PRELIMINARY
HYDRAULICS STUDY FOR
ENVIRONMENTAL IMPACT

ADDENDUM #1 – Addition of Site 1A
Downstream of Site 1 in original September 17, 2014 Report

SITE 1A – MIDDLE CREEK CROSSING AT SUNSET LAKE ROAD (SR 1301)

TIP PROJECT NO. R-2721, R-2828 & R-2829
WAKE AND JOHNSTON COUNTIES
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION

MULKEY, INC.
6750 Tryon Road
P.O. Box 33127
Raleigh, NC 27636
(919) 851-1912

February 16, 2015

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Each site includes the following information (if applicable):

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- **Photos/Field Notes**
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I. Hydraulic Aspects of Environmental Impact

HYDRAULIC ASPECTS OF ENVIRONMENTAL IMPACT OF THE TRIANGLE EXPRESSWAY PROTECTED CORRIDOR BETWEEN NC 55 BYPASS (HOLLY SPRINGS) AND US 64 BYPASS (KNIGHTDALE).
TIP PROJECT NO. R-2721, R-2828 AND R-2829

The North Carolina Turnpike Authority (NCTA) proposes to construct a multi-lane facility on new location between NC 55 in Apex and US 64/264 in Knightdale. The proposed typical section that is being considered for the project is a 6 lane median divided facility. The length of the proposed corridor is approximately 30 +/- miles. See the attached quad map for specific locations of the sites. All of the crossings are located in the Neuse River Basin.

It was discovered during a recent Agency field meeting that during Functional Designs a project corridor was extended to cover the downstream crossing of Site 1. This created Site 1A, Sunset Lake Road over Middle Creek. This site was never studied in the original report, therefore, it is now being investigated as an additional site (Site 1A), as Addendum #1. The staff of Mulkey, Inc. recently conducted a field investigation and preliminary hydraulic study for the subject stream crossing. In consideration of all aspects noted below, the hydraulic recommendations are summarized as follows:

Site 1A is a crossing of Middle Creek on an existing location; Sunset Lake Road. The normal water depth at the proposed site is 2.5 feet. The channel has a base width of 25 feet and a depth of 4.5 feet. Average upstream/downstream top of bank to top of bank measures approximately 35 feet. Recent drift was observed to be 5.0 feet above the stream bed. Debris potential is high and existing timber debris was noted in the upstream portion of the channel during recent site visit. The drainage area for this crossing is 3,554 acres (5.55 square miles). A majority of the area is zoned as Residential or Mixed Use. This crossing is located below headwater. Based on preliminary hydraulic analysis of this site, it is recommended that the proposed structure be a 100 foot bridge. Further detailed analysis will be required during final design in order to adequately address all the impacts associated with the floodplain. The creek is in a FEMA detailed study Special Flood Hazard Zone AE containing a published floodway. The creek is listed on the North Carolina Division of Water Quality (NCDWQ) 303(d) list (27-43-15-(1)b1) for impaired streams. This stretch of creek is located in Class C and NSW per NCDWQ classifications for this site.

Wake County participates in the National Flood Insurance Regulatory Program. Results of this study were based upon the current Effective FIRM maps for Wake County. The Hydraulics Unit will coordinate with the Federal Emergency Management Agency (FEMA) to determine if a Conditional Letter of Map Revision (CLOMR) and a subsequent final Letter of Map Revision (LOMR) are required for the project. If required, the Division will submit sealed as-built construction plans to the Hydraulics Unit upon project completion certifying the project was built as shown on construction plans.

Wetlands were observed sporadically through the entire corridor. NCDOT "Best Management Practices for the Protection of Surface Waters" will be utilized throughout the life of the project. Erosion and sedimentation will be controlled through the specification, installation, and maintenance of more stringent erosion and sedimentation control methods. Existing drainage patterns will be maintained to the extent practicable. Groundwater resources should not be affected by the project, as the roadway approaches are primarily on fill. Nutrient sensitive buffers are located throughout the entire project. There are no water supply watershed critical areas located downstream of this project, therefore Hazardous Spill Basins are not required for this project. It is anticipated that construction of the project will require a United States Army Corps of Engineers 404 individual permit and a 401 Water Quality Certification.

SUMMARY TABLE OF HYDRAULIC RECOMMENDATIONS

SITE	STREAM	EXISTING STRUCTURE	DA (SQ. MI.)	FLOOD ZONE	DETAILED STUDY	RECOMMENDED STRUCTURE
1A	Middle Creek	2@142”x 91” CSPA	5.55 (3,554 Ac.)	Yes	Yes (Zone AE)	100’ Bridge

II. Preliminary Design and Assessment Checklist

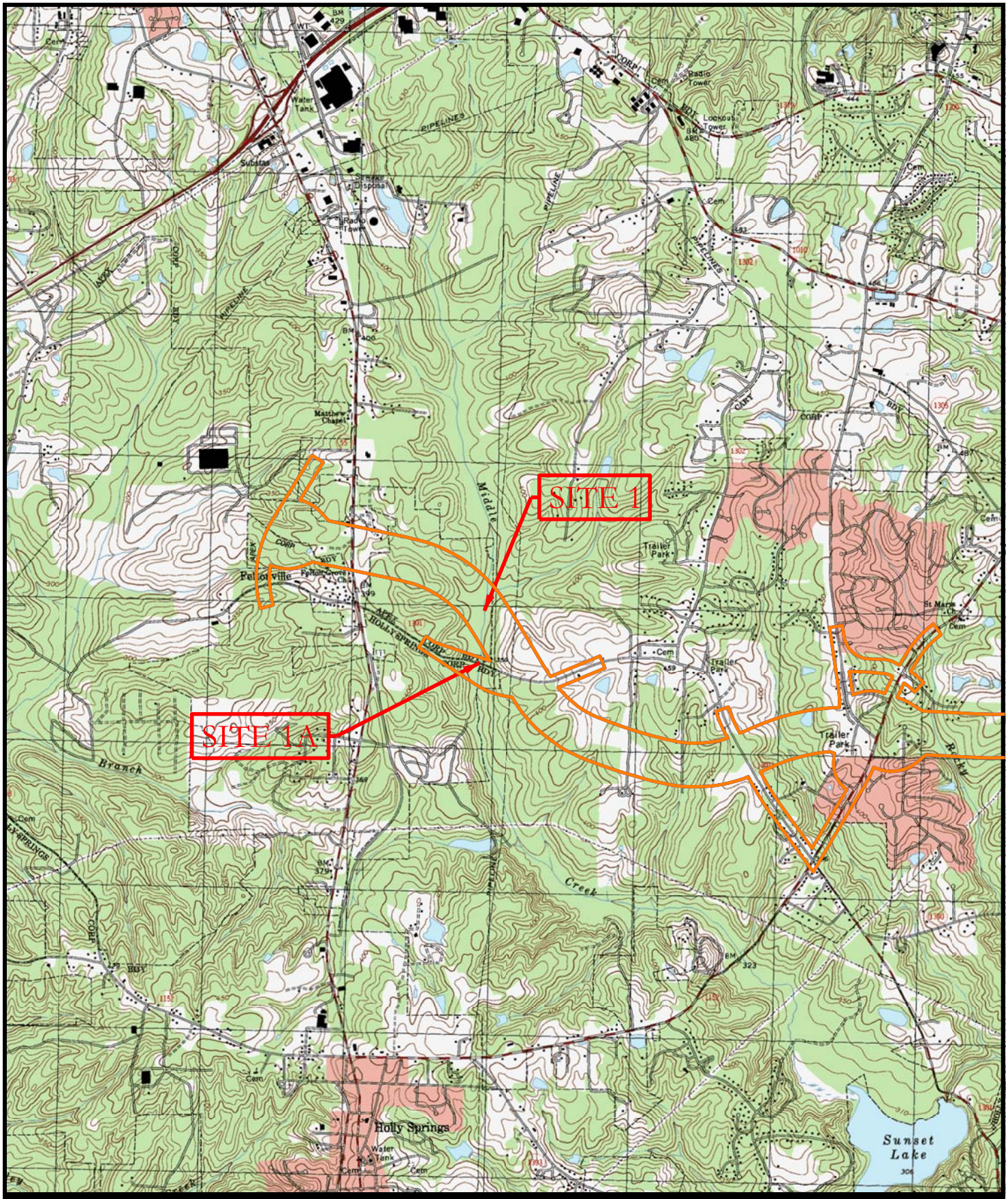
CHECKLIST FOR PRELIMINARY HYDRAULIC INVESTIGATION

R-2721/R-2828

TIP No.: ~~R-2829~~ **County:** WAKE **Prepared By:** MLL

ITEM No.		
		OFFICE DATA:
1	✓	**PROJECT INITIATION-** research existing files
2	✓	**PRELIMINARY DESIGN FORM-** appendix D of design guidelines
3	✓	**LOCATION MAP-** identify project limits and nearby drainage structures
4	✓	**BMU DATABASE DATA-** highlight important information (old project#, structures, etc.)
5	NA	**OLD BRIDGE/CULVERT SURVEY REPORTS**
6	✓	**USGS QUAD MAP** -Label:quad map name, begin/end project, streams, major drainage structures
7	✓	**FLOOD MAP** - Label: panel no. & date, community name, stream, scale, legend - FIS data (discharges, profiles, etc.) - Request HEC-2 data from COE or FEMA (date ordered: 4/7/2010)
8	✓	**PRELIMINARY HYDROLOGIC DESIGN** - Determine drainage area from gauge records,old structure reports, FEMA studies, or planimeter - Compute and compare discharges with other studies
9	NA	**PRELIMINARY HYDRAULIC DESIGN** - Check with bridge scour group for previous scour studies - Determine replacement and detour structures
10	✓	**PERMIT** - Attach a copy of the environmental sensitivity map - Determine if above (<5cfs average daily flow) or (>5cfs adf) headwaters - Check CAMA Jurisdiction
		FIELD DATA:
11	✓	**PLAN AND PROFILE VIEWS OF THE SITE** - Plan; Label: north arrow, utilities, road name/#, stream name and direction, structures in flood plain - Profile; Label: road direction, high water marks, road and flood plain profiles normal and ordinary high water marks - Conduct site interviews - Investigate alignments of replacement and detour structures
12	✓	**PHOTOS** - Upstream structure face, up and downstream waterways, both roadway approaches, and other significant features

III. Project Maps



Quad map with Site Locations

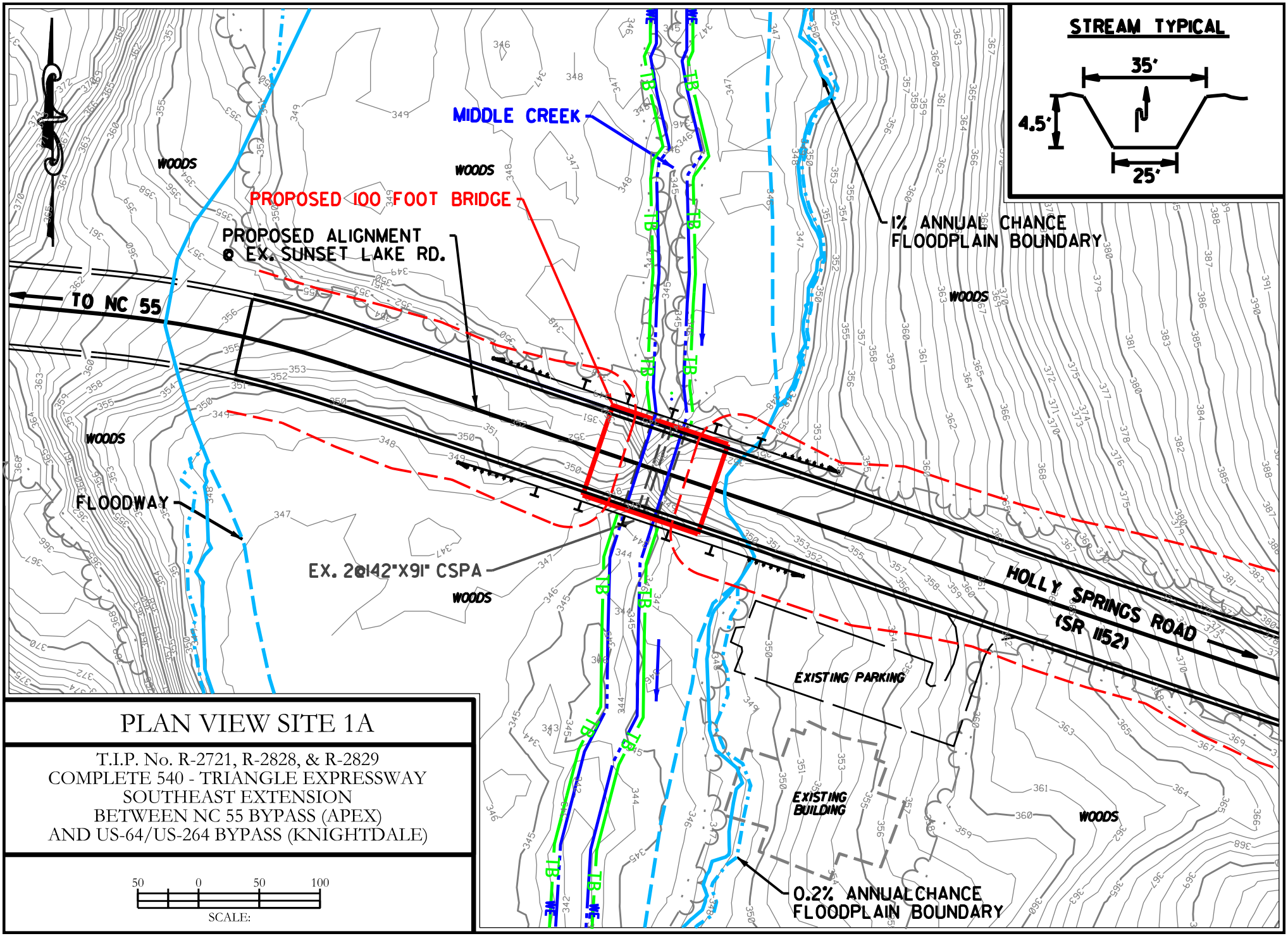
T.I.P. No. R-2721, R-2828, & R-2829
COMPLETE 540 - TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
BETWEEN NC 55 BYPASS (APEX)
AND US-64/US-264 BYPASS (KNIGHTDALE)

1,500 0 1,500 3,000

SCALE:

IV. Site Information (Site 1A)

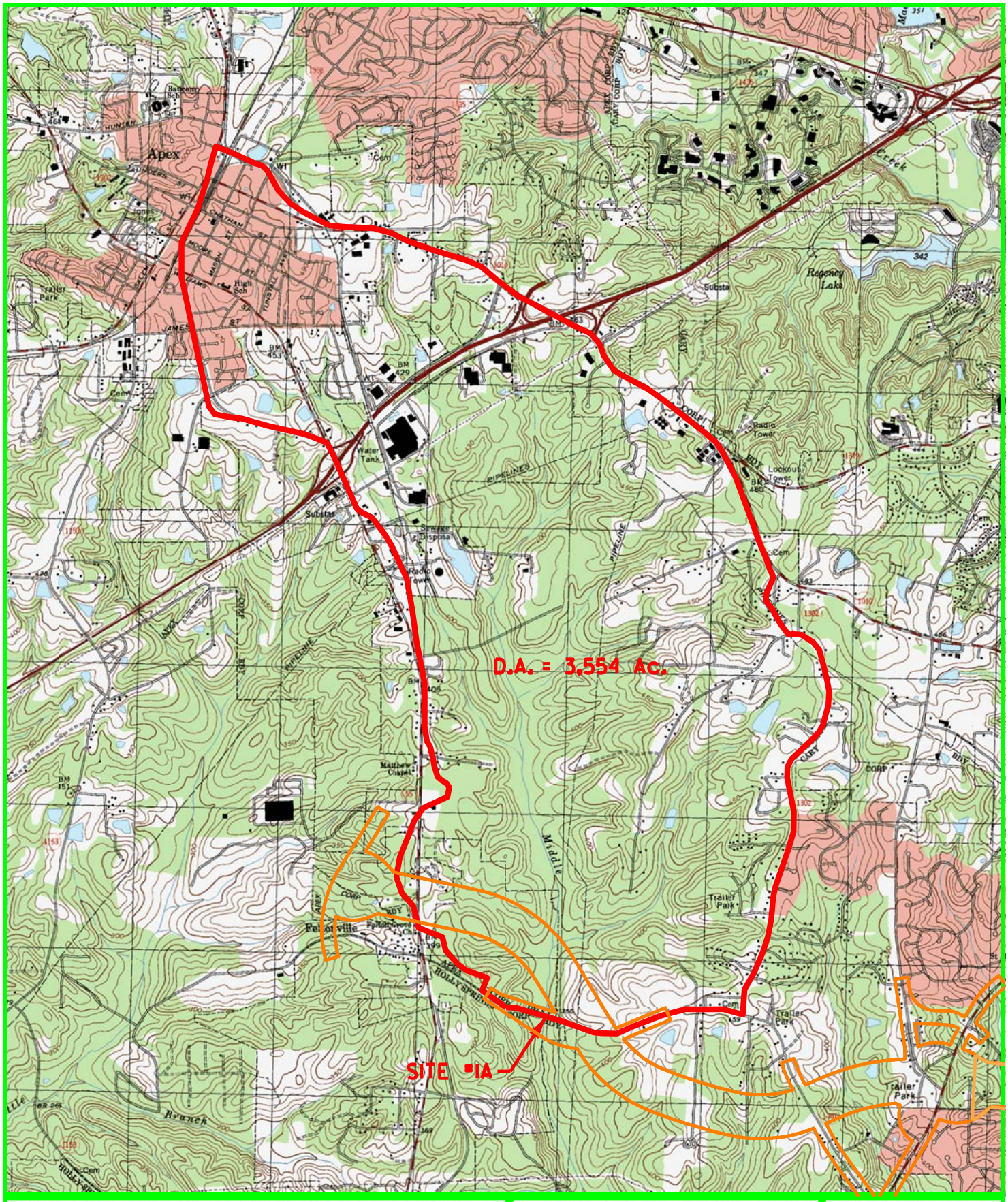
Site 1A



PLAN VIEW SITE 1A

T.I.P. No. R-2721, R-2828, & R-2829
COMPLETE 540 - TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
BETWEEN NC 55 BYPASS (APEX)
AND US-64/US-264 BYPASS (KNIGHTDALE)

50 0 50 100
SCALE:



QUAD MAP - SITE 1A

T.I.P. No. R-2721, R-2828, & R-2829
COMPLETE 540 - TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
BETWEEN NC 55 BYPASS (APEX)
AND US-64/US-264 BYPASS (KNIGHTDALE)

1,500 0 1,500 3,000
SCALE:

North Carolina

12/19/2014

PROJECT NAME: Triangle Expressway SE Ext | **STREAM NAME: Middle Creek** | **REGION: BLUE RIDGE** | **Site #1A**

ENGLISH Drainage Area = 5.55 sq. miles | **METHOD USED: Fact Sheet 007-00**

USGS RURAL REGRESSION EQUATIONS (OLD)

FREQUENCY	Sand Hills (cfs)	Coastal Plain (cfs)	Blue Ridge (cfs)
2YR	104.31	205.00	470.62
5YR	172.87	403.98	781.86
10YR	228.91	586.47	1044.00
25YR	312.23	900.89	1434.92
50YR	384.25	1182.40	1769.97
100YR	465.87	1530.48	2164.26
200YR	574.08	1956.41	2600.89
500YR	694.24	2635.72	3286.80

RURAL EQUATIONS Report 01-4207

FREQUENCY	Blue Ridge (cfs)	Coastal Plain (cfs)	Sand Hills (cfs)
2YR	449.60	205.03	113.50
5YR	772.15	383.01	184.52
10YR	1038.65	539.38	240.71
25YR	1437.73	776.38	321.71
50YR	1787.40	989.95	392.18
100YR	2174.40	1234.57	464.95
200YR	2609.58	1514.38	550.85
500YR	3271.56	1946.94	678.13

USGS URBAN REGRESSION EQUATIONS

BDF= 11

(These Equations are used only for comparison)

FREQUENCY	Sand Hills (cfs)	Coastal Plain (cfs)	Blue Ridge (cfs)	
5YR	602.35	1167.88	1954.67	
10YR	712.90	1499.02	2364.13	
25YR	877.79	2049.04	2973.56	
50YR	1033.03	2567.49	3559.78	
100YR	1229.65	3261.09	4332.70	
200YR	1996.13	4197.26	6619.55	(Based on 2.80xQ10)
500YR	1706.62	5096.07	6107.34	

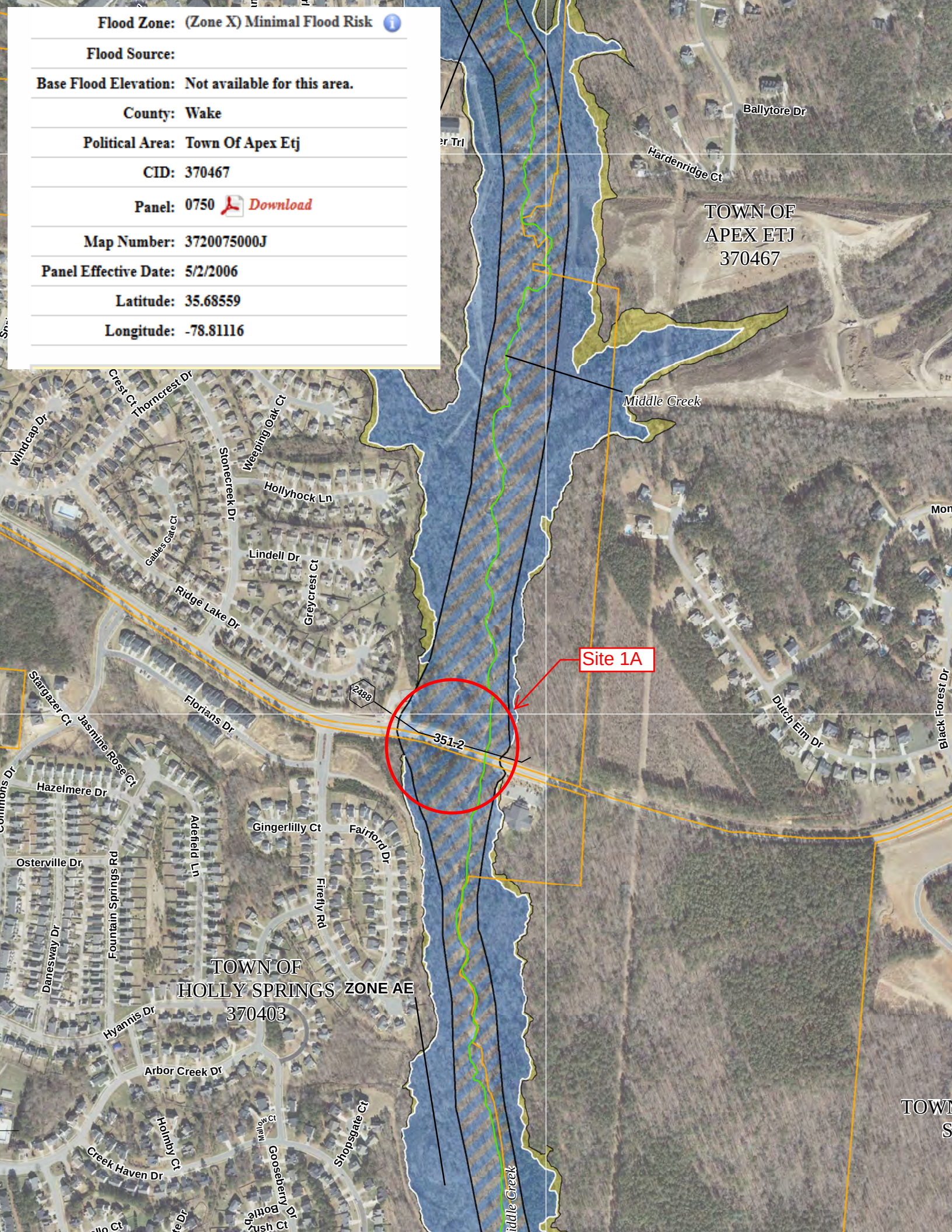
NC REGRESSION EQUATIONS (% Impervious) USGS Fact Sheet 007-00

% Impervious = 45

FREQUENCY	Sand Hills (cfs)	Coastal Plain (cfs)	Blue Ridge (cfs)	Discharge Used
5YR	1452.53	1848.99	2236.55	
10YR	1713.22	2259.51	2662.42	
25YR	2029.25	2918.73	3415.85	
50YR	2286.84	3289.62	3749.97	3700
100YR	2495.83	3621.47	4037.27	
200YR	4797.01	6326.62	7454.77	(Based on 2.80xQ10)
500YR	6270.38	8269.80	9744.45	(Based on 3.66xQ10)

FEMA

FREQUENCY	Disharges
10YR	1050
50YR	2150
100YR	2800
500YR	5200

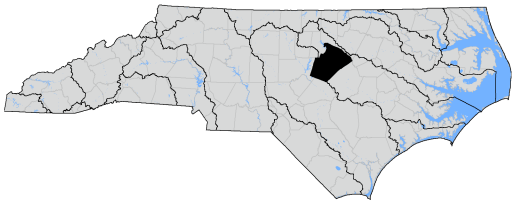

Flood Zone: (Zone X) Minimal Flood Risk
Flood Source:
Base Flood Elevation: Not available for this area.
County: Wake
Political Area: Town Of Apex Etj
CID: 370467
Panel: 0750 Download
Map Number: 3720075000J
Panel Effective Date: 5/2/2006
Latitude: 35.68559
Longitude: -78.81116
TOWN OF APEX ETJ 370467
TOWN OF HOLLY SPRINGS 370403
ZONE AE
Middle Creek
Site 1A
351.2
2488
Ballytore Dr
Hardenridge Ct
Crest Ct
Thorncrest Dr
Windcap Dr
Weeping Oak Ct
Stonecreek Dr
Hollyhock Ln
Gables Gate Ct
Lindell Dr
Greycrest Ct
Ridge Lake Dr
Stargazer Ct
Jasmine Rose Ct
Florians Dr
Dutch Elm Dr
Black Forest Dr
Hazelmere Dr
Gingerlilly Ct
Fairford Dr
Osterville Dr
Adefield Ln
Fountain Springs Rd
Firefly Rd
Danesway Dr
Hyannis Dr
Arbor Creek Dr
Holmby Ct
Mallow Ct
Shopsgate Ct
Creek Haven Dr
Gooseberry Dr

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

A Report of Flood Hazards in

WAKE COUNTY, NORTH CAROLINA AND INCORPORATED AREAS



Community Name	Community Number
CITY OF RALEIGH	370243
TOWN OF APEX	370467
TOWN OF CARY	370238
TOWN OF FUQUAY-VARINA	370239
TOWN OF GARNER	370240
TOWN OF HOLLY SPRINGS	370403
TOWN OF KNIGHTDALE	370241
TOWN OF MORRISVILLE	370242
TOWN OF ROLESVILLE	370468
TOWN OF WAKE FOREST	370244
TOWN OF WENDELL	370245
TOWN OF ZEBULON	370246
WAKE COUNTY	370368

NORTH CAROLINA
Cooperating Technical State
FEMA'S COOPERATING TECHNICAL PARTNER

EFFECTIVE: 4/16/2013
REVISED: 4/16/2013
Federal Emergency Management Agency
State of North Carolina
Flood Insurance Study Number
37183CV000
www.fema.gov and www.ncfloodmaps.com

Table 9 - Flooding Sources Studied by Detailed Methods: Redelineated

Source	Riverine Sources		Affected Communties
	From	To	
Middle Creek SITE 1A	The confluence with Swift Creek	Approximately 0.7 mile upstream of confluence of Middle Creek Tributary	Rdu Town Of Apex Town Of Cary Town Of Fuquay-Varina Town Of Holly Springs Wake County
Millbrook Tributary to Marsh Creek (Basin 18, Stream 19)	The confluence with Marsh Creek (Basin 18, Stream 17)	East Millbrook Road	City Of Raleigh
Mills Branch (Basin 22, Stream 5)	The confluence with Middle Creek (Basin 22, Stream 1)	Railroad	Rdu Town Of Fuquay-Varina Wake County
Mine Creek (Basin 18, Stream 31)	The confluence with Crabtree Creek (Basin 18, Stream 9)	The confluences of East Fork Mine Creek (Basin 18, Stream 34) and West Fork Mine Creek (Basin 12, Stream 33)	City Of Raleigh
Morrisville Tributary (Basin 18, Stream 26)	The confluence with Crabtree Creek (Basin 18, Stream 9)	Approximately 0.3 mile upstream of Railroad	Town Of Morrisville
Mud Branch (Basin 4, Stream 15)	The confluence with Horse Creek (Basin 4, Stream 1)	Approximately 3.0 miles upstream of confluence with Horse Creek (Basin 4, Stream 1)	Rdu Wake County
Neil Branch (Basin 24, Stream 8)	The confluence with Neil Creek (Basin 24, Stream 7)	East Spring Avenue	Town Of Fuquay-Varina
Neil Creek (Basin 24, Stream 7)	The confluence with Angier Creek (Basin 24, Stream 4)	Holland Road	Town Of Fuquay-Varina
Neuse River	Entire shoreline in Wake County	Entire shoreline within Granville County	Rdu Wake County
Neuse River	Wayne/Lenoir County boundary	Falls of the Neuse Road	City Of Raleigh Rdu Town Of Clayton Town Of Knightdale Town Of Wake Forest Wake County
New Light Creek	The confluence with Neuse River (Basin 15, Stream 1)	The confluence of Basin 3, Stream 8	Rdu Wake County
Panther Branch (Basin 22, Stream 2)	The confluence with Middle Creek (Basin 22, Stream 1)	Approximately 0.5 mile upstream of Banks Road	Rdu Wake County
Panther Creek	The Chatham/Wake County Boundary	Approximately 1.0 mile upstream of Green Level to Durham Road	Town Of Cary
Perry Creek East Branch (Basin 15, Stream 27)	The confluence with Perry Creek (Basin 15, stream 26)	Approximately 0.3 mile upstream of Bivens Drive	City Of Raleigh
Pigeon House Branch (Basin 18, Stream 27)	The confluence with Crabtree Creek (Basin 18, Stream 9)	West Peace Street	City Of Raleigh
Poplar Branch (Basin 13, Stream 2)	The confluence with Poplar Creek (Basin 13, Stream 1)	Farm Road	Town Of Knightdale
Poplar Creek (Basin 13, Stream 1)	The confluence with Neuse River (Basin 15, Stream 1)	Approximately 900 Feet upstream of Fayetteville Street	Rdu Town Of Knightdale Wake County
Powell Creek (Basin 8, Stream 7)	The confluence with Hodges Creek (Basin 8, Stream 1)	Approximately 1.3 miles upstream of Peebles Road	City Of Raleigh Rdu Town Of Rolesville Wake County
Reedy Creek (Basin 20, Stream 11)	The confluence with Swift Creek (Basin 20, Stream 1)	Seventh Avenue	Rdu Town Of Garner Wake County
Reedy Creek (Basin 6, Stream 8)	The confluence with Sanford Creek (Basin 6, Stream 7)	Rogers Road	Town Of Rolesville Town Of Wake Forest
Reedy Creek Tributary (Basin 20, Stream 9)	The confluence with Reedy Creek (Basin 20, Stream 11)	Claymore Drive	Town Of Garner
Richland Creek (Basin 18, Stream 3)	The confluence with Crabtree Creek (Basin 18, Stream 9)	Trinity Road	City Of Raleigh
Rocky Branch (Basin 22, Stream 8)	The confluence with Middle Creek (Basin 22, Stream 1)	Holly Springs Road	Rdu Town Of Holly Springs Wake County
Rocky Branch (Basin 30, Stream 5)	Approximately 60 feet downstream of Western Boulevard (upstream crossing)	Approximately 900 feet upstream of Pullen Road	City Of Raleigh
Rocky Branch (Basin 30, Stream 5)	The confluence with Walnut Creek (Basin 30, Stream 1)	Approximately 215 feet upstream of Fayetteville Road	City Of Raleigh
Rocky Ford Branch (Basin 24, Stream 5)	The confluence with Kenneth Creek (Basin 24, Stream 2)	Approximately 0.9 mile upstream of confluence with Kenneth Creek (Basin 24, Stream 2)	Rdu Town Of Fuquay-Varina Wake County
Sanford Creek (Basin 6, Stream 7)	The confluence with Smith Creek (Basin 6, Stream 1)	Approximately 300 feet upstream of the confluence of Basin 6, Stream 9	Rdu Town Of Rolesville Town Of Wake Forest Wake County
Smith Creek	The confluence with Neuse River (Basin 15, Stream 1)	Approximately 0.9 mile upstream of Oak Grove Church Road	Rdu Town Of Wake Forest Wake County
Southeast Prong Beaverdam Creek (Basin 18, Stream 30)	The confluence with Beaverdam Creek (Basin 18, Stream 28)	Wade Avenue	City Of Raleigh

Table 13 - Summary of Discharges

Flooding Source		Discharges (cfs)			
Location	Drainage Area (square miles)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Approximately 575 feet upstream of Glenraven Road	4.09	*	*	3,530	*
At confluence of Millbrook Tributary to Marsh Creek (Basin 18, Stream 19)	2.11	*	*	1,500	*
Approximately 1,060 feet upstream of Millbrook Road	1.60	*	*	1,070	*
Approximately 50 feet downstream of Forest Oak Drive	1.52	*	*	1,630	*
Approximately 350 feet downstream of Quail Ridge Road	1.21	*	*	1,880	*
Medfield Tributary (Basin 18, Stream 39)					
At mouth	1.20	*	*	1,200	*
Approximately 0.6 mile upstream of Old Trinity Road	0.80	*	*	950	*
Middle Creek					
At County boundary	65.30	*	*	10,800	*
Just upstream of Panther Branch (Basin 22, Stream 2)	56.70	*	*	9,900	*
Just upstream of Terrible Creek (Basin 22, Stream 19)	43.60	*	*	8,600	*
At US Route 401	38.70	*	*	7,500	*
At Johnson Pond Road	33.30	*	*	7,000	*
Just upstream of Camp Branch (Basin 22, Stream 7)	24.90	*	*	6,100	*
At State Route 1301	20.40	*	*	5,500	*
At State Route 1152	8.60	*	*	3,500	*
At State Route 1301	5.60	*	*	2,800	*
Millbrook Tributary to Marsh Creek (Basin 18, Stream 19)					
At mouth	1.00	*	*	1,100	*
At Millbrook Road	0.80	*	*	840	*
Mills Branch (Basin 22, Stream 5)					
At mouth	3.40	*	*	1,850	*
Approximately 1,580 feet downstream of Fayetteville Road	1.43	*	*	574	*
At downstream side of Fayetteville Road	1.34	*	*	552	*
Approximately 1,060 feet upstream of Fayetteville Road	1.21	*	*	521	*
Mine Creek					
At mouth[11]	9.90	*	*	1,500	*
Just downstream of Lynn Road Tributary (Basin 18, Stream 32)	8.30	*	*	3,200	*
Just downstream of NRCS dam[11]	8.30	*	*	175	*
Just downstream of East Fork Mine Creek and West Fork Mine Tributary	6.00	*	*	2,550	*
Mingo Creek (Basin 12, Stream 2)					
At confluence of Beaverdam Creek (Basin 12, Stream 1)	0.89	*	*	933	*
Approximately 0.4 mile upstream of Beaverdam Creek (Basin 12, Stream 1)	0.87	*	*	928	*
Approximately 125 feet upstream of Forrestville Road	0.78	*	*	977	*
Approximately 530 feet downstream of N Smithfield Road	0.45	*	*	848	*
Moccasin Creek					
Approximately 0.4 mile upstream of Franklin/Nash County boundary	27.96	*	*	7,470	*
Approximately 0.9 mile upstream of Franklin/Nash County boundary	26.57	*	*	7,230	*
Approximately 1,060 feet upstream of NC 97	25.00	*	*	6,960	*
Approximately 0.8 mile upstream of NC 97	20.10	*	*	6,070	*
Approximately 1,060 feet downstream of US Highway 64	15.49	*	*	5,160	*
Approximately 1,580 feet upstream of US Highway 64	13.95	*	*	4,840	*
Approximately 0.4 mile upstream of Sheppard School Road	12.16	*	*	4,440	*

SITE 1A

Table 16 - Roughness Coefficients

Stream	Channel "n"	Overbank "n"
Big Branch	0.050	0.140
Big Branch (Basin 10, Stream 8)	0.030 to 0.070	0.070 to 0.130
Big Branch (Basin 18, Stream 21)	0.035 to 0.055	0.090 to 0.200
Big Branch (Basin 26, Stream 5)	0.050	0.140
Big Branch Tributary No. 3	0.030 to 0.070	0.070 to 0.120
Big Branch Tributary No.1 (Basin 30, Stream 6)	0.030 to 0.070	0.070 to 0.120
Black Creek	0.025 to 0.060	0.030 to 0.150
Bradley Creek (Basin 24, Stream 3)	0.030 to 0.070	0.070 to 0.110
Bridges Branch	0.050	0.130
Brier Creek (Basin 18, Stream 14)	0.024 to 0.040	0.100 to 0.200
Buckhorn Creek	0.040 to 0.048	0.145
Buffalo Creek (Basin 9, Stream 1)	0.030 to 0.070	0.035 to 0.140
Buffalo Creek West	0.045 to 0.052	0.030 to 0.140
Burdens Creek	0.042 to 0.050	0.100 to 0.200
Cary Branch	0.040	0.140
Cedar Fork (Basin 10, Stream 15)	0.420 to 0.042	0.130
Clark Branch (Basin 28, Stream 3)	0.050	0.150
Coles Branch (Basin 18, Stream 24)	0.030 to 0.070	0.070 to 0.200
Crabtree Creek (Basin 18, Stream 9)	0.030 to 0.070	0.070 to 0.150
Crabtree Creek Tributary No. 6 (Basin 18, Stream 20)	0.030 to 0.070	0.070 to 0.130
Fowlers Mill Creek (Basin 10, Stream 12)	0.042	0.130
Guffy Branch (Basin 21, Stream 4)	0.047	0.130
Hatchet Grove Tributary (Basin 18, Stream 25)	0.030 to 0.070	0.070 to 0.130
Hodges Creek (Basin 8, Stream 1)	0.030 to 0.070	0.070 to 0.160
Hominy Creek (Basin 10, Stream 7)	0.030 to 0.070	0.070 to 0.130
Horse Creek	0.042 to 0.050	0.080 to 0.150
Horse Creek Tributary 1	0.048	0.120 to 0.150
Jack Branch (Basin 28, Stream 4)	0.055	0.155
Jim Branch	0.045	0.145
Juniper Branch (Basin 21, Stream 2)	0.045	0.110 to 0.130
Kenneth Branch (Basin 24, Stream 6)	0.030 to 0.070	0.070 to 0.150
Kenneth Creek	0.030 to 0.070	0.070 to 0.160
Kit Creek	0.030 to 0.070	0.070 to 0.110
Kit Creek Tributary 2 (Basin 29, Stream 8)	0.030 to 0.070	0.070 to 0.110
Lakemont Tributary (Basin 18, Stream 22)	0.050 to 0.062	0.120 to 0.200
Ledge Creek	0.050	0.150
Little Beaver Creek	0.045 to 0.055	0.100 to 0.220
Little Beaverdam Creek (Basin 2, Stream 2)	0.030 to 0.070	0.070 to 0.150
Little Black Creek	0.030 to 0.070	0.070 to 0.130
Little Branch (Basin 26, Stream 3)	0.040	0.148
Little Brier Creek (Basin 18, Stream 15)	0.030 to 0.070	0.070 to 0.130
Little Brier Creek East (Basin 18, Stream 16)	0.030 to 0.070	0.070 to 0.140
Little Creek (Basin 11, Stream 2)	0.030 to 0.080	0.070 to 0.150
Little Creek (Into Middle Creek)	0.033 to 0.047	0.095 to 0.140
Little River	0.040 to 0.066	0.070 to 0.240
Little White Oak Creek (Basin 26, Stream 9)	0.035 to 0.050	0.148
Little White Oak Creek Tributary 2	0.040	0.140
Marks Creek	0.025 to 0.070	0.070 to 0.130
Marsh Creek (Basin 18, Stream 17)	0.038 to 0.060	0.090 to 0.200
Middle Creek	0.042 to 0.050	0.030 to 0.140
Mill Branch	0.050	0.140
Mills Branch (Basin 22, Stream 5)	0.030 to 0.070	0.070 to 0.130
Mingo Creek (Basin 12, Stream 2)	0.041 to 0.044	0.100 to 0.200
Moccasin Creek	0.030 to 0.070	0.070 to 0.220
Morris Branch	0.030 to 0.050	0.100 to 0.200
Neil Branch (Basin 24, Stream 8)	0.030 to 0.070	0.070 to 0.130
Neil Creek (Basin 24, Stream 7)	0.030 to 0.070	0.070 to 0.110
Neuse River	0.035 to 0.060	0.055 to 0.250
New Hope Tributary to Marsh Creek (Basin 18, Stream 18)	0.040 to 0.065	0.110 to 0.200
New Light Creek	0.040 to 0.070	0.070 to 0.150
Norris Branch	0.048	0.145

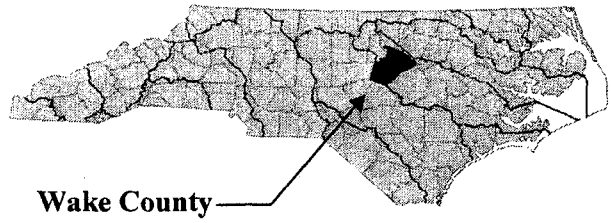
SITE 1A

FLOOD INSURANCE STUDY

A Report of Flood Hazards in

WAKE COUNTY, NORTH CAROLINA

AND INCORPORATED AREAS



VOLUME 2 OF 7

Community Name	Community Number	River Basin
Apex, Town of	370467	Cape Fear/Neuse
Cary, Town of	370238	Cape Fear/Neuse
Fuquay-Varina, Town of	370239	Cape Fear
Garner, Town of	370240	Neuse
Holly Springs, Town of	370403	Cape Fear/Neuse
Knightdale, Town of	370241	Neuse
Morrisville, Town of	370242	Cape Fear/Neuse
Raleigh, City of	370243	Neuse
Rolesville, Town of	370468	Neuse
Wake County (Unincorporated Areas)	370368	Cape Fear/Neuse
Wake Forest, Town of	370244	Neuse
Wendell, Town of	370245	Neuse
Zebulon, Town of	370246	Neuse

NORTH CAROLINA Cooperating Technical State
FEMA'S COOPERATING TECHNICAL PARTNER

May 2, 2006

Federal Emergency Management Agency
State of North Carolina

Flood Insurance Study Number
37183CV002A

www.fema.gov and www.ncfloodmaps.com

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Middle Creek (Basin 22, Stream 1) (continued)								
2035	203,540	670	3,655	2.1	270.0	270.0	270.6	0.6
2041	204,130	610	3,484	2.2	271.1	271.1	272.1	1.0
2050	205,000	740	3,910	1.9	274.1	274.1	274.4	0.3
2070	207,000	900	3,771	2.0	276.0	276.0	276.2	0.2
2094	209,350	840	4,073	1.8	280.1	280.1	280.2	0.1
2115	211,450	700	3,437	2.1	282.7	282.7	283.4	0.7
2134	213,400	840	5,181	1.4	284.7	284.7	285.6	0.9
2145	214,530	830	4,806	1.5	285.6	285.6	286.5	0.9
2156	215,600	780	3,253	2.2	287.0	287.0	288.0	1.0
2161	216,140	730	3,371	2.0	289.2	289.2	289.3	0.1
2181	218,070	750	4,617	1.4	291.1	291.1	291.5	0.4
2198	219,800	800	4,686	1.4	292.1	292.1	292.7	0.6
2204	220,375	560	2,480	2.6	292.7	292.7	293.3	0.6
2221	222,125	500	2,602	2.4	297.2	297.2	297.2	0.0
2242	224,160	500	3,457	1.8	299.5	299.5	300.2	0.7
2258	225,800	238	1,989	2.9	300.9	300.9	301.9	1.0
2275	227,500	120	1,383	4.1	304.3	304.3	305.0	0.7
2277	227,665	260	2,792	2.7	311.3	311.3	311.7	0.4
2329	232,910	310	1,109	3.1	314.5	314.5	315.0	0.5
2366	236,595	390	2,273	1.5	322.3	322.3	323.0	0.7
Site 1A 2488	248,810	500	1,387	2.5	351.2	351.2	251.2	0.0
2613	261,270	190	1,080	3.2	379.2	379.2	379.7	0.5

[1]Feet above mouth

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

WAKE COUNTY, NC AND INCORPORATED AREAS

FLOODWAY DATA

MIDDLE CREEK (BASIN 22, STREAM 1)

FLOOD INSURANCE STUDY

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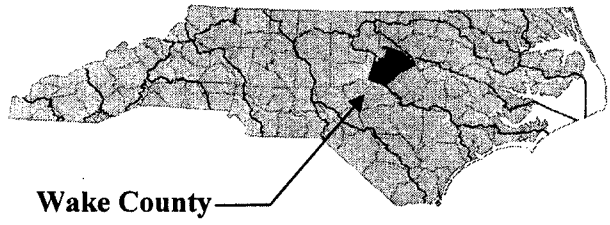
WAKE COUNTY, NORTH CAROLINA

AND INCORPORATED AREAS



VOLUME 5 OF 7

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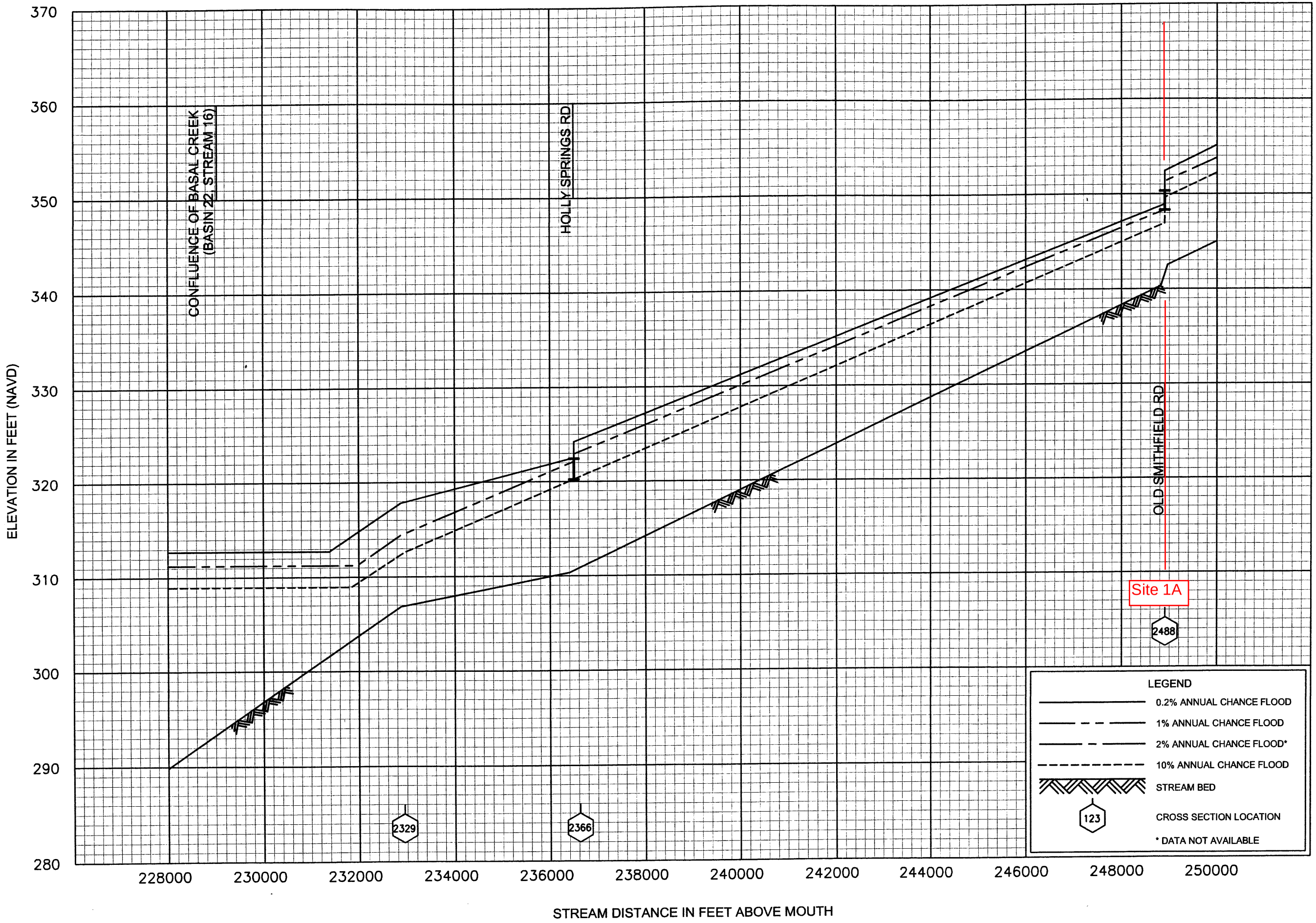


FLOOD PROFILES

MIDDLE CREEK (BASIN 22, STREAM 1)

FEDERAL EMERGENCY MANAGEMENT AGENCY

WAKE COUNTY, NC
AND INCORPORATED AREAS

218P

.0315 NEUSE RIVER BASIN

Name of Stream	Description	Class	Class Date	Index No.
Unnamed Tributary to Swift Creek (Yates Mill Pond)	From dam at Silver Lake to a point 0.5 mile upstream of mouth	WS-III;NSW	08/03/92	27-43-5-(1.5)
Unnamed Tributary to Swift Creek	From a point 0.5 mile upstream of mouth to Swift Creek	WS-III;NSW,CA	08/03/92	27-43-5-(2)
Swift Creek (Lake Benson)	From a point 0.6 mile upstream of Wake County SR 1006 to dam at Lake Benson	WS-III;NSW,CA	08/03/92	27-43-(5.5)
Buck Branch	From source to a point 0.6 mile upstream of mouth	WS-III;NSW	08/03/92	27-43-6-(1)
Buck Branch	From a point 0.6 mile upstream of mouth to Lake Benson, Swift Creek	WS-III;NSW,CA	08/03/92	27-43-6-(2)
Reedy Branch	From source to a point 0.5 mile upstream of mouth	WS-III;NSW	08/03/92	27-43-7-(1)
Reedy Branch	From a point 0.5 mile upstream of mouth to Lake Benson, Swift Creek	WS-III;NSW,CA	08/03/92	27-43-7-(2)
Swift Creek	From dam at Lake Benson to Neuse River	C;NSW	05/01/88	27-43-(8)
Mahlers Creek	From source to Swift Creek	C;NSW	05/01/88	27-43-9
Neal Branch	From source to Swift Creek	C;NSW	05/01/88	27-43-10
White Oak Creek (Austin Pond)	From source to Swift Creek	C;NSW	05/01/88	27-43-11
Little Creek	From source to Swift Creek	C;NSW	05/01/88	27-43-12
Cooper Branch	From source to Swift Creek	C;NSW	05/01/88	27-43-13
Reedy Branch (Little Branch)	From source to Swift Creek	C;NSW	05/01/88	27-43-14
Middle Creek	From source to backwaters of Sunset Lake	C;NSW	05/01/88	27-43-15-(1)
Middle Creek (Sunset Lake)	From backwaters of Sunset Lake to dam at Sunset Lake	B;NSW	05/01/88	27-43-15-(2)
Basal Creek [(Bass Lake, (Mills Pond)]	From source to Sunset Lake, Middle Creek	B;NSW	05/01/88	27-43-15-3
Middle Creek	From dam at Sunset Lake to Swift Creek	C;NSW	05/01/88	27-43-15-(4)
Rocky Branch	From source to Middle Creek	C;NSW	05/01/88	27-43-15-4.5
Camp Branch	From source to Middle Creek	C;NSW	05/01/88	27-43-15-5
Bells Lake	Entire lake and connecting stream to Middle Creek	C;NSW	05/01/88	27-43-15-6
Mills Branch	From source to Middle Creek	C;NSW	05/01/88	27-43-15-7
Terrible Creek (Johnsons Pond)	From source to dam at Johnsons Pond	B;NSW	05/01/88	27-43-15-8-(1)
Terrible Creek	From dam at Johnsons Pond to Middle Creek	C;NSW	05/01/88	27-43-15-8-(2)
Panther Branch	From source to Middle Creek	C;NSW	05/01/88	27-43-15-9
Little Creek	From source to Middle Creek	C;NSW	05/01/88	27-43-15-10

2014 AU Number:	AU Name:	AU Length Area:	AU Units:	Classification:
	AU Description:			

27-43-15-(4)a1 Middle Creek 4.5 FW Miles C;NSW

From dam at Sunset Lake to small impoundment upstream of US 401

IRCategory:	ACS:	Parameter Of Interest:	Collection Year:	303(d) yr:
5	**EC**	**Fish Community Poor (Nar, AL, FW)**	**2011**	**2014**

27-43-15-(1)b1 Middle Creek 3.0 FW Miles C;NSW

From 0.8 miles south of US 1 to ut on west of creek 3.0 miles downstream

IRCategory:	ACS:	Parameter Of Interest:	Collection Year:	303(d) yr:
5	**EC**	**Benthos Fair (Nar, AL, FW)**	**2005**	**2008**

27-43-15-(1)b2 Middle Creek 1.6 FW Miles C;NSW

From ut on west isde of creek 3.0 miles downstream to backwaters of Sunset Lake

IRCategory:	ACS:	Parameter Of Interest:	Collection Year:	303(d) yr:
5	**EC**	**Benthos Fair (Nar, AL, FW)**	**2010**	**2012**

27-52-(1)b Mill Creek (Moorewood Pond) 11.3 FW Miles C;NSW

From source to Stone Creek

IRCategory:	ACS:	Parameter Of Interest:	Collection Year:	303(d) yr:
5	**EC**	**Dissolved Oxygen (4 mg/l, AL, FW)**	**2012**	**2014**

27-33-14a Mine Creek 3.3 FW Miles C;NSW

From source to Shelly Lake

IRCategory:	ACS:	Parameter Of Interest:	Collection Year:	303(d) yr:
5	**EC**	**Benthos Fair (Nar, AL, FW)**	**2011**	**1998**

27-33-14b Mine Creek 1.5 FW Miles C;NSW

FromShelly Lake to Crabtree Creek

IRCategory:	ACS:	Parameter Of Interest:	Collection Year:	303(d) yr:
5	**EC**	**Benthos Fair (Nar, AL, FW)**	**2011**	**1998**

27-53-(0.5) Moccasin Creek (Holts Pond) 10.5 FW Miles C;NSW

From source to a point 0.6 mile downstream of dam at Holts Pond

IRCategory:	ACS:	Parameter Of Interest:	Collection Year:	303(d) yr:
5	**EC**	**Benthos Fair (Nar, AL, FW)**	**2010**	**2012**

27-(36) NEUSE RIVER 4.3 FW Miles WS-V;NSW

From mouth of Beddingfield Creek to a point 0.2 mile downstream of Johnston County SR 1700

IRCategory:	ACS:	Parameter Of Interest:	Collection Year:	303(d) yr:
5e	**EC**	**Copper (7 µg/l, AL, FW)**	**2008**	**2008**
5e	**EC**	**Zinc (50 µg/l, AL, FW)**	**2008**	**2008**

PRELIMINARY DESIGN AND ASSESSMENT OF STREAM CROSSINGS AND ENCROACHMENTS

COUNTY Wake PROJECT NUMBER R-2721, R-2828 & 2829

STREAM Middle Creek (Site 1A) ROUTE SR 1301(Sunset Lake Rd.)

ASSESSMENT PREPARED BY Mulkey, INC. (WBP) DATE 12/23/2014

HYDROLOGIC EVALUATION

NEAREST GAGING STATION ON THIS STREAM _____ (NONE X)

ARE FLOOD STUDIES AVAILABLE ON THIS STREAM**:** Yes

FLOOD DATA:
Q_{10} 2,700 CFS EST. BKWTR. N/A FT. Q_{25} 3,400 CFS EST. BKWTR. N/A FT.
Q_{50} 3,700 CFS EST. BKWTR. N/A FT. Q_{100} 4,000 CFS EST. BKWTR. N/A FT.
Q_{500} 9,700 CFS EST. BKWTR. N/A FT.
DRAINAGE AREA 5.55 Sq.Mi. METHOD USED TO COMPUTE Q: USGS Urban Regression

PROPERTY RELATED EVALUATIONS

DAMAGE POTENTIAL: LOW _____ MODERATE _____ HIGH X

COULD THIS BE SIGNIFICANTLY INCREASED BY PROPOSED

ENCROACHMENT: YES _____ NO X

EXPLANTION: A floodway modification may be required at this site.

LIST BUILDINGS IN FLOOD PLAIN: None LOCATION: _____

UPSTREAM LAND USE Residential
ANTICIPATE ANY CHANGE? No

ANY FLOOD ZONING? (FIA STUDIES, ETC.) YES X NO _____

TYPE OF STUDY: FEMA – Special Flood Hazard Zone AE

REGULATORY FLOODWAY WIDTH 500 ft. Section 2488 (AS NOTED IN FIS)

COMMENTS: _____

TRAFFIC RELATED EVALUATIONS

PRESENT YEAR 2011 TRAFFIC COUNT 6,700 VPD % TRUCKS 6

DESIGN YEAR 2035 TRAFFIC COUNT 44,800 VPD % TRUCKS 12

EMERGENCY ROUTE _____ SCHOOL BUS ROUTE _____ MAIL ROUTE _____

DETOUR AVAILABLE? Yes LENGTH OF DETOUR 7 MILES

DOES THE LEVEL OF TRAFFIC SERVICE OF AN EXISTING CROSSING VARY GREATLY FROM STANDARD DESIGN LEVELS? No

IS THE TRAFFIC VOLUME, TYPE, USAGE SUCH TO WARRANT CONSIDERATION FOR VARIANCE FROM STANDARDS OR EXISTING LEVEL OF INTERRUPTION? No

COMMENTS:

HIGHWAY AND BRIDGE (CULVERT) RELATED EVALUATIONS

NOTE ANY OUTSIDE FEATURES WHICH MIGHT AFFECT STAGE, DISCHARGE OR FREQUENCY.

LEVEES _____ AGGRADATION/DEGRADATION _____ RESERVOIRS _____

DIVERSIONS _____ DRAINAGE DISTRICT _____ NAVIGATION _____

BACKWATER FROM ANOTHER SOURCE _____

EXPLANATION: _____
_____

ROADWAY OVERFLOW SECTION (NONE X) LENGTH 480’ ELEVATION 352

EMBANKMENT: SOIL TYPE Wehadkee TYPE SLOPE COVER Vegetation

COMMENTS: Soil Type from 1970 “Soil Survey Wake County North Carolina” which was published by the United States Department of Agriculture Soil Conservation Service

ENVIRONMENTAL CONSIDERATIONS

LIST SPECIAL CONDITIONS OR CONSIDERATIONS WHICH AFFECT HYDRAULIC DESIGN: FEMA SPECIAL FLOOD HAZARD SONE AE

MISCELLANEOUS COMMENTS

IS THERE UNUSUAL SCOUR POTENTIAL? YES ___ NO X PROTECTION NEEDED ___

ARE BANKS STABLE? Yes PROTECTION NEEDED No

DOES STREAM CARRY APPRECIABLE AMOUNT OF LARGE DEBRIS? Yes

COMMENTS: Existing site had large debris in upstream channel.

ALTERNATIVES

RECOMMENDED DESIGN: Proposed 100 ft. bridge.

DETOUR STRUCTURE N/A

BRIDGE WATERWAY OPENING

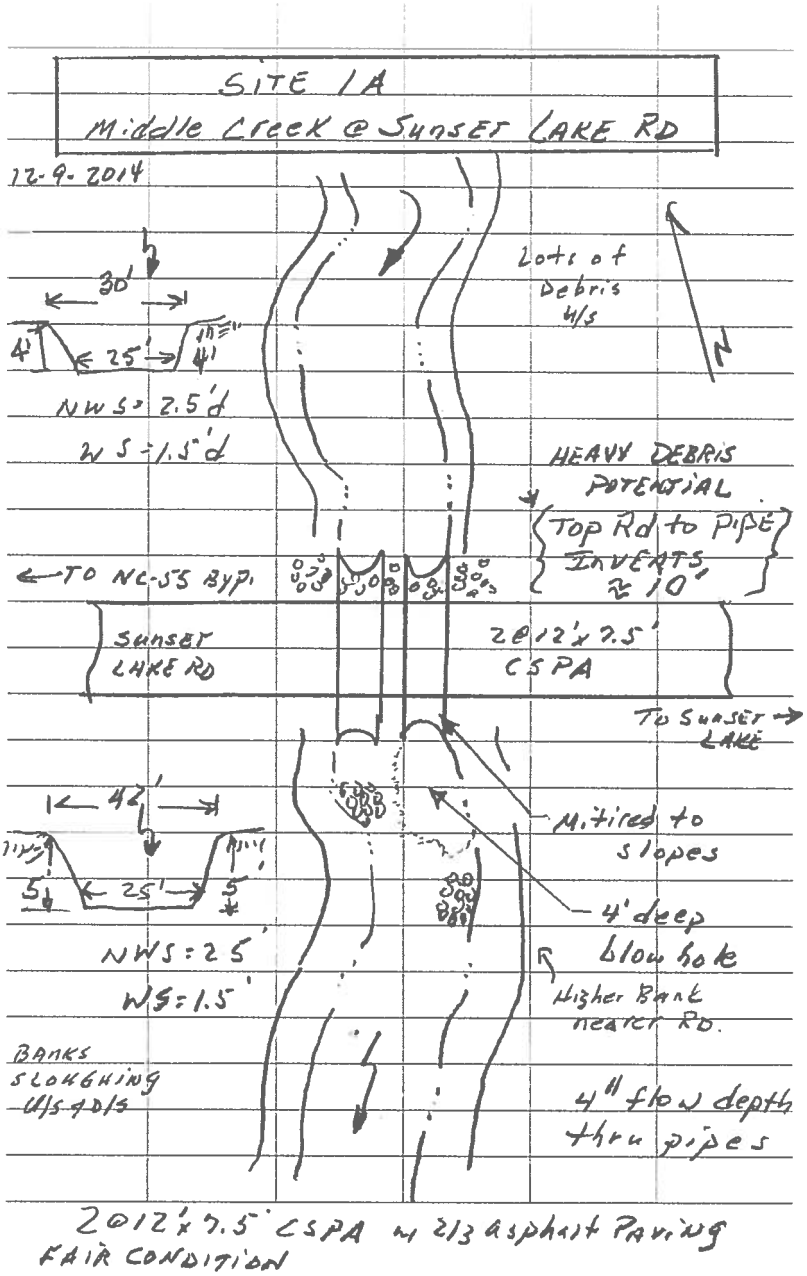
WERE OTHER HYDRAULIC ALTERNATIVES CONSIDERED? YES NO X
DISCUSSION:

THIS SITE ASSESSMENT INDICATES THE DESIGN SHOULD FOLLOW:

(1) _____ NORMAL PROCESS

(2) X NORMAL PROCESS WITH SPECIAL SPECIFIC CONSIDERATION FOR
100 year Base Flood and Floodway Elevation

(3) _____ SPECIFIC DESIGN PROCESS WITH APPROPRIATE RISK/ECONOMIC
EVALUATION ADDRESSING: _____


SITE 1A
Middle Creek @ Sunset Lake Rd
12-9-2014
30'
4'
25'
4'
NWS = 2.5'd
WS = 1.5'd
Lots of Debris U/S
N
HEAVY DEBRIS POTENTIAL
Top Rd to Pipe Inverts ≈ 10'
TO NC-55 Bypl
SUNSET LAKE RD
2@12'x7.5' CSPA
To Sunset Lake
42'
5'
25'
5'
NWS = 2.5'
WS = 1.5'
M. fired to slopes
4' deep blow hole
Higher Bank nearer Rd.
BANKS SLOUGHING U/S & D/S
4" flow depth thru pipes
2@12'x7.5' CSPA w/ 2/3 asphalt Paving
FAIR CONDITION

SITE 1A

NC DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
BRIDGE MANAGEMENT UNIT

ATTENTION

BRIDGE INSPECTION REPORT

INSPECTION TYPE: Routine Inspection

COUNTY WAKE **BRIDGE NUMBER** 910372 **INSPECTION CYCLE** 2 **YRS**

ROUTE SR1301 **ACROSS** MIDDLE CREEK **M.P.** 0

LOCATION 0.6MI.E.JCT.NC55

2 LINES 142X91 CSPA;46'- 0" ALONG CENTERLINE PIPE

SUPERSTRUCTURE 2 LINES 142X91 CSPA;60'6 ALONG CENTERLINE PIPE

SUBSTRUCTURE

SPANS

LONGITUDE 78° 49' 26.88" **LATITUDE** 35° 40' 46.49"

INSPECTION DATE 12/18/2012 **PRESENT CONDITION** FAIR

PRESENT POSTING Not Posted NOT POSTED **PROPOSED POSTING**

OTHER SIGNS PRESENT DELINEATORS

LOOKING EAST

SIGN NOTICE ISSUED FOR		NUMBERED REQUIRED
No	WEIGHT LIMIT	
No	DELINEATORS	
No	NARROW BRIDGE	
No	ONE LANE BRIDGE	
No	LOW CLEARANCE	

Site 1A - D/S Structure

NC DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
BRIDGE MANAGEMENT UNIT

ATTENTION

BRIDGE INSPECTION REPORT

INSPECTION TYPE: Routine Inspection

COUNTY WAKE | BRIDGE NUMBER 910543 | INSPECTION CYCLE 2 YRS

ROUTE SR1152 | ACROSS BEAVER CREEK | M.P. 0

LOCATION 0.3MI.S.JCT SR1549

SUPERSTRUCTURE TRIPLE 10'X9' RCBC, 28'8 ALONG CENTERLINE CULVERT

SUBSTRUCTURE

SPANS

LONGITUDE 78° 48' 14.37" | LATITUDE 35° 39' 40.13"

INSPECTION DATE 02/27/2013 | PRESENT CONDITION FAIR

PRESENT POSTING Not Posted | PROPOSED POSTING

OTHER SIGNS PRESENT DELINEATORS

LOOKING EAST

Fracture Critical	No
Temporary Shoring	No
Scour Critical	No
Scour POA	No

SIGN NOTICE ISSUED FOR		NUMBERED REQUIRED
No	WEIGHT LIMIT	
No	DELINEATORS	
No	NARROW BRIDGE	
No	ONE LANE BRIDGE	
No	LOW CLEARANCE	

Looking Upstream from Sunset Lake Road (Proposed Site)

Looking Downstream from Sunset Lake Road (Proposed Site)

Looking downstream at existing 2@12'x7.5' CSPA w/ 2/3 asphalt paving

Looking upstream at existing 2@12'x7.5' CSPA

Triple 10'x 9' RCBC Downstream Structure

Looking Upstream from Downstream Structure.