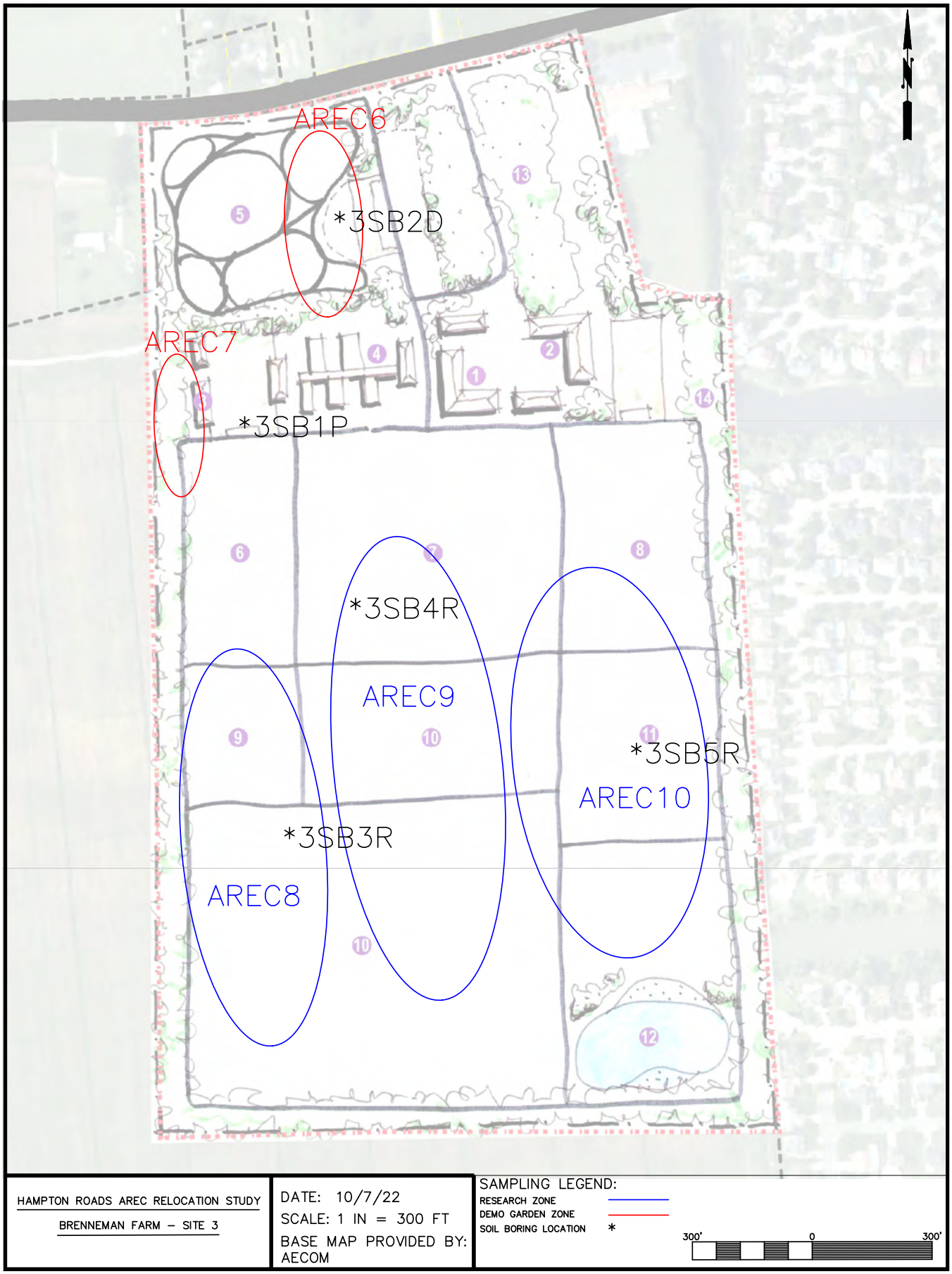
This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

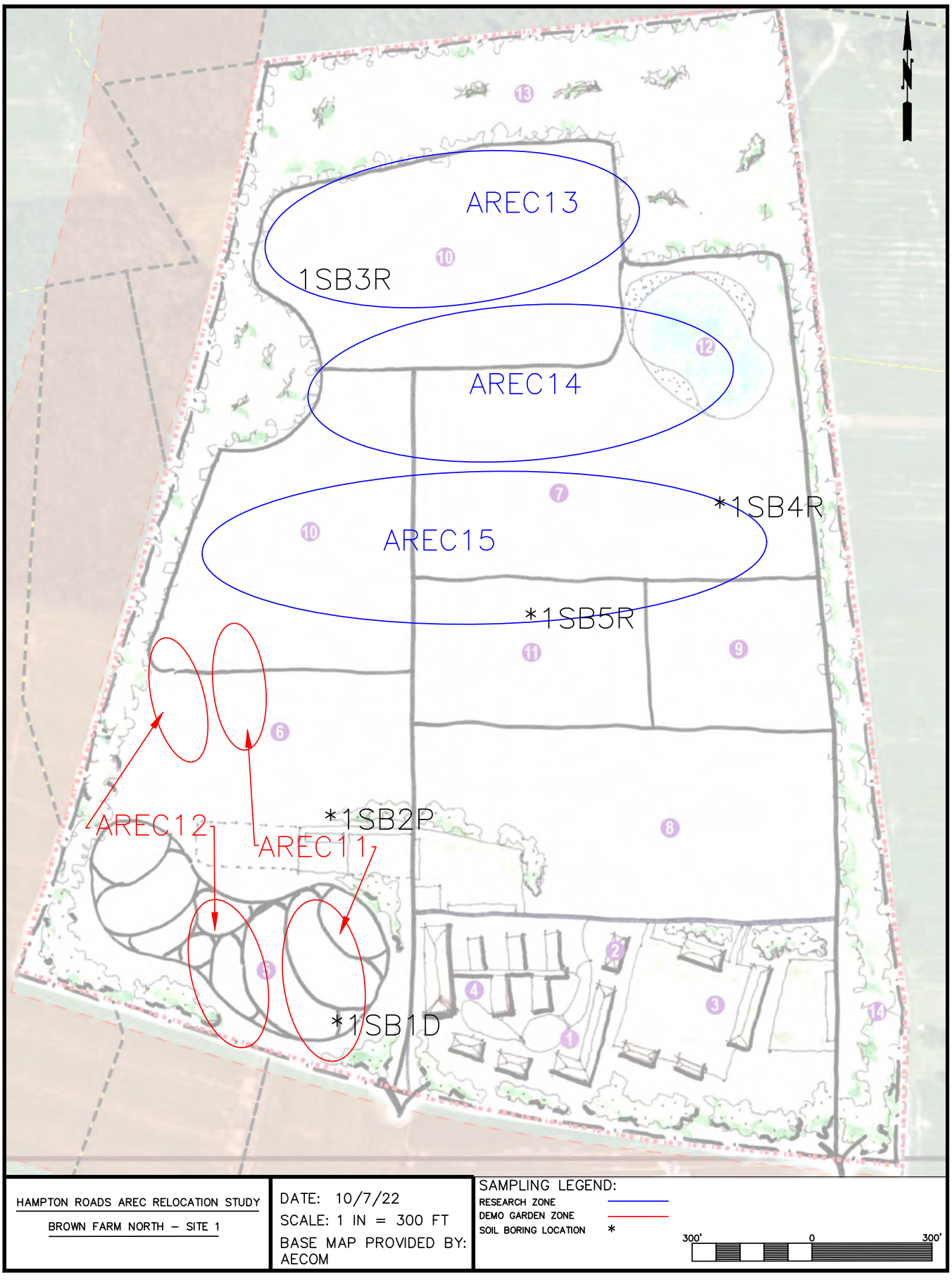
National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

Appendix C.3

Site Soil Sampling Maps for North Landing Road Proposed Sites

and NMP Plot Management & Sampling Plan for the HR AREC


AREC6
*3SB2D
AREC7
*3SB1P
*3SB4R
AREC9
*3SB5R
AREC10
*3SB3R
AREC8
N
HAMPTON ROADS AREC RELOCATION STUDY
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'

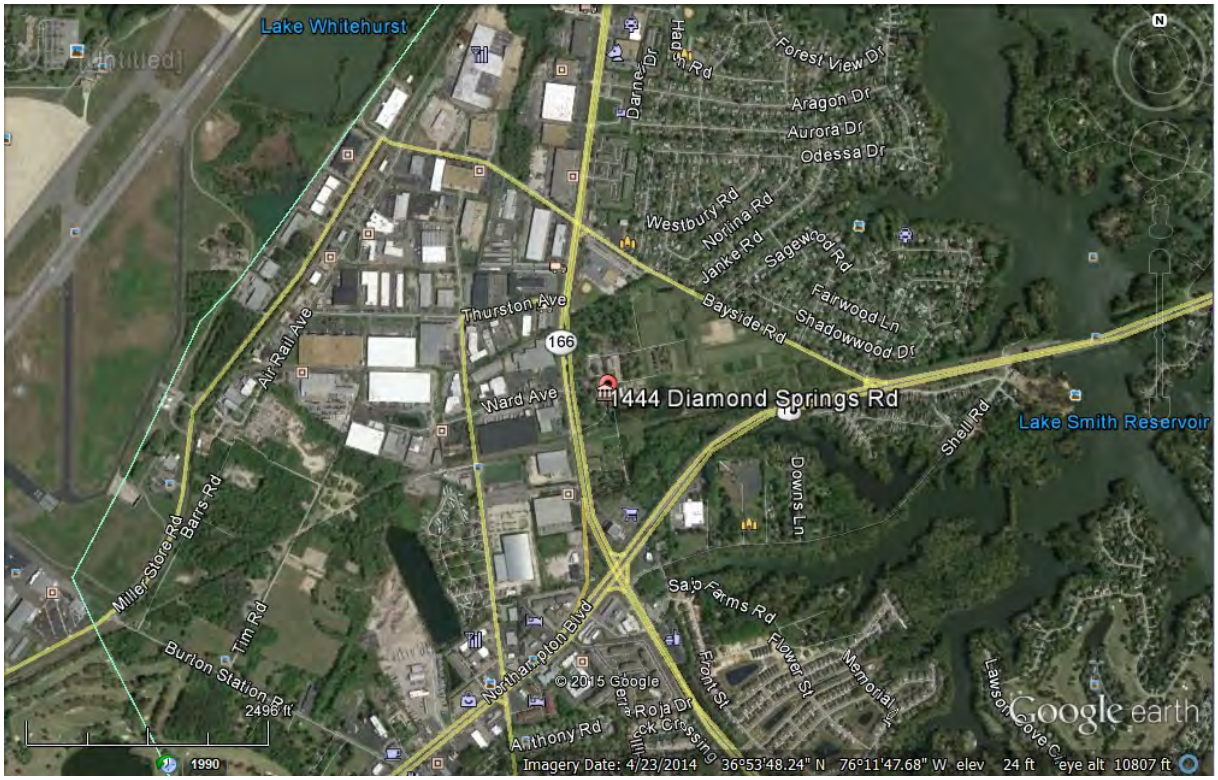

AREC13
1SB3R
AREC14
*1SB4R
AREC15
*1SB5R
AREC12
AREC11
*1SB2P
*1SB1D
N
HAMPTON ROADS AREC RELOCATION STUDY
BROWN FARM NORTH – SITE 1
DATE: 10/7/22
SCALE: 1 IN = 300 FT
BASE MAP PROVIDED BY: AECOM
SAMPLING LEGEND:
RESEARCH ZONE
DEMO GARDEN ZONE
SOIL BORING LOCATION
300' 0 300'


*2SB1R
AREC3
AREC4
AREC5
*2SB2R
*2SB3R
*2SB4P
AREC1
AREC2
AREC6
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'


AURORA DR
ODESSA DR
JANKE RD
DIAMOND SPRINGS RD
HACKLEYSACK RD
WESTBURY RD
NORLINA RD
HEDGEROW DR
ROD LN
SUNNYWOOD DR
FAIRWOOD LN
SAGEWOOD DR
BAYSIDE RD
SHADOWWOOD
*VTSB2
*VTSB1
*VTSB3
PANDORIA CT
PANDORIA AVE
NORTHAMPTON BLVD
SAPPHIRE DR
SHELL RD
HAMPTON ROADS AREC RELOCATION STUDY
EXISTING HR AREC FACILITY
DATE: 10/7/22
SCALE: 1 IN = 500 FT
BASE MAP PROVIDED BY: 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

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

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

3SB2D Image

3SB3R: (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.

Notes: 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.

3SB5R: (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.

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

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

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

2SB2R: (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.

Notes: Increased soil moisture observed 52-60", no free water observed.

2SB3R: (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.

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

2SB4P: (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.

Notes: 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.

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

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

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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 (Ap horizon).
b. Argillic horizon -the zone between 8 and 47 inches (Bt horizon).

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										

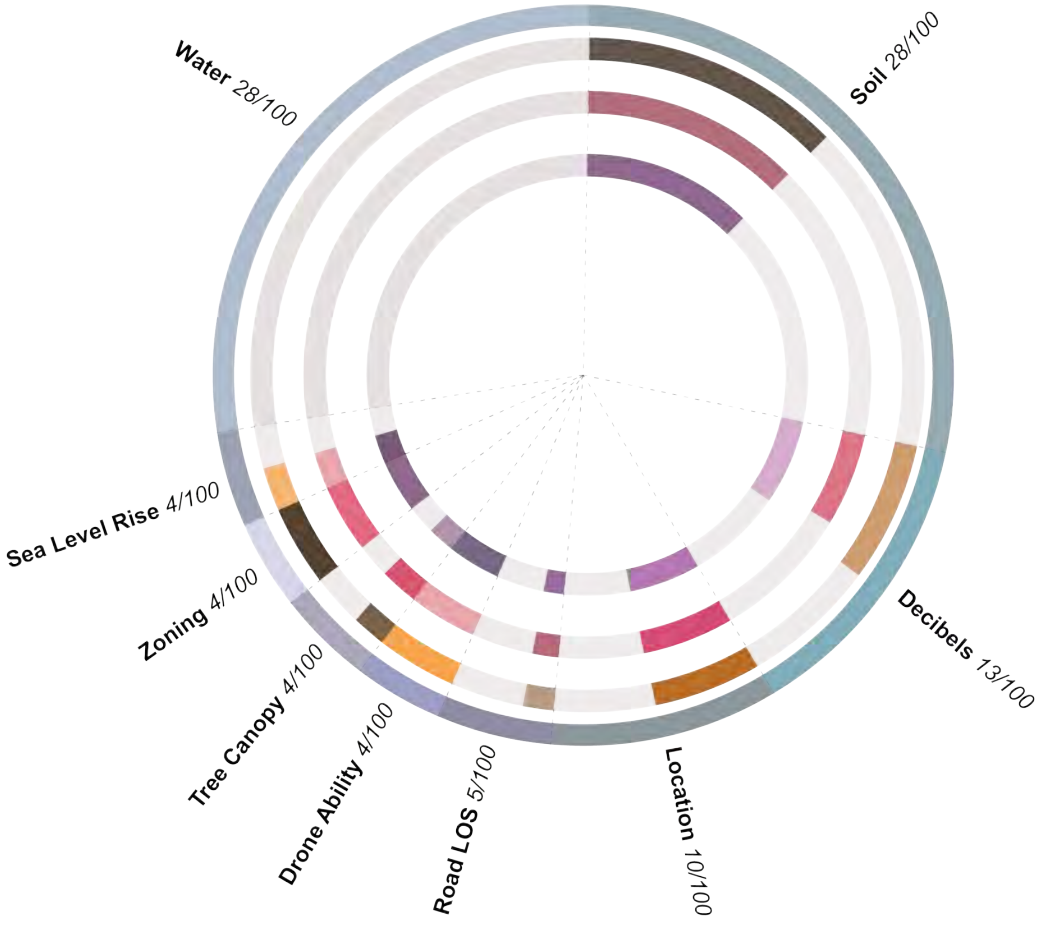
Appendix D - Site Selection Criteria

Site Selection Criteria Development

During the initial data gathering phase, a series of site criteria was developed that identified critical attributes serving the current HR AREC. Additional factors such as distance from major transportation nodes and levels of service on the existing roadways were also included in the site selection criteria since they tangentially support the work of the HR AREC. The weight or importance to decision making was developed on a scale of 0 to100 with input from current HR AREC leadership.

Since all potentially suitable parcels identified in this report were located in the same area, the site criteria weighting did not return weighted values that helped prioritize a specific site; all three parcel options returned the same value. The list and weighting of site criteria is included in this appendix for reference and for use in identifying and prioritizing potential parcels that may be considered in the future.

Site Screening Criteria Summary



Water conditions on site including water table levels and well capabilities are unknown. Water values were not included in this weighted calculation.

Zoning/Land Use Compatibility	
Parcels with Agricultural zoning have the highest compatibility due to the nature of the HR AREC's research. Zoning has a weighted value of 4 out of 100.	**Legend** Very High High Moderate *Low* *Very Low*

Source: AECOM; https://gis.data.vbgov.com/

Location	
10 minutes (mins) (5 mins is the approximate time between I-64 and current HR AREC) was the drivetime established as satisfactory. Sites located greater than 10 mins from major transportation nodes may need additional examination regarding potential partnership impacts. Location has a weighted value of 10 out of 100.	**Legend** Less Than 5 mins 6- 10 mins 11 mins - 15 mins More than 16 mins

Source: AECOM; Esri Street Map

SITE	SCORE	ZONING
VT AREC EXISTING SITE	**3**	**R7.5**
BRENNEMAN FARM	4	AG1
BROWN FARM NORTH	4	AG1
BROWN FARM SOUTH	4	AG1

SITE	SCORE	MINUTES
VT AREC EXISTING SITE	**10**	**5**
BRENNEMAN FARM	5	19
BROWN FARM NORTH	5	20
BROWN FARM SOUTH	5	19

Soil Types		
Description	**Soil Name**	**Legend**
The soil survey is used to evaluate the potential of the soil and the management needed for farming, planning land use, selecting sites for construction, and identifying special practices needed to ensure proper use. The soil's score reflects the intensity of intervention required to create a working landscape. Soil is a critical component of the HR AREC's mission and has a weighted value of 28 out of 100.	Acredale silt loam	*Very High*
	Udorthents	*Very High*
	Augusta loam	High
	Bojac fine sand loam	Moderate
	Nawney silt loam	Low
	Tomotley loam	Low
	Teototum loam	Very Low

Source: USDA, https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

SITE	SCORE	SOIL TYPE
VT AREC EXISTING SITE	**28**	**Teototum/ State**
BRENNEMAN FARM	8	1 Acredale
BROWN FARM NORTH	8	1 Acredale
BROWN FARM SOUTH	8	1 Acredale

3ft Sea Level Rise	
Sea Level Rise (SLR) vulnerability was mapped up to a 3-feet of SLR scenario. No parcels were inundated or directly impacted even in the worst storm scenario; however, access to sites during extreme storm scenarios may be impacted as roads leading to the sites are inundated. SLR has a weighted value of 4 out of 100.	**Legend**
	N/A
	Potential for impacts to access

Source: NOAA, https://coast.noaa.gov/slr/#/layer/slr; https://gis.data.vbgov.com/

SITE	SCORE	3ft SLR
VT AREC EXISTING SITE	**4**	**N/A**
BRENNEMAN FARM	2	Potential access impact
BROWN FARM NORTH	2	Potential access impact
BROWN FARM SOUTH	2	Potential access impact

Urban Tree Canopy Cover		
Description	**UTC %**	**Legend**
The Urban Tree Canopy (UTC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. In addition to environmental and health benefits, canopy coverage also plays a role in research at the HR AREC in their utility line planting exhibit, the arboretum, and shade tolerance studies. The HR AREC's current UTC average is 43.98%. UTC data is only available by parcel; Brown Farm South was assessed at one point below Brown Farm North due to the location of the existing trees. The UTC has a weighted value of 4 out of 100. *Existing tree assets like the arboretum cannot be immediately replaced at a 1:1 value, but existing canopy is important for other research need such as shade tolerance.*	41+	***Substantial***
	31 - 40	Satisfactory
	21 - 30	Suboptimal
	11 - 20	Minimal
	0 - 10	Insufficient

Source: https://gis.data.vbgov.com/

SITE	SCORE	URBAN TREE CANOPY %
VT AREC EXISTING SITE	**4**	**43.98%**
BRENNEMAN FARM	2	0.5
BROWN FARM NORTH	3	14.89
BROWN FARM SOUTH	2	14.89

Average Daily Traffic (ADT)		
Description	**Street Frontage (Feet)**	**Legend**
Average Daily Traffic calculates the average number of vehicles that pass by a designated point daily. Typically, roads with higher ADT values are more accessible. The HR AREC's current position on Diamond Springs Road affords both accessibility and a highly visible position, encouraging public interaction and facilitating external partnerships. ADT has a weighted value of 5 out of 100.	20001 +	***Optimal***
	15000 - 20000	Satisfactory
	10001 - 15000	Suboptimal
	5001 - 10000	Minimal
	0 - 5000	Insufficient

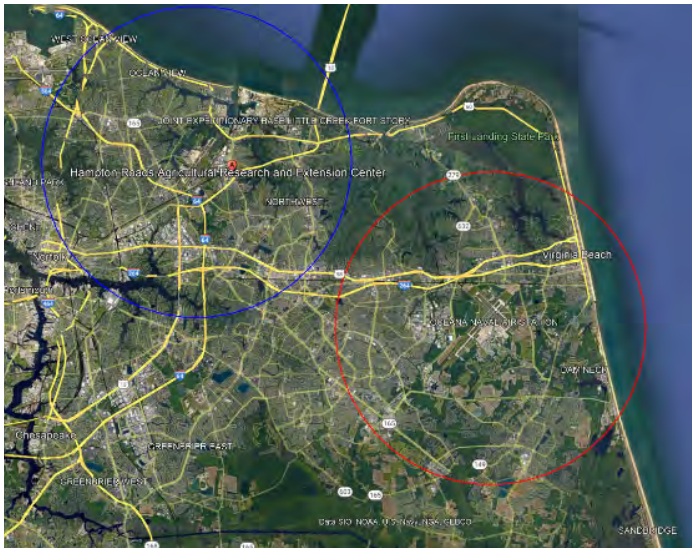
Source: AECOM, VB Gov Transportation Data Management System

SITE	SCORE	ADT (year)
VT AREC EXISTING SITE	**5**	**29,192 (2017)**
BRENNEMAN FARM	1	8,259 (2021)
BROWN FARM NORTH	2	8,259 (2021)
BROWN FARM SOUTH	2	8,259 (2021)

Decibel Level		
Description	**UTC %**	**Legend**
Virginia Beach is home to Naval Air Station Oceana, a master jet base that supports all strike fighter jet squadrons on the east coast. To the southeast of Virginia Beach, in Chesapeake, VA, is Naval Auxiliary Landing Feild Fentress, a military use airport operated by NAS Oceana. Both NAS Oceana and NALF Fentress operate regularly, and Virginia Beach has a robust Air Installation Compatible Use Zone (AICUZ) Program to help guide planning and development in the city. Decibel registers are a component of the AICUZ program, as decibels over 70 for a prolonged period can cause damage to hearing. In addition to noise impact, jet and aircraft noise also produce vibrations that can be detrimental to sensitive equipment without proper insulation. Decibel levels have a weighted value of 13 out of 100.	>75	*Very High*
	70 - 75	High
	65 - 69	Moderate
	<64	Low

Source: AECOM; https://gis.data.vbgov.com/

SITE	SCORE	DECIBEL LEVEL%
VT AREC EXISTING SITE	**13**	**Low**
BRENNEMAN FARM	7	High
BROWN FARM NORTH	6	Very High
BROWN FARM SOUTH	5	Very High



Drone Flying		
Description	**Feet Height Restrictions**	**Legend**
Norfolk International Airport: The Federal Aviation Administration (FAA) requires commercial operators of Model Aircraft to provide notice to FAA Norfolk Tower prior to operating within 5 miles of the airport. FAA Norfolk Tower will assess the activity and provide feedback on whether the intended activity is allowed based on the location with respect to controlled airspace. The assessment does not include any potential for nuisance or privacy issues. NAS OCEANA: No Drone Zone The FAA has prohibited flying Unmanned Aircraft Systems (UAS or "drones") over U.S. Department of Defense installations, including Naval Air Station Oceana and NAS Oceana Dam Neck Annex in Virginia Beach, Virginia, and Naval Auxiliary Landing Field Fentress in Chesapeake Virginia. These naval installations, and others in Hampton Roads, are designated "National Defense Airspace" in Notice to Airmen 7/7282 issued on April 7, 2017. UAS operators who violate this NOTAM may be criminally charged in U.S. District Court under 49 U.S. Code 46307 and punished by fine and/or imprisonment. Unauthorized drone operations are prohibited within five miles of airports. Drone capabilities have a weighted value of 4 out of 100	+400	*No Impact*
	300 to 399	Low Impact
	200 to 299	Moderate
	0 to 199	High Impact

SITE	SCORE	FAA Requirements
VT AREC EXISTING SITE	**4**	**High**
BRENNEMAN FARM	4	Moderate
BROWN FARM NORTH	4	No Impact
BROWN FARM SOUTH	4	High

Source: AECOM;
https://faa.maps.arcgis.com/apps/webappviewer/index.html?id=9c2e4406710048e19806ebf6a06754ad

Appendix E - Cost Model

VT AREC COST MODEL

Summary by New Site — **15 December 2022**

	Brenneman Total research area: 66.24 acres Total site area: 88.50 acres			Brown Farm North Total research area: 76.61 acres Total site area: 109.00 acres			Brown Farm South Total research area: 88.58 acres Total site area: 118.00 acres		
	Construction Cost including CM markups (Q4 '22)	Total Project Cost (Q4 '22)	% of Total	Construction Cost including CM markups (Q4 '22)	Total Project Cost (Q4 '22)	% of Total	Construction Cost including CM markups (Q4 '22)	Total Project Cost (Q4 '22)	% of Total
Buildings and Site Development									
Replacement Buildings	$ 25,185,000	$ 32,237,000	30.4%	$ 25,185,000	$ 32,237,000	31.5%	$ 25,185,000	$ 32,237,000	27.0%
Total Buildings	**$ 25,185,000**	**$ 32,237,000**		**$ 25,185,000**	**$ 32,237,000**		**$ 25,185,000**	**$ 32,237,000**	
Site Preparation	$ 159,000	$ 204,000	0.2%	$ 196,000	$ 251,000	0.2%	$ 212,000	$ 271,000	0.2%
Drainage	$ 6,151,000	$ 7,873,000	7.4%	$ 6,472,000	$ 8,284,000	8.1%	$ 8,140,000	$ 10,419,000	8.7%
Irrigation	$ 2,132,000	$ 2,729,000	2.6%	$ 2,092,000	$ 2,678,000	2.6%	$ 2,360,000	$ 3,021,000	2.5%
Soil Amendment	$ 23,681,000	$ 30,312,000	28.6%	$ 25,845,000	$ 33,082,000	32.4%	$ 29,150,000	$ 37,312,000	31.3%
Buffer	$ 20,769,000	$ 26,584,000	25.1%	$ 12,479,000	$ 15,973,000	15.6%	$ 21,292,000	$ 27,254,000	22.8%
New Pond	$ 856,000	$ 1,096,000	1.0%	$ 903,000	$ 1,156,000	1.1%	$ 1,058,000	$ 1,354,000	1.1%
Hardscape (roadways)	$ 3,849,000	$ 4,927,000	4.6%	$ 6,700,000	$ 8,576,000	8.4%	$ 5,839,000	$ 7,474,000	6.3%
Total, Site	**$ 57,597,000**	**$ 73,725,000**		**$ 54,687,000**	**$ 70,000,000**		**$ 68,051,000**	**$ 87,105,000**	
TOTAL Site + Buildings	**$ 82,782,000**	**$ 105,962,000**		**$ 79,872,000**	**$ 102,237,000**		**$ 93,236,000**	**$ 119,342,000**	

VT AREC COST MODEL

BRENNEMAN — **15 December 2022**

Total research area: 66.24 acres

Total site area: 88.50 acres

BUILDINGS		QTY	UOM	Rate	Total
1.0 Replacement Buildings					
Administration, Education, Research, Outreach		19,299	GSF	$ 497	$ 9,588,186
Greenhouses		16,012	GSF	$ 298	$ 4,772,028
Residential		5,098	GSF	$ 342	$ 1,743,112
Warehouses / Storage / Shops		14,986	GSF	$ 255	$ 3,820,169
Hazardous Material Storage		2,339	GSF	$ 369	$ 862,230
Site Support Building		860	GSF	$ 345	$ 296,875
Site Support Elements		1	LS	$ 3,402,900	$ 3,402,900
Fueling Station		1	LS	$ 237,000	$ 237,000
Dedicated Generator		1	LS	$ 406,000	$ 406,000
Fuel Tanks		1	LS	$ 56,188	$ 56,188
Sub-total Buildings; direct cost					$ 25,184,686
CM/GC markups, including design contingency	20% to 25%				*incl.*
Sub-total Buildings					$ 25,184,686
CT project cost multiplier	28%				$ 7,051,712
TOTAL PROJECT COST: EXISTING BUILDINGS					$ 32,236,399

VT AREC COST MODEL

BRENNEMAN — **15 December 2022**

Total research area: 66.24 acres

Total site area: 88.50 acres

LAND DEVELOPMENT

1.0	**Site preparation**						
	Clear and prepare site (minimal requirements)			88.50	88.50	acres	$ 1,500	$ 132,750
2.0	**Drainage**							
	Drainage ditches (not included in buffer)		14,674 LF					
	Drainage Ditch (assumed 10' wide)			146,740	146,740	SF	$ 25	$ 3,668,500
	Culverts (Assumed Quantity based on road layout)		allow	30		EA	$ 7,500	$ 225,000
	Outfall Structures		allow	15		EA	$ 10,000	$ 150,000
	Tile drain system (quantity is allowance)		30,000 LF					
	Underground pipe infrastructure, including pipe, connections, etc.							
	4" pipe		50%	15,000	15,000	LF	$ 20	$ 300,000
	5" pipe		25%	7,500	7,500	LF	$ 25	$ 187,500
	6" pipe		25%	7,500	7,500	LF	$ 30	$ 225,000
	Pipe bedding / insulation			30,000	30,000	LF	$ 10	$ 300,000
	Outfall structures			20	20	EA	$ 3,500	$ 70,000
3.0	**Irrigation**							
	Underground Irrigation							
	Demonstration Gardens			5.21		acres	$ 65,340	$ 340,421
	Headhouse / Greenhouse			2.03		acres	$ 65,340	$ 132,640
	Container Pad			1.09		acres	$ 65,340	$ 71,221
	Turf Research			3.90		acres	$ 65,340	$ 254,826
	Underground pipe infrastructure							
	Pumps; including head house			3		EA	$ 75,000	$ 225,000
	Hydrants; including backflow protection			32		EA	$ 7,500	$ 240,000
	Pipe; including elbows, connections, etc.							
	2" pipe			3,440	3,440	LF	$ 25	$ 86,000
	3" pipe			1,183	1,183	LF	$ 40	$ 47,320
	6" pipe			4,134	4,134	LF	$ 60	$ 248,040
	Pipe bedding / insulation			8,757		LF	$ 15	$ 131,355
4.0	**Soil Amendment and Grading**							
	Constructed Soil			77,837	77,837	CY	$ 30	$ 2,335,105
	Engineered Soil			231,992	231,992	CY	$ 75	$ 17,399,363
5.0	**Buffer (including drainage ditch)**		**13.42 acres**					
	Planted edge zone (assume shrubs and small plants)			29,227	29,227	SF	$ 30	$ 876,797
	Bioswale zone			58,453	58,453	SF	$ 25	$ 1,461,329
	Gravel Service Road			87,680	87,680	SF	$ 15	$ 1,315,196
	Grassy Channel (trench drain)			175,359	175,359	SF	$ 30	$ 5,260,785
	Turf edge			87,680	87,680	SF	$ 3	$ 219,199
	Woodland edge			87,680	87,680	SF	$ 60	$ 5,260,785
	Soil Amendment		64,948 CY					
	Engineered Soil (assume average 3' deep)			6,495	6,495	CY	$ 80	$ 519,583
	Construction Soil			58,453	58,453	CY	$ 30	$ 1,753,593
	Perimeter wildlife / deer fence (8' high)				8,000	LF	$ 80	$ 640,000
6.0	**New pond**							
	Pond			19,324	19,324	SF	$ 30	$ 579,709
	Edge detail			534	534	LF	$ 250	$ 133,500

VT AREC COST MODEL

BRENNEMAN

Total research area: 66.24 acres

Total site area: 88.50 acres

15 December 2022

7.0	**Hardscape (roadways)**					
	Paved	106,914	106,914	SF	$ 30	$ 3,207,420
	Sub-total Land Development					$ 47,997,938
	CM/GC markups, including design contingency	20%				$ 9,599,588
	Sub-total Buildings					$ 57,597,526
	Project (Soft Cost) Multiplier	28%				$ 16,127,307
	TOTAL PROJECT COST: LAND DEVELOPMENT					$ 73,724,833
	TOTAL BUILDINGS + LAND DEVELOPMENT					**$ 105,961,232**

VT AREC COST MODEL

BROWN FARM NORTH **15 December 2022**

Total research area: 76.61 acres

Total site area: 109.00 acres

BUILDINGS		QTY	UOM	Rate	Total
1.0 Replacement Buildings					
Administration, Education, Research, Outreach		19,299	GSF	$ 497	$ 9,588,186
Greenhouses		16,012	GSF	$ 298	$ 4,772,028
Residential		5,098	GSF	$ 342	$ 1,743,112
Warehouses / Storage / Shops		14,986	GSF	$ 255	$ 3,820,169
Hazardous Material Storage		2,339	GSF	$ 369	$ 862,230
Site Support Building		860	GSF	$ 345	$ 296,875
Site Support Elements		1	LS	$ 3,402,900	$ 3,402,900
Fueling Station		1	LS	$ 237,000	$ 237,000
Dedicated Generator		1	LS	$ 406,000	$ 406,000
Fuel Tanks		1	LS	$ 56,188	$ 56,188
Sub-total Buildings; direct cost					$ 25,184,686
CM/GC markups, including design contingency	20% to 25%				*incl.*
Sub-total Buildings					$ 25,184,686
CT project cost multiplier	28%				$ 7,051,712
TOTAL PROJECT COST: EXISTING BUILDINGS					$ 32,236,399

VT AREC COST MODEL

BROWN FARM NORTH — **15 December 2022**

Total research area: 76.61 acres

Total site area: 109.00 acres

LAND DEVELOPMENT

1.0	**Site preparation**						
	Clear and prepare site (minimal requirements)			109.00	109.00	acres	$ 1,500	$ 163,500
2.0	**Drainage**							
	Drainage ditches (not included in buffer)		15,743 LF					
	Drainage Ditch (assumed 10' wide)			157,430	157,430	SF	$ 25	$ 3,935,750
	Culverts (Assumed Quantity based on road layout)		allow	30		EA	$ 7,500	$ 225,000
	Outfall Structures		allow	15		EA	$ 10,000	$ 150,000
	Tile drain system (quantity is allowance)		30,000 LF					
	Underground pipe infrastructure, including pipe, connections, etc.							
	4" pipe		50%	15,000	15,000	LF	$ 20	$ 300,000
	5" pipe		25%	7,500	7,500	LF	$ 25	$ 187,500
	6" pipe		25%	7,500	7,500	LF	$ 30	$ 225,000
	Pipe bedding / insulation			30,000	30,000	LF	$ 10	$ 300,000
	Outfall structures			20	20	EA	$ 3,500	$ 70,000
3.0	**Irrigation**							
	Underground Irrigation							
	Demonstration Gardens			5.78		acres	$ 65,340	$ 377,665
	Headhouse / Greenhouse			2.00		acres	$ 65,340	$ 130,680
	Container Pad			1.09		acres	$ 65,340	$ 71,221
	Turf Research			3.90		acres	$ 65,340	$ 254,826
	Underground pipe infrastructure							
	Pumps; including head house			4		EA	$ 75,000	$ 300,000
	Hydrants; including backflow protection			25		EA	$ 7,500	$ 187,500
	Pipe; including elbows, connections, etc.							
	2" pipe			3,935	3,935	LF	$ 25	$ 98,375
	3" pipe			1,402	1,402	LF	$ 40	$ 56,080
	6" pipe			2,497	2,497	LF	$ 60	$ 149,820
	Pipe bedding / insulation			7,834		LF	$ 15	$ 117,510
4.0	**Soil Amendment and Grading**							
	Constructed Soil			77,090	77,090	CY	$ 30	$ 2,312,712
	Engineered Soil			256,327	256,327	CY	$ 75	$ 19,224,536
5.0	**Buffer (including drainage ditch)**		**7.86 acres**					
	Planted edge zone (assume shrubs and small plants)			17,113	17,113	SF	$ 30	$ 513,376
	Bioswale zone			34,225	34,225	SF	$ 25	$ 855,627
	Gravel Service Road			51,338	51,338	SF	$ 15	$ 770,065
	Grassy Channel (trench drain)			102,675	102,675	SF	$ 30	$ 3,080,258
	Turf edge			51,338	51,338	SF	$ 2.50	$ 128,344
	Woodland edge			51,338	51,338	SF	$ 60	$ 3,080,258
	Soil Amendment		38,028 CY					
	Engineered Soil (assume average 3' deep)			3,803	3,803	CY	$ 80	$ 304,223
	Construction Soil			34,225	34,225	CY	$ 30	$ 1,026,752
	Perimeter wildlife / deer fence (8' high)				8,000	LF	$ 80	$ 640,000
6.0	**New pond**							
	Pond			20,402	20,402	SF	$ 30	$ 612,052
	Edge detail			562	562	LF	$ 250	$ 140,500

VT AREC COST MODEL

BROWN FARM NORTH

Total research area: 76.61 acres

Total site area: 109.00 acres

15 December 2022

7.0	**Hardscape (roadways)**					
	Paved	186,098	186,098	SF	$ 30	$ 5,582,940
	Sub-total Land Development					$ 45,572,071
	CM/GC markups, including design contingency	20%				$ 9,114,414
	Sub-total Buildings					$ 54,686,485
	Project (Soft Cost) Multiplier	28%				$ 15,312,216
	TOTAL PROJECT COST: LAND DEVELOPMENT					$ 69,998,700
	TOTAL BUILDINGS + LAND DEVELOPMENT					**$ 102,235,099**

VT AREC COST MODEL

BROWN FARM SOUTH **15 December 2022**

Total research area: 88.58 acres

Total site area: 118.00 acres

BUILDINGS		QTY	UOM	Rate	Total
1.0 Replacement Buildings					
Administration, Education, Research, Outreach		19,299	GSF	$ 497	$ 9,588,186
Greenhouses		16,012	GSF	$ 298	$ 4,772,028
Residential		5,098	GSF	$ 342	$ 1,743,112
Warehouses / Storage / Shops		14,986	GSF	$ 255	$ 3,820,169
Hazardous Material Storage		2,339	GSF	$ 369	$ 862,230
Site Support Building		860	GSF	$ 345	$ 296,875
Site Support Elements		1	LS	$ 3,402,900	$ 3,402,900
Fueling Station		1	LS	$ 237,000	$ 237,000
Dedicated Generator		1	LS	$ 406,000	$ 406,000
Fuel Tanks		1	LS	$ 56,188	$ 56,188
Sub-total Buildings; direct cost					$ 25,184,686
CM/GC markups, including design contingency	20% to 25%				*incl.*
Sub-total Buildings					$ 25,184,686
CT project cost multiplier	28%				$ 7,051,712
TOTAL PROJECT COST: EXISTING BUILDINGS					$ 32,236,399

VT AREC COST MODEL

BROWN FARM SOUTH — **15 December 2022**

Total research area: 88.58 acres

Total site area: 118.00 acres

LAND DEVELOPMENT

1.0	**Site preparation**						
	Clear and prepare site (minimal requirements)			118.00	118.00	acres	$ 1,500	$ 177,000
2.0	**Drainage**							
	Drainage ditches (not included in buffer)		19,954 LF					
	Drainage Ditch (assumed 10' wide)			199,540	199,540	SF	$ 25	$ 4,988,500
	Culverts (Assumed Quantity based on road layout)		allow	30		EA	$ 7,500	$ 225,000
	Outfall Structures		allow	15		EA	$ 10,000	$ 150,000
	Tile drain system (quantity is allowance)		40,000 LF					
	Underground pipe infrastructure, including pipe, connections, etc.							
	4" pipe		50%	20,000	20,000	LF	$ 20	$ 400,000
	5" pipe		25%	10,000	10,000	LF	$ 25	$ 250,000
	6" pipe		25%	10,000	10,000	LF	$ 30	$ 300,000
	Pipe bedding / insulation			40,000	40,000	LF	$ 10	$ 400,000
	Outfall structures			20	20	EA	$ 3,500	$ 70,000
3.0	**Irrigation**							
	Underground Irrigation							
	Display Gardens			5.78		acres	$ 65,340	$ 377,665
	Headhouse / Greenhouse			2.10		acres	$ 65,340	$ 137,214
	Container Pad			1.08		acres	$ 65,340	$ 70,567
	Turf Research			3.90		acres	$ 65,340	$ 254,826
	Underground pipe infrastructure							
	Pumps; including head house			4		EA	$ 75,000	$ 300,000
	Hydrants; including backflow protection			36		EA	$ 7,500	$ 270,000
	Pipe; including elbows, connections, etc.							
	2" pipe			3,819	3,819	LF	$ 25	$ 95,475
	3" pipe			1,371	1,371	LF	$ 40	$ 54,840
	6" pipe			4,378	4,378	LF	$ 60	$ 262,680
	Pipe bedding / insulation			9,568		LF	$ 15	$ 143,520
4.0	**Soil Amendment and Grading**							
	Constructed Soil			91,920	91,920	CY	$ 30	$ 2,757,592
	Engineered Soil			287,122	287,122	CY	$ 75	$ 21,534,173
5.0	**Buffer (including drainage ditch)**		**13.77 acres**					
	Planted edge zone (assume shrubs and small plants)			29,991	29,991	SF	$ 30	$ 899,732
	Bioswale zone			59,982	59,982	SF	$ 25	$ 1,499,553
	Gravel Service Road			89,973	89,973	SF	$ 15	$ 1,349,598
	Grassy Channel (trench drain)			179,946	179,946	SF	$ 30	$ 5,398,391
	Turf edge			89,973	89,973	SF	$ 2.50	$ 224,933
	Woodland edge			89,973	89,973	SF	$ 60	$ 5,398,391
	Soil Amendment		66,647 CY					
	Engineered Soil (assume average 3' deep)			6,665	6,665	CY	$ 80	$ 533,174
	Construction Soil			59,982	59,982	CY	$ 30	$ 1,799,462
	Perimeter wildlife / deer fence (8' high)				8,000	LF	$ 80	$ 640,000
6.0	**New pond**							
	Pond			23,853	23,853	SF	$ 30	$ 715,595
	Edge detail			665	665	LF	$ 250	$ 166,250

VT AREC COST MODEL

BROWN FARM SOUTH — **15 December 2022**

Total research area: 88.58 acres
Total site area: 118.00 acres

7.0	**Hardscape (roadways)**					
	Paved	162,196	162,196	SF	$ 30	$ 4,865,880
	Sub-total Land Development					$ 56,710,010
	CM/GC markups, including design contingency	20%				$ 11,342,002
	Sub-total Buildings					$ 68,052,012
	Project (Soft Cost) Multiplier	28%				$ 19,054,563
	TOTAL PROJECT COST: LAND DEVELOPMENT					$ 87,106,576
	TOTAL BUILDINGS + LAND DEVELOPMENT					**$ 119,342,974**

VT AREC COST MODEL

Backup Cost / GSF of Replacement Buildings (without escalation) — **15 December 2022**

Building 1		QTY	UOM	Rate	Total	16,269 GSF	
Administration		**2,155**	**DGSF**			**$ 826,050**	**$ 383.32/ SF**
Horticulture office		245	DGSF	$ 340.00	$ 83,300		
Director's office		160	DGSF	$ 370.00	$ 59,200		
Mail		65	DGSF	$ 370.00	$ 24,050		
Reception		75	DGSF	$ 370.00	$ 27,750		
Administration office		105	DGSF	$ 340.00	$ 35,700		
Safety manager's office		70	DGSF	$ 300.00	$ 21,000		
Entomology office		130	DGSF	$ 340.00	$ 44,200		
Server room		95	DGSF	$ 440.00	$ 41,800		
Staff room		95	DGSF	$ 510.00	$ 48,450		
Farm manager's office		95	DGSF	$ 340.00	$ 32,300		
Stormwater office		175	DGSF	$ 340.00	$ 59,500		
Pathology office		160	DGSF	$ 340.00	$ 54,400		
Post-doc office		100	DGSF	$ 370.00	$ 37,000		
Lounge		325	DGSF	$ 440.00	$ 143,000		
Board room		260	DGSF	$ 440.00	$ 114,400		
Education		**2,045**	**DGSF**			**$ 839,750**	**$ 410.64/ SF**
Grad student Space		715	DGSF	$ 390.00	$ 278,850		
Large classroom		1,215	DGSF	$ 420.00	$ 510,300		
Small classroom		115	DGSF	$ 440.00	$ 50,600		
Lab / Research		**7,965**	**DGSF**			**$ 3,555,900**	**$ 446.44/ SF**
Lab support		1,050	DGSF	$ 420.00	$ 441,000		
Stormwater management lab		335	DGSF	$ 490.00	$ 164,150		
Coolers and utilities		890	DGSF	$ 420.00	$ 373,800		
Pathology lab		1,400	DGSF	$ 530.00	$ 742,000		
Entomology lab		690	DGSF	$ 490.00	$ 338,100		
Horticulture lab		1,210	DGSF	$ 420.00	$ 508,200		
Turfgrass lab		580	DGSF	$ 420.00	$ 243,600		
Small fruit lab		1,305	DGSF	$ 420.00	$ 548,100		
Fallout shelter / temporary lab		505	DGSF	$ 390.00	$ 196,950		
Outreach		**1,740**	**DGSF**			**$ 648,800**	
Outreach office		745	DGSF	$ 350.00	$ 260,750		
Outreach classroom		995	DGSF	$ 390.00	$ 388,050		
Building Support							
Core and shell on grossing factor area		**2,364**	**GSF**	$ 200.00	$ 472,770	**$ 595,690**	**$ 252.00/ SF**
MEP	30%	709	GSF	$ 60.00	$ 42,549		
Circulation	50%	1,182	GSF	$ 60.00	$ 70,916		
Walls / structure / intersitial space	20%	473	GSF	$ 20.00	$ 9,455		
Sub-total, Building 1						**$ 6,466,190**	
GC / CM markups, design contingency	25%					$ 1,616,548	
SUB-TOTAL Building 1 - Constrution Cost inluding CM mark-ups						**$ 8,082,738**	**$ 496.82/ SF**

VT AREC COST MODEL

Backup Cost / GSF of Replacement Buildings (without escalation) — **15 December 2022**

Building 2		QTY	UOM	Rate	Total	33,227 GSF	
Greenhouses		**29,470**	**DGSF**			**$ 8,447,750**	**$ 286.66/ SF**
Headhouse		2,780	DGSF	$ 280.00	$ 778,400		
Greenhouse		8,805	DGSF	$ 250.00	$ 2,201,250		
Storage		40	DGSF	$ 250.00	$ 10,000		
Lockers		40	DGSF	$ 280.00	$ 11,200		
Temporary open air greenhouse		1,350	DGSF	$ 180.00	$ 243,000		
Overwintering greenhouse		2,875	DGSF	$ 300.00	$ 862,500		
Solar greenhouse		2,500	DGSF	$ 320.00	$ 800,000		
Potting storage		60	DGSF	$ 250.00	$ 15,000		
Tunnel		4,760	DGSF	$ 320.00	$ 1,523,200		
High tunnel		6,260	DGSF	$ 320.00	$ 2,003,200		
Building Support							
Core and shell on grossing factor area		**3,757**	**GSF**	$ 140.00	$ 526,040	**$ 721,426**	**$ 192.00/ SF**
MEP	30%	1,127	GSF	$ 60.00	$ 67,634		
Circulation	50%	1,879	GSF	$ 60.00	$ 112,723		
Walls / structure / intersitial space	20%	751	GSF	$ 20.00	$ 15,030		
Sub-total, Building 2						**$ 9,169,176**	
GC / CM markups, design contingency	20%					$ 1,833,835	
SUB-TOTAL Building 2 - Constrution Cost inluding CM mark-ups						**$ 11,003,011**	**$ 331.14/ SF**

Building 3		QTY	UOM	Rate	Total	5,441 GSF	
Residential		**4,650**	**DGSF**			**$ 1,336,400**	**$ 287.40/ SF**
Basement		1,060	DGSF	$ 210.00	$ 222,600		
Dining room		495	DGSF	$ 280.00	$ 138,600		
Living room		850	DGSF	$ 300.00	$ 255,000		
Kitchen		340	DGSF	$ 390.00	$ 132,600		
Shared		240	DGSF	$ 320.00	$ 76,800		
Shared bedroom		765	DGSF	$ 320.00	$ 244,800		
Garage		200	DGSF	$ 210.00	$ 42,000		
Bedroom		700	DGSF	$ 320.00	$ 224,000		
Building Support							
Core and shell on grossing factor area		**791**	**GSF**	$ 140.00	$ 110,670	**$ 151,776**	**$ 192.00/ SF**
MEP	30%	237	GSF	$ 60.00	$ 14,229		
Circulation	50%	395	GSF	$ 60.00	$ 23,715		
Walls / structure / intersitial space	20%	158	GSF	$ 20.00	$ 3,162		
Sub-total, Building 3						**$ 1,488,176**	
GC / CM markups, design contingency	25%					$ 372,044	
SUB-TOTAL Building 3 - Constrution Cost inluding CM mark-ups						**$ 1,860,220**	**$ 341.92/ SF**

VT AREC COST MODEL

Backup Cost / GSF of Replacement Buildings (without escalation) — **15 December 2022**

Building 4		QTY	UOM	Rate	Total	15,266 GSF	
General storage		**14,070**	**DGSF**			**$ 3,049,200**	**$ 216.72/ SF**
General storage		230	DGSF	$ 210.00	$ 48,300		
Vehicle garage		1,305	DGSF	$ 210.00	$ 274,050		
Storage		610	DGSF	$ 210.00	$ 128,100		
Golf cart and mower storage		1,320	DGSF	$ 210.00	$ 277,200		
Tractor garage		2,925	DGSF	$ 210.00	$ 614,250		
Attic		3,410	DGSF	$ 180.00	$ 613,800		
Tool storage		245	DGSF	$ 210.00	$ 51,450		
Entomology storage		470	DGSF	$ 210.00	$ 98,700		
Master gardener storage		250	DGSF	$ 210.00	$ 52,500		
Shed		135	DGSF	$ 210.00	$ 28,350		
Quonset hut		1,150	DGSF	$ 210.00	$ 241,500		
Mechanic shop		700	DGSF	$ 350.00	$ 245,000		
Wood shop		460	DGSF	$ 350.00	$ 161,000		
Turfgrass garage / workshop		860	DGSF	$ 250.00	$ 215,000		
Building Support							
Core and shell on grossing factor area		**1,196**	**GSF**	$ 110.00	$ 131,555	**$ 193,744**	**$ 162.00/ SF**
MEP	30%	359	GSF	$ 60.00	$ 21,527		
Circulation	50%	598	GSF	$ 60.00	$ 35,879		
Walls / structure / intersitial space	20%	239	GSF	$ 20.00	$ 4,784		
Sub-total, Building 4						**$ 3,242,944**	
GC / CM markups, design contingency	20%					$ 648,589	
SUB-TOTAL Building 4 - Constrution Cost inluding CM mark-ups						**$ 3,891,533**	**$ 254.92/ SF**

Building 5		QTY	UOM	Rate	Total	1,979 GSF	
Hazardous material storage		**1,755**	**DGSF**			**$ 564,900**	**$ 321.88/ SF**
Hazardous material storage		110	DGSF	$ 350.00	$ 38,500		
Fertilizer storage		725	DGSF	$ 320.00	$ 232,000		
Small fruit pesticide storage		230	DGSF	$ 320.00	$ 73,600		
Turfgrass pesticide storage		445	DGSF	$ 320.00	$ 142,400		
Entomology pesticide storage		245	DGSF	$ 320.00	$ 78,400		
Building Support							
Core and shell on grossing factor area		**224**	**GSF**	$ 140.00	$ 31,327	**$ 42,962**	**$ 192.00/ SF**
MEP	30%	67	GSF	$ 60.00	$ 4,028		
Circulation	50%	112	GSF	$ 60.00	$ 6,713		
Walls / structure / intersitial space	20%	45	GSF	$ 20.00	$ 895		
Sub-total, Building 5						**$ 607,862**	
GC / CM markups, design contingency	20%					$ 121,572	
SUB-TOTAL Building 5 - Constrution Cost inluding CM mark-ups						**$ 729,435**	**$ 368.63/ SF**

Building 6		QTY	UOM	Rate	Total	693 GSF	
Site Support Building		**615**	**SF**			**$ 182,850**	**$ 297.32/ SF**
Boiler house		560	SF	$ 300.00	$ 168,000		
Small pump house		55	SF	$ 270.00	$ 14,850		
Building Support							
Core and shell on grossing factor area		**78**	**GSF**	$ 160.00	$ 12,546	**$ 16,623**	**$ 212.00/ SF**
MEP	30%	24	GSF	$ 60.00	$ 1,411		
Circulation	50%	39	GSF	$ 60.00	$ 2,352		
Walls / structure / intersitial space	20%	16	GSF	$ 20.00	$ 314		
Sub-total, Building 6						**$ 199,473**	
GC / CM markups, design contingency	20%					$ 39,895	
SUB-TOTAL Building 6 - Constrution Cost inluding CM mark-ups						**$ 239,368**	**$ 345.20/ SF**

VT AREC COST MODEL

Backup Cost / GSF of Replacement Buildings (without escalation) **15 December 2022**

Site Support		QTY	UOM	Rate	Total	
Site Support Elements						**$ 2,835,750**
Netted high tunnel		1,600	SF	$ 200.00	$ 320,000	
Solar panels		600	SF	$ 500.00	$ 300,000	
Potting yard / paved area		4,675	SF	$ 50.00	$ 233,750	
Rain out / drought research		4,690	SF	$ 200.00	$ 938,000	
High tunnel		4,320	SF	$ 200.00	$ 864,000	
Mulch / bark storage area (excludes stockpile)		1,200	SF	$ 150.00	$ 180,000	
Sub-total, Site Support Elements						**$ 2,835,750**
GC / CM markups, design contingency	20%					$ 567,150
SUB-TOTAL Site Support - Constrution Cost inluding CM mark-ups						**$ 3,402,900**

Building 7		QTY	UOM	Rate	Total	
Fueling Station						**$ 197,500**
Above Ground 200 Gallon Fuel Tank Double Lined including pad)		1	EA	$ 20,000.00	$ 20,000	
Fuel Oil Pumps		2	EA	$ 25,000.00	$ 50,000	
Direct Buried Fuel Lind to Pumps (double lined)		50	LF	$ 400.00	$ 20,000	
Concrete Pad for Pumps (incl Foundations)		200	SF	$ 100.00	$ 20,000	
Roof Canopy		300	SF	$ 100.00	$ 30,000	
Fire Suppression System		1	LS	$ 15,000.00	$ 15,000	
Double sided Concrete Vehicle Access (truck Loading Capacity)		1,600	SF	$ 25.00	$ 40,000	
Signage, etc		1	LS	$ 2,500.00	$ 2,500	
Sub-total, Building 7						**$ 197,500**
GC / CM markups, design contingency	20%					$ 39,500
SUB-TOTAL Building 7 - Constrution Cost inluding CM mark-ups						**$ 237,000**

Dedicated Generator		QTY	UOM	Rate	Total	
Fueling Station						**$ 280,000**
Indoor emergency generator; diesel		500	KVA	$ 500.00	$ 250,000	
Switch, panel, wire & conduit, allow		1	LS	$ 30,000.00	$ 30,000	
Sub-total, Dedicated Generator						**$ 280,000**
GC / CM markups, design contingency	45%					$ 126,000
SUB-TOTAL Dedicated Generator - Constrution Cost inluding CM mark-ups						**$ 406,000**

Fuel tanks		QTY	UOM	Rate	Total	
1,000 Gallon Gasoline Tank						**$ 23,000**
Above ground tank		1,000	GAL	$ 10.00	$ 10,000	
Foundation / concrete pad incl. site prep		100	SF	$ 55.00	$ 5,500	
Pump, piping, etc., allow		1	LS	$ 5,000.00	$ 5,000	
Electrical work for pump, allow		1	LS	$ 2,500.00	$ 2,500	
Gasoline					*excl.*	
550 Gallon Diesel Tank						**$ 15,750**
Above ground tank		550	GAL	$ 10.00	$ 5,500	
Foundation / concrete pad incl. site prep		50	SF	$ 55.00	$ 2,750	
Pump, piping, etc., allow		1	LS	$ 5,000.00	$ 5,000	
Electrical work for pump, allow		1	LS	$ 2,500.00	$ 2,500	
Diesel					*excl.*	
Sub-total, Dedicated Generator						**$ 38,750**
GC / CM markups, design contingency	45%					$ 17,438
SUB-TOTAL Dedicated Generator - Constrution Cost inluding CM mark-ups						**$ 56,188**

Note: Final Buidling Areas (and corresponding costs) are found on the summary page

VT AREC COST MODEL

Backup Cost of Operational Continuity — **15 December 2022**

Plant Replacement Costs		
Garden		$ 1,265,597
Turf		$ 321,926
Shade Turf		$ 198,572
Blackberry		$ 54,050
Kiwi		$ 69,600
Maple		$ 189,750
Sub-total		**$ 2,099,495**
Markups		incl.
TOTAL		**$ 2,099,495**

Moves		
Farm Management		$ 248,164
Outdoor Supplies		$ 46,637
Office Items		$ 106,561
Laboratory Equipment and Supplies		$ 667,591
Graduate / Staff Housing		$ 24,532
Sub-total		**$ 1,093,485**
Contingencies	15.00%	$164,023
Insurance	3.50%	$44,013
O & P	21.00%	$273,319
TOTAL		**$ 1,574,839**

2nd Location Equipment		
Equipment		$ 566,000
Labor		$ 249,600
Sub-total		**$ 815,600**
Markups		incl.
TOTAL		**$ 815,600**

Sub-total Plant Replacement Costs + Moves + Equipment		$4,489,934
Project (Soft Cost) Multiplier:		
Planning, PM, Co-ordination, etc.; allow	5.00%	$224,497
Total Plant Replacement Costs + Moves + Equipment		$4,714,431

Appendix F - Alternative Site Organization

Additional Potential Site Organization Alternatives

The limits of the relocation study provided three rendered and cost modeled potential relocation sites for the project. During the test fit phase of the project when the current functions of the HR AREC were reorganized into the selected parcels, two additional alternatives were developed for the Brown Farm South property to demonstrate site flexibility as well as to highlight potential hindrances. Brown Farm North and Brenneman Farm did not have as many unknown variables such as parcel acquisition and future construction impacts, therefore no additional alternatives were developed for those sites.

Brown Farm South – 1A

This scenario only uses parcels currently owned by the City of Virginia Beach, creating an uneven southern edge of the site. The demonstration garden is separated from the administrative, classroom, and laboratory hub by a privately owned parcel and becomes an individual area within the site. The administrative hub is in the southeastern corner of the site and its street frontage is interrupted by a privately owned parcel. There are four entrances to the site from North Landing Road, one on either end of the parcel, one adjacent to the demonstration garden, and one adjacent to the administrative hub.

The greenhouses are located near the administrative hub and are separated from the demonstration garden and Master Gardeners by a privately held parcel. The maintenance and storage area is adjacent to the administrative hub and removed from the demonstration garden. The research areas are arranged in a grid to accommodate the existing wooded areas with turfgrass adjacent to the wood line to optimize opportunities for shade research.

The 100-foot buffer begins midway along the western parcel edge, just above the existing woods, and extends along the northern and eastern edges. The administrative hub along North Landing Road is planted but is not part of the buffer; the buffer extends along the perimeter of the privately owned parcel and wraps around the demonstration areas before joining the existing canopy to the north of the demonstration garden. The stormwater pond is placed in the northeastern corner to protect it from possible public interference.

This scenario reroutes the proposed bicycle trail depicted in the 2017 Interfacility Traffic Area and Vicinity Master Plan to North Landing Road to prevent the path from bisecting the site and creating security concerns (Figure 56).

Site Strengths

- The demonstration areas and main hubs are located on a main road.
- The existing wooded areas help protect the site from potential contaminant infiltration and manage stormwater.
- There are no restrictions on drone use at the HR AREC's level of use.
- The site is not predicted to be directly impacted by flooding even in the most extreme scenario.

Site Opportunities

- All new construction would significantly improve the overall condition and technological capabilities of the HR AREC facilities.
- The existing wooded areas create a shady environment for research.

Site Weaknesses

- The move from northern Virginia Beach near major roads and institutions to more rural southern Virginia Beach may impact visitation numbers, volunteer hours, funding partners, and outreach opportunities.
- To avoid acquiring privately owned parcels, this scenario creates an uneven edge and isolated areas across the site.
- The Acredale soil on site requires intensive and costly soil amendment.
- The decibel impact of aircraft flight paths may disturb lectures and events and may cause physical stress to staff and visitors.
- The VAES standard for internet is 1 gigabit speed. It is unknown if the potential site has this capacity.
- A section of the existing woods in the southwestern corner of the lot is a woody wetland, likely subject to wetland jurisdiction.
- Additional infrastructure will be required to manage stormwater and wildlife.

- An arboretum, demonstration garden, riparian buffer display, and utility line display would need to be planted in their entirety. A mature arboretum would not exist for public education and benefit for at least 50 years.

Site Threats

- Flood projections that account for 1.5 feet of sea level rise indicate the site will be isolated and inaccessible during flooding events due to flooding of access roads.
- This scenario assumes the proposed bicycle path can be rerouted south of the site to North Landing Road.
- There are four entrances and exits to the site, which may confuse visitors. Multiple points of access also create a security concern and a potential for traffic congestion on North Landing Road.
- If the Nimmo Parkway extension is complete, this scenario will not have valuable frontage and access from Nimmo Parkway.
- If the municipal service facility is built on the north side of the site as indicated in the 2017 Interfacility Traffic Area and Vicinity Master Plan, potential traffic and compatible use impacts may not coincide with the HR AREC needs.

Brown Farm South – 1A

Figure 56. Sketch of Brown Farm South with an alternative layout.

Brown Farm South – 1B

This scenario only uses parcels currently owned by the City of Virginia Beach and places the main entrance on the proposed Nimmo Parkway extension. The administrative, classroom, and laboratory hub is in a prominent position at the corner of the proposed Landstown Road and Nimmo Parkway extensions, creating a highly visible presence for the HR AREC. The demonstration areas are located adjacent to the proposed Nimmo Parkway extension.

The greenhouses extend from the laboratory building toward the demonstration areas, creating a shared space for researchers and Master Gardeners. The maintenance and storage area is located south of the administrative hub and behind the 100-foot wooded buffer with integrated stormwater management, shielding it from public view. There is one main entrance to the site off the proposed Nimmo Parkway extension that extends south through the site to North Landing Road. A second exit to North Landing Road is created on the eastern edge of the parcel to facilitate movement of maintenance and delivery vehicles.

The research areas are organized in a ladder pattern across the southern half of the site and accommodate the existing wooded areas. The stormwater pond is in the northeastern corner of the site and helps protect the research areas from surface runoff from the proposed Nimmo Parkway extension. The 100-foot buffer begins midway along the northern edge of the parcel parallel to the proposed Nimmo Parkway extension and extends east to the corner of the parcel and wraps around its eastern and southern edges before joining the existing wooded area in the southwestern corner. The northeastern edge of the parcel has a small section of buffer to shield the maintenance area from the proposed Landstown Road extension but tapers off to allow the administrative hub to be viewed from the road.

This scenario reroutes the proposed bicycle trail depicted in the 2017 Interfacility Traffic Area and Vicinity Master Plan to North Landing Road to prevent the path from bisecting the site and creating security concerns (Figure 57).

Site Strengths

- The demonstration areas and main hubs are located on the corner of two major thoroughfares if the extensions are constructed.
- The existing wooded areas help protect the site from potential contaminant infiltration and manage stormwater.
- There are no restrictions on drone use at the HR AREC's level of use.
- The site is not predicted to be directly impacted by flooding even in the most extreme scenario.

Site Opportunities

- All new construction would significantly improve the overall condition and technological capabilities of the HR AREC facilities.
- The site creates a front and back door, allowing maintenance and heavy vehicle traffic to remain removed from the public domain.
- The existing wooded areas create a shady environment for research.

Site Weaknesses

- The move from northern Virginia Beach near major roads and institutions to more rural southern Virginia Beach may impact visitation numbers, volunteer hours, funding partners, and outreach opportunities.
- This scenario does not have contiguous street frontage along North Landing Road because it avoids privately-owned parcels.
- The Acredale soil on site requires intensive and costly soil amendment.
- The decibel impact of aircraft flight paths may disturb lectures and events and may cause physical stress to staff and visitors.
- The VAES standard for internet is 1 gigabit speed. It is unknown if the potential site has this capacity. A section of the existing woods in the southwestern corner of the lot is a woody wetland, likely subject to wetland jurisdiction.
- Additional infrastructure will be required to manage stormwater and wildlife.
- An arboretum, demonstration garden, riparian buffer display, and utility line display would need to be planted in their entirety. A mature arboretum would not exist for public education and benefit for at least 50 years.

Site Threats

- Flood projections that account for 1.5 feet of sea level rise indicate the site will be isolated and inaccessible during flooding events due to flooding of access roads.
- This scenario assumes the proposed bicycle path can be rerouted south of the site to North Landing Road.
- Currently, it is uncertain if the road extensions will be constructed or what the road extension project timeline may be. This option is dependent on the road extensions.
- If the municipal service facility is built on the north side of the site as indicated in the 2017 Interfacility Traffic Area and Vicinity Master Plan, potential traffic and compatible use impacts may not coincide with the HR AREC needs.

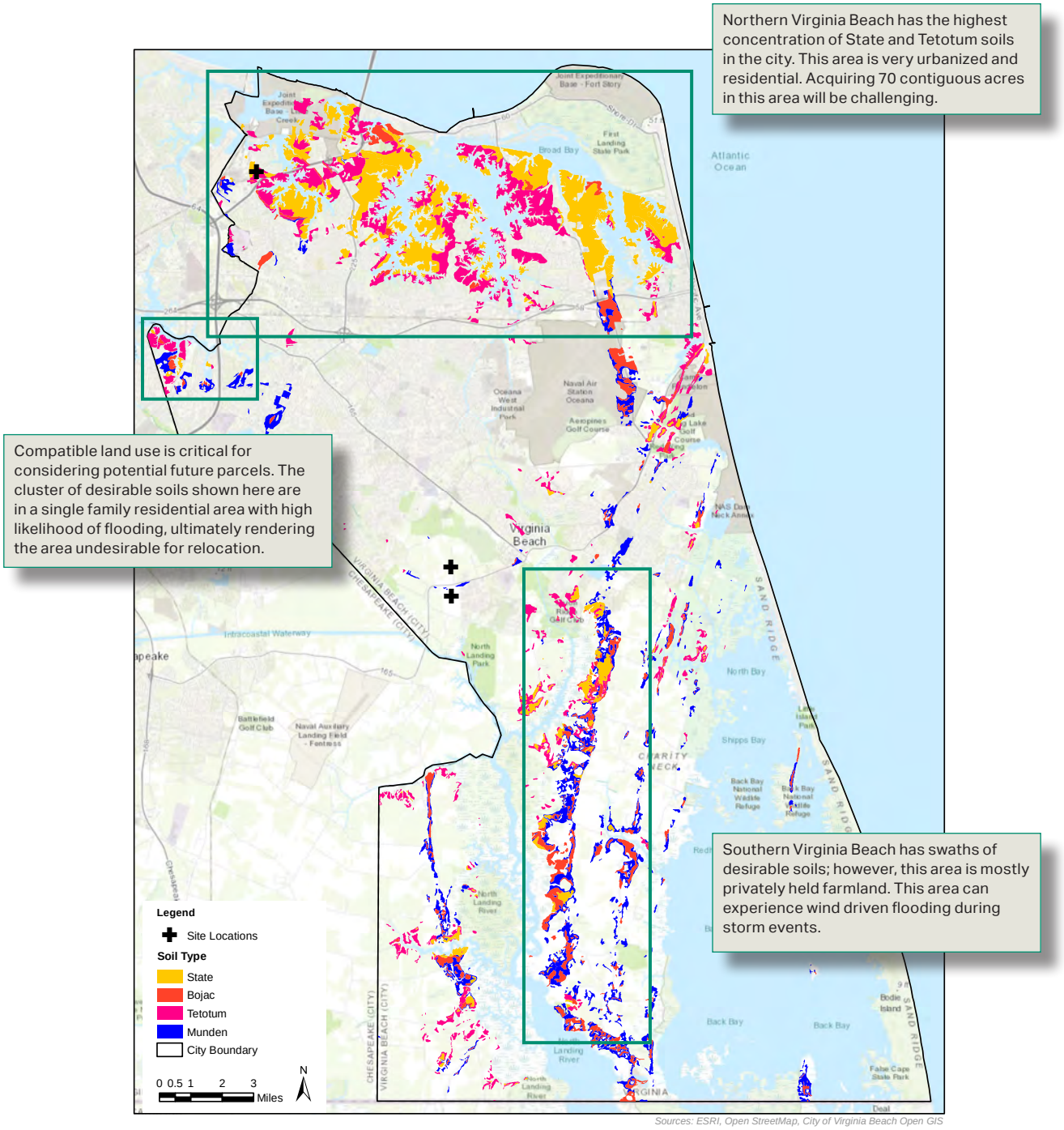
Brown Farm South – 1B

Figure 57. Sketch of Brown Farm South with an alternative layout.

Appendix G - Virginia Beach Soils

Identifying Additional Potential Sites

Soil conditions are a critical component of the HR AREC's success. The sites presented in the report require extensive soil engineering and site modification to overcome the poor existing soil conditions. A significant cost savings could be incurred if the relocation site had desirable soils in situ. Desirable soils include State, Bojac, Tetotum, and Munden due to their permeability and well drained character. The map below identifies areas within the city with known desirable soils.



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