THE VAULT ON 17th

WILMINGTON, NORTH CAROLINA

STORMWATER AND EROSION CONTROL NARRATIVE

Prepared for:

The Vault on 17th, LLC

1051 Military Cutoff Rd., Suite 200
Wilmington, NC 28405

Final SW Calcs
SWP 2017023
6/23/17
RAC

Prepared by:

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Project #16312.PE

~~March 2017~~
May 2017

NORTH CAROLINA PROFESSIONAL SEAL 034354 ENGINEER JAMES BRANCH SMITH

J Branch Smith
5-5-17

THE VAULT ON 17^{th}

WILMINGTON, NORTH CAROLINA

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PROJECT NARRATIVE

The Vault on 17th, LLC will be the future managing LLC of the proposed mini storage facility. The current active LLC is known as Cisco Acquisitions. The proposed project will consist of a single ~~76,253~~ sqft climate-controlled mini storage facility located at 11~~01~~ 13 S. 17th Street in the City of Wilmington Zoning limits. The site is further identified by New Hanover County Parcel ID #: R05415-003-001-000 (3.92 ac) for a total land disturbance of 2.0 acres. The site is located on 17th Street at the intersection of Martsellar Street (Lat: 39° 57' 47.57", Long: W85° 49' 38.25").

The site is bound to the north by Seaboard Coast Railroad, south by government owned wooded property, east by multi-family residences, and west by 17th Street. The project has had no previous stormwater or grading permits to the Owner's knowledge.

The topography of the site falls from 17th St to the rear and and east towards a small draw that leaves the property and enters the railroad property. The existing soils on the site are predominantly Baymeade fine sands (Be) according to the NRCS Web Soil Survey. According to the attached USGS map, the site is within the Greenfield Lake watershed, which is classified as Sc (Cape Fear River Basin).

PROPOSED EROSION CONTROL MEASURES

A. **TEMPORARY CONSTRUCTION ENTRANCE (DENR PRACTICE 6.06)** An existing curb cut driveway will serve as one construction entrance off 17th Street, and a new one is proposed along 17th St in the other permanent driveway.

B. **TEMPORARY SILT (SEDIMENT) FENCE (DENR PRACTICE 6.62)** Temporary silt fence will be installed to keep sedimentation on-site and to prevent the sediment from washing into undisturbed areas.

C. **TEMPORARY INLET PROTECTION (DENR PRACTICE 6.51)** Inlet protection is shown for the new drainage inlets and they will be noted for maximum sediment blockage on the inlets since the inlets are for the permanent infiltration trench system.

D. **TEMPORARY TREE PROTECTION FENCING (DENR PRACTICE 6.05)** Temporary tree protections are shown using the City of Wilmington standard tree protection guidance. Certain live oaks have specific instructions on the plans for proper care during grading and constructing curbing, etc.

PROPOSED STORMWATER CONTROL MEASURES

Double rows of 30-inch infiltration pipe and trenches will be used to treat the required 1.5-inch rainfall-runoff per NC Coastal Stormwater Rules for Infiltration Systems [NCAC 02H.1051]. The design also accounts for the peak discharge control for the 2, 10, and 25-yr design storms per the City of Wilmington Stormwater Ordinance. The infiltration trenches were calculated utilizing SCS TR-20 hydrograph routing through the HydroCAD software application. The infiltration trench is sized to infiltrate using the reported infiltration rate, a minimum 2-ft of separation between SHWT, have pretreatment catch basin sumps, and drawdown the design volume within 3 days. Reference ECS Soil Testing Report 49-4162 dated January 25, 2017 included herein for infiltration rate and depth to seasonal high water table.

Infiltration Trench System (IT-1):

Pre DA = 127,310 sqft (2.92 ac)
Post DA = 127,310 sqft (2.92 ac)

Pre CN = 39 (COW Allowable: Grass w/ HSG A)
Post CN = 98 (Impervious)

Pre Tc = 15.0 min (Kirpich Method)
Post Tc = 5.0 min (Min. Tc)

Storm Routing:		**Pre-Dev:**
Q1 = 0 cfs	<	Q1 = 0.01 cfs
Q2 = 0 cfs	<	Q2 = 0.05 cfs
Q10 = 0 cfs	<	Q10 = 1.14 cfs
Q25 = 1.87 cfs	<	Q25 = 2.05 cfs
Q50 = 4.23 cfs		
Q100 = 8.44 cfs		

WSEL1 = 39.10'
WSEL2 = 39.48'
WSEL10 = 40.54'
WSEL25 = 40.88' > Overflow Wall = 40.60'
WSEL50 = 41.08'
WSEL100 = 41.37' < Top of Trench = 41.50'

Storm inlet calculations have been performed utilizing the Rational Method for the 10, 25, and 50-yr design storms to check for flood surcharge for the two largest drainage inlet areas. The inlets are considered 50% clogged, and the drainage areas include the area of the buildings that will be piped into the box as opposed to surface runoff to the inlets. Hydraulic grade line (HGL) calculations were not modeled since this system is designed as a continuous infiltration pipe trench system.

Project Name: The Vault on 17th
Client: The Vault on 17th, LLC
Project Number: 16312.PE
Prepared By: JBS
Date: 5/5/17

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[#1] Infiltration Trench

Stormwater Quality Requirement:

Drainage Area to System =	2.920	Ac.	
Impervious Area =	2.920	Ac.	
% Impervious	100.00	%	
Runoff Coefficent (Rv) =	0.950	in/in	
Req. 1.5" Runoff Volume =	15,104	cf	
1.5" Volume Elev. =	40.40	ft	
1.5" Volume Prov. =	40.60	ft	
Prov. 1.5" Runoff Volume =	17,401	cf	from HydroCAD

Soils Information: [Per ECS Report 49.3814]

Soil Type =	Baymeade Fine Sands		
EL at Test =	41.5	El.	
Depth to SHWL =	66	inches	
SHWL =	36.00	El.	
Infiltration Rate =	10	In/Hr	(Actual Infiltration Rate)

Infiltration Pipe Dimensions

Pipe Size =	30	in	
Trench Depth =	48	in	
Trench Width =	53.1	in	from HydroCAD
Stone Void Ratio =	40	%	

Design Calculations

Pipe Volume =	4.91	cf/lf	
Voids Volume=	5.12	cf/lf	
Total Trench Volume =	10.03	cf/lf	
Provided Pipe Length =	2310	lf	
Calc. Provided Storage Volume =	23,158	cf	
Provided Storage Volume =	25,128	cf	from HydroCAD

Draw Down Analysis:

Bottom Infiltration Area	12,279	sf	from HydroCAD
Bottom Elevation of Trench	38.00	ft	
Draw Down Time =	0.24	days	

Elev	Stage	Storage	Storage Drained	Qdarcy	Drawdown Time			
ft	ft	cf	cf	cfs	sec	min	hours	days
40.6	2.60	17,401	0	3.69507	0.0	0	0	0
40.3	2.30	15,021	2,380	3.26872	728.1	12.14	0.20	0.01
40.0	2.00	12,566	4,835	2.84236	1701.1	28.35	0.47	0.02
39.7	1.70	10,112	7,289	2.41601	3017.0	50.28	0.84	0.03
39.2	1.20	6,232	11,169	1.70542	6549.1	109.15	1.82	0.08
39.0	1.00	4,848	12,553	1.42118	8832.8	147.21	2.45	0.10
38.0	0.00	0	17,401					

Draw Down Time = 0.24 days

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10-yr Only considers largest areas.

DI- 103			
Area	C	i_{10} [in/hr]	Q_{10} [cfs]
0.19	0.95	7.23	**1.31**

Weir Condition

$Q_w = C_w P h^{1.5}$

Q_w [cfs] =	1.31
C_w [-] =	3
P [ft] =	4
h [ft] =	0.23

Orifice Condition

$Q_o = C_o A\sqrt{2gh}$

Q_o [cfs] =	1.31
C_o [-] =	0.67
A [ft^2] =	0.5
g [ft/s^2] =	32.2
h [ft] =	0.24

Grate will act as Orifice	
Head Above Grate =	**0.24**
Grate Elevation =	**42.85**
Q10 Surcharge Elev =	**43.09**

* Drop inlet area and perimeter values take into account a 50% clog of void space.

DI 106			
Area	C	i_{10} [in/hr]	Q_{10} [cfs]
0.22	0.95	7.23	**1.5**

Weir Condition

$Q_w = C_w P h^{1.5}$

Q_w [cfs] =	1.51107
C_w [-] =	3
P [ft] =	4.08
h [ft] =	0.25

Orifice Condition

$Q_o = C_o A\sqrt{2gh}$

Q_o [cfs] =	1.51107
C_o [-] =	0.67
A [ft^2] =	1.83
g [ft/s^2] =	32.2
h [ft] =	0.02

Grate will act as Weir	
Head Above Grate =	**0.25**
Grate Elevation =	**42.50**
Q10 Surcharge Elev =	**42.75**

* Drop inlet area and perimeter values take into account a 50% clog of void space.

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25-yr

DI- 103			
Area	**C**	**i_{25} [in/hr]**	**Q_{25} [cfs]**
0.19	0.95	8.15	**1.47**

Weir Condition

$Q_w = C_w P h^{1.5}$ im

Q_w [cfs] =	1.47
C_w [-] =	3
P [ft] =	4
h [ft] =	0.25

Orifice Condition

$Q_o = C_o A\sqrt{2gh}$

Q_o [cfs] =	1.47
C_o [-] =	0.67
A [ft^2] =	0.5
g [ft/s^2] =	32.2
h [ft] =	0.30

Grate will act as Orifice	
Head Above Grate =	**0.30**
Grate Elevation =	**42.85**
Q25 Surcharge Elev =	**43.15**

* Drop inlet area and perimeter values take into account a 50% clog of void space.

DI 106			
Area	**C**	**i_{25} [in/hr]**	**Q_{25} [cfs]**
0.22	0.95	8.15	**1.7**

Weir Condition

$Q_w = C_w P h^{1.5}$

Q_w [cfs] =	1.70335
C_w [-] =	3
P [ft] =	4.08
h [ft] =	0.27

Orifice Condition

$Q_o = C_o A\sqrt{2gh}$

Q_o [cfs] =	1.70335
C_o [-] =	0.67
A [ft^2] =	1.83
g [ft/s^2] =	32.2
h [ft] =	0.03

Grate will act as Weir	
Head Above Grate =	**0.27**
Grate Elevation =	**42.50**
Q25 Surcharge Elev =	**42.77**

* Drop inlet area and perimeter values take into account a 50% clog of void space.

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50-yr

DI- 103			
Area	**C**	**i_{50} [in/hr]**	**Q_{50} [cfs]**
0.19	0.95	8.87	**1.60**

Weir Condition

$Q_w = C_w P h^{1.5}$

Q_w [cfs] =	1.60
C_w [-] =	3
P [ft] =	4
h [ft] =	0.26

Orifice Condition

$Q_o = C_o A\sqrt{2gh}$

Q_o [cfs] =	1.60
C_o [-] =	0.67
A [ft^2] =	0.5
g [ft/s^2] =	32.2
h [ft] =	0.35

Grate will act as Orifice	
Head Above Grate =	**0.35**
Grate Elevation =	**42.85**
Q50 Surcharge Elev =	**43.20**

* Drop inlet area and perimeter values take into account a 50% clog of void space.

DI 106			
Area	**C**	**i_{50} [in/hr]**	**Q_{50} [cfs]**
0.22	0.95	8.87	**1.85**

Weir Condition

$Q_w = C_w P h^{1.5}$

Q_w [cfs] =	1.85383
C_w [-] =	3
P [ft] =	4.08
h [ft] =	0.28

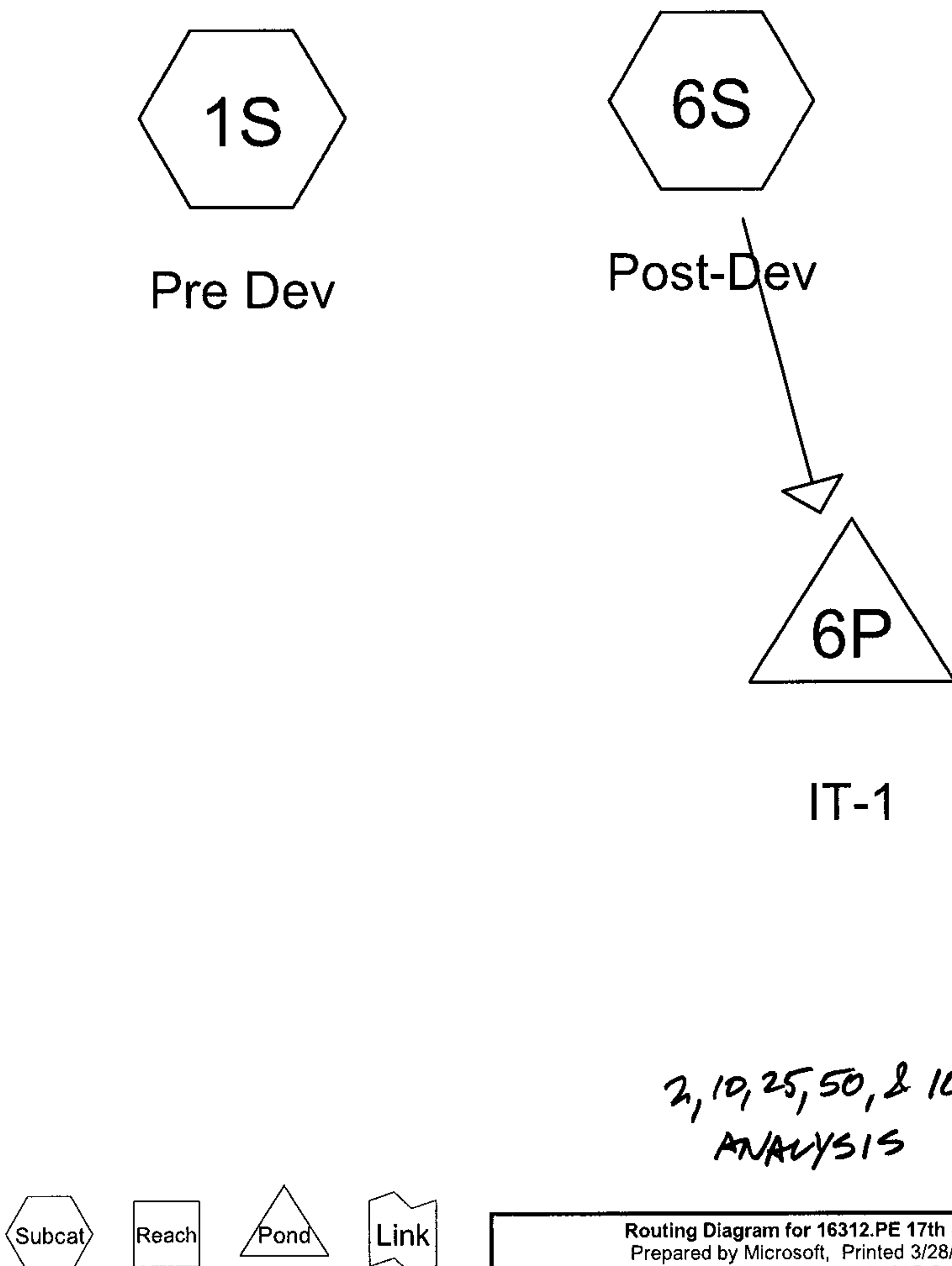
Orifice Condition

$Q_o = C_o A\sqrt{2gh}$

Q_o [cfs] =	1.85383
C_o [-] =	0.67
A [ft^2] =	1.83
g [ft/s^2] =	32.2
h [ft] =	0.04

Grate will act as Weir	
Head Above Grate =	**0.28**
Grate Elevation =	**42.50**
Q50 Surcharge Elev =	**42.78**

* Drop inlet area and perimeter values take into account a 50% clog of void space.



2, 10, 25, 50, & 100-YR
ANALYSIS

Routing Diagram for 16312.PE 17th St MS
Prepared by Microsoft, Printed 3/28/2017

Summary for Subcatchment 1S: Pre Dev

Runoff = 0.05 cfs @ 14.71 hrs, Volume= 998 cf, Depth> 0.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=4.60"

	Area (ac)	CN	Description
*	2.920	39	(COW Allowable), Good, HSG A
	2.920		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry,**

Summary for Subcatchment 6S: Post-Dev

Runoff = 13.21 cfs @ 12.07 hrs, Volume= 44,129 cf, Depth> 4.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=4.60"

	Area (ac)	CN	Description
*	2.920	98	IMPV
	2.920		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5min per Inlet**

Summary for Pond 6P: IT-1

Inflow Area = 127,195 sf,100.00% Impervious, Inflow Depth > 4.16" for 2-Year event
Inflow = 13.21 cfs @ 12.07 hrs, Volume= 44,129 cf
Outflow = 3.89 cfs @ 12.38 hrs, Volume= 44,117 cf, Atten= 71%, Lag= 18.9 min
Discarded = 3.89 cfs @ 12.38 hrs, Volume= 44,117 cf
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 39.48' @ 12.38 hrs Surf.Area= 12,279 sf Storage= 8,364 cf

Plug-Flow detention time= 11.3 min calculated for 44,117 cf (100% of inflow)
Center-of-Mass det. time= 11.2 min (732.4 - 721.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	38.00'	13,613 cf	**10.42'W x 1,178.00'L x 4.00'H Field A** 49,110 cf Overall - 15,077 cf Embedded = 34,033 cf x 40.0% Voids
#2A	38.50'	11,515 cf	**ADS N-12 30** x 2 Inside #1 Inside= 30.0"W x 30.0"H => 4.90 sf x 20.00'L = 98.0 cf Outside= 36.0"W x 36.0"H => 6.42 sf x 20.00'L = 128.3 cf

	Row Length Adjustment= +1,155.00' x 4.90 sf x 2 rows
25,128 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	40.60'	**4.0' long Wall** 2 End Contraction(s)
#2	Discarded	38.00'	**10.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 34.00'

Discarded OutFlow Max=3.89 cfs @ 12.38 hrs HW=39.48' (Free Discharge)
↑—**2=Exfiltration** (Controls 3.89 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=38.00' (Free Discharge)
↑—**1=Wall** (Controls 0.00 cfs)

Summary for Subcatchment 1S: Pre Dev

Runoff = 1.14 cfs @ 12.38 hrs, Volume= 7,310 cf, Depth> 0.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=7.10"

	Area (ac)	CN	Description
*	2.920	39	(COW Allowable), Good, HSG A
	2.920		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry,**

Summary for Subcatchment 6S: Post-Dev

Runoff = 20.47 cfs @ 12.07 hrs, Volume= 69,413 cf, Depth> 6.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=7.10"

	Area (ac)	CN	Description
*	2.920	98	IMPV
	2.920		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5min per Inlet**

Summary for Pond 6P: IT-1

Inflow Area = 127,195 sf,100.00% Impervious, Inflow Depth > 6.55" for 10-Year event
Inflow = 20.47 cfs @ 12.07 hrs, Volume= 69,413 cf
Outflow = 4.65 cfs @ 12.46 hrs, Volume= 69,394 cf, Atten= 77%, Lag= 23.4 min
Discarded = 4.65 cfs @ 12.46 hrs, Volume= 69,394 cf
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 40.54' @ 12.46 hrs Surf.Area= 12,279 sf Storage= 16,933 cf

Plug-Flow detention time= 21.7 min calculated for 69,210 cf (100% of inflow)
Center-of-Mass det. time= 21.4 min (736.4 - 715.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	38.00'	13,613 cf	**10.42'W x 1,178.00'L x 4.00'H Field A** 49,110 cf Overall - 15,077 cf Embedded = 34,033 cf x 40.0% Voids
#2A	38.50'	11,515 cf	**ADS N-12 30** x 2 Inside #1 Inside= 30.0"W x 30.0"H => 4.90 sf x 20.00'L = 98.0 cf Outside= 36.0"W x 36.0"H => 6.42 sf x 20.00'L = 128.3 cf

	Row Length Adjustment= +1,155.00' x 4.90 sf x 2 rows
25,128 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	40.60'	**4.0' long Wall** 2 End Contraction(s)
#2	Discarded	38.00'	**10.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 34.00'

Discarded OutFlow Max=4.65 cfs @ 12.46 hrs HW=40.54' (Free Discharge)
↑—**2=Exfiltration** (Controls 4.65 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=38.00' (Free Discharge)
↑—**1=Wall** (Controls 0.00 cfs)

Summary for Subcatchment 1S: Pre Dev

Runoff = 2.05 cfs @ 12.29 hrs, Volume= 11,087 cf, Depth> 1.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=8.10"

	Area (ac)	CN	Description
*	2.920	39	(COW Allowable), Good, HSG A
	2.920		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry,**

Summary for Subcatchment 6S: Post-Dev

Runoff = 23.37 cfs @ 12.07 hrs, Volume= 79,520 cf, Depth> 7.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=8.10"

	Area (ac)	CN	Description
*	2.920	98	IMPV
	2.920		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5min per Inlet**

Summary for Pond 6P: IT-1

Inflow Area = 127,195 sf,100.00% Impervious, Inflow Depth > 7.50" for 25-Year event
Inflow = 23.37 cfs @ 12.07 hrs, Volume= 79,520 cf
Outflow = 6.76 cfs @ 12.39 hrs, Volume= 79,499 cf, Atten= 71%, Lag= 19.4 min
Discarded = 4.89 cfs @ 12.39 hrs, Volume= 77,620 cf
Primary = 1.87 cfs @ 12.39 hrs, Volume= 1,879 cf

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 40.88' @ 12.39 hrs Surf.Area= 12,279 sf Storage= 19,444 cf

Plug-Flow detention time= 23.3 min calculated for 79,288 cf (100% of inflow)
Center-of-Mass det. time= 23.0 min (736.5 - 713.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	38.00'	13,613 cf	**10.42'W x 1,178.00'L x 4.00'H Field A** 49,110 cf Overall - 15,077 cf Embedded = 34,033 cf x 40.0% Voids
#2A	38.50'	11,515 cf	**ADS N-12 30** x 2 Inside #1 Inside= 30.0"W x 30.0"H => 4.90 sf x 20.00'L = 98.0 cf Outside= 36.0"W x 36.0"H => 6.42 sf x 20.00'L = 128.3 cf

	Row Length Adjustment= +1,155.00' x 4.90 sf x 2 rows
25,128 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	40.60'	**4.0' long Wall** 2 End Contraction(s)
#2	Discarded	38.00'	**10.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 34.00'

Discarded OutFlow Max=4.89 cfs @ 12.39 hrs HW=40.87' (Free Discharge)
└**2=Exfiltration** (Controls 4.89 cfs)

Primary OutFlow Max=1.86 cfs @ 12.39 hrs HW=40.87' (Free Discharge)
└**1=Wall** (Weir Controls 1.86 cfs @ 1.71 fps)

Summary for Subcatchment 1S: Pre Dev

Runoff = 3.10 cfs @ 12.26 hrs, Volume= 14,976 cf, Depth> 1.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=9.00"

	Area (ac)	CN	Description
*	2.920	39	(COW Allowable), Good, HSG A
	2.920		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry,**

Summary for Subcatchment 6S: Post-Dev

Runoff = 25.98 cfs @ 12.07 hrs, Volume= 88,614 cf, Depth> 8.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=9.00"

	Area (ac)	CN	Description
*	2.920	98	IMPV
	2.920		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5min per Inlet**

Summary for Pond 6P: IT-1

Inflow Area = 127,195 sf,100.00% Impervious, Inflow Depth > 8.36" for 50-Year event
Inflow = 25.98 cfs @ 12.07 hrs, Volume= 88,614 cf
Outflow = 9.26 cfs @ 12.32 hrs, Volume= 88,590 cf, Atten= 64%, Lag= 15.0 min
Discarded = 5.03 cfs @ 12.32 hrs, Volume= 83,571 cf
Primary = 4.23 cfs @ 12.32 hrs, Volume= 5,020 cf

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 41.08' @ 12.32 hrs Surf.Area= 12,279 sf Storage= 20,783 cf

Plug-Flow detention time= 22.9 min calculated for 88,587 cf (100% of inflow)
Center-of-Mass det. time= 22.8 min (735.1 - 712.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	38.00'	13,613 cf	**10.42'W x 1,178.00'L x 4.00'H Field A** 49,110 cf Overall - 15,077 cf Embedded = 34,033 cf x 40.0% Voids
#2A	38.50'	11,515 cf	**ADS N-12 30** x 2 Inside #1 Inside= 30.0"W x 30.0"H => 4.90 sf x 20.00'L = 98.0 cf Outside= 36.0"W x 36.0"H => 6.42 sf x 20.00'L = 128.3 cf

	Row Length Adjustment= +1,155.00' x 4.90 sf x 2 rows
25,128 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	40.60'	**4.0' long Wall** 2 End Contraction(s)
#2	Discarded	38.00'	**10.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 34.00'

Discarded OutFlow Max=5.03 cfs @ 12.32 hrs HW=41.07' (Free Discharge)
└─**2=Exfiltration** (Controls 5.03 cfs)

Primary OutFlow Max=4.16 cfs @ 12.32 hrs HW=41.07' (Free Discharge)
└─**1=Wall** (Weir Controls 4.16 cfs @ 2.25 fps)

Summary for Subcatchment 1S: Pre Dev

Runoff = 4.68 cfs @ 12.25 hrs, Volume= 20,788 cf, Depth> 1.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=10.20"

	Area (ac)	CN	Description
*	2.920	39	(COW Allowable), Good, HSG A
	2.920		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry,**

Summary for Subcatchment 6S: Post-Dev

Runoff = 29.46 cfs @ 12.07 hrs, Volume= 100,734 cf, Depth> 9.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=10.20"

	Area (ac)	CN	Description
*	2.920	98	IMPV
	2.920		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5min per Inlet**

Summary for Pond 6P: IT-1

Inflow Area = 127,195 sf,100.00% Impervious, Inflow Depth > 9.50" for 100-Year event
Inflow = 29.46 cfs @ 12.07 hrs, Volume= 100,734 cf
Outflow = 13.67 cfs @ 12.23 hrs, Volume= 100,707 cf, Atten= 54%, Lag= 9.7 min
Discarded = 5.23 cfs @ 12.23 hrs, Volume= 90,953 cf
Primary = 8.44 cfs @ 12.23 hrs, Volume= 9,754 cf

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 41.37' @ 12.23 hrs Surf.Area= 12,279 sf Storage= 22,114 cf

Plug-Flow detention time= 22.3 min calculated for 100,703 cf (100% of inflow)
Center-of-Mass det. time= 22.1 min (733.3 - 711.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	38.00'	13,613 cf	**10.42'W x 1,178.00'L x 4.00'H Field A** 49,110 cf Overall - 15,077 cf Embedded = 34,033 cf x 40.0% Voids
#2A	38.50'	11,515 cf	**ADS N-12 30** x 2 Inside #1 Inside= 30.0"W x 30.0"H => 4.90 sf x 20.00'L = 98.0 cf Outside= 36.0"W x 36.0"H => 6.42 sf x 20.00'L = 128.3 cf

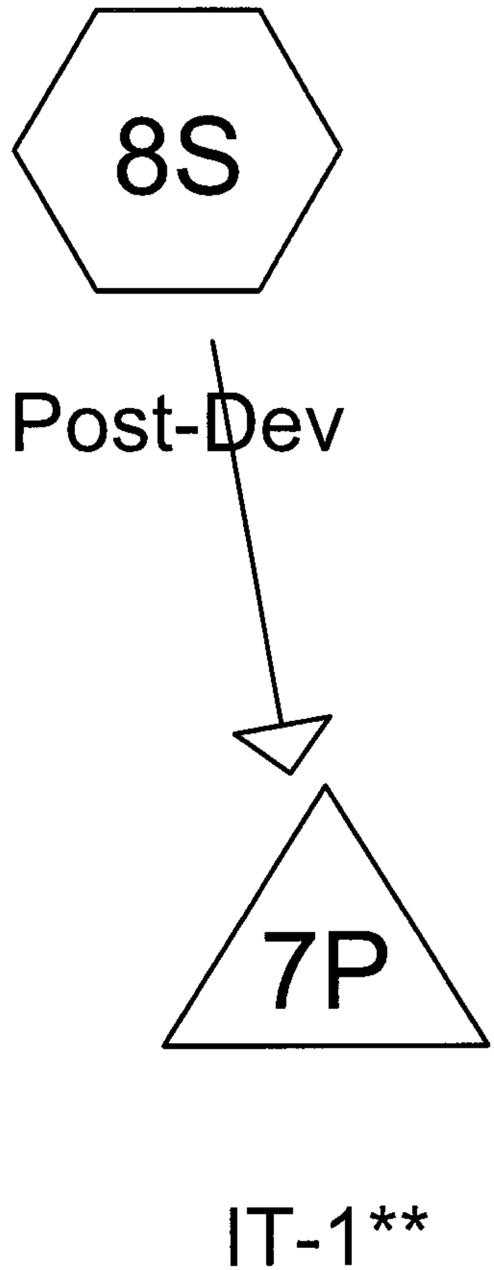
	Row Length Adjustment= +1,155.00' x 4.90 sf x 2 rows
25,128 cf	Total Available Storage

Storage Group A created with Chamber Wizard

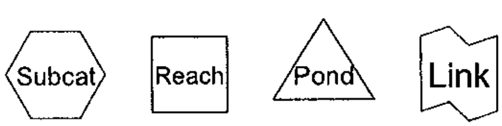
Device	Routing	Invert	Outlet Devices
#1	Primary	40.60'	**4.0' long Wall** 2 End Contraction(s)
#2	Discarded	38.00'	**10.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 34.00'

Discarded OutFlow Max=5.23 cfs @ 12.23 hrs HW=41.36' (Free Discharge)
↑—**2=Exfiltration** (Controls 5.23 cfs)

Primary OutFlow Max=8.30 cfs @ 12.23 hrs HW=41.36' (Free Discharge)
↑—**1=Wall** (Weir Controls 8.30 cfs @ 2.85 fps)



50 & 100-YR
ANALYSIS ASSUMING
NO INFILTRATION



Routing Diagram for 16312.PE 17th St MS
Prepared by Microsoft, Printed 3/29/2017
HydroCAD® 10.00-12 s/n 08877 © 2014 HydroCAD Software Solutions LLC

Summary for Subcatchment 8S: Post-Dev

Runoff = 25.98 cfs @ 12.07 hrs, Volume= 88,614 cf, Depth> 8.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=9.00"

	Area (ac)	CN	Description
*	2.920	98	IMPV
	2.920		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5min per Inlet**

Summary for Pond 7P: IT-1**

Inflow Area = 127,195 sf,100.00% Impervious, Inflow Depth > 8.36" for 50-Year event
Inflow = 25.98 cfs @ 12.07 hrs, Volume= 88,614 cf
Outflow = 25.15 cfs @ 12.10 hrs, Volume= 70,518 cf, Atten= 3%, Lag= 2.0 min
Primary = 25.15 cfs @ 12.10 hrs, Volume= 70,518 cf

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 42.24' @ 12.10 hrs Surf.Area= 12,279 sf Storage= 25,128 cf

Plug-Flow detention time= 133.5 min calculated for 70,325 cf (79% of inflow)
Center-of-Mass det. time= 74.9 min (787.3 - 712.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	38.00'	13,613 cf	**10.42'W x 1,178.00'L x 4.00'H Field A** 49,110 cf Overall - 15,077 cf Embedded = 34,033 cf x 40.0% Voids
#2A	38.50'	11,515 cf	**ADS N-12 30** x 2 Inside #1 Inside= 30.0"W x 30.0"H => 4.90 sf x 20.00'L = 98.0 cf Outside= 36.0"W x 36.0"H => 6.42 sf x 20.00'L = 128.3 cf Row Length Adjustment= +1,155.00' x 4.90 sf x 2 rows
		25,128 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	40.60'	**4.0' long Wall** 2 End Contraction(s)

Primary OutFlow Max=24.69 cfs @ 12.10 hrs HW=42.22' (Free Discharge)
↑—**1=Wall** (Weir Controls 24.69 cfs @ 4.16 fps)

NO SURCHARGE FROM INLETS

Summary for Subcatchment 8S: Post-Dev

Runoff = 29.46 cfs @ 12.07 hrs, Volume= 100,734 cf, Depth> 9.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=10.20"

	Area (ac)	CN	Description
*	2.920	98	IMPV
	2.920		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5min per Inlet**

Summary for Pond 7P: IT-1**

Inflow Area = 127,195 sf,100.00% Impervious, Inflow Depth > 9.50" for 100-Year event
Inflow = 29.46 cfs @ 12.07 hrs, Volume= 100,734 cf
Outflow = 36.07 cfs @ 12.10 hrs, Volume= 82,581 cf, Atten= 0%, Lag= 1.7 min
Primary = 36.07 cfs @ 12.10 hrs, Volume= 82,581 cf

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 42.72' @ 12.10 hrs Surf.Area= 12,279 sf Storage= 25,128 cf

Plug-Flow detention time= 124.9 min calculated for 82,354 cf (82% of inflow)
Center-of-Mass det. time= 70.6 min (781.8 - 711.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	38.00'	13,613 cf	**10.42'W x 1,178.00'L x 4.00'H Field A**
			49,110 cf Overall - 15,077 cf Embedded = 34,033 cf x 40.0% Voids
#2A	38.50'	11,515 cf	**ADS N-12 30** x 2 Inside #1
			Inside= 30.0"W x 30.0"H => 4.90 sf x 20.00'L = 98.0 cf
			Outside= 36.0"W x 36.0"H => 6.42 sf x 20.00'L = 128.3 cf
			Row Length Adjustment= +1,155.00' x 4.90 sf x 2 rows
		25,128 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	40.60'	**4.0' long Wall** 2 End Contraction(s)

Primary OutFlow Max=35.57 cfs @ 12.10 hrs HW=42.70' (Free Discharge)
└─**1=Wall** (Weir Controls 35.57 cfs @ 4.74 fps)

SLIGHT SURCHARGE FROM INLETS
NO STRUCTURE IMPACT

ECS SOUTHEAST, LLP
"Setting the Standard for Service"
Geotechnical • Construction Materials • Environmental • Facilities
NC Registered Engineering Firm F-1078
NC Registered Geologists Firm C-406
SC Registered Engineering Firm 3239

January 25, 2017

Mr. Mike Brown
Cape Fear Commercial
1051 Military Cutoff Road, Suite 200
Wilmington, North Carolina 28405

Reference: Report of Seasonal High Water Table Estimation and Infiltration Testing
17th Street Mini Storage Site
Wilmington, New Hanover County, North Carolina
ECS Project No. 49.-4162

Dear Mr. Brown:

ECS Southeast, LLP (ECS) recently conducted a seasonal high water table (SHWT) estimation and infiltration testing within the stormwater best management practice (BMP) area(s) 1101 South 17th Street in Wilmington, New Hanover County, North Carolina. This letter, with attachments, is the report of our testing.

Field Testing

On January 24, 2017, ECS conducted an exploration of the subsurface soil and groundwater conditions at two requested locations shown on the attached Boring Location Plan (Figure 1). ECS located the borings using a site plan provided by Paramount Engineering. The purpose of this exploration was to obtain subsurface information of the in situ soils for the stormwater BMP area(s). ECS explored the subsurface soil and groundwater conditions by advancing one hand auger boring into the existing ground surface at each of the requested boring locations. ECS visually classified the subsurface soils and obtained representative samples of each soil type encountered. ECS also recorded the SHWT and groundwater elevation observed at the time of the hand auger borings. The attached Infiltration Testing Form provides a summary of the subsurface conditions encountered at the hand auger boring locations.

The SHWT and groundwater elevation was estimated at the boring locations below the existing grade elevation. A summary of the findings are as follows:

Location	SHWT	Groundwater
B-1	102 inches	>120 inches
B-2	96 inches	>120 inches

ECS has conducted two infiltration tests utilizing a compact constant head permeameter near the hand auger borings in order to estimate the infiltration rate for the subsurface soils. Infiltration tests are typically conducted at two feet above the SHWT or in the most restrictive soil horizon. Tests in clayey conditions are conducted and calculated up to 30 minute intervals. If an exact hydraulic conductivity is necessary for these locations, then ECS recommends collecting samples by advancing Shelby tubes and performing laboratory permeability testing.

Field Test Results

Below is a summary of the infiltration test results:

Location	Description	Depth	Inches/ hour
B-1	Tan/gray/orange fine SAND	66 inches	9.90
B-2	Tan fine SAND	66 inches	10.10

Infiltration rates and SHWT may vary within the proposed site due to changes in elevation and subsurface conditions. ECS observed an interval of clayey sand from 36 inches to 60 inches below grade elevation at both boring locations. ECS recommends removing this restrictive layer of soil within the BMP if an infiltration BMP is being designed for the site.

Closure

ECS's analysis of the site has been based on our understanding of the site, the project information provided to us, and the data obtained during our exploration. If the project information provided to us is changed, please contact us so that our recommendations can be reviewed and appropriate revisions provided, if necessary. The discovery of any site or subsurface conditions during construction which deviate from the data outlined in this exploration should be reported to us for our review, analysis and revision of our recommendations, if necessary. The assessment of site environmental conditions for the presence of pollutants in the soil and groundwater of the site is beyond the scope of this geotechnical exploration.

ECS appreciates the opportunity to provide our services to you on this project. If you have any questions concerning this report or this project, please contact us at (910) 686-9114.

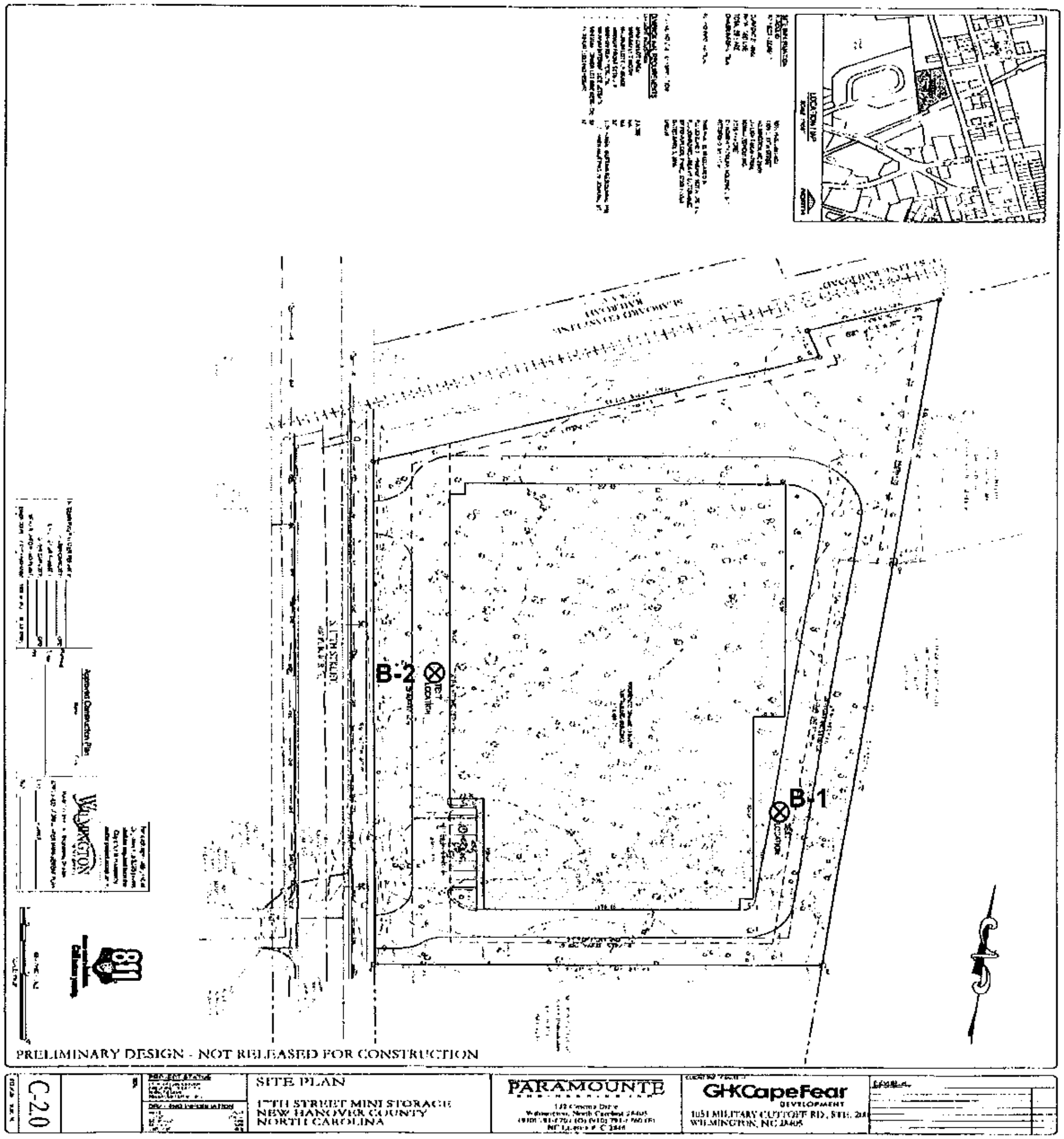
Respectfully,

ECS SOUTHEAST, LLP

K. Brooks Wall
Project Manager
bwall@ecslimited.com
910-686-9114

W. Brandon Fulton, PSC, PWS, LSS
Environmental Department Manager
bfulton@ecslimited.com
704-525-5152

Attachments: Figure 1 - Boring Location Plan
Infiltration Testing Form
ASFE Document



⊗ **APPROXIMATE BORING LOCATIONS**

NOT TO SCALE

17TH St. Mini Storage Site
Wilmington, New Hanover County,
North Carolina

ECS Project # 49.3814
January 24, 2017
KBW

Figure 1– Boring Location Plan

Provided by: Paramounte Engineering

Infiltration Testing Form
17 Street Mini Storage Site
Wilmington, New Hanover County, North Carolina
ECS Project No. 49.3814
January 24, 2017

Location	Depth	USCS	Soil Description
B-1	0-18”	SP	Gray fine SAND
	18”-36”	SP	Tan fine SAND
	36”-55”	SC	Tan clayey SAND
	55”-102”	SP	Tan/gray/orange fine SAND
	10”-120”	SM	Brown/gray silty SAND

Seasonal High Water Table was estimated to be at 102 inches below the existing grade elevation.
Groundwater was encountered up to 120 inches below the existing grade elevation.
Test was conducted at 66 inches below existing grade elevation
Infiltration Rate: 9.90 inches per hour

Location	Depth	USCS	Soil Description
B-2	0-14”	SP	Gray fine SAND
	14”-36”	SP	Tan fine SAND
	36”-52”	SC	Tan clayey SAND
	52”-96”	SP	Tan/gray/orange fine SAND
	96”-120”	SM	Brown/gray silty SAND

Seasonal High Water Table was estimated to be at 96 inches below the existing grade elevation.
Groundwater was encountered up to 120 inches below the existing grade elevation.
Test was conducted at 66 inches below existing grade elevation
Infiltration Rate: 10.10 inches per hour

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one - not even you* - should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from alight industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes - even minor ones - and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ-sometimes significantly from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the express purpose of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in-this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechnical Engineer For Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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