

*Stormwater Analysis*

**North Chatham Village**

Chatham County, North Carolina  
KHA Project ID No. 012700000

Prepared for:  
The Keith Corporation  
Submitted: July 1, 2014

STORMWATER IMPACT ANALYSIS

NORTH CHATHAM VILLAGE  
COLE PLACE ROAD  
CHATHAM COUNTY, NC

PREPARED FOR:  
THE KEITH CORPORATION  
5935 CARNEGIE BOULEVARD SUITE 200  
CHARLOTTE, NC 28209

PREPARED BY:  
KIMLEY-HORN AND ASSOCIATES, INC.  
333 FAYETTEVILLE ST. SUITE 600  
RALEIGH, NORTH CAROLINA 27601  
NC CERT. OF AUTH: F-0102

SUBMITTED:  
JULY1, 2014

KHA #012700000



**Disclosure Statement:**

This document, together with the concepts and designs presented herein, as an instrument of service, is intended only for the specific purpose and client for which it was prepared. Reuse of and improper reliance on this document without written authorization and adaptation by Kimley-Horn and Associates, Inc. shall be without liability to Kimley-Horn and Associates, Inc.

# TABLE OF CONTENTS

## OVERVIEW

Narrative

## APPENDICES

Appendix A – FEMA Flood Insurance Rate Map

Appendix B – Portion of Chatham USGS Map

Appendix C – USDA Soil Map

Appendix D – Pre-Development Drainage Area Map  
Post-Development Drainage Area Map  
Stormwater BMP Calculation  
Stormwater Quantity Routing Calculations

Appendix E – Impervious Area Calculations, Pre vs Post Development

Appendix F – Chapel Hill Rainfall Intensities and Depths Charts

Appendix G – Skimmer Basin Calculations

## OVERVIEW

### Background

This report contains the approach and results of a stormwater impact analysis conducted for the proposed North Chatham Village development. The project site is located at the northeast corner of the intersection of Hwy 15-501 N and Plaza Road on Cole Place Road just south of Chapel Hill, North Carolina. The drainage area is approximately 8.7 acres with approximately 0.6 acres of run-on from adjacent commercial properties. The area consists of an existing commercial retail development that as proposed will be redeveloped. For the purpose of this report, the existing conditions of the site are based on a July 2013 survey performed by James Mauney & Associates, P.A., Professional Land Surveyors. Of the existing 8.7-acre development in the study area, approximately 2.7 acres (+/- 30%) are proposed to be redirected towards the stormwater wet detention basin. The remaining acreage will follow existing drainage patterns. Refer to Appendix D for drainage area maps containing Pre- and Post-Development Landcover Breakdowns.

From the USDA Soils Map (Appendix C), a majority of the soils are classified as Georgeville-Urban land complex (GnC). The on-site soils were classified as hydrologic group B. For the purpose of this analysis, hydrologic soils group B was used in Pond Pack calculations. Ground cover was assumed to be in good condition for both the pre- and post-development calculations. The existing site consists of mostly developed areas referenced in soils Zone X (FEMA FIRM – Appendix A). The project site is located within the Morgan Creek subwatershed which is a tributary to the Jordan Lake Watershed (Per NCDENR Local Watershed Plan Map).

### Proposed Development

The project site was previously developed including connected BUA from commercial buildings and parking areas with no stormwater treatment. This project proposes to construct and redevelop the area while lowering the impervious area onsite. The proposed development will reduce the overall impervious coverage in the study area to 7.5 -acres (81% impervious) as compared to the existing conditions. The proposed wet detention basin stormwater control measure is designed to control and treat the stormwater runoff generated from 30% of the site by the first 1.2 inch of rain and reduces post development discharge of the site to below predevelopment conditions for the one-year, five-year and 10-year, 24-hour storm event. As seen in Appendix D, the Pre-Development condition Outfall consists of 2 separate Nodes while the Post-Development condition Outfall also consists of 2 separate nodes.

### Stormwater Analysis

Stormwater management measures shall be designed in accordance with NCDENR and the Chatham County Stormwater Ordinance. In accordance with the stormwater quantity requirements, the 1-year, 5-year and 10-year, 24-hour peak storm discharge rates are not to be increased above the pre-development levels. If the flow rates are increased, the post-development flow will be reduced to the pre-development flow rate via detention devices.

### Water Quantity

The limits of the study area were established by determining two downstream point of analysis (POA) which encompasses the impacted site area. The undetained flow rates at the points of analysis were evaluated using the SCS Method. The time of concentration for each POA were assumed to have a time of concentration of 5 minutes.

Since detention is required, the project proposes to construct a wet detention pond. Stormwater Quantity analysis was performed using the SCS Method which was modeled with PondPack Software by Bentley. The 1-, 2-, 5-, 10- and 100-year storm events were analyzed using rainfall depths of 2.86, 3.45, 4.30, 4.96 and 7.26 inches respectively. Using the BMP, the site will detain the 1-year, 5-year and 10-year storm events to at or below the pre-development peak runoff rate. Refer to Appendix D for stormwater quantity calculations and BMP calculations.

A summary of the results are as follows:

Flow Evaluation Summary										
Catchment Name	Pre-Development 1-year discharge	Post-Development 1-year discharge	Pre-Development 2-year discharge	Post-Development 2-year Discharge	Pre-Development 5-year Discharge	Post-Development 5-year Discharge	Pre-Development 10-year Discharge	Post-Development 10-year Discharge	Pre-Development 100-year Discharge	Post-Development 100-year Discharge
OUTFALL 1	9.03	6.76	11.4	8.68	14.84	11.48	17.53	13.68	26.89	21.33
OUTFALL 2	19.56	13.49	24.89	17.04	32.67	22.58	38.75	27.33	59.90	56.82

The Proposed Stormwater Wet Detention Basin will outlet to an existing catch basin onsite.

### Water Quality

No nutrient reduction is required as the amount of impervious area is reduced. The proposed pond has been sized to treat 30% of the site for 85% TSS.

### Erosion Control

Erosion and Sedimentation control measures shall be designed in accordance with 15A NCAC, Chapter 4 (NC Sedimentation Pollution Control Act of 1973) to minimize the amount of sediment laden runoff exiting the site. Erosion control measures will be required to be in place before any other site construction begins. Measures include silt fencing, stone construction entrances, and inlet protection at existing and proposed storm inlets. The Proposed Stormwater Wet Detention Basin will serve the site as a Skimmer sediment basin and will be utilized to prevent sediment laden runoff from leaving the site. Rip-rap aprons will be utilized at proposed pipe inlet to pond in order to dissipate the outflow velocity as well as stone outlets where semi-concentrated flow is experienced along the silt fence line.

Reference the Appendix G for skimmer basin calculations.

## Results

The proposed stormwater management measures will be sized and designed using methods prescribed by Chatham County and NCDENR resources. The calculations indicate that the proposed development will comply with local and state stormwater requirements. A newly constructed Wet Detention Basin is required for water quantity reduction in order to meet Chatham County's pre/post requirements and redevelopment requirements.

---

# **APPENDIX A**

---





SCALE 1" = 500' (1 : 6,000)

FEET

**NFP** NATIONAL FLOOD INSURANCE PROGRAM

PANEL 9776J

**FIRM**  
FLOOD INSURANCE RATE MAP  
NORTH CAROLINA

**PANEL 9776**  
SEE LOCATION DIAGRAM ON MAP INDEX FOR FIRM  
PANEL LOCATION  
**VOLUME**  
SHEET NO. 2100  
SHEET TOTAL 308  
COUNTY  
COMMUNITY  
DATE OF  
REVISION

**EFFECTIVE DATE**  
FEBRUARY 2, 2007

**MAP NUMBER**  
37097600



State of North Carolina  
Federal Emergency Management Agency

NOTE: This is a digital copy of a portion of the above referenced flood map. It was extracted using FIRM Online. This map does not reflect changes to the original map. For the latest product information about National Flood Insurance Program flood maps, check the FEMA Flood Map Store at www.fema.gov.

ZONE X

Chatham County  
Unincorporated Area  
370299

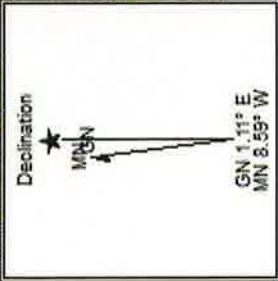
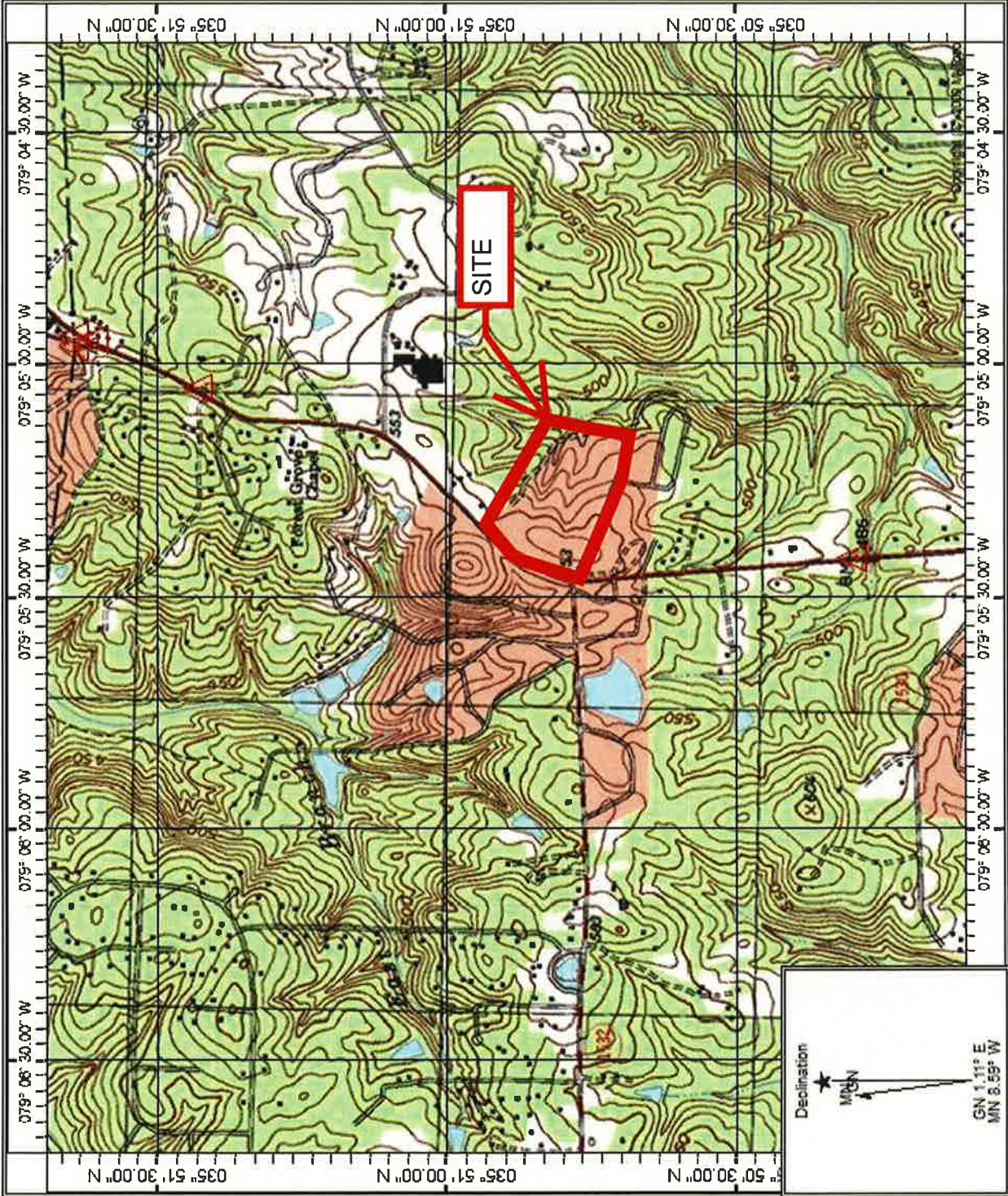
**SITE**

ZONE X

ZONE X

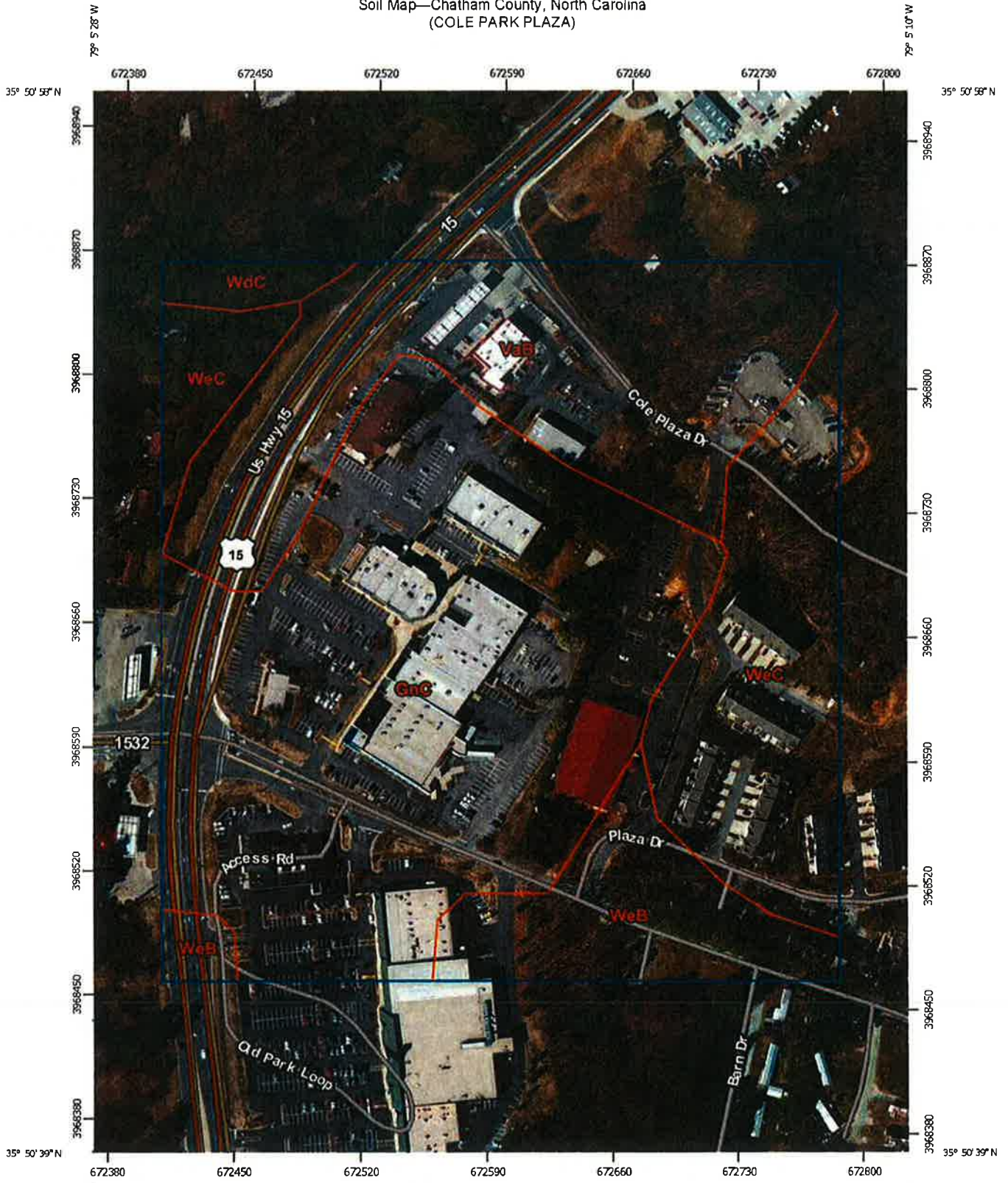


# **APPENDIX B**

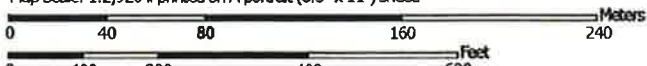


# **APPENDIX C**

Soil Map—Chatham County, North Carolina  
(COLE PARK PLAZA)



Map Scale: 1:2,920 if printed on A portrait (8.5" x 11") sheet.







































Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84



Soil Map—Chatham County, North Carolina  
(COLE PARK PLAZA)

**MAP LEGEND**

 Area of Interest (AOI)	 Spoil Area
<b>Soils</b>	 Stony Spot
 Soil Map Unit Polygons	 Very Stony Spot
 Soil Map Unit Lines	 Wet Spot
 Soil Map Unit Points	 Other
<b>Special Point Features</b>	 Special Line Features
 Blowout	<b>Water Features</b>
 Borrow Pit	 Streams and Canals
 Clay Spot	<b>Transportation</b>
 Closed Depression	 Rails
 Gravel Pit	 Interstate Highways
 Gravelly Spot	 US Routes
 Landfill	 Major Roads
 Lava Flow	 Local Roads
 Marsh or swamp	<b>Background</b>
 Mine or Quarry	 Aerial Photography
 Miscellaneous Water	
 Perennial Water	
 Rock Outcrop	
 Saline Spot	
 Sandy Spot	
 Severely Eroded Spot	
 Sinkhole	
 Slide or Slip	
 Sodic Spot	

**MAP INFORMATION**

The soil surveys that comprise your AOI were mapped at 1:24,000.

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: <http://websoilsurvey.nrcs.usda.gov>  
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: Chatham County, North Carolina  
Survey Area Data: Version 16, Dec 20, 2013

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

Date(s) aerial images were photographed: Jul 20, 2010—Apr 2, 2011

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

<b>Chatham County, North Carolina (NC037)</b>			
<b>Map Unit Symbol</b>	<b>Map Unit Name</b>	<b>Acres in AOI</b>	<b>Percent of AOI</b>
GnC	Georgeville-Urban land complex, 2 to 10 percent slopes	17.4	48.0%
VaB	Vance sandy loam, 2 to 6 percent slopes	9.1	23.9%
WdC	Wedowee sandy loam, 2 to 15 percent slopes, bouldery	0.6	1.6%
WeB	Wedowee sandy loam, 2 to 6 percent slopes	3.8	10.1%
WeC	Wedowee sandy loam, 6 to 10 percent slopes	7.0	18.4%
<b>Totals for Area of Interest</b>		<b>38.0</b>	<b>100.0%</b>

## Chatham County, North Carolina

### GnC—Georgeville-Urban land complex, 2 to 10 percent slopes

#### Map Unit Setting

*Elevation:* 270 to 700 feet  
*Mean annual precipitation:* 37 to 60 inches  
*Mean annual air temperature:* 59 to 66 degrees F  
*Frost-free period:* 200 to 240 days

#### Map Unit Composition

*Georgeville and similar soils:* 55 percent  
*Urban land:* 40 percent  
*Minor components:* 5 percent

#### Description of Georgeville

##### Setting

*Landform:* Interfluves  
*Landform position (two-dimensional):* Summit, shoulder  
*Landform position (three-dimensional):* Interfluve  
*Down-slope shape:* Convex  
*Across-slope shape:* Convex  
*Parent material:* Residuum weathered from metavolcanics and/or argillite

##### Typical profile

*A - 0 to 8 inches:* moderately acid, silt loam  
*Bt1 - 8 to 15 inches:* very strongly acid, clay loam  
*Bt2 - 15 to 45 inches:* very strongly acid, clay  
*BC - 45 to 80 inches:* very strongly acid, loam

##### Properties and qualities

*Slope:* 2 to 10 percent  
*Depth to restrictive feature:* More than 80 inches  
*Natural drainage class:* Well drained  
*Capacity of the most limiting layer to transmit water (Ksat):*  
Moderately high to high (0.57 to 1.98 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* Moderate (about 8.5 inches)

##### Interpretive groups

*Farmland classification:* Not prime farmland  
*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 3e  
*Hydrologic Soil Group:* B

#### Description of Urban Land

##### Setting

*Parent material:* Impervious layers over human transported material



**Interpretive groups**

*Farmland classification:* Not prime farmland

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 8

**Minor Components**

**Tarrus**

*Percent of map unit:* 5 percent

*Landform:* Interfluves

*Landform position (two-dimensional):* Summit

*Landform position (three-dimensional):* Interfluve

*Down-slope shape:* Convex

*Across-slope shape:* Convex

**Data Source Information**

Soil Survey Area: Chatham County, North Carolina

Survey Area Data: Version 16, Dec 20, 2013

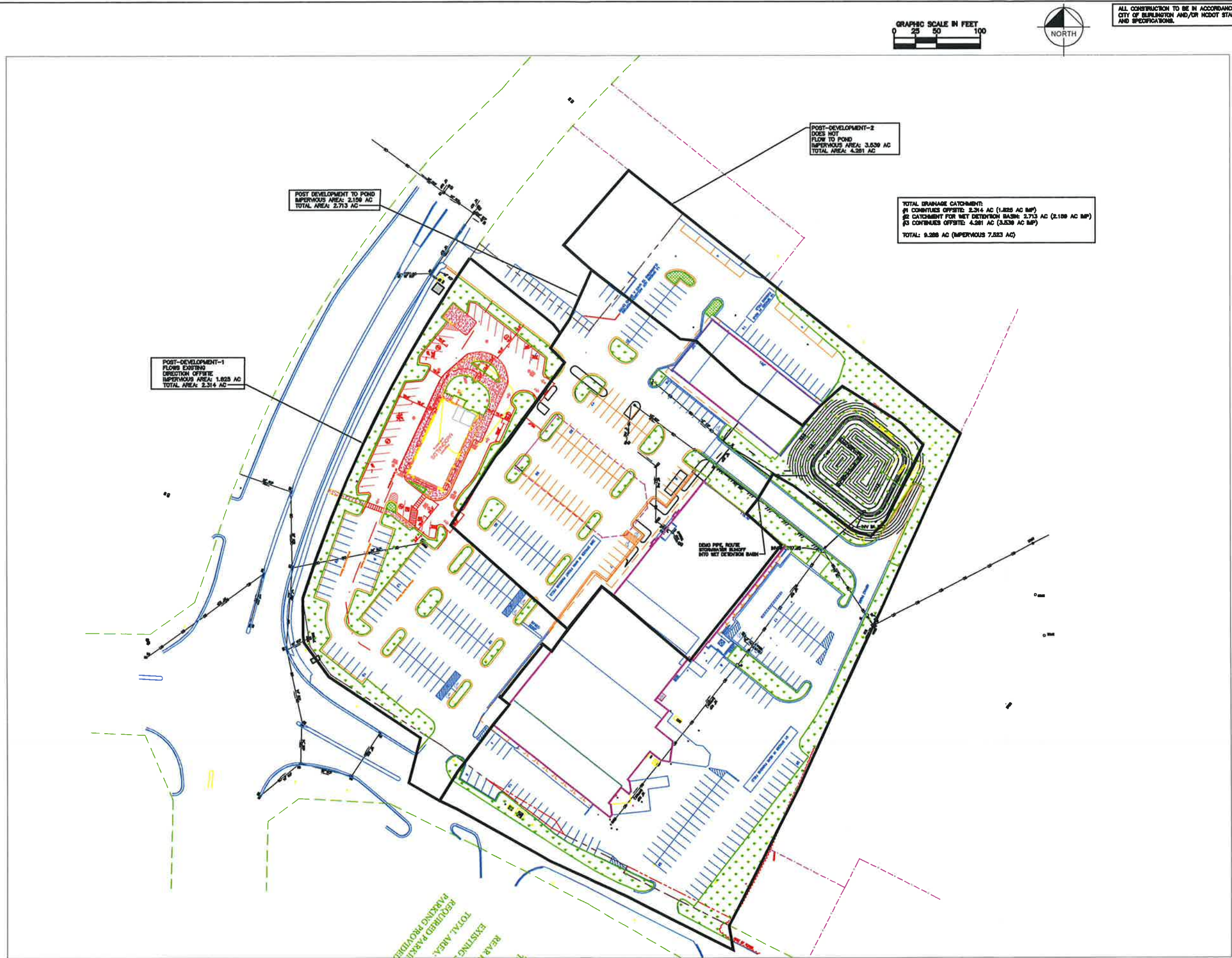
# **APPENDIX D**



This document, together with the concepts and designs presented herein, is an instrument of service, is intended only for the specific purpose and client for which it was prepared. Release of and liability for design or engineering services shall be without liability to Kimley-Horn and Associates, Inc.



Know what's below.  
Call before you dig.



No.	REVISIONS	DATE	BY

**Kimley-Horn and Associates, Inc.**  
 © 2014 KIMLEY-HORN AND ASSOCIATES, INC.  
 333 FAYETTEVILLE STREET, SUITE 800, RALEIGH, NC 27601  
 PHONE: 919-835-1484 FAX: 919-835-5847  
 WWW.KIMLEY-HORN.COM  
 NCLICENSE # F-0102

KHA PROJECT	012700000
DATE	JUNE 25, 2014
SCALE	AS SHOWN
DESIGNED BY	AMP
DRAWN BY	AMP
CHECKED BY	COB
DATE	

COLE PARK PLAZA  
 PREPARED FOR  
 COLE PARK PLAZA, LLC  
 CHAPEL HILL NORTH CAROLINA

SHEET NUMBER	1
OF	1



### Wet Pond 1 Water Quality Calculations

#### Project Information

Project Name: Cole Park Plaza  
 KHA Project #: 01270000  
 Designed by: AMP Date: 6/25/2014  
 Revised by: \_\_\_\_\_ Date: \_\_\_\_\_  
 Checked by: COB Date: 6/26/2014

#### Design Resource:

NCDENR - Stormwater Best Management Practices (April 1999)  
 NCDENR - Updated Draft Manual of Stormwater Best Management Practices (July 2005)

#### Site Information

Sub Area Location: Drainage Area to Pond  
 Drainage Area (DA) = 2.71 Acres 118047.6  
 Impervious Area (IA) = 2.17 Acres 94525.2  
 Percent Impervious (I) = 80.1 %

#### Average Permanent Pool Depth (d<sub>av</sub>):

d<sub>av</sub> (Option 1) = 3.00 ft

$$d_{av} = V_{perm\_pool} / A_{perm\_pool}$$

d<sub>av</sub> (Option 2) = 3.00 ft

$$d_{av} = \{0.25 * [1 + (A_{bot\_shell} / A_{perm\_pool})]\} + \{[(A_{bot\_shell} + A_{bot\_pond})/2] * (D / A_{bot\_shell})\}$$

#### Required Surface Area (85% TSS):

SA/DA for d<sub>av</sub> = 3 and 80% Impervious = 4.50  
 SA/DA for d<sub>av</sub> = 3 and 90% Impervious = 5.00  
 Surface Area to DA Ratio (SA/DA) = 4.50  
 Required Surface Area at Perm. Pool = 5,316 sf

(Taken from Table 10-1)  
 (Taken from Table 10-1)

#### Required Storage Volume (Water Quality):

Design Storm = 1.2 inch  
 Determine Rv Value = 0.05 + .009 (I) =  
 Design Storm Storage Volume = 9,098 cf  
 Storage Volume Required = 9,098 cf

0.77 in/in

#### Summary of Proposed BMP

Bottom of Pond Elevation = 539.50 ft  
 Sediment Cleanout Elevation = 540.50 ft  
 Average Depth = 3.05  
 Permanent Pool Elevation = 545.00 ft  
 Temporary Pool Elevation = 546.50 ft  
 Top of Berm Elevation = 549.00 ft  
 Surface Area at Permanent Pool = 5,392 sf  
 Forebay Volume (FV) = 2,148 cf  
 Permanent Pool Volume (PPV) = 10,138 cf  
 Temporary Pool Volume (TPV) = 10,389 cf  
 Total Storage Volume (TSV) = 42,106 cf  
 Total Pond Volume (PV=PPV+TSV) = 52,244 cf

(Required Surface Area = 5316 sf )  
 (21.2% of Permanent Pool Volume)

(Required Volume = 9098 cf )



Proposed Water Quality Volumes

Water Quality Volume

Water Quality Volume Required =	9,098
Water Quality Volume Provided =	10,389

POND				
Elevation	Contour Area	Incremental Volume	Accumulated Volume, S	Stage, Z
	cu ft	cu ft	cu ft	ft
		0	0	0.00
		0	0	0.00
0.00	0	0	0	0.00
539.50	191	0	0	0.00
540.50	472	332	332	1.00
541.50	977	725	1,056	2.00
542.50	1,759	1,368	2,424	3.00
543.50	2,684	2,222	4,646	4.00
544.50	3,737	3,211	7,856	5.00
545.00	5,392	2,282	10,138	5.50
545.06	5,462	301	10,439	5.56
545.50	6,869	2,741	13,180	6.00
546.00	7,344	3,553	16,733	6.50
546.50	7,831	3,794	20,527	7.00
547.00	8,334	4,041	24,568	7.50
548.00	9,381	8,858	33,426	8.50
549.00	10,484	18,818	52,244	9.50
FOREBAY				
Elevation	Contour Area	Incremental Volume	Accumulated Volume, S	Stage, Z
	cu ft	cu ft	cu ft	ft
540.50	18	0	0	0.00
541.50	141	80	80	1.00
542.50	335	238	318	2.00
543.50	601	468	786	3.00
544.50	935	768	1,554	4.00
545.00	1,444	595	2,148	4.50

(Bottom of Pond)

(Bottom of Shelf)  
(Permanent Pool Elevation)

(Temporary Pool Elevation)





Kimley-Horn  
and Associates, Inc.

**Wet Detention Basin  
ANTI-FLOTATION DEVICE SIZING**

**Project Information**

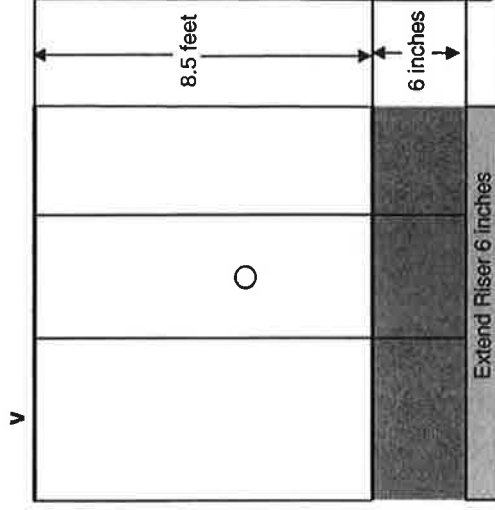
Project Name: Cole Park Plaza  
 KHA Project #: 01270000  
 Designed by: AMP Date: 6/25/2014  
 Revised by: Date:  
 Checked by: COB Date: 6/26/2014

**Anti-Flotation Device**

Riser Width = 4 ft  
 Riser Length (L) = 4 ft  
 Wall Thickness (WT) = 6 in  
 Top Riser Elev. (Top) = 547.50 ft  
 Bottom Riser Elev. (Bot) = 539.00 ft  
 Height of Riser (H) = 8.50 ft = Top - Bot  
 Area of Riser (A) = 16.0 sf (Water Displaced) = Width \* L  
 Volume of Riser (V) = 136.0 cf (Water Displaced) = A \* H  
 Volume of Riser Wall (V<sub>rw</sub>) = 76.5 cf = [(Width\*WT/12\*2)\*(L\*WT/12\*2)-A]\*H  
 Factor of Safety (SF) = 1.10  
 Weight (W) = 8486.4 lbs = V\*62.4  
 Weight Req'd from Anti-Flotation Device (W<sub>req</sub>) = 9335.0 lbs = W\*SF  
 \*Weight of Riser (W<sub>r</sub>) = 8576.4 lbs (V<sub>rw</sub> \* Buoyant Wt. + Weight of 6" Base)  
 Additional Volume of Concrete Req'd (V<sub>req</sub>) = 5.1 cf = (W<sub>req</sub>-W<sub>r</sub>)/150  
 Extend Riser (RE) = 6.00 in  
 Volume of Riser Extension (V<sub>RE</sub>) = 12.5 cf = [(Width\*WT/12\*2)\*(L\*WT/12\*2)]\*RE/12  
 Volume of Anti-flotation 0'x0' Concrete Slab (V<sub>cs</sub>) = 0.0 cf = Length<sub>cs</sub>\*Width<sub>cs</sub>\*Depth<sub>cs</sub>  
 Volume Provided (V<sub>pr</sub>) = 12.5 cf = V<sub>RE</sub>+V<sub>cs</sub>

Is the Anti-flotation Device Sufficient (yes/no)?

\*Assume buoyant weight of concrete = (150-62.4) pcf

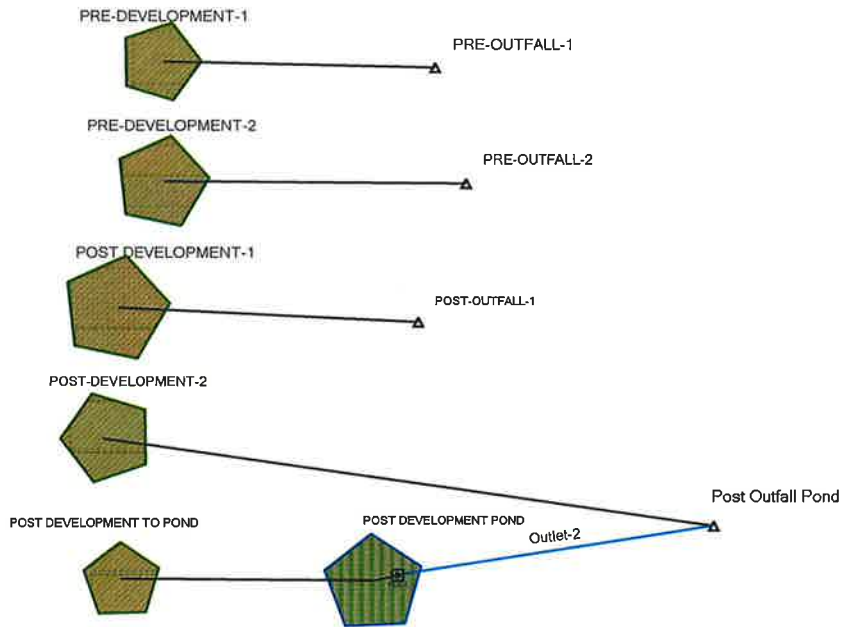


12.5 > 5.1

Yes



# Scenario: 2 year



## Table of Contents

	Master Network Summary	1
Chapel Hill, NC	100-Year	
	Time-Depth Curve	4
	Time-Depth Curve	6
	Time-Depth Curve	8
	Time-Depth Curve	10
	Time-Depth Curve	12
PRE-DEVELOPMENT-1	Time of Concentration Calculations	14
POST DEVELOPMENT TO POND	1-Year Storm	
	Runoff CN-Area	16
POST DEVELOPMENT-1	1-Year Storm	
	Runoff CN-Area	17
POST-DEVELOPMENT-2	1-Year Storm	
	Runoff CN-Area	18
PRE-DEVELOPMENT-1	1-Year Storm	
	Runoff CN-Area	19
PRE-DEVELOPMENT-2	1-Year Storm	
	Runoff CN-Area	20
	Unit Hydrograph Equations	21
POST DEVELOPMENT POND	1-Year Storm	
	Elevation-Area Volume Curve	23
	Elevation-Area Volume Curve	24
	Elevation-Area Volume Curve	25
	Elevation-Area Volume Curve	26
	Elevation-Area Volume Curve	27
Composite Outlet Structure - 1	Outlet Input Data	28

Subsection: Master Network Summary

**Catchments Summary**

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft <sup>3</sup> /s)
PRE-DEVELOPMENT-1	1 year	1	0.503	11.900	9.03
PRE-DEVELOPMENT-1	2 year	2	0.641	11.900	11.40
PRE-DEVELOPMENT-1	5 year	5	0.846	11.900	14.84
PRE-DEVELOPMENT-1	10 year	10	1.008	11.900	17.53
PRE-DEVELOPMENT-1	100 year	100	1.584	11.900	26.89
POST DEVELOPMENT TO POND	1 year	1	0.436	11.900	7.89
POST DEVELOPMENT TO POND	2 year	2	0.563	11.900	10.13
POST DEVELOPMENT TO POND	5 year	5	0.753	11.900	13.40
POST DEVELOPMENT TO POND	10 year	10	0.904	11.900	15.96
POST DEVELOPMENT TO POND	100 year	100	1.444	11.900	24.88
PRE-DEVELOPMENT-2	1 year	1	1.084	11.900	19.56
PRE-DEVELOPMENT-2	2 year	2	1.391	11.900	24.89
PRE-DEVELOPMENT-2	5 year	5	1.847	11.900	32.67
PRE-DEVELOPMENT-2	10 year	10	2.210	11.900	38.75
PRE-DEVELOPMENT-2	100 year	100	3.501	11.900	59.90
POST-DEVELOPMENT-2	1 year	1	0.750	11.900	13.46
POST-DEVELOPMENT-2	2 year	2	0.956	11.900	16.99
POST-DEVELOPMENT-2	5 year	5	1.260	11.900	22.12
POST-DEVELOPMENT-2	10 year	10	1.502	11.900	26.13
POST-DEVELOPMENT-2	100 year	100	2.361	11.900	40.08
POST DEVELOPMENT-1	1 year	1	0.373	11.900	6.76
POST DEVELOPMENT-1	2 year	2	0.482	11.900	8.68
POST DEVELOPMENT-1	5 year	5	0.645	11.900	11.48
POST DEVELOPMENT-1	10 year	10	0.775	11.900	13.68
POST DEVELOPMENT-1	100 year	100	1.237	11.900	21.33

**Node Summary**

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft <sup>3</sup> /s)
PRE-OUTFALL-1	1 year	1	0.503	11.900	9.03

Subsection: Master Network Summary

**Node Summary**

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft <sup>3</sup> /s)
PRE-OUTFALL-1	2 year	2	0.641	11.900	11.40
PRE-OUTFALL-1	5 year	5	0.846	11.900	14.84
PRE-OUTFALL-1	10 year	10	1.008	11.900	17.53
PRE-OUTFALL-1	100 year	100	1.584	11.900	26.89
Post Outfall Pond	1 year	1	0.944	11.900	13.49
Post Outfall Pond	2 year	2	1.276	11.900	17.04
Post Outfall Pond	5 year	5	1.768	11.900	22.58
Post Outfall Pond	10 year	10	2.159	11.900	27.33
Post Outfall Pond	100 year	100	3.552	11.950	56.82
PRE-OUTFALL-2	1 year	1	1.084	11.900	19.56
PRE-OUTFALL-2	2 year	2	1.391	11.900	24.89
PRE-OUTFALL-2	5 year	5	1.847	11.900	32.67
PRE-OUTFALL-2	10 year	10	2.210	11.900	38.75
PRE-OUTFALL-2	100 year	100	3.501	11.900	59.90
POST-OUTFALL-1	1 year	1	0.373	11.900	6.76
POST-OUTFALL-1	2 year	2	0.482	11.900	8.68
POST-OUTFALL-1	5 year	5	0.645	11.900	11.48
POST-OUTFALL-1	10 year	10	0.775	11.900	13.68
POST-OUTFALL-1	100 year	100	1.237	11.900	21.33

**Pond Summary**

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft <sup>3</sup> /s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
POST DEVELOPMENT POND (IN)	1 year	1	0.436	11.900	7.89	(N/A)	(N/A)
POST DEVELOPMENT POND (OUT)	1 year	1	0.194	13.050	0.45	546.67	0.270
POST DEVELOPMENT POND (IN)	2 year	2	0.563	11.900	10.13	(N/A)	(N/A)
POST DEVELOPMENT POND (OUT)	2 year	2	0.320	12.400	1.07	546.95	0.321
POST DEVELOPMENT POND (IN)	5 year	5	0.753	11.900	13.40	(N/A)	(N/A)

Subsection: Master Network Summary

**Pond Summary**

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft <sup>3</sup> /s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
POST DEVELOPMENT POND (OUT)	5 year	5	0.507	12.300	1.64	547.47	0.423
POST DEVELOPMENT POND (IN)	10 year	10	0.904	11.900	15.96	(N/A)	(N/A)
POST DEVELOPMENT POND (OUT)	10 year	10	0.657	12.050	7.24	547.66	0.463
POST DEVELOPMENT POND (IN)	100 year	100	1.444	11.900	24.88	(N/A)	(N/A)
POST DEVELOPMENT POND (OUT)	100 year	100	1.190	12.000	21.21	548.03	0.541

Subsection: Time-Depth Curve  
 Label: Chapel Hill, NC

Return Event: 100 years  
 Storm Event: 100-Year

Time-Depth Curve: 100-Year

Label	100-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	100 years

**CUMULATIVE RAINFALL (in)**

**Output Time Increment = 0.100 hours**

**Time on left represents time for first value in each row.**

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.1	0.1	0.1
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.2
2.000	0.2	0.2	0.2	0.2	0.2
2.500	0.2	0.2	0.2	0.2	0.3
3.000	0.3	0.3	0.3	0.3	0.3
3.500	0.3	0.3	0.3	0.3	0.4
4.000	0.4	0.4	0.4	0.4	0.4
4.500	0.4	0.4	0.4	0.5	0.5
5.000	0.5	0.5	0.5	0.5	0.5
5.500	0.5	0.6	0.6	0.6	0.6
6.000	0.6	0.6	0.6	0.7	0.7
6.500	0.7	0.7	0.7	0.7	0.7
7.000	0.8	0.8	0.8	0.8	0.8
7.500	0.8	0.8	0.9	0.9	0.9
8.000	0.9	0.9	0.9	1.0	1.0
8.500	1.0	1.0	1.0	1.1	1.1
9.000	1.1	1.1	1.2	1.2	1.2
9.500	1.2	1.3	1.3	1.3	1.3
10.000	1.4	1.4	1.4	1.5	1.5
10.500	1.6	1.6	1.6	1.7	1.7
11.000	1.8	1.8	1.9	2.0	2.1
11.500	2.2	2.3	2.7	3.3	4.3
12.000	5.0	5.2	5.3	5.4	5.5
12.500	5.6	5.7	5.7	5.8	5.8
13.000	5.9	5.9	6.0	6.0	6.0
13.500	6.1	6.1	6.1	6.2	6.2
14.000	6.2	6.3	6.3	6.3	6.3
14.500	6.4	6.4	6.4	6.4	6.5
15.000	6.5	6.5	6.5	6.6	6.6
15.500	6.6	6.6	6.6	6.7	6.7
16.000	6.7	6.7	6.7	6.7	6.8
16.500	6.8	6.8	6.8	6.8	6.8
17.000	6.9	6.9	6.9	6.9	6.9
17.500	6.9	7.0	7.0	7.0	7.0

Subsection: Time-Depth Curve  
 Label: Chapel Hill, NC

Return Event: 100 years  
 Storm Event: 100-Year

**CUMULATIVE RAINFALL (in)**  
**Output Time Increment = 0.100 hours**  
**Time on left represents time for first value in each row.**

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	7.0	7.0	7.0	7.0	7.1
18.500	7.1	7.1	7.1	7.1	7.1
19.000	7.1	7.1	7.2	7.2	7.2
19.500	7.2	7.2	7.2	7.2	7.2
20.000	7.2	7.3	7.3	7.3	7.3
20.500	7.3	7.3	7.3	7.3	7.3
21.000	7.3	7.4	7.4	7.4	7.4
21.500	7.4	7.4	7.4	7.4	7.4
22.000	7.4	7.4	7.5	7.5	7.5
22.500	7.5	7.5	7.5	7.5	7.5
23.000	7.5	7.5	7.5	7.6	7.6
23.500	7.6	7.6	7.6	7.6	7.6
24.000	7.6	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time-Depth Curve  
 Label: Chapel Hill, NC

Return Event: 10 years  
 Storm Event: 10-Year

Time-Depth Curve: 10-Year	
Label	10-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	10 years

**CUMULATIVE RAINFALL (in)**  
**Output Time Increment = 0.100 hours**  
**Time on left represents time for first value in each row.**

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.2	0.2	0.2	0.2
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.2	0.3	0.3	0.3	0.3
4.500	0.3	0.3	0.3	0.3	0.3
5.000	0.3	0.3	0.3	0.3	0.4
5.500	0.4	0.4	0.4	0.4	0.4
6.000	0.4	0.4	0.4	0.4	0.4
6.500	0.5	0.5	0.5	0.5	0.5
7.000	0.5	0.5	0.5	0.5	0.6
7.500	0.6	0.6	0.6	0.6	0.6
8.000	0.6	0.6	0.6	0.7	0.7
8.500	0.7	0.7	0.7	0.7	0.7
9.000	0.8	0.8	0.8	0.8	0.8
9.500	0.8	0.9	0.9	0.9	0.9
10.000	0.9	1.0	1.0	1.0	1.0
10.500	1.1	1.1	1.1	1.1	1.2
11.000	1.2	1.2	1.3	1.3	1.4
11.500	1.5	1.6	1.8	2.2	2.9
12.000	3.4	3.5	3.6	3.7	3.7
12.500	3.8	3.8	3.9	3.9	3.9
13.000	4.0	4.0	4.0	4.1	4.1
13.500	4.1	4.1	4.2	4.2	4.2
14.000	4.2	4.2	4.3	4.3	4.3
14.500	4.3	4.3	4.3	4.4	4.4
15.000	4.4	4.4	4.4	4.4	4.5
15.500	4.5	4.5	4.5	4.5	4.5
16.000	4.5	4.5	4.6	4.6	4.6
16.500	4.6	4.6	4.6	4.6	4.6
17.000	4.6	4.7	4.7	4.7	4.7
17.500	4.7	4.7	4.7	4.7	4.7



Subsection: Time-Depth Curve  
 Label: Chapel Hill, NC

Return Event: 10 years  
 Storm Event: 10-Year

**CUMULATIVE RAINFALL (in)**  
**Output Time Increment = 0.100 hours**  
**Time on left represents time for first value in each row.**

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	4.7	4.8	4.8	4.8	4.8
18.500	4.8	4.8	4.8	4.8	4.8
19.000	4.8	4.8	4.8	4.9	4.9
19.500	4.9	4.9	4.9	4.9	4.9
20.000	4.9	4.9	4.9	4.9	4.9
20.500	4.9	4.9	4.9	5.0	5.0
21.000	5.0	5.0	5.0	5.0	5.0
21.500	5.0	5.0	5.0	5.0	5.0
22.000	5.0	5.0	5.0	5.0	5.1
22.500	5.1	5.1	5.1	5.1	5.1
23.000	5.1	5.1	5.1	5.1	5.1
23.500	5.1	5.1	5.1	5.1	5.1
24.000	5.2	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time-Depth Curve  
 Label: Chapel Hill, NC

Return Event: 1 years  
 Storm Event: 1-Year Storm

Time-Depth Curve: 1-Year Storm	
Label	1-Year Storm
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	1 years

**CUMULATIVE RAINFALL (in)**  
**Output Time Increment = 0.100 hours**  
**Time on left represents time for first value in each row.**

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.0	0.0	0.0
1.500	0.0	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.1	0.1	0.1
3.500	0.1	0.1	0.1	0.1	0.1
4.000	0.1	0.1	0.1	0.2	0.2
4.500	0.2	0.2	0.2	0.2	0.2
5.000	0.2	0.2	0.2	0.2	0.2
5.500	0.2	0.2	0.2	0.2	0.2
6.000	0.2	0.2	0.2	0.3	0.3
6.500	0.3	0.3	0.3	0.3	0.3
7.000	0.3	0.3	0.3	0.3	0.3
7.500	0.3	0.3	0.3	0.3	0.3
8.000	0.4	0.4	0.4	0.4	0.4
8.500	0.4	0.4	0.4	0.4	0.4
9.000	0.4	0.4	0.5	0.5	0.5
9.500	0.5	0.5	0.5	0.5	0.5
10.000	0.5	0.5	0.6	0.6	0.6
10.500	0.6	0.6	0.6	0.7	0.7
11.000	0.7	0.7	0.7	0.8	0.8
11.500	0.8	0.9	1.0	1.3	1.7
12.000	2.0	2.0	2.1	2.1	2.1
12.500	2.2	2.2	2.2	2.2	2.3
13.000	2.3	2.3	2.3	2.3	2.3
13.500	2.4	2.4	2.4	2.4	2.4
14.000	2.4	2.4	2.4	2.5	2.5
14.500	2.5	2.5	2.5	2.5	2.5
15.000	2.5	2.5	2.5	2.5	2.6
15.500	2.6	2.6	2.6	2.6	2.6
16.000	2.6	2.6	2.6	2.6	2.6
16.500	2.6	2.6	2.6	2.6	2.7
17.000	2.7	2.7	2.7	2.7	2.7
17.500	2.7	2.7	2.7	2.7	2.7

Subsection: Time-Depth Curve  
 Label: Chapel Hill, NC

Return Event: 1 years  
 Storm Event: 1-Year Storm

**CUMULATIVE RAINFALL (in)**  
**Output Time Increment = 0.100 hours**  
**Time on left represents time for first value in each row.**

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	2.7	2.7	2.7	2.7	2.7
18.500	2.7	2.7	2.8	2.8	2.8
19.000	2.8	2.8	2.8	2.8	2.8
19.500	2.8	2.8	2.8	2.8	2.8
20.000	2.8	2.8	2.8	2.8	2.8
20.500	2.8	2.8	2.8	2.8	2.8
21.000	2.8	2.8	2.9	2.9	2.9
21.500	2.9	2.9	2.9	2.9	2.9
22.000	2.9	2.9	2.9	2.9	2.9
22.500	2.9	2.9	2.9	2.9	2.9
23.000	2.9	2.9	2.9	2.9	2.9
23.500	2.9	2.9	2.9	2.9	2.9
24.000	3.0	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time-Depth Curve  
 Label: Chapel Hill, NC

Return Event: 2 years  
 Storm Event: 2-Year

Time-Depth Curve: 2-Year	
Label	2-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	2 years

**CUMULATIVE RAINFALL (in)**  
**Output Time Increment = 0.100 hours**  
**Time on left represents time for first value in each row.**

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.0	0.0	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.1	0.1	0.1
3.500	0.1	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.2
4.500	0.2	0.2	0.2	0.2	0.2
5.000	0.2	0.2	0.2	0.2	0.2
5.500	0.3	0.3	0.3	0.3	0.3
6.000	0.3	0.3	0.3	0.3	0.3
6.500	0.3	0.3	0.3	0.3	0.3
7.000	0.4	0.4	0.4	0.4	0.4
7.500	0.4	0.4	0.4	0.4	0.4
8.000	0.4	0.4	0.4	0.5	0.5
8.500	0.5	0.5	0.5	0.5	0.5
9.000	0.5	0.5	0.5	0.6	0.6
9.500	0.6	0.6	0.6	0.6	0.6
10.000	0.6	0.7	0.7	0.7	0.7
10.500	0.7	0.7	0.8	0.8	0.8
11.000	0.8	0.9	0.9	0.9	1.0
11.500	1.0	1.1	1.3	1.5	2.0
12.000	2.4	2.4	2.5	2.5	2.6
12.500	2.6	2.6	2.7	2.7	2.7
13.000	2.7	2.8	2.8	2.8	2.8
13.500	2.8	2.9	2.9	2.9	2.9
14.000	2.9	2.9	2.9	3.0	3.0
14.500	3.0	3.0	3.0	3.0	3.0
15.000	3.0	3.0	3.1	3.1	3.1
15.500	3.1	3.1	3.1	3.1	3.1
16.000	3.1	3.1	3.1	3.2	3.2
16.500	3.2	3.2	3.2	3.2	3.2
17.000	3.2	3.2	3.2	3.2	3.2
17.500	3.2	3.3	3.3	3.3	3.3

Subsection: Time-Depth Curve  
 Label: Chapel Hill, NC

Return Event: 2 years  
 Storm Event: 2-Year

**CUMULATIVE RAINFALL (in)**  
**Output Time Increment = 0.100 hours**  
**Time on left represents time for first value in each row.**

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	3.3	3.3	3.3	3.3	3.3
18.500	3.3	3.3	3.3	3.3	3.3
19.000	3.3	3.3	3.3	3.4	3.4
19.500	3.4	3.4	3.4	3.4	3.4
20.000	3.4	3.4	3.4	3.4	3.4
20.500	3.4	3.4	3.4	3.4	3.4
21.000	3.4	3.4	3.4	3.4	3.5
21.500	3.5	3.5	3.5	3.5	3.5
22.000	3.5	3.5	3.5	3.5	3.5
22.500	3.5	3.5	3.5	3.5	3.5
23.000	3.5	3.5	3.5	3.5	3.5
23.500	3.5	3.5	3.5	3.6	3.6
24.000	3.6	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time-Depth Curve  
 Label: Chapel Hill, NC

Return Event: 5 years  
 Storm Event: 5-Year

Time-Depth Curve: 5-Year	
Label	5-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	5 years

**CUMULATIVE RAINFALL (in)**  
**Output Time Increment = 0.100 hours**  
**Time on left represents time for first value in each row.**

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.2
4.500	0.2	0.3	0.3	0.3	0.3
5.000	0.3	0.3	0.3	0.3	0.3
5.500	0.3	0.3	0.3	0.3	0.3
6.000	0.4	0.4	0.4	0.4	0.4
6.500	0.4	0.4	0.4	0.4	0.4
7.000	0.4	0.4	0.5	0.5	0.5
7.500	0.5	0.5	0.5	0.5	0.5
8.000	0.5	0.5	0.6	0.6	0.6
8.500	0.6	0.6	0.6	0.6	0.6
9.000	0.7	0.7	0.7	0.7	0.7
9.500	0.7	0.7	0.8	0.8	0.8
10.000	0.8	0.8	0.8	0.9	0.9
10.500	0.9	0.9	1.0	1.0	1.0
11.000	1.0	1.1	1.1	1.2	1.2
11.500	1.3	1.4	1.6	1.9	2.5
12.000	3.0	3.0	3.1	3.2	3.2
12.500	3.3	3.3	3.3	3.4	3.4
13.000	3.4	3.5	3.5	3.5	3.5
13.500	3.6	3.6	3.6	3.6	3.6
14.000	3.6	3.7	3.7	3.7	3.7
14.500	3.7	3.7	3.8	3.8	3.8
15.000	3.8	3.8	3.8	3.8	3.8
15.500	3.9	3.9	3.9	3.9	3.9
16.000	3.9	3.9	3.9	3.9	4.0
16.500	4.0	4.0	4.0	4.0	4.0
17.000	4.0	4.0	4.0	4.0	4.0
17.500	4.1	4.1	4.1	4.1	4.1

Subsection: Time-Depth Curve  
 Label: Chapel Hill, NC

Return Event: 5 years  
 Storm Event: 5-Year

**CUMULATIVE RAINFALL (in)**  
**Output Time Increment = 0.100 hours**  
**Time on left represents time for first value in each row.**

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	4.1	4.1	4.1	4.1	4.1
18.500	4.1	4.1	4.2	4.2	4.2
19.000	4.2	4.2	4.2	4.2	4.2
19.500	4.2	4.2	4.2	4.2	4.2
20.000	4.2	4.2	4.2	4.3	4.3
20.500	4.3	4.3	4.3	4.3	4.3
21.000	4.3	4.3	4.3	4.3	4.3
21.500	4.3	4.3	4.3	4.3	4.3
22.000	4.3	4.4	4.4	4.4	4.4
22.500	4.4	4.4	4.4	4.4	4.4
23.000	4.4	4.4	4.4	4.4	4.4
23.500	4.4	4.4	4.4	4.4	4.4
24.000	4.5	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time of Concentration Calculations  
Label: PRE-DEVELOPMENT-1

Return Event: 1 years  
Storm Event: 1-Year Storm

Time of Concentration Results

---

Segment #1: User Defined Tc

---

Time of Concentration	0.083 hours
-----------------------	-------------

---

---

Time of Concentration (Composite)

---

Time of Concentration (Composite)	0.083 hours
--------------------------------------	-------------

---



Subsection: Time of Concentration Calculations  
Label: PRE-DEVELOPMENT-1

Return Event: 1 years  
Storm Event: 1-Year Storm

**==== User Defined**

Tc = Value entered by user  
Where: Tc= Time of concentration, hours

Subsection: Runoff CN-Area  
 Label: POST DEVELOPMENT TO POND

Return Event: 1 years  
 Storm Event: 1-Year Storm

**Runoff Curve Number Data**

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Impervious Areas - Paved; curbs and storm sewers - Soil B	98.000	2.150	0.0	0.0	98.000
Open space (Lawns,parks etc.) - Good condition; grass cover > 75% - Soil B	61.000	0.550	0.0	0.0	61.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	2.700	(N/A)	(N/A)	90.463

Subsection: Runoff CN-Area  
 Label: POST DEVELOPMENT-1

Return Event: 1 years  
 Storm Event: 1-Year Storm

**Runoff Curve Number Data**

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Impervious Areas - Paved parking lots, roofs, driveways, Streets and roads - Soil B	98.000	1.825	0.0	0.0	98.000
Open space (Lawns,parks etc.) - Good condition; grass cover > 75% - Soil B	61.000	0.489	0.0	0.0	61.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	2.314	(N/A)	(N/A)	90.181

Subsection: Runoff CN-Area  
 Label: POST-DEVELOPMENT-2

Return Event: 1 years  
 Storm Event: 1-Year Storm

**Runoff Curve Number Data**

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Open space (Lawns,parks etc.) - Good condition; grass cover > 75% - Soil B	61.000	0.720	0.0	0.0	61.000
Impervious Areas - Paved parking lots, roofs, driveways, Streets and roads - Soil B	98.000	3.540	0.0	0.0	98.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	4.260	(N/A)	(N/A)	91.746

Subsection: Runoff CN-Area  
 Label: PRE-DEVELOPMENT-1

Return Event: 1 years  
 Storm Event: 1-Year Storm

**Runoff Curve Number Data**

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Open space (Lawns,parks etc.) - Good condition; grass cover > 75% - Soil B	61.000	0.472	0.0	0.0	61.000
Impervious Areas - Paved parking lots, roofs, driveways, Streets and roads - Soil B	98.000	2.386	0.0	0.0	98.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	2.858	(N/A)	(N/A)	91.889

Subsection: Runoff CN-Area  
Label: PRE-DEVELOPMENT-2

Return Event: 1 years  
Storm Event: 1-Year Storm

**Runoff Curve Number Data**

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Open space (Lawns,parks etc.) - Good condition; grass cover > 75% - Soil B	61.000	1.260	0.0	0.0	61.000
Impervious Areas - Paved parking lots, roofs, driveways, Streets and roads - Soil B	98.000	5.170	0.0	0.0	98.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	6.430	(N/A)	(N/A)	90.750

Subsection: Unit Hydrograph Equations

**Unit Hydrograph Method (Computational Notes)**

**Definition of Terms**

At	Total area (acres): $A_t = A_i + A_p$
Ai	Impervious area (acres)
Ap	Pervious area (acres)
CNi	Runoff curve number for impervious area
CNp	Runoff curve number for pervious area
fLoss	f loss constant infiltration (depth/time)
gKs	Saturated Hydraulic Conductivity (depth/time)
Md	Volumetric Moisture Deficit
Psi	Capillary Suction (length)
hK	Horton Infiltration Decay Rate ( $\text{time}^{-1}$ )
fo	Initial Infiltration Rate (depth/time)
fc	Ultimate(capacity)Infiltration Rate (depth/time)
Ia	Initial Abstraction (length)
dt	Computational increment (duration of unit excess rainfall) Default dt is smallest value of $0.1333T_c$ , $t_{rm}$ , and $t_h$ (Smallest dt is then adjusted to match up with $T_p$ )
UDdt	User specified override computational main time increment (only used if UDdt is $\Rightarrow .1333T_c$ )
D(t)	Point on distribution curve (fraction of P) for time step t
K	$2 / (1 + (T_r/T_p))$ : default K = 0.75: (for $T_r/T_p = 1.67$ )
Ks	Hydrograph shape factor = Unit Conversions * K: $= ((1\text{hr}/3600\text{sec}) * (1\text{ft}/12\text{in}) * ((5280\text{ft})^2/\text{sq.mi})) * K$ Default $K_s = 645.333 * 0.75 = 484$
Lag	Lag time from center of excess runoff (dt) to $T_p$ : $\text{Lag} = 0.6T_c$
P	Total precipitation depth, inches
Pa(t)	Accumulated rainfall at time step t
PI(t)	Incremental rainfall at time step t
qp	Peak discharge (cfs) for 1in. runoff, for 1hr, for 1 sq.mi. $= (K_s * A * Q) / T_p$ (where $Q = 1\text{in. runoff}$ , $A = \text{sq.mi.}$ )
Qu(t)	Unit hydrograph ordinate (cfs) at time step t
Q(t)	Final hydrograph ordinate (cfs) at time step t
Rai(t)	Accumulated runoff (inches) at time step t for impervious area
Rap(t)	Accumulated runoff (inches) at time step t for pervious area
Rii(t)	Incremental runoff (inches) at time step t for impervious area
Rip(t)	Incremental runoff (inches) at time step t for pervious area
R(t)	Incremental weighted total runoff (inches)
Rtm	Time increment for rainfall table
Si	S for impervious area: $S_i = (1000/CN_i) - 10$
Sp	S for pervious area: $S_p = (1000/CN_p) - 10$
t	Time step (row) number
Tc	Time of concentration
Tb	Time (hrs) of entire unit hydrograph: $T_b = T_p + T_r$
Tp	Time (hrs) to peak of a unit hydrograph: $T_p = (dt/2) + \text{Lag}$
Tr	Time (hrs) of receding limb of unit hydrograph: $T_r = \text{ratio of } T_p$

Subsection: Unit Hydrograph Equations

**Unit Hydrograph Method**

**Computational Notes**

**Precipitation**

Column (1)	Time for time step t
Column (2)	D(t) = Point on distribution curve for time step t
Column (3)	Pi(t) = Pa(t) - Pa(t-1): Col.(4) - Preceding Col.(4)
Column (4)	Pa(t) = D(t) x P: Col.(2) x P

**Pervious Area Runoff (using SCS Runoff CN Method)**

Column (5)	Rap(t) = Accumulated pervious runoff for time step t If (Pa(t) is <= 0.2Sp) then use: Rap(t) = 0.0 If (Pa(t) is > 0.2Sp) then use:  $Rap(t) = (Col.(4) - 0.2Sp) * 2 / (Col.(4) + 0.8Sp)$
Column (6)	Rip(t) = Incremental pervious runoff for time step t $Rip(t) = Rap(t) - Rap(t-1)$ Rip(t) = Col.(5) for current row - Col.(5) for preceding row.

**Impervious Area Runoff**

Column (7 & 8)...	Did not specify to use impervious areas.
-------------------	--

**Incremental Weighted Runoff**

Column (9)	$R(t) = (Ap/At) \times Rip(t) + (Ai/At) \times Rii(t)$ $R(t) = (Ap/At) \times Col.(6) + (Ai/At) \times Col.(8)$
------------	--

**SCS Unit Hydrograph Method**

Column (10)	Q(t) is computed with the SCS unit hydrograph method using R(t) and Qu(t).
-------------	--



Subsection: Elevation-Area Volume Curve  
 Label: POST DEVELOPMENT POND

Return Event: 1 years  
 Storm Event: 1-Year Storm

Elevation (ft)	Planimeter (ft <sup>2</sup> )	Area (acres)	A1+A2+sq (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
545.00	0.0	0.124	0.000	0.000	0.000
545.05	0.0	0.125	0.374	0.006	0.006
545.50	0.0	0.158	0.424	0.064	0.070
546.00	0.0	0.169	0.489	0.082	0.151
546.50	0.0	0.180	0.522	0.087	0.238
547.00	0.0	0.191	0.557	0.093	0.331
548.00	0.0	0.215	0.610	0.203	0.534
549.00	0.0	0.241	0.684	0.228	0.762

Subsection: Elevation-Area Volume Curve  
 Label: POST DEVELOPMENT POND

Return Event: 2 years  
 Storm Event: 1-Year Storm

Elevation (ft)	Planimeter (ft <sup>2</sup> )	Area (acres)	A1+A2+sq (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
545.00	0.0	0.124	0.000	0.000	0.000
545.05	0.0	0.125	0.374	0.006	0.006
545.50	0.0	0.158	0.424	0.064	0.070
546.00	0.0	0.169	0.489	0.082	0.151
546.50	0.0	0.180	0.522	0.087	0.238
547.00	0.0	0.191	0.557	0.093	0.331
548.00	0.0	0.215	0.610	0.203	0.534
549.00	0.0	0.241	0.684	0.228	0.762

Subsection: Elevation-Area Volume Curve  
 Label: POST DEVELOPMENT POND

Return Event: 5 years  
 Storm Event: 1-Year Storm

Elevation (ft)	Planimeter (ft <sup>2</sup> )	Area (acres)	A1+A2+sq (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
545.00	0.0	0.124	0.000	0.000	0.000
545.05	0.0	0.125	0.374	0.006	0.006
545.50	0.0	0.158	0.424	0.064	0.070
546.00	0.0	0.169	0.489	0.082	0.151
546.50	0.0	0.180	0.522	0.087	0.238
547.00	0.0	0.191	0.557	0.093	0.331
548.00	0.0	0.215	0.610	0.203	0.534
549.00	0.0	0.241	0.684	0.228	0.762

Subsection: Elevation-Area Volume Curve  
 Label: POST DEVELOPMENT POND

Return Event: 10 years  
 Storm Event: 1-Year Storm

Elevation (ft)	Planimeter (ft <sup>2</sup> )	Area (acres)	A1+A2+sq (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
545.00	0.0	0.124	0.000	0.000	0.000
545.05	0.0	0.125	0.374	0.006	0.006
545.50	0.0	0.158	0.424	0.064	0.070
546.00	0.0	0.169	0.489	0.082	0.151
546.50	0.0	0.180	0.522	0.087	0.238
547.00	0.0	0.191	0.557	0.093	0.331
548.00	0.0	0.215	0.610	0.203	0.534
549.00	0.0	0.241	0.684	0.228	0.762

Subsection: Elevation-Area Volume Curve  
 Label: POST DEVELOPMENT POND

Return Event: 100 years  
 Storm Event: 1-Year Storm

Elevation (ft)	Planimeter (ft <sup>2</sup> )	Area (acres)	A1+A2+sq (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
545.00	0.0	0.124	0.000	0.000	0.000
545.05	0.0	0.125	0.374	0.006	0.006
545.50	0.0	0.158	0.424	0.064	0.070
546.00	0.0	0.169	0.489	0.082	0.151
546.50	0.0	0.180	0.522	0.087	0.238
547.00	0.0	0.191	0.557	0.093	0.331
548.00	0.0	0.215	0.610	0.203	0.534
549.00	0.0	0.241	0.684	0.228	0.762

Subsection: Outlet Input Data  
 Label: Composite Outlet Structure - 1

Return Event: 1 years  
 Storm Event: 1-Year Storm

Requested Pond Water Surface Elevations	
Minimum (Headwater)	545.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	549.00 ft

**Outlet Connectivity**

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Area	Orifice - 2 yr	Forward	Culvert - 1	546.50	549.00
Inlet Box	Riser - 1	Forward	Culvert - 1	547.50	549.00
Orifice-Circular	Orifice - Water Quality	Forward	Culvert - 1	545.00	549.00
Culvert-Circular	Culvert - 1	Forward	TW	539.00	549.00
Rectangular Weir	Weir - 1	Forward	TW	548.00	549.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Subsection: Outlet Input Data  
Label: Composite Outlet Structure - 1

Return Event: 1 years  
Storm Event: 1-Year Storm

---

Structure ID: Orifice - Water Quality	
Structure Type: Orifice-Circular	
<hr/>	
Number of Openings	1
Elevation	545.00 ft
Orifice Diameter	1.3 in
Orifice Coefficient	0.600
<hr/>	
Structure ID: Riser - 1	
Structure Type: Inlet Box	
<hr/>	
Number of Openings	1
Elevation	547.50 ft
Orifice Area	16.0 ft <sup>2</sup>
Orifice Coefficient	0.600
Weir Length	16.00 ft
Weir Coefficient	3.00 (ft <sup>0.5</sup> )/s
K Reverse	1.000
Manning's n	0.000
Key, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

---

Subsection: Outlet Input Data  
 Label: Composite Outlet Structure - 1

Return Event: 1 years  
 Storm Event: 1-Year Storm

Structure ID: Culvert - 1	
Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	18.0 in
Length	66.00 ft
Length (Computed Barrel)	66.01 ft
Slope (Computed)	0.017 ft/ft
Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.018
Kr	0.000
Convergence Tolerance	0.00 ft
Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	1.087
T2 ratio (HW/D)	1.188
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.  
 Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control, interpolate between flows at T1 & T2...

T1 Elevation	540.63 ft	T1 Flow	7.58 ft <sup>3</sup> /s
T2 Elevation	540.78 ft	T2 Flow	8.66 ft <sup>3</sup> /s



Subsection: Outlet Input Data  
 Label: Composite Outlet Structure - 1

Return Event: 1 years  
 Storm Event: 1-Year Storm

Structure ID: Orifice - 2 yr	
Structure Type: Orifice-Area	
Number of Openings	1
Elevation	546.50 ft
Orifice Area	0.3 ft <sup>2</sup>
Top Elevation	546.83 ft
Datum Elevation	546.50 ft
Orifice Coefficient	0.600
Structure ID: Weir - 1	
Structure Type: Rectangular Weir	
Number of Openings	1
Elevation	548.00 ft
Weir Length	25.00 ft
Weir Coefficient	3.00 (ft <sup>0.5</sup> )/s
Structure ID: TW	
Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall
Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft <sup>3</sup> /s
Flow Tolerance (Maximum)	10.000 ft <sup>3</sup> /s

# Index

## C

- Chapel Hill, NC (Time-Depth Curve, 1 years)...8, 9
- Chapel Hill, NC (Time-Depth Curve, 10 years)...6, 7
- Chapel Hill, NC (Time-Depth Curve, 100 years)...4, 5
- Chapel Hill, NC (Time-Depth Curve, 2 years)...10, 11
- Chapel Hill, NC (Time-Depth Curve, 5 years)...12, 13
- Composite Outlet Structure - 1 (Outlet Input Data, 1 years)...28, 29, 30, 31

## M

- Master Network Summary...1, 2, 3

## P

- POST DEVELOPMENT POND (Elevation-Area Volume Curve, 1 years)...23
- POST DEVELOPMENT POND (Elevation-Area Volume Curve, 10 years)...26
- POST DEVELOPMENT POND (Elevation-Area Volume Curve, 100 years)...27
- POST DEVELOPMENT POND (Elevation-Area Volume Curve, 2 years)...24
- POST DEVELOPMENT POND (Elevation-Area Volume Curve, 5 years)...25
- POST DEVELOPMENT TO POND (Runoff CN-Area, 1 years)...16
- POST DEVELOPMENT-1 (Runoff CN-Area, 1 years)...17
- POST-DEVELOPMENT-2 (Runoff CN-Area, 1 years)...18
- PRE-DEVELOPMENT-1 (Runoff CN-Area, 1 years)...19
- PRE-DEVELOPMENT-1 (Time of Concentration Calculations, 1 years)...14, 15
- PRE-DEVELOPMENT-2 (Runoff CN-Area, 1 years)...20

## U

- Unit Hydrograph Equations...21, 22

# **APPENDIX E**



Kimley-Horn  
and Associates, Inc.

## Impervious & Pervious Calculations Pre vs Post Development Conditions

### Project Information:

Project Name: Cole Park Plaza  
KHA Project #: 0127000  
Designed by: AMP Date: 6/25/2014  
Revised by: Date:  
Checked by: COB Date: 6/26/2014

### Pre-Development Conditions:

Type:	Area:
Pervious:	1.73
Impervious:	7.557
Total:	9.287
Percent Impervious:	81.37%

### Post-Development Conditions:

Type:	Area:
Pervious:	1.765
Impervious:	7.523
Total:	9.288
Percent Impervious:	81.00%

### Post-Development Impervious Area Reduction:

Reduction Amount:  
0.45%

# **APPENDIX F**



NOAA Atlas 14, Volume 2, Version 3  
 Location name: Chapel Hill, North Carolina, US\*  
 Latitude: 35.8470°, Longitude: -79.0890°  
 Elevation: 556 ft\*  
 \* source: Google Maps



POINT PRECIPITATION FREQUENCY ESTIMATES

G. M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley  
 NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aeriels](#)

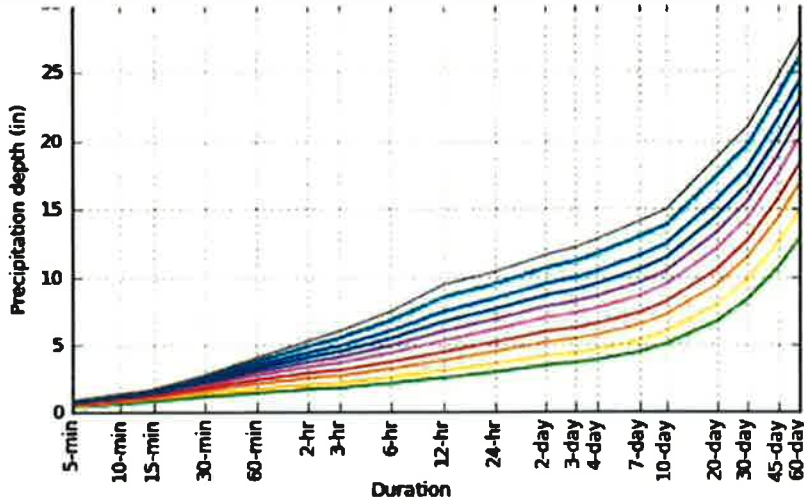
PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) <sup>1</sup>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.414 (0.379-0.453)	0.488 (0.447-0.534)	0.562 (0.515-0.614)	0.620 (0.568-0.676)	0.680 (0.619-0.742)	0.723 (0.655-0.788)	0.761 (0.686-0.830)	0.794 (0.711-0.867)	0.829 (0.736-0.906)	0.866 (0.754-0.937)
10-min	0.661 (0.605-0.723)	0.780 (0.715-0.854)	0.900 (0.824-0.984)	0.991 (0.906-1.08)	1.08 (0.986-1.18)	1.15 (1.04-1.26)	1.21 (1.09-1.32)	1.26 (1.13-1.37)	1.31 (1.16-1.43)	1.36 (1.19-1.48)
15-min	0.826 (0.756-0.904)	0.980 (0.898-1.07)	1.14 (1.04-1.25)	1.25 (1.15-1.37)	1.37 (1.25-1.50)	1.46 (1.32-1.59)	1.53 (1.38-1.67)	1.69 (1.42-1.73)	1.65 (1.47-1.80)	1.69 (1.49-1.85)
30-min	1.13 (1.04-1.24)	1.35 (1.24-1.48)	1.62 (1.48-1.77)	1.82 (1.66-1.98)	2.04 (1.85-2.22)	2.20 (1.99-2.39)	2.34 (2.11-2.56)	2.47 (2.22-2.70)	2.63 (2.33-2.87)	2.74 (2.41-3.00)
60-min	1.41 (1.29-1.55)	1.70 (1.56-1.86)	2.07 (1.90-2.27)	2.37 (2.16-2.58)	2.71 (2.47-2.96)	2.98 (2.70-3.24)	3.23 (2.91-3.52)	3.47 (3.11-3.79)	3.77 (3.35-4.12)	4.00 (3.52-4.38)
2-hr	1.68 (1.53-1.85)	2.03 (1.85-2.23)	2.50 (2.28-2.75)	2.87 (2.61-3.15)	3.34 (3.01-3.66)	3.70 (3.33-4.06)	4.06 (3.63-4.45)	4.41 (3.91-4.84)	4.87 (4.28-5.34)	5.24 (4.56-5.76)
3-hr	1.79 (1.63-1.96)	2.16 (1.98-2.37)	2.67 (2.44-2.93)	3.09 (2.81-3.38)	3.62 (3.27-3.96)	4.05 (3.64-4.43)	4.47 (3.99-4.89)	4.91 (4.35-5.36)	5.48 (4.80-6.00)	5.97 (5.17-6.54)
6-hr	2.14 (1.97-2.35)	2.59 (2.38-2.83)	3.20 (2.93-3.50)	3.71 (3.39-4.05)	4.37 (3.97-4.77)	4.92 (4.43-5.36)	5.47 (4.89-5.95)	6.04 (5.34-6.57)	6.81 (5.93-7.41)	7.45 (6.41-8.13)
12-hr	2.53 (2.33-2.77)	3.05 (2.81-3.34)	3.80 (3.49-4.15)	4.43 (4.05-4.83)	5.27 (4.78-5.72)	5.97 (5.38-6.47)	6.69 (5.96-7.24)	7.46 (6.56-8.05)	8.51 (7.36-9.19)	9.40 (8.01-10.2)
24-hr	2.95 (2.76-3.15)	3.55 (3.34-3.81)	4.45 (4.17-4.76)	5.15 (4.82-5.50)	6.10 (5.68-6.52)	6.85 (6.37-7.32)	7.61 (7.06-8.15)	8.40 (7.76-9.01)	9.49 (8.72-10.2)	10.3 (9.46-11.1)
2-day	3.44 (3.22-3.68)	4.15 (3.89-4.44)	5.15 (4.82-5.51)	5.92 (5.54-6.34)	6.97 (6.49-7.45)	7.79 (7.23-8.34)	8.63 (7.99-9.25)	9.48 (8.75-10.2)	10.7 (9.78-11.5)	11.6 (10.6-12.5)
3-day	3.65 (3.42-3.90)	4.38 (4.11-4.69)	5.41 (5.07-5.79)	6.22 (5.81-6.65)	7.31 (6.81-7.82)	8.17 (7.58-8.75)	9.06 (8.37-9.71)	9.95 (9.17-10.7)	11.2 (10.3-12.1)	12.2 (11.1-13.1)
4-day	3.85 (3.61-4.12)	4.62 (4.33-4.94)	5.68 (5.32-6.07)	6.52 (6.09-6.97)	7.66 (7.12-8.20)	8.56 (7.93-9.17)	9.48 (8.75-10.2)	10.4 (9.60-11.2)	11.7 (10.7-12.6)	12.7 (11.6-13.8)
7-day	4.43 (4.17-4.72)	5.28 (4.98-5.63)	6.42 (6.04-6.84)	7.32 (6.88-7.80)	8.55 (8.01-9.12)	9.53 (8.90-10.2)	10.5 (9.79-11.2)	11.6 (10.7-12.4)	13.0 (11.9-13.9)	14.1 (12.9-15.1)
10-day	5.04 (4.76-5.36)	5.98 (5.64-6.36)	7.19 (6.77-7.64)	8.13 (7.65-8.64)	9.40 (8.82-10.0)	10.4 (9.73-11.1)	11.4 (10.6-12.2)	12.4 (11.6-13.3)	13.8 (12.8-14.8)	14.9 (13.8-16.0)
20-day	6.75 (6.37-7.13)	7.96 (7.52-8.41)	9.39 (8.87-9.93)	10.5 (9.94-11.1)	12.1 (11.4-12.8)	13.3 (12.5-14.1)	14.5 (13.6-15.4)	15.8 (14.7-16.8)	17.5 (16.2-18.6)	18.8 (17.3-20.1)
30-day	8.36 (7.93-8.84)	9.85 (9.32-10.4)	11.4 (10.8-12.1)	12.7 (12.0-13.4)	14.3 (13.5-15.1)	15.6 (14.6-16.4)	16.8 (15.8-17.8)	18.1 (16.9-19.1)	19.7 (18.4-21.0)	21.0 (19.5-22.4)
45-day	10.7 (10.2-11.2)	12.5 (11.9-13.1)	14.3 (13.6-15.0)	15.7 (14.9-16.5)	17.5 (16.6-18.4)	18.9 (17.9-19.8)	20.2 (19.1-21.3)	21.6 (20.3-22.7)	23.3 (21.9-24.7)	24.7 (23.1-26.1)
60-day	12.8 (12.2-13.4)	14.9 (14.2-15.6)	16.8 (16.1-17.6)	18.3 (17.5-19.2)	20.2 (19.2-21.2)	21.6 (20.6-22.7)	23.0 (21.8-24.2)	24.4 (23.1-25.7)	26.1 (24.7-27.5)	27.4 (25.8-29.0)

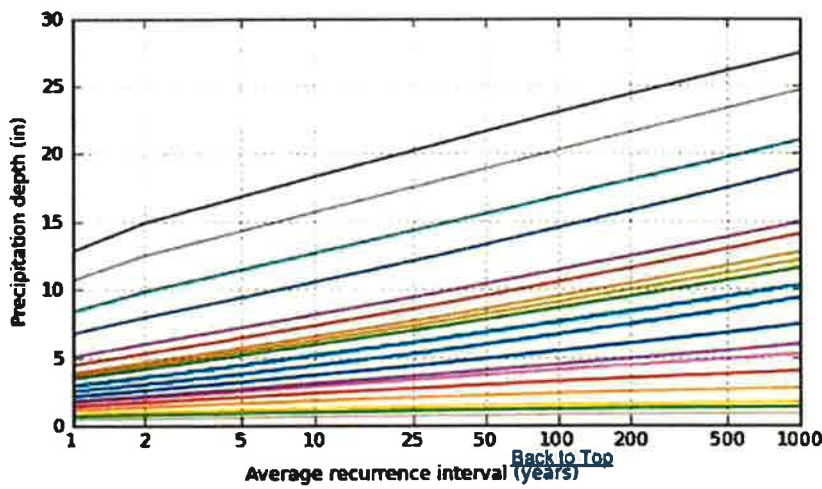
<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical



Average recurrence interval (years)
1
2
5
10
25
50
100
200
500
1000



Duration
6-min
10-min
15-min
30-min
60-min
2-hr
3-hr
6-hr
12-hr
24-hr
2-day
3-day
4-day
7-day
10-day
20-day
30-day
45-day
60-day

**Maps & aeriels**

Created (GMT): Wed Jun 18 10:57:39 2014

NOAA Atlas 14, Volume 2, Version 3

Small scale terrain









NOAA Atlas 14, Volume 2, Version 3  
 Location name: Chapel Hill, North Carolina, US\*  
 Latitude: 35.8470°, Longitude: -79.0890°  
 Elevation: 556 ft\*  
 \* source: Google Maps



**POINT PRECIPITATION FREQUENCY ESTIMATES**

G M Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerials](#)

**PF tabular**

<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)<sup>1</sup></b>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.97 (4.55-5.44)	5.86 (5.36-6.41)	6.74 (6.18-7.37)	<b>7.44</b> (6.79-8.11)	8.16 (7.43-8.90)	8.68 (7.86-9.46)	9.13 (8.23-9.96)	9.53 (8.53-10.4)	9.95 (8.83-10.9)	10.3 (9.05-11.2)
10-min	3.97 (3.63-4.34)	4.68 (4.29-5.12)	5.40 (4.94-5.90)	6.95 (5.44-6.49)	6.50 (5.92-7.10)	6.91 (6.26-7.53)	7.26 (6.55-7.92)	7.55 (6.76-8.24)	7.87 (6.98-8.59)	8.09 (7.13-8.85)
15-min	3.30 (3.02-3.62)	3.92 (3.59-4.29)	4.65 (4.17-4.98)	5.01 (4.58-5.47)	5.50 (5.00-6.00)	5.83 (5.28-6.36)	6.12 (5.51-6.67)	6.35 (5.69-6.94)	6.60 (5.86-7.21)	6.77 (5.96-7.41)
30-min	2.26 (2.07-2.48)	2.71 (2.48-2.96)	3.23 (2.96-3.54)	3.63 (3.32-3.97)	4.07 (3.70-4.44)	4.39 (3.98-4.79)	4.68 (4.22-5.11)	4.94 (4.43-5.40)	5.25 (4.66-5.74)	5.48 (4.83-6.00)
60-min	1.41 (1.29-1.55)	1.70 (1.56-1.86)	2.07 (1.90-2.27)	2.37 (2.16-2.58)	2.71 (2.47-2.96)	2.98 (2.70-3.24)	3.23 (2.91-3.52)	3.47 (3.11-3.79)	3.77 (3.35-4.12)	4.00 (3.52-4.38)
2-hr	0.839 (0.766-0.924)	1.01 (0.926-1.11)	1.25 (1.14-1.37)	1.44 (1.30-1.58)	1.67 (1.51-1.83)	1.85 (1.67-2.03)	2.03 (1.81-2.23)	2.21 (1.96-2.42)	2.44 (2.14-2.67)	2.62 (2.28-2.88)
3-hr	0.594 (0.544-0.653)	0.718 (0.658-0.789)	0.888 (0.812-0.976)	1.03 (0.936-1.13)	1.20 (1.09-1.32)	1.35 (1.21-1.47)	1.49 (1.33-1.63)	1.63 (1.45-1.79)	1.83 (1.60-2.00)	1.99 (1.72-2.18)
6-hr	0.358 (0.329-0.392)	0.432 (0.397-0.473)	0.534 (0.490-0.585)	0.619 (0.566-0.677)	0.730 (0.663-0.796)	0.821 (0.740-0.895)	0.913 (0.816-0.994)	1.01 (0.891-1.10)	1.14 (0.991-1.24)	1.24 (1.07-1.36)
12-hr	0.210 (0.194-0.230)	0.253 (0.233-0.277)	0.315 (0.289-0.344)	0.368 (0.336-0.401)	0.437 (0.397-0.475)	0.496 (0.446-0.537)	0.566 (0.495-0.601)	0.619 (0.545-0.668)	0.705 (0.611-0.763)	0.780 (0.665-0.844)
24-hr	0.123 (0.115-0.131)	0.148 (0.139-0.159)	0.186 (0.174-0.198)	0.215 (0.201-0.229)	0.254 (0.237-0.272)	0.285 (0.265-0.305)	0.317 (0.294-0.340)	0.350 (0.323-0.375)	0.395 (0.363-0.425)	0.431 (0.394-0.464)
2-day	0.072 (0.067-0.077)	0.086 (0.081-0.092)	0.107 (0.100-0.115)	0.123 (0.115-0.132)	0.145 (0.135-0.155)	0.162 (0.151-0.174)	0.180 (0.166-0.193)	0.198 (0.182-0.212)	0.222 (0.204-0.239)	0.241 (0.221-0.260)
3-day	0.051 (0.047-0.054)	0.061 (0.057-0.065)	0.075 (0.070-0.080)	0.086 (0.081-0.092)	0.102 (0.095-0.109)	0.114 (0.105-0.122)	0.126 (0.116-0.135)	0.138 (0.127-0.148)	0.155 (0.142-0.167)	0.169 (0.154-0.182)
4-day	0.040 (0.038-0.043)	0.048 (0.045-0.051)	0.059 (0.055-0.063)	0.068 (0.063-0.073)	0.080 (0.074-0.085)	0.089 (0.083-0.095)	0.099 (0.091-0.106)	0.109 (0.100-0.117)	0.122 (0.112-0.132)	0.133 (0.121-0.143)
7-day	0.026 (0.025-0.028)	0.031 (0.030-0.033)	0.038 (0.036-0.041)	0.044 (0.041-0.046)	0.051 (0.048-0.054)	0.057 (0.053-0.061)	0.063 (0.058-0.067)	0.069 (0.064-0.074)	0.077 (0.071-0.083)	0.084 (0.077-0.090)
10-day	0.021 (0.020-0.022)	0.025 (0.024-0.027)	0.030 (0.028-0.032)	0.034 (0.032-0.036)	0.039 (0.037-0.042)	0.043 (0.041-0.046)	0.048 (0.044-0.051)	0.052 (0.048-0.055)	0.058 (0.053-0.062)	0.062 (0.057-0.067)
20-day	0.014 (0.013-0.015)	0.017 (0.016-0.018)	0.020 (0.018-0.021)	0.022 (0.021-0.023)	0.025 (0.024-0.027)	0.028 (0.026-0.029)	0.030 (0.028-0.032)	0.033 (0.031-0.035)	0.036 (0.034-0.039)	0.039 (0.036-0.042)
30-day	0.012 (0.011-0.012)	0.014 (0.013-0.014)	0.016 (0.015-0.017)	0.018 (0.017-0.019)	0.020 (0.019-0.021)	0.022 (0.020-0.023)	0.023 (0.022-0.025)	0.025 (0.023-0.027)	0.027 (0.025-0.029)	0.029 (0.027-0.031)
45-day	0.010 (0.009-0.010)	0.012 (0.011-0.012)	0.013 (0.013-0.014)	0.015 (0.014-0.015)	0.016 (0.015-0.017)	0.017 (0.017-0.018)	0.019 (0.018-0.020)	0.020 (0.019-0.021)	0.022 (0.020-0.023)	0.023 (0.021-0.024)
60-day	0.009 (0.008-0.009)	0.010 (0.010-0.011)	0.012 (0.011-0.012)	0.013 (0.012-0.013)	0.014 (0.013-0.015)	0.015 (0.014-0.016)	0.016 (0.015-0.017)	0.017 (0.016-0.018)	0.018 (0.017-0.019)	0.019 (0.018-0.020)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).  
 Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.  
 Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

**PF graphical**

# **APPENDIX G**

## Skimmer Basin #1

2,710 Total Drainage Area (Acres)  
 2,710 Disturbed Area (Acres)  
 8.06496 Peak Flow from 10-year Storm (cfs)

Q10 = C\*1\*A  
 Q10 = 0.4\*7.44\*3.280

4,878.0 Required Volume ft<sup>3</sup>  
 2,621.1 Required Surface Area ft<sup>2</sup>  
 36.2 Suggested Width ft  
 72.4 Suggested Length ft

Contour	Contour Area sq ft	Incremental Volume cu ft	Accumulated Volume, S cu ft	Stage, Z ft
546.50	0	0	0	0.00
546.00	3,065	3,065	3,065	0.50
545.50	3,553	3,553	6,619	1.00
545.00	7,839	7,839	14,458	2.00

Spillway Elevation:  
 Sediment Storage:  
 Bottom Elevation:

Elevation (ft)
546.50
546.00
545.00

Trial Side Slope Ratio Z:1  
 Trial Depth ft (2 to 3.5 feet above grade)

5,392.0 Bottom Area ft<sup>2</sup>  
 14,457.5 Actual Volume ft<sup>3</sup>  
 8,334.0 Actual Surface Area ft<sup>2</sup>

### Weir Design

17.0 Spillway Capacity cfs  
 6.2 Embankment Width ft  
 1.00 Freeboard ft (1' min.)

### Skimmer Design

2.8 Skimmer Size (inches)  
 0.208 Head on Skimmer (feet)  
 2.36 Orifice Size (1/4 inch increments)  
 2.71 Dewatering Time (days)  
 Suggest about 3 days

Dimensions WxL (ft)	Elevation, min (ft)
Top of Dam	546.50

Okay  
 Okay

Top of Dam:  
 Okay

Skimmer Size (Inches)	Head on Skimmer (Feet)
2.8	0.125
3.0	0.167
3.2	0.208
3.4	0.250
3.6	0.333
3.8	0.417
4.0	0.500
4.2	0.667

Okay  
 Okay

NOTES:  
 Calculated Q's are based off larger of pre-development drainage area vs. pipe network drainage area.  
 Design Intensity was taken from the NOAA Atlas 14 for Burlington, NC

## EROSION CONTROL CALCS (RIP-RAP FOR INCOMING PIPE CALCULATIONS)

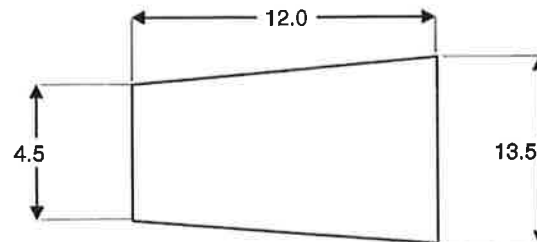
### Project Information

Project Name: Cole Park Plaza  
 KHA Project #: 1270000  
 Designed by: AMP Date: 6/25/2014  
 Revised by: \_\_\_\_\_ Date: \_\_\_\_\_  
 Revised by: \_\_\_\_\_ Date: \_\_\_\_\_  
 Checked by: COB Date: 6/26/2014

### Pond Inlet

Pipe Diameter	d=	18 in
Number of Pipes	#=	1 total
Pipe Slope	s=	0.50 %
Manning's number	n=	0.013
Flow	Q=	7.45 cfs
Velocity	V=	4.21 ft/s

Dissipator Dimensions *	Zone =	4
	Stone Filling Class =	1
	D <sub>0</sub> =	1.5 ft
	Entry Width ( 3 X D <sub>0</sub> ) =	4.5 ft
	Length ( 8 X D <sub>0</sub> ) =	12.0 ft
	Width (La + D <sub>0</sub> ) =	13.5 ft
	Min. Thickness =	24 inches
	Min. Stone Diameter=	13 inches



\* All units are in feet

\*\* Dissipator pad designed for full flow of pipe