Design of Stormwater Infiltration System for the Reserve at Mitchell Mill,

Town of Rolesville, North Carolina

For

Hopper Communities

1616 Cleveland Avenue

Charlotte, NC

August 1, 2025

By

Landis, PLLC

Barrett L. Kays, Ph.D., NCLSS #1005

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Introduction

Barrett Kays, Ph.D., Soil Scientist has designed stormwater infiltration systems for the North Waterfront Park in Wilmington, NC, the North Carolina Museum of Art Sculpture Garden Entrance, and the Historic Moore Square Park in Raleigh, NC.

He has also designed stormwater infiltration systems for the Restoration of the Great Lawn in Central Park and Hudson River Park Promenade in New York City, Restoration of the Main Fountain Garden at Longwood Gardens in Kennett Square, PA, Dwight D. Eisenhower Memorial, National Mall and Restoration of the National Air & Space Museum, National Mall, Washington, DC.

The larger infiltration systems include:

- Great Lawn in Central Park, 26-acre infiltration system, 100-year storm design, 27 years in operation
- Hudson River Promenade, 10-acre infiltration system, 10-year storm design, 20 years in operation
- Dwight D. Eisenhower Memorial, 15-acre infiltration system, 200-year storm design, 8 years in operation

Other infiltration system include:

- North Waterfront Park, 15-acre infiltration system, 10-year storm design, 5 years in operation
- Historic Moore Square Park, 1-acre infiltration system, 25-years storm design, 5 years in operation
- NC Museum of Art Sculpture Garden Oval, 0.5-acre infiltration system, 10-year storm design, 8 years in operation
- Main Fountain Garden at Longwood Gardens, 10-acre infiltration system, 10-year storm design, 8 years in operation
- National Air & Space Museum, 10-acre infiltration system, 10-year storm design, under construction.

Reserve at Mitchell Mill, Rolesville, NC

The Reserve at Mitchell Mill is a 9.14-acre commercial development located adjacent to Mitchell Mill Road. The Town has required a small park to be included in the commercial development. The soils on the project site consist of the Louisburg – Wedowee Complex (LwC2). The soils have a shallow depth over rock.

MDC 1: Soil Investigations

All of the soil materials that will be used for the construction of the infiltration system will be imported to the project site. The attached geotechnical report includes analysis of the imported sandy soils.

MDC 2: Separation from the SHWT

The seasonally high water table is greater than two feet below the bottom of the infiltration system and therefore meets or exceeds the minimum required separation. The seasonally high water table elevation is 268.5-feet above mean sea level at the south east corner of the subject site.

MDC 3: Soil Subgrade Surface

The surface of the subgrade of the infiltration system will slope less than two percent.

MDC 4: Pretreatment

All of the stormwater will be pretreated to remove sediment, trash, and debris before reaching the infiltration trenches. Pretreatment will be provided to prevent clogging of the infiltration system. Stormwater will be filtered as the runoff reaches each portion of the various collection systems across the site. Media filters media in the stormwater collection pretreatment system will filter the stormwater before the stormwater reaches the infiltration system.

MDC 5: Drawdown Time

All of the components of the stormwater system have been designed to dewater a 6-inch rainfall within 72 hours.

Equation 2: Minimum Surface Area for Infiltration System

The minimum surface area of the Infiltration System is 25,000 square feet in size. The hydraulic conductivity of the soil material is 94.45 inches/hour, based upon using the NCDOT #78 Stone/Sand Media.

SA Surface Area Provided = 25,000 SF

SA Min. Surface Area = 706 SF

FS Safety Factor = 35.4

DV Design Volume = 200,000 CF

K Hydraulic Conductivity = 94.45 inches/hour

T Max. Dewatering Time = 72 hours

Equation 2: Minimum Surface Area for Infiltration System

The minimum surface area of the Infiltration System is 25,000 square feet in size. The hydraulic conductivity of the soil material is 10 inches/hour, based upon using the PermaTill C330 Bioretention Media.

SA Surface Area Provided = 25,000 SF

SA Min. Surface Area = 466 SF

FS Safety Factor = 53.6

DV Design Volume = 200,000 CF

K Hydraulic Conductivity = 143 inches/hour

T Max. Dewatering Time = 72 hours

MDC 6: Observation Port

One observation port is located in lowest location to allow for monitoring of the depth of water below the ground surface. The port will be a 6-inch diameter standard DEQ monitoring well with a locked cap.

Stormwater Collection Pretreatment System:

The NCDOT #78 Stone/Sand media will be used to filter the stormwater before it reaches the Infiltration System. The NCDOT #6 Gravel will be used be used to bed and cover the HDPE ADS Slotted Pipes .

Infiltration System:

Infiltration Recommendation 1: Media

The attached geotechnical report includes analysis of the following imported soil materials:

1. PermaTill C330 Bioretention Media, or Stalite 70% MDC-16, 20% Compost, and 10% Pine Bark fines, as equivalent
2. NCDOT #78 Stone/Sand Media
3. NCDOT #6 Stone Drainage Gravel
4. NCDOT Rip Rap, Class A

Infiltration Recommendation 2: Geotextiles

Geotechnical fabric is required to be used on the bottom, side walls, and below the top of the infiltration system. However, I request that the requirement for a geotechnical fabric be waived, because the bottom and side walls will consist of existing granite rock and not soil.

Infiltration Recommendation 3: Pumped Infiltration

Pumped infiltration is not proposed or needed for the subject project.

Construction:

Compaction of Infiltration Soil Materials

The soil material will be placed in the infiltration system using a track equipment only. The soil testing is based upon compaction not exceeding 95%.

Runoff shall not be diverted into the Infiltration System until the it has been constructed.

Trenches will divert the runoff around and bypass the Infiltration System, until the Infiltration System has been completed.

The Infiltration System shall not be covered by any type of impermeable or partially impermeable surface.

One six-inch diameter standard DEQ monitoring well with locking cap is shown on the plans.

Maintenance of Infiltration System:

Maintenance access shall be provided by a 10-foot wide drive along the northern and southern sides of the Infiltration System, and extending to the public street on the west side of the Infiltration System. A permanent recorded easement shall include the entire area of the Infiltration System. The Infiltration System shall be located and labeled within the permanent recorded easement. The private development shall own the recorded easement, but access shall be granted to the Wake County Stormwater Program. The Operation and Maintenance Agreement shall be recorded and reference on the final plat and permanent recorded easement.

Inspection Schedule: The Infiltration System shall be inspected quarterly and within 24 hours after every storm event greater than 1.0-inches. Records of operation and maintenance shall be kept in a known location and shall be available upon request.

1. All sediment, trash, and debris shall be removed.
2. The grass shall be mowed on a weekly basis to maintain a height of 2-inches.
3. Correct any damages to the infiltration system.
4. Water should not pond on the surface and if so, corrective action shall be taken.
5. Check the water depth in the observation well.

Maintenance of Pretreatment Systems:

Inspection Schedule: The Pretreatment Systems shall be inspected quarterly and within 24 hours after every storm event greater than 1.0-

inches. Records of operation and maintenance shall be kept in a known location and shall be available upon request.

1. Clean out sediment, trash, and debris from the stormwater tank inlet filters.
2. Clean out trash and debris from the roof top inlet filters.
3. Check the stormwater collection system in the parking lots and remove any sediment, trash, and debris.
4. Clean up any sediment accumulated at the inlets to the stormwater collection system in the parking lots.

The above maintenance requirements shall be included in the Operation and Maintenance Agreement by the private development and access shall be granted to the Wake County Stormwater Program.

Explanation of How the Soil Layers Function in the Infiltration System

On page 24 of this report, it lists the various soil layers that have been scientifically designed to function in unison to provide maximum treatment of the stormwater. For example, layer 2 functions to be a pressure break and hold moisture up in layer 1; however, when bottom portion of layer 1 becomes saturated, layer 1 will drain into layer 2 and stop draining when layer 1 interface is no longer saturated. Layer 7 functions in the same way to allow drainage when the bottom portion layer 7 becomes saturated. This keeps moisture in layer 7 and layer 7 to provide maximum treatment of the stormwater. During the design storm event, infiltration will rapidly drip into layer 3 and layer 8, as well as, the other layers, until the layers become unsaturated. This automatic drainage system important in the proper functioning the infiltration system. Holding moisture in the layers produces and maintains the necessary soil biology to provide optimum treatment of the stormwater.

Soil Laboratory Testing of Custom Soils for Reserve at Mitchell Mill Stormwater Infiltration System

For

Hopper Communities

1616 Cleveland Avenue

Charlotte, NC

By

GeoTechnologies, Inc.

Raleigh, NC

TABLE 1

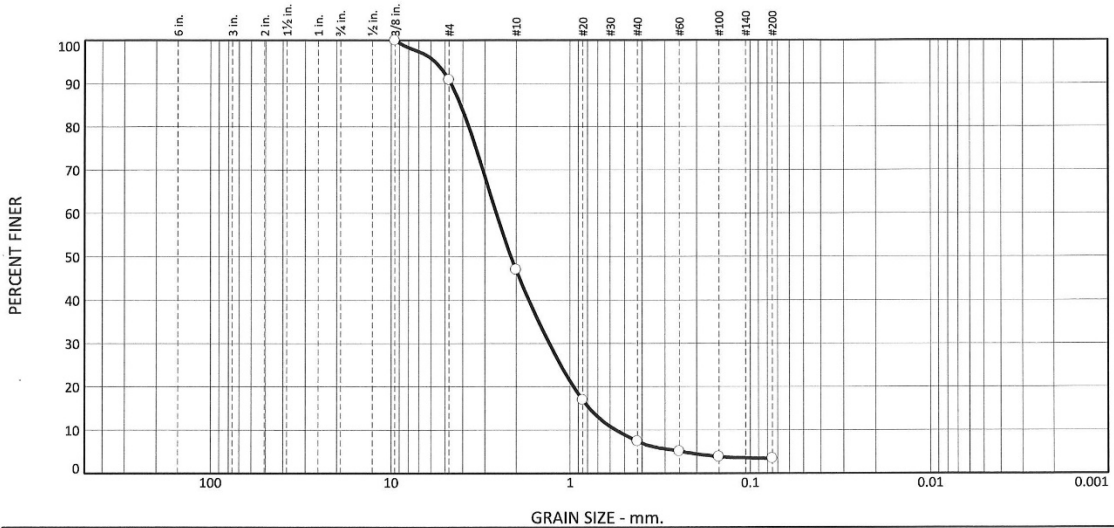
HYDRAULIC CONDUCTIVITY RESULTS

Reserve @ Mitchell Mill
Project No. 1-25-0177-EA

SAMPLE	DESCRIPTION	COMPACTION, %	HYDRAULIC CONDUCTIVITY	
			cm/sec	in/hr
1	WM-CMS	75	5.63E-05	7.98E-02
		85	3.91E-05	5.54E-02
		95	2.70E-06	3.83E-03
2	WM-BIO	75	4.42E-04	0.63
		85	2.29E-04	0.32
		95	1.20E-04	0.17
3	PERMA TILL C330 Bio Media	75 *	3.97E-01	562.67
		85	3.83E-01	542.83
		95	1.01E-01	143.15
4	78M Stone Sunrock - Kittrel	95	6.66E-02	94.45

* NOTE: Sample 3, Visibly consolidated under flow.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.1	43.9	39.6	4.0	3.4	

Test Results (ASTM D422 & D1140)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
0.375"	100.0		
#4	90.9		
#10	47.0		
#20	16.9		
#40	7.4		
#60	5.1		
#100	3.8		
#200	3.4		

* (no specification provided)

Sample Number: 3

Material Description
PERMA TILL

Sieve Test (ASTM D422 & D1140)

Test Date: 4-7-25 **Technician:** SA

Test Notes

Hydrometer Test

Test Date: _____ **Technician:** _____

Test Notes

Atterberg (ASTM D4318)

PL= LL= PI=

Coefficients

D_{90}= 4.6272 D_{85}= 4.0866
D_{60}= 2.5847 D_{50}= 2.1380
D_{30}= 1.3050 D_{15}= 0.7800
D_{10}= 0.5587
C_u= 4.63 C_c= 1.18

USCS (ASTM D2487)

SP

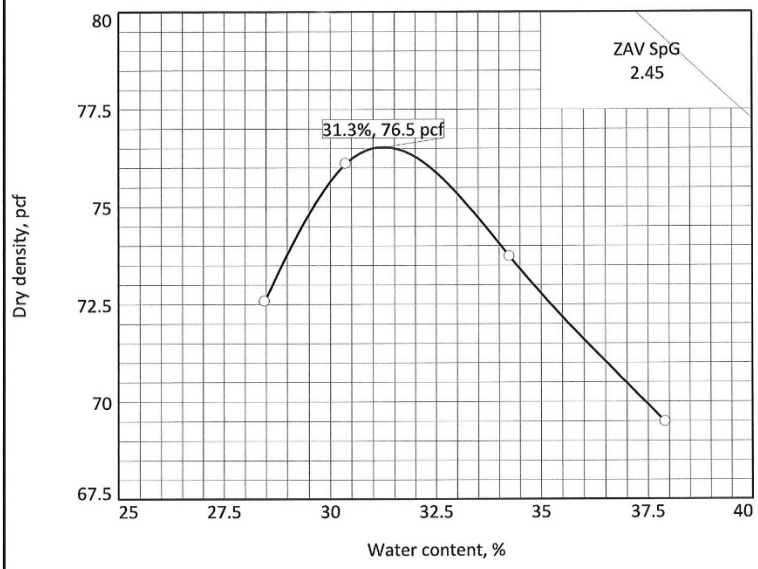
Date Sampled: 3-17-25
Date Received: 3-17-25
Checked By: DH
Title: SI

GeoTechnologies, Inc.

Client:
Project: Reserve at Mitchell MIll

Project No: 1-25-0177-EA **Figure**

COMPACTION TEST REPORT



Curve No.
3

Test Specification:
ASTM D 698-12 Method B Standard

Preparation Method	Moist
Hammer Wt.	5.5 lb.
Hammer Drop	12 in.
Hammer Type:	Manual
Layers three	**Blows/Layer** 25
Mold Size	0.03333 cu. ft.
Test Performed on Material	
Passing 3/8 in.	**Sieve**
NM	**LL** **PI**
Sp.G. (Assumed):	2.45
%>3/8 in. 0.0	**%<No.200** 3.4
USCS SP	**AASHTO**
Date Sampled	3-17-25
Date Received	3-17-25
Date Tested	3-18-25
Tested By	BB

TESTING DATA	1	2	3	4	5	6
WM + WS	12.29	12.49	12.48	12.38		
WM	9.19	9.19	9.19	9.19		
WW + T #1	358.7	373.2	402.3	430.7		
WD + T #1	298.4	305.9	318.2	332.2		
TARE #1	86.6	84.3	72.7	72.4		
WW + T #2						
WD + T #2						
TARE #2						
MOISTURE	28.5	30.4	34.3	37.9		
DRY DENSITY	72.6	76.1	73.7	69.5		

TEST RESULTS

Maximum dry density = 76.5 pcf

Optimum moisture = 31.3 %

Material Description

PERMA TILL

Remarks:

Project No. 1-25-0177-EA **Client:**
Project: Reserve at Mitchell MIll

○ **Sample Number:** 3

GeoTechnologies, Inc.

Checked by: DH
Title: SI

Figure

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number:	125-0177-EA	**Job Name:**	Reserve at Mitchell Mill		
Date:	29-Apr-25	**Sample I.D.**	#78 Stone	**Depth:**	

Soil Description: #78 Stone

SAMPLE DATA

Type
Remolded

Reference Density: (ASTM C29)

Maximum Dry Density	**92.6**	lbs/cu.ft.
Opt. Moisture Content	**n/a**	%
Required Compaction	**95.0**	%

	Inches	cm.
Length	**5.0**	**12.7**
Diameter	**3.0**	**7.62**
Area	**7.069**	**45.604**
Volume	**35.343**	**579.167**

TEST DATA

Q = Volume of Flow	L = Length of Sample	A = Area of Sample	h = Difference in Head
cm.^3/sec.	cm.	cm.^2	cm.
20.37990838	12.7	45.6	85.09
20.12754098	12.7	45.6	85.09
20.60901019	12.7	45.6	85.09
20.32011796	12.7	45.6	85.09

	ASTM	D 2434	Percent
	k = QL/Ah		Deviation
1	k =	6.67E-02	0.10%
2	k =	6.59E-02	1.14%
3	k =	6.75E-02	1.23%
4	k =	6.65E-02	0.19%

Average	**k =**	**6.66E-02**	cm./sec
		94.45	in/hr

SUNROCK®

Kittrell Quarry
214 Sunrock Road
Kittrell, NC 27544
252-433-4617

Plant 21-Kittrell Quarry

Product K78-78M

Period: 01/01/2025 - 04/22/2025

Name/Title Joseph Short / Manager Aggregate QC

Report Date 04/22/2025

Procedure	Sieve/Test	Result	Unit	NCDOT 78M
	3/4" (19mm)	100	%	100-100
	1/2" (12.5mm)	100	%	98-100
	3/8" (9.5mm)	97	%	75-100
	#4 (4.75mm)	40	%	20-45
	#8 (2.36mm)	5	%	0-15
	#200 (75µm)	0.2	%	0-1

Stormwater Specifications for Infiltration System for the Reserve at Mitchell Mill, Town of Rolesville, North Carolina

For

Hopper Communities

1616 Cleveland Avenue

Charlotte, NC

By

Landis, PLLC

Barrett L. Kays, Ph.D., NCLSS #1005

STORMWATER PRETREATMENT SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work of this Section includes, but is not limited to:
1. NCDOT Rip-Rap stone, Class A
2. #78M Stone/Soil Media
3. #6 Stone, Gravel drainage layer.
4. HDPE ADS Slotted pipes.
5. HDPE ADS Solid pipes.
6. Hancor AdvanEdge Drainage Mats.
7. Fescue grass.

1.2 SUBMITTALS

A. Submittals
1. Product Data: Submit all products for laboratory testing and make submittal of each in laboratory data.
2. Triplicate samples are required for submittals of laboratory data. Submit raw for all samples and also report data as geomeans and include the required minimum and maximum performance standards from this specification.
3. All samples must be labeled as to product, sample number, data sampled, and specific source location.

1.3 DEFINITIONS

A. CEC: Cation exchange capacity indicates the extent to which the soil can hold and exchange basic cations such as calcium, magnesium and potassium, as well as, hydrogen, aluminum, iron, and manganese.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Hydraulic Conductivity, Saturated: The flow rate of water through a saturated soil in inches/hour also referred to as Ksat.

D. Landscape Soil: Soils consisting of types contained in this specification and that have been manufactured with particular soil components and fertilizers to produce a soil mixture for particular locations and layers, as described in this specification, and shown on the plans.

E. Layered Profile: The combination of soil layers and drainage layers constructed in a vertical assembly to provide for soil moisture retention and drainage of excess water. The layers are designed to be constructed without the use of any filter fabric by having adjacent layers adhere to specific particle size bridging and uniformity standards.

F. Manufactured Soil: A landscape soil produced off-site by blending soils, sand, stabilized organic soil amendments, and other materials to produce landscape soil.

G. Organic Humus: Organic Humus Soil Component shall be a finely ground fully decomposed composted with a pH range of 5 to 8.5. At least 100% shall pass a ¼" screen. The electrical conductivity (salt content) shall be at or below 5 mmohs/cm. The organic humus shall be measured on a cubic yard basis for mixing with soil materials. Novozymes Nature's Releaf Topdressing (or equivalent) shall be considered to meet this definition.

H. Plant Available Moisture: The holding capacity of water between -0.025 and -15 bars of soil water tension or -25 to 15,000 cm of water tension.

I. Porosity Total: The total volume of all sizes of pores in a soil; expressed as a percent or a ratio such as 50 percent or 0.50 ratio of total volume of the soil.

J. Soil Profile: The combination of soil layers in a vertical assembly occurring naturally as an undisturbed soil.

K. Soluble Salt Content: The content of sodium salts in the soil solution.

L. SSSA: Soil Science Society of America.

M. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below a layered soil profile or below paving sub-base, drainage fill, drainage course, or soil materials.

N. Surface Soil: Soil that is present at the top layer of the existing naturally occurring undisturbed soil profile. In undisturbed areas, the surface soil is typically called "topsoil."

O. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before landscape soil is placed.

P. Water Holding Capacity: Moisture content at various negative pressures and determined on the fine earth and humus fractions of the soil.

Q. Whole Earth Fraction: The total soil particles in a mineral soil consisting of the fine earth and coarse earth fractions of the soil.

1.3 SOIL PRE-MANUFACTURING

A. Soil Pre-Manufacturing Conference: Conduct conference to include General Contractor, Landscape Subcontractor, Soil Manufacturing Subcontractor, and the Projects Soil Scientist. Pre-Manufacturing Conference shall be scheduled by General Contractor within one week of the date of the contract award. Timing of production and testing of the soil materials is critical so this meeting is important.

B. All soil components and amendments shall be approved by the Project Soil Scientist prior to manufacturing any of the soil mixes, before shipment to the project site, and before the soil materials are placed on the job site.

1.4 ACTION SUBMITTALS

A. Soil Fertility: Submit three sample boxes of the # 78M stone/soil material to Soil Testing Laboratory, Agronomic Division, NCDA&CS for routine fertility testing for fescue crop.
B. On-site manufacturing of # 78M and # 6 stone/soil materials. Collect samples and subject laboratory testing to confirm compliance with the following performance factors:
   1. Bridging Factor – D15 of #6 gravel must be less than or equal to 8 times D85 of #78M.
   2. Permeability Factor – D15 of #6 gravel must greater than or equal to 5 times D15 of #78.
   3. Uniformity Factor – D90/D15 of #6 gravel is less or equal to 3.0.
C. Adjust the on-site manufacturing and screening process as necessary to achieve the above bridging, permeability, and uniformity factors.

PART 2 - PRODUCTS

2.1 SUBSURFACE PIPES

A. Slotted Pipes:
   1. 12” diameter HDPE ADS Slotted Pipes shall be installed in locations and depths as shown on the plans with all of the necessary fittings (end caps, unions, and connectors), and concrete blocking.
   2. 24” Gravel layer over and under the drain lines shall be with #6 stone or equivalent.
   3. 24” # 78M stone/soil material shall be used to cover the #6 stone layer and shall be extent up to the top of the trench.

B. Solid Pipes:
   1. 12” diameter HDPE ADS Solid Pipes shall be installed in locations and depths as shown on the plans with all of the necessary fittings (end caps, unions, and connectors), and concrete blocking.

C. Drainage Mats:
   1. 18” Hancor AdvanEdge Drainage Mats shall be installed in the locations and depths as shown on the plans with all of the necessary fittings (end caps, unions, and connectors.
   2. 4” Gravel layer over and under the drain lines shall be with #6 stone or equivalent, covering the drainage mats.
   3. 9” of #78 Stone/Soil media shall the #6 stone layer and shall cover the remainder of the site that slopes and drains to the Hancor AdvanEdge Drainage Mats.

2.2 SOIL/STONE PRODUCTS

A. NCDOT Rip-Rap stone, Class A
B. #78M Stone/Soil Media
C. #6 Stone/Gravel as drainage layer.

2.3 SOIL AMENDMENTS

A. Soil Amendments shall be used only for the soil material above and upslope of the 18” Hancor AdvanEdge Drainage Mats.

B. Lime:
   1. ASTM C 602: agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   2. Class: T with a minimum of 99 percent passing through N. 8 (2.36-mm) sieve and a minimum of 75 percent passing through No. 60 (0.25-mm) sieve.
   3. Form: Provide lime in form of finely ground dolomitic limestone.
   4. Rate: Lime shall be based upon soil test report or as prescribed in specification; the prescribed amount is already based upon soil test report. Lime shall be mixed into the soil mix prior to performance testing and authorization for shipment to the site.

C. Fertilizer: Fertilizer rates shall be based upon the soil fertility laboratory test report. The fertilizer shall be added to soil mix prior to final screening and prior to delivery to the project site.

   1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and10 percent phosphoric acid, and, or

   2. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 46 percent available phosphoric acid. The super phosphate shall be in a ground powder form, and, or

   3. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

      a. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

      b. Composition: 10 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight, or

      c. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

PART 3 - EXECUTION

2.4 GENERAL

A. Install all of the components according to this specification and the construction plans.

B. Confirm the soil profile is to be installed by referencing the specification and construction plans.

C. Install the soil materials and #6 stone/gravel below the HDPE ADS Slotted Pipes and cover the pipes with 6-inch layer of the stone.

D. Install the #78M Stone/Soil media over the #6 Stone and bring the #78M Stone/Sand up to the top of the trench.

E. Confirm compaction does not exceed 95% by geotechnical testing of each foot of #78M Stone/Soil media.

F. Once sufficient soil material has been added, complete the pretreatment system by hand raking and smoothing surface soil. The elevations of the soil must be checked to make sure the surface is at the correct elevations.

G. Plant the fescue grass and water until a 100% cover has been achieved. Obtain final approval by the Project Soil Scientist.

End of Section

STORMWATER INFILTRATION SYSTEM

PART 1 - GENERAL

1.5 WORK INCLUDED

A. The work of this Section includes, but is not limited to:

1. PermaTill Stalite 70% MDC-16, 20% Compost, and 10% Pine Bark fine, as equivalent
2. #78M Stone/Soil Media
3. Geotechnical membrane fabric.
4. #6 Stone as gravel drainage layer.
5. NCDOT Rip-Rap stone, Class A
6. HDPE ADS Perforated pipes
7. HDPE ADS Perforated outlet
8. Bermuda Grass Sod grown on PermaTill C330 Media, or equivalent

1.6 SUBMITTALS

A. Submittals
1. Product Data: Submit all products for laboratory testing and make submittal of each in laboratory data.
2. Triplicate samples are required for submittals of laboratory data. Submit raw for all samples and also report data as geomeans and include the required minimum and maximum performance standards from this specification.
3. All samples must be labeled as to product, sample number, data sampled, and specific source location.

1.3 DEFINITIONS

R. CEC: Cation exchange capacity indicates the extent to which the soil can hold and exchange basic cations such as calcium, magnesium and potassium, as well as, hydrogen, aluminum, iron, and manganese.

S. Finish Grade: Elevation of finished surface of planting soil.

T. Hydraulic Conductivity, Saturated: The flow rate of water through a saturated soil in inches/hour also referred to as Ksat.

U. Landscape Soil: Soils consisting of types contained in this specification and that have been manufactured with particular soil components and fertilizers to produce a soil mixture for particular locations and layers, as described in this specification, and shown on the plans.

V. Layered Profile: The combination of soil layers and drainage layers constructed in a vertical assembly to provide for soil moisture retention and drainage of excess water. The layers are designed to be constructed without the use of any filter fabric by having adjacent layers adhere to specific particle size bridging and uniformity standards.

W. Manufactured Soil: A landscape soil produced off-site by blending soils, sand, stabilized organic soil amendments, and other materials to produce landscape soil.

X. Organic Humus: Organic Humus Soil Component shall be a finely ground fully decomposed composted with a pH range of 5 to 8.5. At least 100% shall pass a ¼" screen. The electrical conductivity (salt content) shall be at or below 5 mmohs/cm. The organic humus shall be measured on a cubic yard basis for mixing with soil materials. Novozymes Nature's Releaf Topdressing (or equivalent) shall be considered to meet this definition.

Y. Plant Available Moisture: The holding capacity of water between -0.025 and -15 bars of soil water tension or -25 to 15,000 cm of water tension.

Z. Porosity Total: The total volume of all sizes of pores in a soil; expressed as a percent or a ratio such as 50 percent or 0.50 ratio of total volume of the soil.

AA. Soil Profile: The combination of soil layers in a vertical assembly occurring naturally as an undisturbed soil.

BB. Soluble Salt Content: The content of sodium salts in the soil solution.

CC. SSSA: Soil Science Society of America.

DD. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below a layered soil profile or below paving sub-base, drainage fill, drainage course, or soil materials.

EE. Surface Soil: Soil that is present at the top layer of the existing naturally occurring undisturbed soil profile. In undisturbed areas, the surface soil is typically called "topsoil."

FF. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before landscape soil is placed.

GG. Water Holding Capacity: Moisture content at various negative pressures and determined on the fine earth and humus fractions of the soil.

HH. Whole Earth Fraction: The total soil particles in a mineral soil consisting of the fine earth and coarse earth fractions of the soil.

1.7 SOIL PRE-MANUFACTURING

A. Soil Pre-Manufacturing Conference: Conduct conference to include General Contractor, Landscape Subcontractor, Soil Manufacturing Subcontractor, and the Projects Soil Scientist. Pre-Manufacturing Conference shall be scheduled by General Contractor within one week of the date of the contract award. Timing of production and testing of the soil materials is critical so this meeting is important.

B. All soil components and amendments shall be approved by the Project Soil Scientist prior to manufacturing any of the soil mixes, before shipment to the project site, and before the soil materials are placed on the job site.

1.8 ACTION SUBMITTALS

A. Soil Fertility: Submit three sample boxes of the Stalite PermaTill soil material to Soil Testing Laboratory, Agronomic Division, NCDA&CS for routine fertility testing for fescue crop.

B. On-site manufacturing of # 78M and # 6 stone/soil materials. Collect samples and subject laboratory testing to confirm compliance with the following performance factors:
   1. Bridging Factor – D15 of #6 gravel must be less than or equal to 8 times D85 of #78M.
   2. Permeability Factor – D15 of #6 gravel must greater than or equal to 5 times D15 of #78.
   3. Uniformity Factor – D90/D15 of #6 gravel is less or equal to 3.0.

C. Stalite PermaTill and # 6 stone/soil materials. Collect samples and subject laboratory testing to confirm compliance with the following performance factors:
   1. Bridging Factor – D15 of #6 gravel must be less than or equal to 8 times D85 of Stalite PermaTill.
   2. Permeability Factor – D15 of #6 gravel must greater than or equal to 5 times D15 of Stalite Perma Till.
   3. Uniformity Factor – D90/D15 of #6 gravel is less or equal to 3.0.

D. On-site manufacturing of NCDOT Rip-Rap stone, Class A and # 6 stone/soil materials. Collect samples and subject laboratory testing to confirm compliance with the following performance factors:
   1. Bridging Factor – D15 of Rip-Rap must be less than or equal to 8 times D85 of #6 stone.
   2. Permeability Factor – D15 of Rip-Rap must greater than or equal to 5 times D15 of #6.
   3. Uniformity Factor – D90/D15 of Rip-Rap is less or equal to 3.0.

E. Adjust the on-site manufacturing and screening process as necessary to achieve the above bridging, permeability, and uniformity factors.

PART 2 - PRODUCTS

2.5 SUBSURFACE PIPES

A. Perforated Pipes:
   1. 12” diameter HDPE ADS Perforated Pipes shall be installed in locations and depths as shown on the plans with all of the necessary fittings (end caps, unions, and connectors) and concrete blocking.
   2. 24” diameter HDPE ADS Perforated Pipe outlet structure.

B. Geotechnical Fabric – requirement has been requested to be waived for this project
   1. Geotechnical Fabric – US 160NW non-woven geotextile made of 100% polypropylene Staple filaments (or equivalent). Relevant standards for US 160 NW fabric are:
      a. Weight – 6.0 oz/SY
      b. Tensile Strength – 160 lbs.
      c. Opening Size – US Sieve #70
      d. Water Flow Rate – 110 gal/min/SF

2.6 SOIL PRODUCTS

A. Stalite PermaTill C330, 20% Compost, and 10% Pine Bark fines.
1. Plant Available Water (PAW): Water Holding Capacity between -0.025 bar and -15 bars of soil moisture tension at 85% Compaction: Minimum of 25% and not more than 35%. Sphagnum peat shall be added to the mixture if PAW is below 25%, and sufficient to increase PAW up to 25%.
2. Saturated Hydraulic Conductivity (Ksat) at 85% Compaction: = or > 10 inches/hour
3. Soluble Salt Content: < 4 mmohs/cm, at 25^{o}C
4. Soil pH: 6.0 to 7.0,
5. No detectable expansive clay minerals are allowed in the mix.
6. Nutrient levels for nitrogen, phosphorus, potassium, and other elements according to soil testing laboratory recommendations.

2.7 TURF PRODUCTS

A. Celebration Bermuda Grass Sod
1. Celebration Bermuda Grass Sod shall be grown on an approved sand or loamy sand soil.
2. Submit sources of the proposed sod and include quart bag of the soil material to the project Soil Scientist. Submit at least three different sources and request approval.

2.8 DESCRIPTION OF INFILTRATION SYSTEM PROFILE LAYERS

1. Bermuda Grass grown on Perma Till C330 media: ½ inch:

   Stalite 70% MDC-16, 20% Compost, and 10% Pine Bark fine: 3.0 foot depth **Top Elevation 285-feet, Bottom Elevation 282-feet**

2. #6 stone media: 1 foot depth: **Top Elevation 282-feet, Bottom Elevation 281-feet**

3. #78 Stone/Sand Media: 4-feet: **Top Elevation 281-feet, Bottom Elevation 277-feet**

4. #6 stone media: 1 foot depth over 12” diameter perforated pipes: **Top Elevation 277-feet, Bottom Elevation 276-feet**

5. 12-inch diameter ADS HDPE Perforated Pipes: **Invert Elevation 275-feet**

6. #6 stone media: 1 foot depth between 12” diameter perforated pipes: 1 foot depth **Top Elevation 276-feet, Bottom Elevation 275-feet**
   #6 stone media: 0.5 foot depth below 12” diameter perforated pipes: 0.5 foot depth: **Top Elevation 275-feet, Bottom Elevation 274.5-feet**

7. #78 Stone/Sand Media: 3.5 foot depth: **Top Elevation 274.5-feet, Bottom Elevation 271-feet**

8. #6 stone media: 0.5 foot depth: **Top Elevation 271-feet, Bottom Elevation 270.5-feet**
9. NCDOT Rip-Rap, Class A, stone layer: 2-foot depth: **Top Elevation 270.5-feet, Bottom Elevation 268.5-feet**
10. Geotechnical fabric – requirement has been requested to be waived

11. Stone subgrade: **Elevation 268.5-feet**

PART 3 - EXECUTION

2.9 GENERAL

H. Install all of the components according to this specification and the construction plans.

I. Stake all edges of Infiltration System and confirm the soil profile is to be installed by referencing the specification and construction plans.

J. Layer #9: Install the geotechnical fabric on the stone subgrade. This requirement has been requested to be waived.

K. Layer #8: Install the NCDOT Rip-Rap, Class A stone using track type equipment. The Rip-Rap layer tapers and thins away from the drainage outlet. The minimum depth of the layer is 1-foot and increases to 3-feet at the drainage outlet.

L. Layer #7: Install the #6 stone layer using track type equipment.

M. Layer #6: Install the #78 Stone/Sand Media **ONLY** using a conveyor system achieving a 4-foot depth. Hand rake and smooth the top of the layer before installing the next layer.

N. Layer #5: Install the #6 stone layer **ONLY** using a conveyor system achieving a 1-foot depth.

O. Layer #4: Install the HDPE 12-inch Perforated Pipes on top of Layer #6. Next install #6 Stone between the HDPE 12-inch Perforated Pipes **ONLY** using a conveyor system.

P. Layer #3: Install #6 stone layer **ONLY** using a conveyor system achieving a 1-foot depth over top of the HDPE 12-inch Perforated Pipes.

Q. Layer #2: Install the Stalite 70% MDC-16, 20% Compost, and 10% Pine Bark fine media **ONLY** using a conveyor system achieving a 2-foot layer of media.
Once sufficient soil material has been added, complete the Infiltration System by raking so that the surface is perfectly smooth. The elevations of the soil must be checked to make sure the surface is at the correct elevations.

R. Layer #1: Plant the Celebration Bermuda Grass sod. Make sure that the sod is tightly laid without any gap between rolls. Install a temporary irrigation system and water until 100% has rooted down

at least 6 inches below the surface. Obtain final approval by the Project Soil Scientist. After approval removed the temporary irrigation system.

End of Section