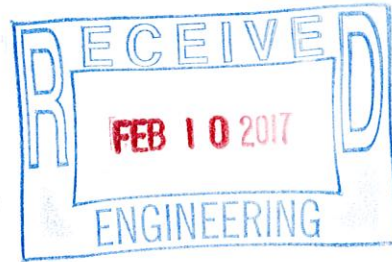


**STORMWATER MANAGEMENT
CALCULATIONS**

for

JACOBS BLUFF

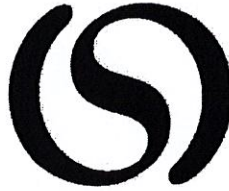


PREPARED FOR

BLACK PACK INVESTMENTS, LLC

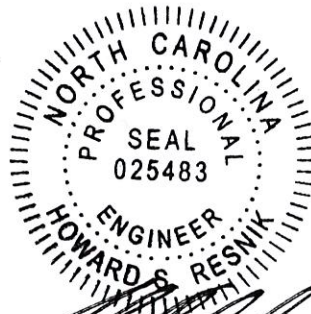
706 Jacobs Creek Lane
Wilmington, NC 28409

Prepared by:



CSD ENGINEERING

PO Box 4041
Wilmington, NC 28406
Phone: 910 791-4441
Fax: 910 791-1501
License # C-2710



A handwritten signature in black ink, appearing to read "Howard Resnik".

Howard Resnik, P.E.

2/7/17

*Final SW Calcs
SWP 2016038R1
2/23/17
rac*

**PERVIOUS PAVEMENT CALCULATIONS for
JACOBS BLUFF**

PONDING TIME

T = PONDING TIME DAYS
P = 1.5 DEPTH OF THE DESIGN STORM (INCHES)
R = 1 A_a/A_p (RATIO OF THE ADDITIONAL BUA TO THE PERMEABLE PAVEMENT, BETWEEN 0 AND 1)
SF = 0.2 SAFETY FACTOR (0.2)
I = 9.1 MEASURED IN-SITU SOIL INFILTRATION RATE (IN/HR)

$$T = P(1+R) / (24XSFXI)$$

$$T = 0.07 \text{ DAYS}$$

AGGREGATE DEPTH OF WATER QUALITY SOTRM (Dwq)

Dwq = DEPTH OF AGGREGATE NEEDED TO TREATE THE WATER QUALITY STORM (INCHES)
P = 1.5 RAINFALL DEPTH FOR THE WATER QUALITY STORM (INCHES)
R = 1 A_a/A_p (RATIO OF THE ADDITIONAL BUA TO THE PERMEABLE PAVEMENT, BETWEEN 0 AND 1)
n = 0.4 PERCENT VOIDS, UNITLESS DECIMAL

$$Dwq = P(1+R)/n$$

$$Dwq = 7.5 \text{ INCHES}$$

AGGREGATE DEPTH TO INFILTRATE 10 YR 24 HR STORM

D10 = DEPTH OF AGGREGATE NEEDED TO INFILTRATE 10 YR STORM (INCHES)
P10 = 7.22 RAINFALL DEPTH FOR THE 10 YR STORM (INCHES)
R = 1 A_a/A_p (RATIO OF THE ADDITIONAL BUA TO THE PERMEABLE PAVEMENT, BETWEEN 0 AND 1)
d = 24 STORM DURATION (24 HRS)
I = 9.1 MEASURED IN-SITU SOIL INFILTRATION RATE (IN/HR)
SF = 0.2 SAFETY FACTOR (0.2)
n = 0.4 PERCENT VOIDS, UNITLESS DECIMAL

$$D10 = P10(1+R) - (d)(I)(SF) / N$$

$$D10 = -73.1 \text{ INCHES}$$

IF D10 IS NEGATIVE THEN AGGREGATE DEPTH NEEDED WILL BE EQUAL TO Dwq



February 26, 2014

Howard Resnik, P.E.
Coastal Site Design
3805 Cherry Avenue
Wilmington, North Carolina 28406

Reference: Report of Infiltration Testing
706 Jacobs Creek Lane
Wilmington, New Hanover County, North Carolina
ECS Project No. 22.20276

Dear Mr. Resnik:

ECS Carolinas, LLP (ECS) recently conducted infiltration testing for the design of the stormwater best management practice (BMP) areas at 706 Jacobs Creek Lane in Wilmington, New Hanover County, North Carolina. This letter, with attachments, is the report of our testing.

Field Testing

On February 21 and 24, 2014, ECS conducted an exploration of the subsurface soil and groundwater conditions at seven requested locations shown on the attached Test Location Plan (Figure 1). ECS located the test areas with GPS equipment and a boring plan provided by Coastal Site Design, PLLC. The purpose of this exploration was to obtain subsurface information of the in-place soils for the stormwater BMP areas. ECS explored the subsurface soil and groundwater conditions by advancing one hand auger boring into the existing ground surface at the requested boring locations. ECS visually classified the subsurface soils and obtained representative samples of each soil type encountered. ECS also recorded the groundwater level and the seasonal high water table (SHWT) 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 were estimated at the boring locations below the existing grade elevation. A summary of the findings are as follows:

Location	SHWT	Groundwater
B-1	12 inches	18 inches
B-2	24 inches	70 inches
B-3	24 inches	70 inches
B-4	24 inches	70 inches
B-5	72 inches	100 inches
B-6	18 inches	42 inches
B-7	24 inches	50 inches

ECS has conducted seven 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.

Field Test Results

Below is a summary of the infiltration test results:

Location	Description	Depth	Inches/hour
B-1	Gray fine SAND w silt	12 inches	3.9
B-2	Tan/orange/gray CLAY	36 inches	0.001
B-3	Tan/orange/gray CLAY	36 inches	0.001
B-4	Tan/orange/gray CLAY	36 inches	0.001
B-5	Tan fine to med SAND	65 inches	14.3
B-6	Tan/orange sandy CLAY	24 inches	0.09
B-7	Tan/orange sandy CLAY	24 inches	0.07

Infiltration rates and SHWT may vary within the proposed site due to changes in elevation and subsurface conditions.

Closure

The activities and evaluative approaches used in this assessment are consistent with those normally employed in assessments of this type. ECS's testing of site conditions has been based on our understanding of the project information and the data obtained during our field activities.

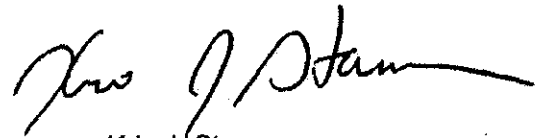
ECS appreciates the opportunity to provide our services to you on this project. If you have any questions concerning this report or this project, please contact us at (910) 686-9114.

Respectfully,

ECS CAROLINAS, LLP

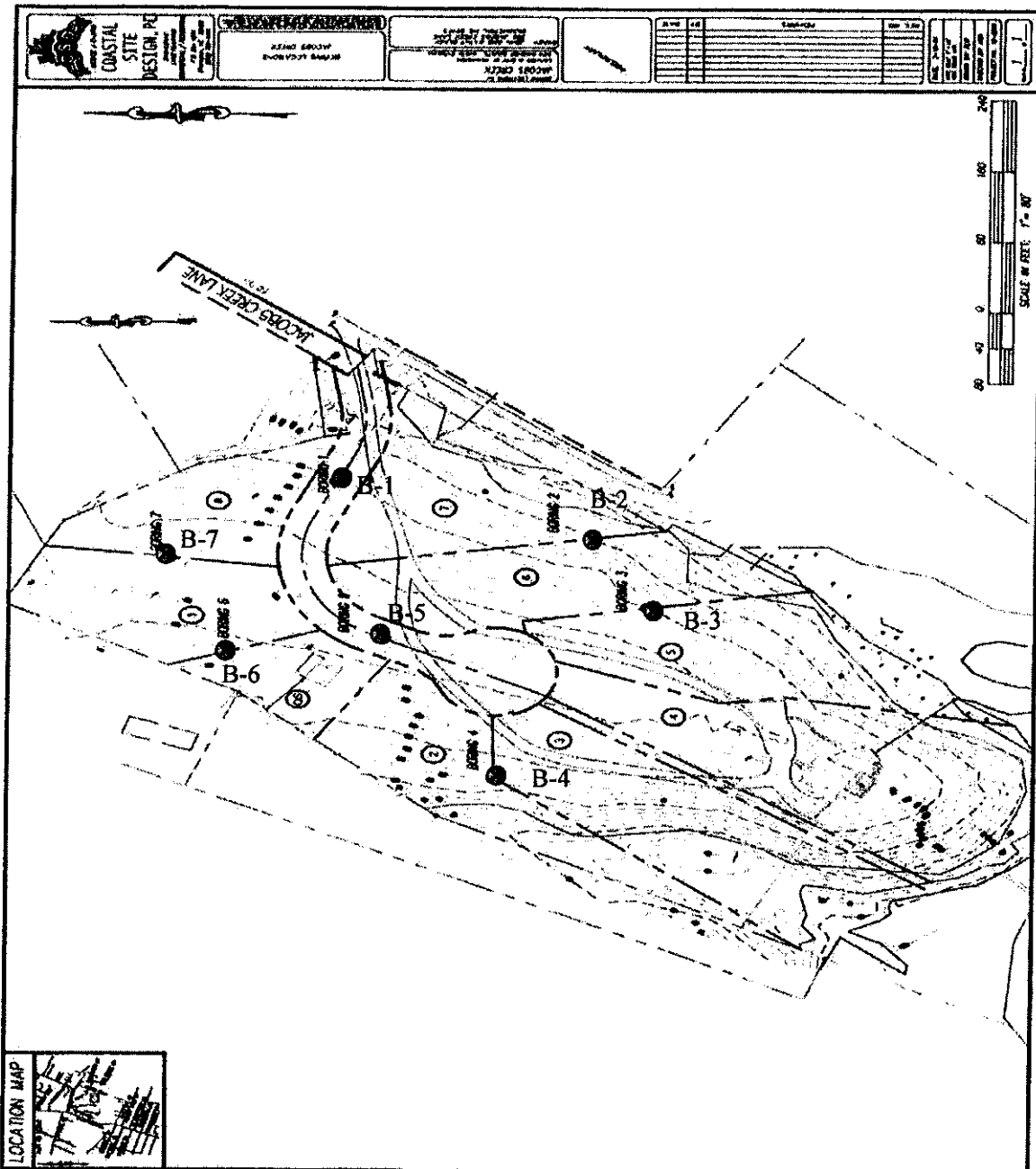


K. Brooks Wall
Project Geologist



Kris J. Stamm
Principal

Attachments: Figure 1 - Test Location Plan
Infiltration Testing Form



● APPROXIMATE BORING LOCATIONS

SCALE SHOWN ABOVE

706 Jacobs Creek Lane
 Wilmington, New Hanover County,
 North Carolina

ECS Project # 20276
 February 21, 2014
 KBW

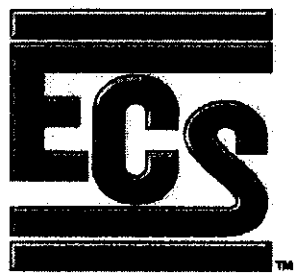


Figure 1- Boring Location Plan

Provided by: CSD, PC



**Infiltration Testing Form
Jacobs Creek Lane Site
Wilmington, New Hanover County, North Carolina
ECS Project No. 22.20276
February 21, 2014**

<u>Location</u>	<u>Depth</u>	<u>Soil Description</u>
B-1	0-24"	Gray fine SAND with silt

Seasonal High Water Table was estimated to be at 12 inches below the existing grade elevation.

Infiltration Rate: 3.9 per hour

Test was conducted at 12 inches below existing grade elevation

Groundwater was encountered at 18 inches below the existing grade elevation.

<u>Location</u>	<u>Depth</u>	<u>Soil Description</u>
B-2	0-3"	PEAT
	3"-30"	Tan fine SAND w/ clay
	30"-70"	Tan/orange/gray CLAY

Seasonal High Water Table was estimated to be at 24 inches below the existing grade elevation.

Infiltration Rate: 0.001 per hour

Test was conducted at 36 inches below existing grade elevation

Groundwater was encountered at 70 inches below the existing grade elevation.

<u>Location</u>	<u>Depth</u>	<u>Soil Description</u>
B-3	0"-28"	Tan fine SAND w/ clay
	28"-70"	Tan/orange/gray CLAY

Seasonal High Water Table was estimated to be at 24 inches below the existing grade elevation.

Infiltration Rate: 0.001 per hour

Test was conducted at 36 inches below existing grade elevation

Groundwater was encountered at 70 inches below the existing grade elevation.

Infiltration Testing Form
Jacobs Creek Lane Site
Wilmington, New Hanover County, North Carolina
ECS Project No. 22.20276
February 21, 2014

<u>Location</u>	<u>Depth</u>	<u>Soil Description</u>
B-4	0-6"	PEAT
	6"-24"	Tan fine SAND w/ clay
	24"-70"	Tan/orange/gray CLAY

Seasonal High Water Table was estimated to be at 24 inches below the existing grade elevation.

Infiltration Rate: 0.001 per hour

Test was conducted at 36 inches below existing grade elevation

Groundwater was encountered at 70 inches below the existing grade elevation.

<u>Location</u>	<u>Depth</u>	<u>Soil Description</u>
B-5	0-6"	Brown silty SAND
	6"-32"	Tan fine SAND
	32"-55"	Orange clayey SAND
	55"-96"	Tan fine to med. SAND
	96"-100"	Gray/orange CLAY

Seasonal High Water Table was estimated to be at 72 inches below the existing grade elevation.

Infiltration Rate: 14.3 per hour

Test was conducted at 65 inches below existing grade elevation

Groundwater was encountered at 100 inches below the existing grade elevation.

Infiltration Testing Form
Jacobs Creek Lane Site
Wilmington, New Hanover County, North Carolina
ECS Project No. 22.20276
February 21, 2014

<u>Location</u>	<u>Depth</u>	<u>Soil Description</u>
B-6	0-12"	Gray fine SAND
	12"-18"	Tan clayey SAND
	18"-36"	Tan/orange sandy CLAY
	36"-48"	Tan/orange fine SAND w/clay

Seasonal High Water Table was estimated to be at 18 inches below the existing grade elevation.

Infiltration Rate: 0.09 per hour

Test was conducted at 24 inches below existing grade elevation

Groundwater was encountered at 42 inches below the existing grade elevation.

<u>Location</u>	<u>Depth</u>	<u>Soil Description</u>
B-7	0-6"	Gray silty SAND
	6"-18"	Tan fine SAND
	18"-38"	Orange sandy CLAY
	38"-50"	Tan/orange fine SAND w/clay
	50"-60"	Gray medium SAND

Seasonal High Water Table was estimated to be at 24 inches below the existing grade elevation.

Infiltration Rate: 0.07 per hour

Test was conducted at 24 inches below existing grade elevation

Groundwater was encountered at 50 inches below the existing grade elevation.