FINAL
PRELIMINARY HYDRAULIC TECHNICAL MEMORANDUM

GASTON COUNTY EAST-WEST CONNECTOR

NCDOT STIP Project No. U-3321

Prepared for:

NORTH CAROLINA Turnpike Authority

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December 10, 2007

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1 PROJECT NARRATIVE

1.1 Project Description

The North Carolina Turnpike Authority (NCTA) proposes to improve east-west travel between I-85 west of Gastonia in Gaston County and I-485/NC 160 in Mecklenburg County. The Gaston East-West Connector is designated as STIP Project No. U-3321 in the NCDOT's *2007-2013 State Transportation Improvement Program* (STIP).

The purpose of the proposed action is to improve east-west transportation mobility in the area around the City of Gastonia, between Gastonia and the Charlotte metropolitan area in general, and particularly to establish direct access between the rapidly growing area of southeast Gaston County and west Mecklenburg County.

Gaston County is located in the South-Central Piedmont section of North Carolina. It is bounded on the east by the Catawba River and Mecklenburg County, on the west by Cleveland County, on the north by Lincoln County and on the south by York County, South Carolina. The nearest major metropolitan area is Charlotte, in Mecklenburg County, which is 20 miles (32 km) to the east. Hickory is 37 miles (60 km) to the north and Asheville is 95 miles (153 km) to the northwest.

The proposed project study area is located in southern Gaston County and western Mecklenburg County. There are sixteen new location Detailed Study Alternatives (DSA) under consideration for the proposed project. **Figure 1** and **Table 1** show the corridor segments comprising these sixteen DSAs. Generally, there are two to four corridor options at any one location. Combinations of these options add up to the sixteen DSAs.

Table 1. Corridor Segments Comprising Each Detailed Study Alternative

Detailed Study Alternative #	West Area - generally west of US 321	Central Area – Generally east of US 321 and west of NC 279 or the South Fork Catawba River	East Area – generally east of NC 279 or the South Fork Catawba River
	H Segments	J Segments	K Segments
4	H2A-H3	J4a-J4b-J2c-J2d-J5a-(J5b+K2A)	(K2A+J5b)-KX1-K3B-K3C
5	H2A-H3	J4a-J2b-J2c-J2d-JX4-J1e-J1f	K1A-K1B-K1C-K4A
6	H2A-H3	J4a-J2b-J2c-J2d-JX4-J1e-J1f	K1A-K1B-K1C-K1D
9	H2A-H3	J4a-J2b-J2c-J2d-JX4-J1e-J1f	K1A-K3A-K3B-K3C
22	H2A-H2B-H2C	J3-J2c-J2d-J5a-(J5b+K2A)	(K2A+J5b)-KX1-K3B-K3C

Table 1. Corridor Segments Comprising Each Detailed Study Alternative

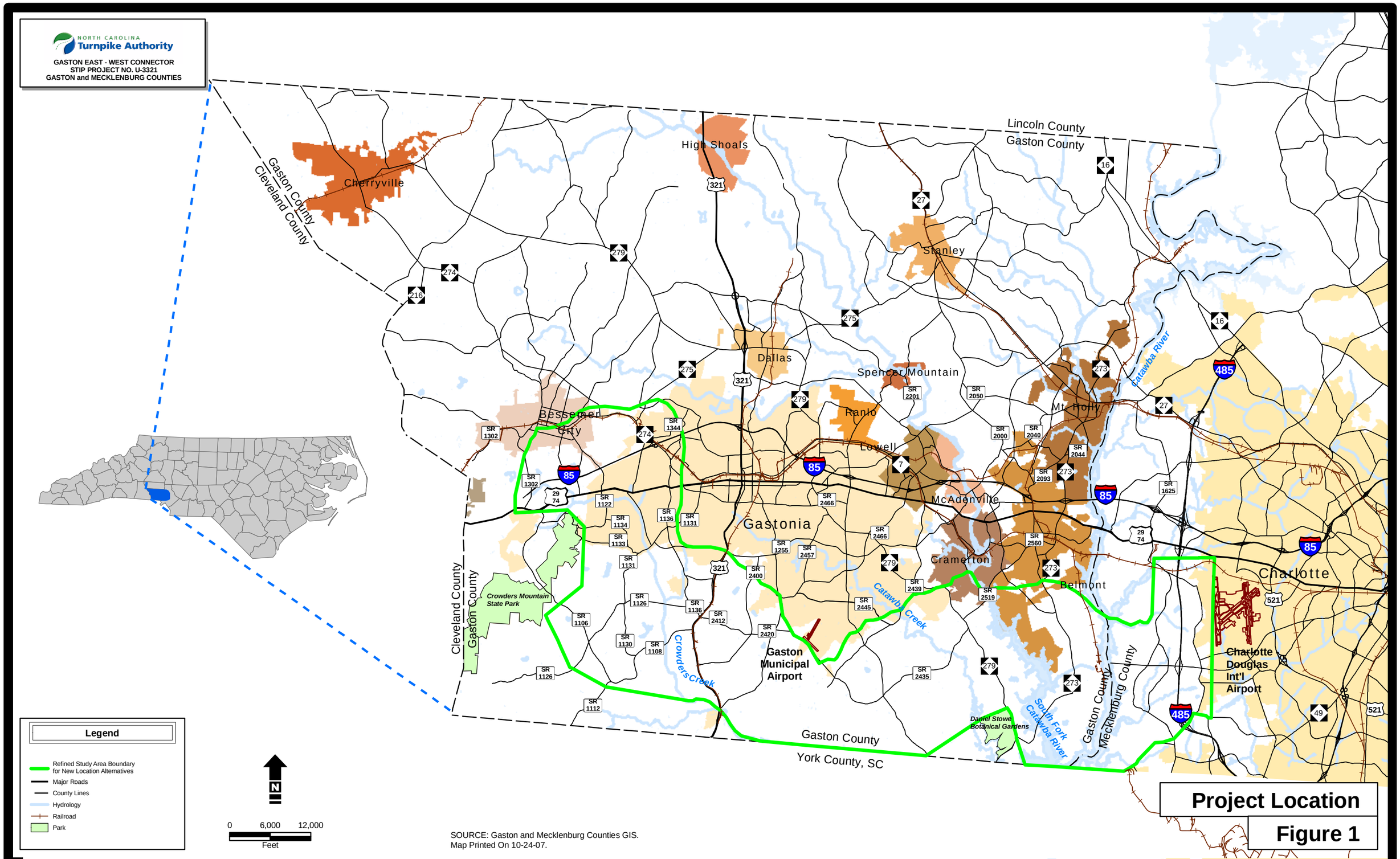
Detailed Study Alternative #	West Area - generally west of US 321	Central Area – Generally east of US 321 and west of NC 279 or the South Fork Catawba River	East Area – generally east of NC 279 or the South Fork Catawba River
	H Segments	J Segments	K Segments
23	H2A-H2B-H2C	J3-J2c-J2d-JX4-Jle-J1f	K1A-K1B-K1C-K4A
24	H2A-H2B-H2C	J3-J2c-J2d-JX4-Jle-J1f	K1A-K1B-K1C-K1D
27	H2A-H2B-H2C	J3-J2c-J2d-JX4-Jle-J1f	K1A-K3A-K3B-K3C
58	H1A-H1B-H1C	J1a-JX1-J2d-J5a-(J5b+K2A)	(K2A+J5b)-KX1-K3B-K3C
64	H1A-H1B-H1C	J1a-J1b-J1c-J1d-J1e-J1f	K1A-K1B-K1C-K4A
65	H1A-H1B-H1C	J1a-J1b-J1c-J1d-J1e-J1f	K1A-K1B-K1C-K1D
68	H1A-H1B-H1C	J1a-J1b-J1c-J1d-J1e-J1f	K1A-K3A-K3B-K3C
76	H1A-HX2	J2a-J2b-J2c-J2d-J5a-(J5b+K2A)	(K2A+J5b)-KX1-K3B-K3C
77	H1A-HX2	J2a-J2b-J2c-J2d-JX4-J1e-J1f	K1A-K1B-K1C-K4A
78	H1A-HX2	J2a-J2b-J2c-J2d-JX4-J1e-J1f	K1A-K1B-K1C-K1D
81	H1A-HX2	J2a-J2b-J2c-J2d-JX4-J1e-J1f	K1A-K3A-K3B-K3C

See **Figure 1** for a map of the Detailed Study Alternatives and their corridor segments.

1.2 Report Purpose

An Environmental Impact Statement (EIS) is currently being prepared for this project in accordance with the requirements set forth in the National Environmental Policy Act (NEPA) of 1969, as amended. The purpose of this report, which will become a part of the overall EIS document, is to evaluate the off-site drainage basins and to determine preliminary sizes for drainage structures at all major crossings (those requiring the equivalent conveyance of a 72" pipe or larger structure). The results of this analysis will assist in the selection of the least environmentally damaging practicable alternative (LEDPA). Following selection of the LEDPA, a more detailed analysis will be conducted that will examine each of the crossings in greater detail.

It should be noted that the results of this report are not intended to establish the final design size of any of the drainage structures under evaluation. There is insufficient data at this preliminary stage to perform final design level hydraulic analysis and additional, more detailed, study will be required once a preferred alignment is selected in order to determine the final structure dimensions. Once a maximum allowable headwater (AHW) is determined for each site, a larger structure may be required in order to meet this constraint.


NORTH CAROLINA
Turnpike Authority
GASTON EAST - WEST CONNECTOR
STIP PROJECT NO. U-3321
GASTON and MECKLENBURG COUNTIES
Lincoln County
Gaston County
Gaston County
Cleveland County
Cleveland County
Gaston County
Gaston County
Mecklenburg County
York County, SC
Cherryville
High Shoals
Stanley
Dallas
Spencer Mountain
Ranlo
Lowell
Bessemer City
Mt. Holly
McAdenville
Gastonia
Cramerton
Belmont
Charlotte
Crowders Mountain State Park
Gaston Municipal Airport
Charlotte Douglas Int'l Airport
Daniel Stowe Botanical Gardens
Catawba River
Catawba Creek
Crowders Creek
South Fork Catawba River
Legend
Refined Study Area Boundary for New Location Alternatives
Major Roads
County Lines
Hydrology
Railroad
Park
N
0 6,000 12,000
Feet
SOURCE: Gaston and Mecklenburg Counties GIS.
Map Printed On 10-24-07.
Project Location
Figure 1

1.3 Data Collection

The PBS&J team included three (3) sub-consultants to conduct field surveys of jurisdictional streams and wetlands within the study area. These teams collected data on the existing drainage features including the presence of wetlands or ponds, stream classification (ephemeral, intermittent, or perennial), average bottom width and average bankfull depth. In order to perform the preliminary hydrologic/hydraulic analysis, PBS&J independently collected the following data for the project study area (eastern Cleveland, Gaston, and western Mecklenburg Counties):

- LIDAR-based topographic mapping (2-, 5-, 10- & 20-foot contour intervals)
- Stream Centerlines
- Soils
- Zoning
- Aerial photography
- Digital Flood Insurance Rate Maps (DFIRMs)
- Digital USGS 7.5-Minute Topographic Quadrangle Maps
- Street Centerlines

2 EXISTING CONDITIONS

2.1 Land Use

Outside the municipal boundaries, the land uses in southern Gaston County are predominantly rural, with residential subdivisions scattered among large tracts of undeveloped land. Businesses and industries are concentrated within the City limits and outside the city along I-85, US 29-74, US 321, NC 274 (Union Road), and NC 273 (South Point Road [SR 2525]) where water and sewer services are provided.

The most prominent developed area in western Mecklenburg County is the Charlotte-Douglas International Airport. Business and commercial uses are concentrated in areas surrounding the airport and along I-85. Land between the airport and the Mecklenburg/Gaston County line is predominantly rural, with scattered residences, forest, and pasture.

The Gaston County Comprehensive Plan (Gaston County website: www.co.gaston.nc.us/CompPlan/ComprehensivePlan.htm) indicates that southeastern Gaston County is an area targeted for future growth.

2.2 Manmade Features

There are numerous stock ponds and drainage structures throughout the project. Detailed data was not available for the ponds; therefore a conservative approach was used, and the effect of these ponds was not modeled in the hydrologic analysis. There are two major dams located upstream of the project along the Catawba River and South Fork Catawba River and one major dam located 10-12 miles downstream of the project near Tega Cay, SC. These major dams are not expected to impact, or be impacted by, any of the DSA alignments. There are also numerous smaller state-registered dams throughout the drainage basin, but none of these are expected to be impacted. Please refer to **Appendix A** for maps from the Gaston County Hazard Mitigation Plan.

2.3 Site Topography, Drainage Patterns, Flow Paths

The entire project is located in the Catawba River basin, and all of the runoff from this project eventually drains to the Catawba River. Although individual basins may flow in any direction, the general trend is to the south and/or southwest.

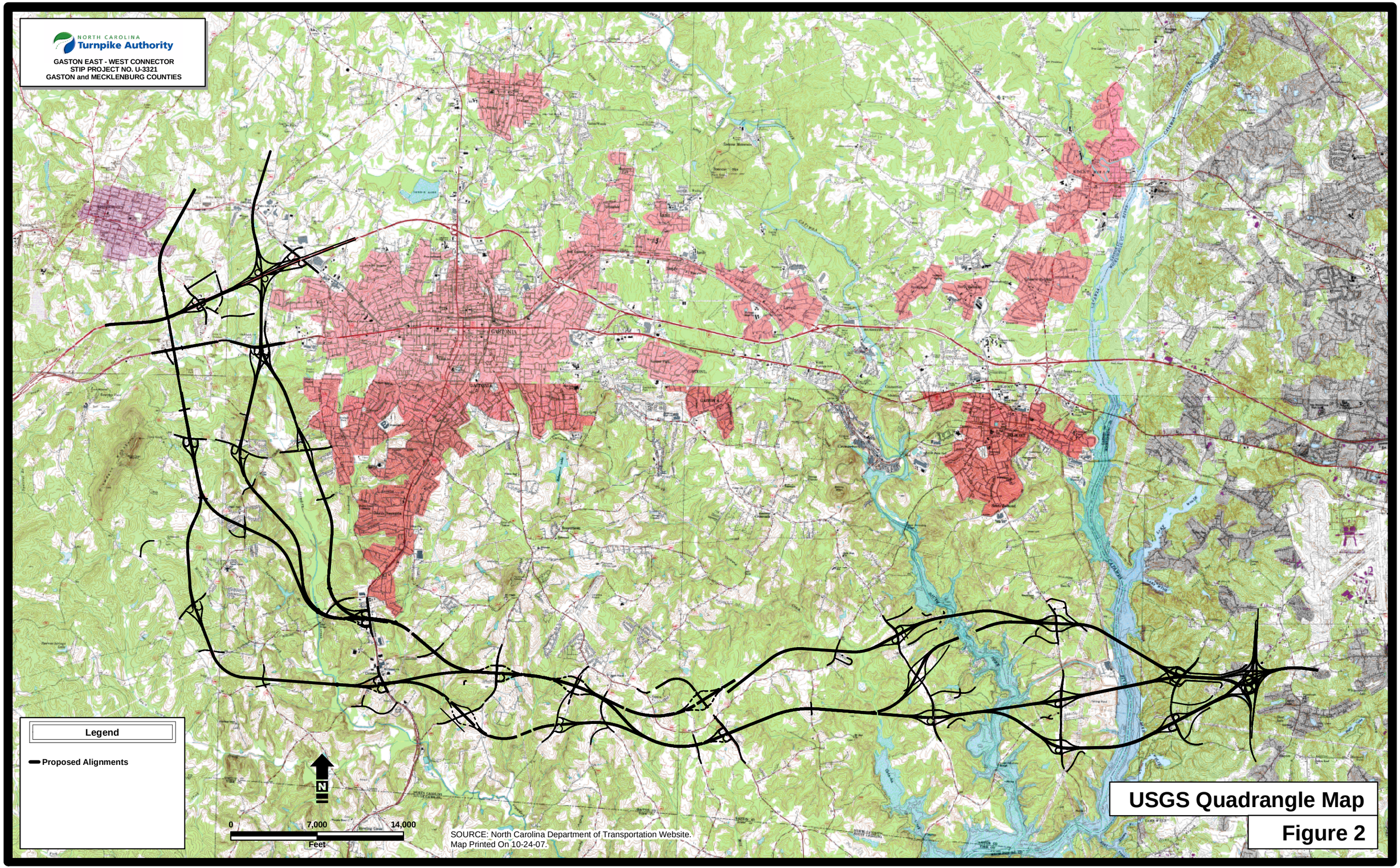
Gaston County has a total area of approximately 364.5 square miles (944.0 square kilometers) (NC Dept. of Commerce website: www.nccommerce.com/en/AboutDOC/PublicationsReports/CountyProfiles.htm). The topography of the county is gently rolling to hilly, with several pronounced ridges, including Kings Mountain Pinnacle, Spencer Mountain, Jackson's Knob, Paysour Mountain and Crowders Mountain.

Elevations above sea level in Gaston County range from 587 feet (179 meters) in the southeast corner to 1,705 feet (520 meters) at the Pinnacle of the Kings Mountain ridge in the southwest. The average elevation is estimated at 825 feet (252 meters). Another natural feature in the Gaston County area is the Catawba River, which forms the boundary with Mecklenburg County. The Catawba River and its lakes provide Gastonia's water supply, as well as boating, fishing and other recreational opportunities. Gastonia draws its drinking water from Mountain Island Lake.

Mecklenburg County has a total area of approximately 531 square miles (1,375 square kilometers). The topography of the county is rolling, with an average elevation of 795 feet above sea level. (NC Dept. of Commerce website: www.nccommerce.com/en/AboutDOC/PublicationsReports/CountyProfiles.htm). Mecklenburg County is the hub of the 13-county Charlotte region, which also includes Gaston County.

The Mecklenburg-Gaston County area has a temperate climate characterized by moderate temperature variations and moderate humidity. The average temperature is about 60 degrees Fahrenheit, ranging from an average winter temperature of 43 degrees to a summer average of 78 degrees. The average annual precipitation is 44 inches (112 centimeters), and the average relative humidity is 54 percent (NC Dept. of Commerce website: www.nccommerce.com/en/AboutDOC/PublicationsReports/CountyProfiles.htm).

The general topography of the project area is illustrated on **Figure 2 – USGS Quadrangle** and an aerial view of the project area is provided on **Figure 3 – Aerial Image**. The primary flow patterns within the project are illustrated on **Figure 5 – Off-Site Drainage Area Map**.


NORTH CAROLINA
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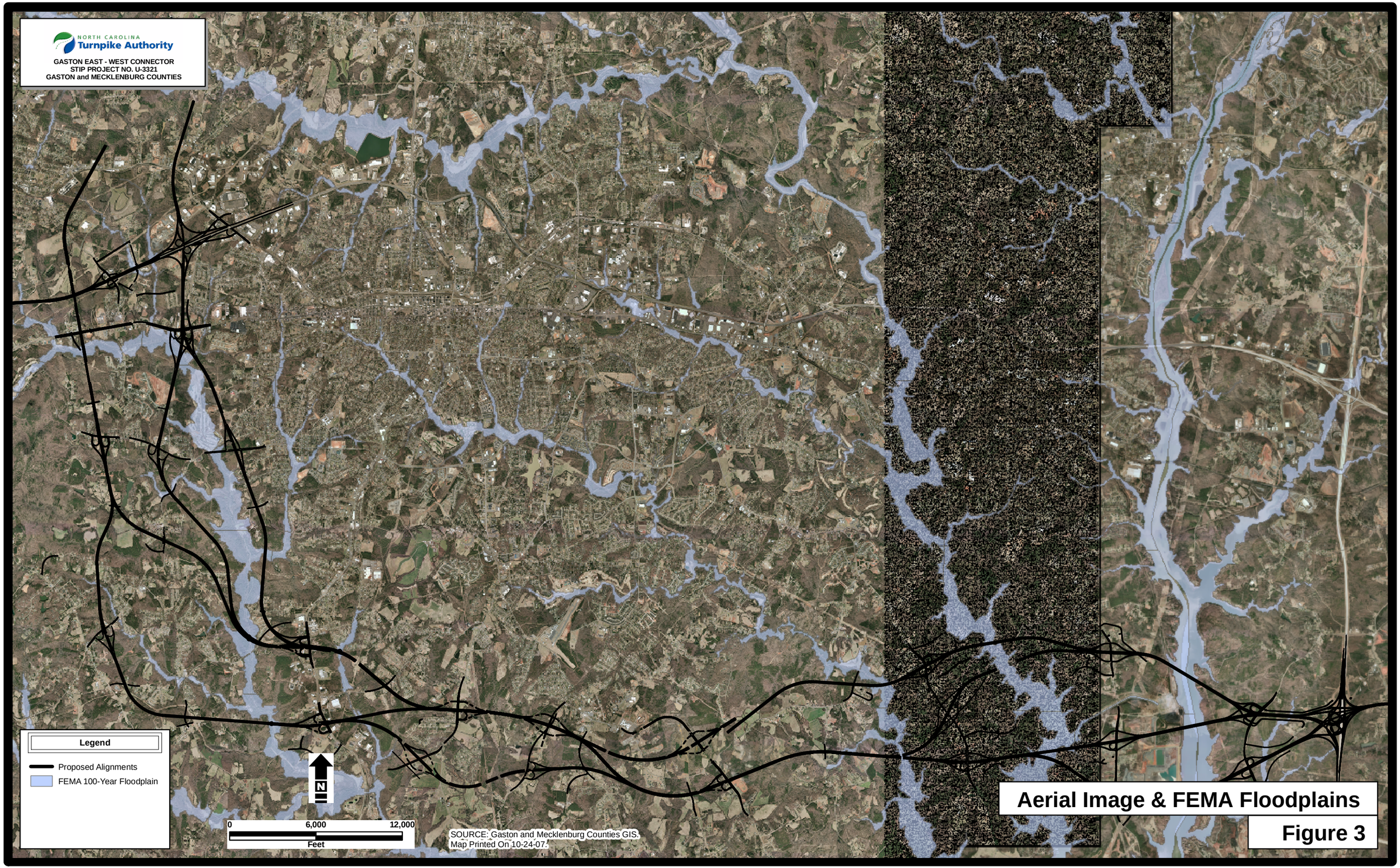
GASTON EAST - WEST CONNECTOR
STIP PROJECT NO. U-3321
GASTON and MECKLENBURG COUNTIES
Legend
Proposed Alignments
N
0
7,000
14,000
Feet
SOURCE: North Carolina Department of Transportation Website.
Map Printed On 10-24-07.
USGS Quadrangle Map
Figure 2



Aerial Image & FEMA Floodplains

Figure 3

2.4 Wetlands and/or Waters of the United States

There are a significant number of wetlands and/or streams identified within the study area and each of the DSA alignments has a varying degree of wetland impacts. The project team included field biologists who performed a qualitative analysis and delineation of the streams within the proposed project corridors and the extent of existing wetlands. The field biologists, in most cases, identified the stream classification (ephemeral, intermittent, or perennial), the presence of wetlands, classification of wetland significance, and the presence of ponds. The results of these analyses have been summarized by Earthtech in a report entitled "Natural Resources Technical Report for the Gaston East-West Connector – Gaston and Mecklenburg Counties", and are included in **Appendix A** as **Figure 3A–3W**. In addition to providing valuable data on the relative environmental impact potential of each DSA alignment, this data also assisted in the selection of the crossing locations to be visited in the field as part of this study.

2.5 Permit Requirements

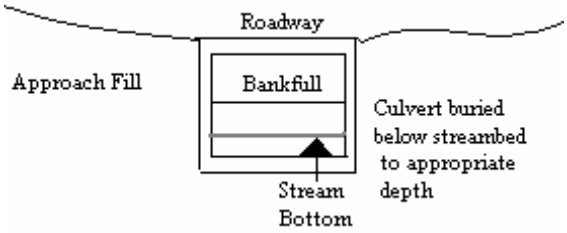
Although it is anticipated that an individual permit will be required for this project, according to the Draft SAW Regional Conditions (Corps Action ID: SAW-2006-41003-5NC) for Nationwide Permits (NWP) issued on October 10, 2006, there are numerous requirements for the drainage crossings in North Carolina that may, nevertheless, impact the final design. This document, in its entirety, is contained in **Appendix A**, and the relevant portions are excerpted below:

All Nationwide Permits

- *NWPs may not be used for activities that may result in the loss or degradation of greater than 300 total linear feet of perennial stream or intermittent stream that exhibits important aquatic function(s). Loss of stream includes the linear feet of stream bed that is filled, excavated, or flooded by the proposed activity. [Note: The Corps uses the Stream Quality Assessment Worksheet, located with Permit Information on the Regulatory Program Web Site to aid in the determination of the intermittent channel stream status.]*
- *Prior to use of any NWP (except 13, 27, 29 and 39), for any activity which impacts more than 150 total linear feet of perennial stream or intermittent stream , the applicant must comply with Nationwide Permit General Condition 27 (Construction Period).*
- *For all NWPs that involve the construction of culverts, measures will be included in the construction that will promote the safe passage of fish and other aquatic*

organisms. The dimension, pattern, and profile of the stream above and below a pipe or culvert should not be modified by widening the stream channel or by reducing the depth of the stream in connection with the construction activity

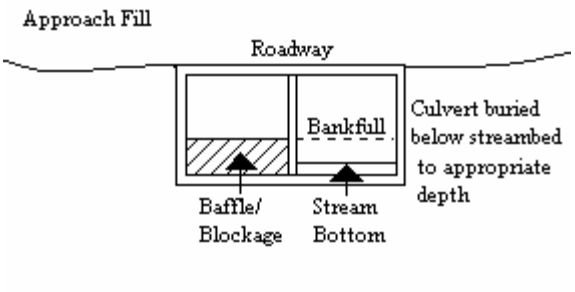
- *All culverts in the 20 CAMA coastal counties must be buried to a depth of one foot below, and at the same slope as, the bed of the stream or wetland.*
  For all other counties, culvert inverts will be buried at least one foot below the bed of the stream for culverts greater than 48 inches in diameter. For culverts 48 inches in diameter or less, culverts shall be placed directly on the stream bed or buried as practicable and appropriate to maintain aquatic passage, and every effort shall be made to maintain the existing channel slope.
  A waiver from the specifications in this Regional Condition may be requested in writing.



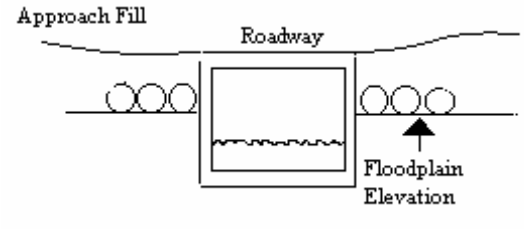
  The waiver will only be issued if it can be demonstrated that the impacts of complying with this Regional condition would result in more adverse impacts to the aquatic environment.
- *For any NWP that permanently impacts more than 150 linear feet of perennial and/or intermittent stream, the applicant shall provide a mitigation proposal to compensate for the loss of aquatic function associated with the proposed activity.*

NWP #14 - Linear Transportation Crossings

- *Applicants shall employ natural channel design to the maximum extent practicable for stream relocations. In the event it is not practicable to employ natural channel design, any stream relocation shall be considered a permanent impact and the applicant shall provide a mitigation plan to compensate for the loss of aquatic function associated with the proposed activity.*
- *Bank-full flows (or less) shall be accommodated through maintenance of the existing bank-full channel cross sectional area. Additional culverts at such crossings shall be allowed only to receive flows exceeding bank-full.*



- *Where adjacent floodplain is available, flows exceeding bank-full should be accommodated by installing culverts at the floodplain elevation.*



Given the above requirements, the number of crossing locations, and the level of impact at each crossing, it is clear that an individual permit will be required for this project and that an NWP will not be applicable. Also, in addition to the above requirements, a State Storm Water Permit will be required if the project crosses HQW (High Quality Waters) or ORW (Outstanding Resource Waters), however, neither of these waters are currently within the study area.

FEMA Buyout Property, if present in the area, should not be directly impacted. Contained in the Gaston County Hazard Mitigation Plan (Subsection 3-1, S3-1-9) is the following recommendation:

> *Evaluate built-upon areas within the flood zone for possible elevation and/or buy-out. Currently identified potential buy-out areas are* ***Woodland Acres Mobile Home Park on Archie Whitesides Road*** *and* ***Fern Forest subdivision in Gastonia****.*

The Woodland Acres site is downstream of crossing HB1 and is outside of the project corridor. The Fern Forest site is within the City of Gastonia and is also outside of the project corridor. Although it is believed that both of these sites were/are under consideration for possible purchase, the Gaston County Floodplain Administrator (personal communication, 10/23/07) did not know whether the purchases had been made.

2.6 Soils

Based upon GIS information obtained from the Soil Conservation Service, the soils within the study area are comprised of thirty-one major soils units. Since detailed hydrologic analysis using HEC-1 or HEC-HMS was not performed as part of this study, these soil groups were not utilized in the hydrologic analysis; however, they have been identified and are included in this report as **Figure 4 – Soils Map**.

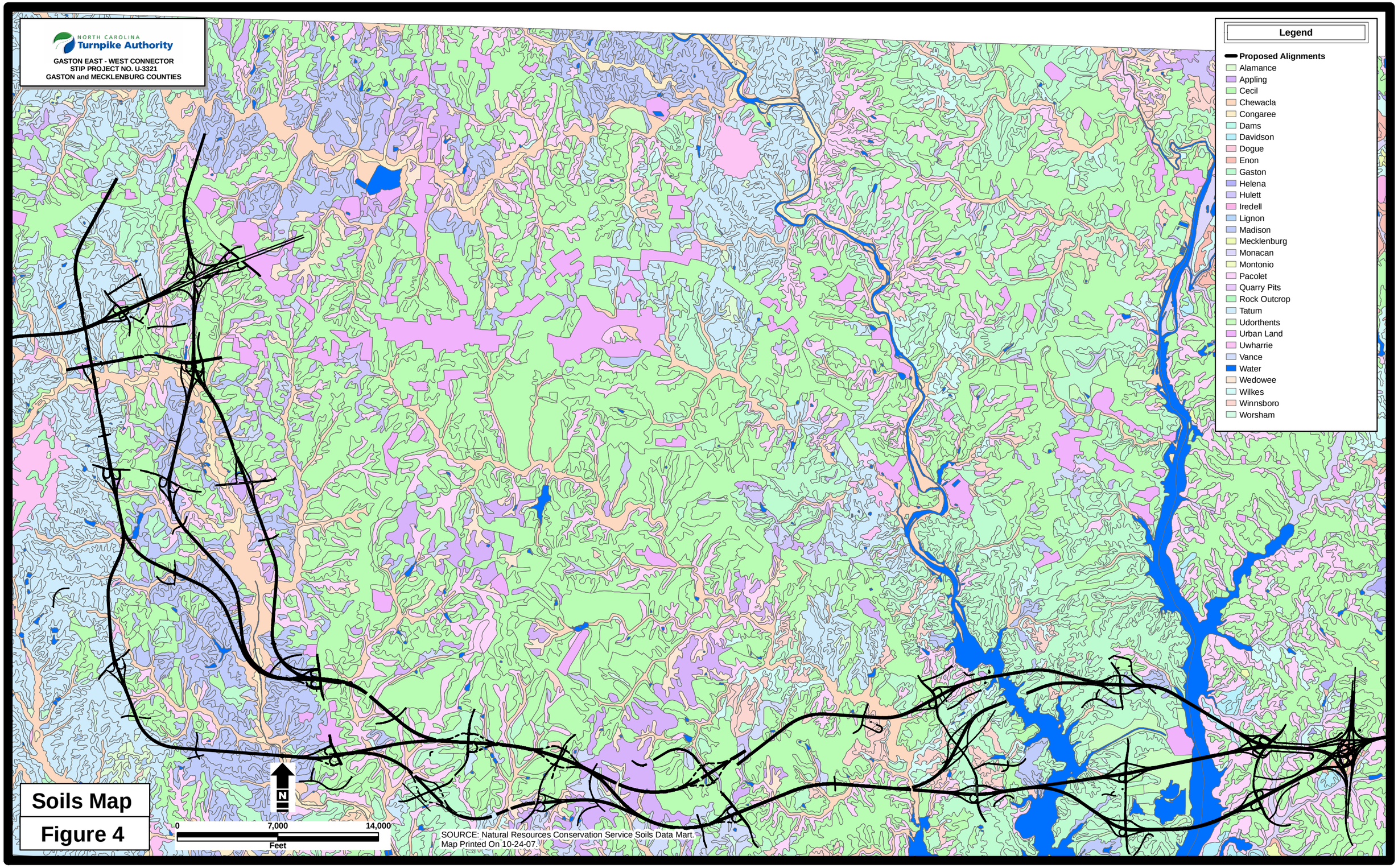
2.7 USGS Gage Locations

There appear to be two USGS gage location within the project watershed, and both of them are located north of the DSA alignments and near the I-85 corridor. The two locations are as follows:

1. Station No.: 02145000
   Station Name: South Fork Catawba River at Lowell, NC
2. Station No.: 02144000
   Station Name: Long Creek near Bessemer City, NC

2.8 FEMA Flood Zone Delineations

FEMA FIRM Panels were obtained for Gaston and Mecklenburg Counties and there are numerous locations where the alternative alignments cross an area that has a designated floodplain. The corresponding Flood Insurance Study (FIS) report was also obtained and the discharges used in the FEMA analyses were included in the decision table used to determine the design discharge. In order to establish the FEMA discharge at a particular crossing location, the location was identified on the included FEMA FIRM panels and, if the crossing fell within a detailed study area, the river reach was noted and the nearest applicable discharge was obtained from the FIS document. In addition to the data contained in the appendix, **Figure 3 – Aerial Image & FEMA Floodplains** has also been developed which shows the floodplain locations within the study area and their relation to the DSA alignments.



Soils Map

Figure 4

3 HYDROLOGIC/HYDRAULIC ANALYSIS

3.1 Drainage Basin Delineation

Initially, a target contributing area was selected that would likely produce sufficient runoff to merit the installation of a 60-inch or larger culvert. The 60-inch size was chosen since the NWP requirements state that any culvert over 48" in diameter must have the invert buried one (1) foot to meet environmental requirements for fish and wildlife passage. This would require increasing the installed size of all 60" diameter culverts to 72 inches.

To ensure that no potential locations were missed in the analysis, the minimum area warranting a 60-inch or greater culvert was set at approximately 16 acres, which an initial USGS regression equation calculation showed to produce a flow slightly larger than the capacity of a 54-inch RCP culvert at a 0.5% slope. Using these constraints, a total of 167 crossing locations were identified and analyzed. Maps of these crossing locations and associated drainage areas can be found in **Appendix C**.

3.2 Hydrologic Computations

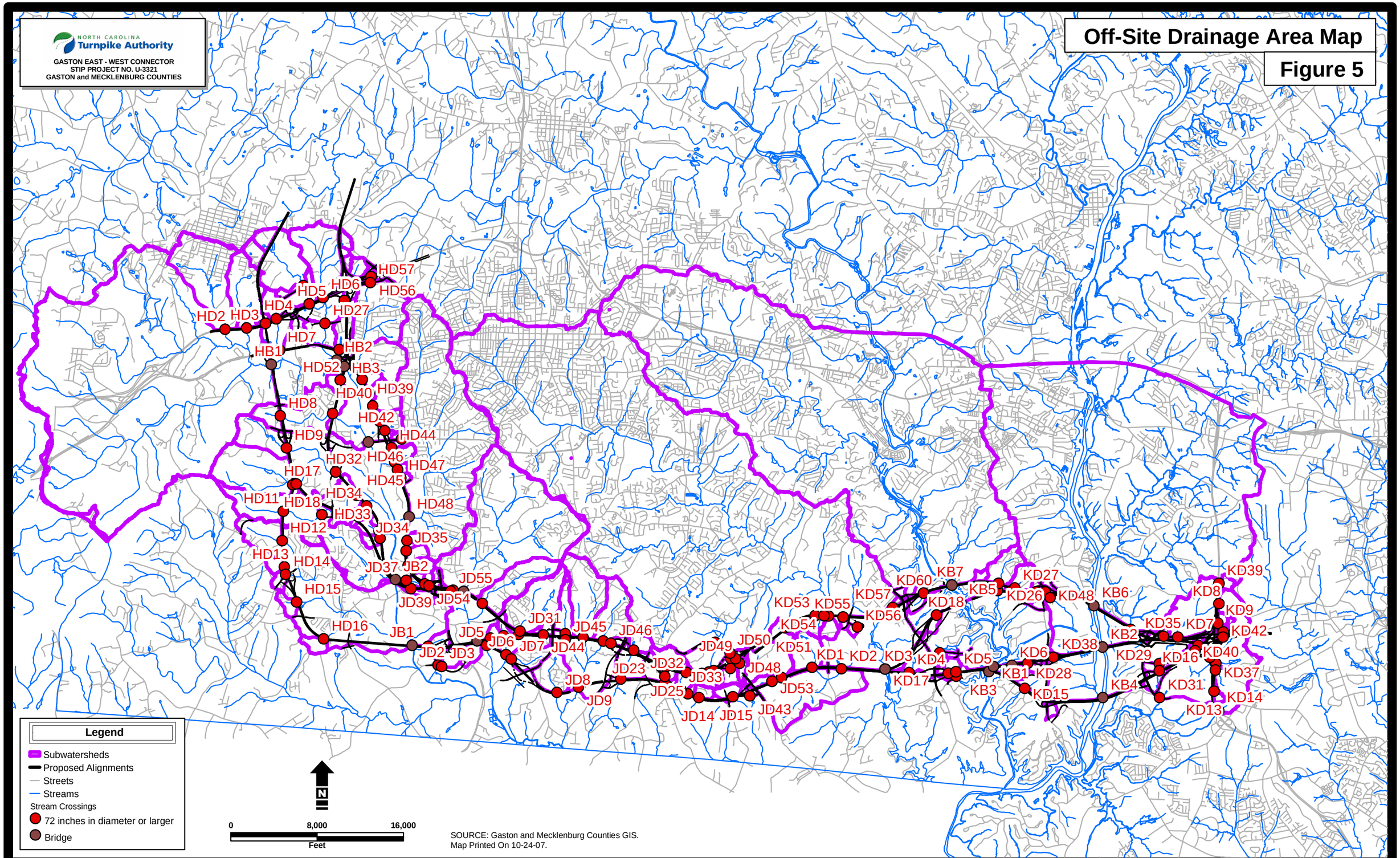
An analysis of the available methodologies showed the USGS Urban Equation, and the FEMA data to be in reasonably close agreement. Based on discussions with the NCDOT Hydraulics Unit (Meeting held 9/14/07), it was agreed that the USGS and NCDOT Urban results would be utilized for analysis and design given the expected future growth and development in this area (calculations using Rural methodology would not be used). For areas less than 100 acres, the NCDOT Urban Highway Charts produced discharges that were notably less than the USGS Urban Equation and NCDOT believed that these lower values were more reasonable for the smaller drainage areas. Therefore, the peak runoff for each location was computed using the NCDOT Highway charts for urban conditions (areas less than 100 acres), the USGS Urban Regression Equations (areas greater than 100 acres), and any FEMA FIS data that was available. The resulting calculated peak discharges at each location were compared to the FEMA data (if available) and the highest value was chosen for analysis (see **Table 2** for the resulting flows).

The USGS Urban Equation requires an estimate of the percentage of impervious area. Since much of the area is currently undeveloped and/or only partially developed, an assumption was made that between 10 and 20 percent (depending on the size of the drainage area) of the drainage area would be impervious in the future condition. In order to arrive at an assumed value for our analysis, USGS publications were reviewed and the percentage of impervious area relative to the drainage area size was noted. It was determined that, for the purposes of

our analysis, areas smaller than 2 square miles (1280 acres) would be considered 20% impervious, areas between 2 and 5 square miles would be considered 15% impervious, and areas greater than 5 square miles (3200 acres) would be considered 10% impervious. The percentages used for the USGS calculations are included on a table in Appendix C.

The NCDOT Urban Highway Chart requires the selection of a development type. Since all of the drainage areas under 100 acres in size are adjacent to the proposed corridors and could eventually be developed commercially, it was decided that areas under 75 acres would be designated "Small Are Full Business" and assigned a correction factor of 1.4 and areas above 75 acres (and up to 100 acres) would be designated "Large Area Full Business" and assigned a correction factor of 1.2 (see NCDOT "*Guidelines for Drainage Studies and Hydraulic Design*").

Once the LEDPA alternative is selected, it is assumed that the hydrologic calculations will be revisited in greater detail and individual values can be assigned for each drainage basin. Please refer to **Figure 5 - Off-Site Drainage Area Map** for an overall view of the project watershed. For maps of individual contributing drainage areas, refer to **Appendix C**.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STIP PROJECT NO. U-3321
GASTON and MECKLENBURG COUNTIES
Off-Site Drainage Area Map
Figure 5
HD57
HD6
HD56
HD5
HD4
HD27
HD2
HD3
HD7
HB1
HB2
HD52
HB3
HD40
HD39
HD8
HD42
HD9
HD44
HD32
HD46
HD47
HD17
HD45
HD34
HD11
HD18
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KB4
KD39
KD8
KD9
KD35
KD7
KD42
KD16
KD40
KD31
KD37
KD13
KD14
Legend
Subwatersheds
Proposed Alignments
Streets
Streams
Stream Crossings
72 inches in diameter or larger
Bridge
N
0
8,000
16,000
Feet
SOURCE: Gaston and Mecklenburg Counties GIS.
Map Printed On 10-24-07.

TABLE 2 - HYDROLOGIC CALCULATION SUMMARY

CULVERT ID	CATCHMENT AREA (ac)	CATCHMENT AREA (sq mi)	NCDOT RUNOFF Q_{50} (cfs)	NCDOT RUNOFF Q_{100} (cfs)	USGS URBAN Q_{50} ANALYSIS (cfs)	USGS URBAN Q_{100} ANALYSIS (cfs)	FEMA RUNOFF Q_{50} (cfs)	FEMA RUNOFF Q_{100} (cfs)		DESIGN FLOW Q_{50} (cfs)	DESIGN FLOW Q100 (cfs)
HB1	10078.47	15.74761			3872.71	4373.41	4311.00	5216.00		4311.00	5216.00
HB2	12858.22	20.09097			4484.34	5053.02	4788.00	5793.00		4788.00	5793.00
HB3	13026.95	20.35461			4519.67	5092.24	4788.00	5793.00		4788.00	5793.00
HD2	769.61	1.20252			1083.21	1219.37				1083.21	1219.37
HD3	404.72	0.63238			735.68	832.95				735.68	832.95
HD4	108.47	0.16948			332.99	381.52				332.99	381.52
HD5	698.05	1.09070			1021.41	1150.80	862.00	1042.00		1021.41	1150.80
HD6	489.02	0.76409			824.43	931.85	741.00	896.00		824.43	931.85
HD7	283.79	0.44342			594.13	674.84				594.13	674.84
HD8	109.37	0.17089			334.65	383.39				334.65	383.39
HD9	274.18	0.42841			581.94	661.20				581.94	661.20
HD10	642.13	1.00333			971.33	1095.21				971.33	1095.21
HD11	268.61	0.41970			574.79	653.20				574.79	653.20
HD12	248.97	0.38902			549.11	624.44	365.00	441.00		549.11	624.44
HD13	57.73	0.09020	217.56	252.84						217.56	252.84
HD14	43.33	0.06770	165.76	192.64						165.76	192.64
HD15	59.01	0.09220	220.15	255.85						220.15	255.85
HD16	66.15	0.10336	246.05	285.95						246.05	285.95
HD17	659.49	1.03045			987.06	1112.67				987.06	1112.67
HD18	546.44	0.85381			881.41	995.26				881.41	995.26
HD20	615.45	0.96164			946.83	1067.99				946.83	1067.99
HD24	699.72	1.09331			1022.88	1152.43	862.00	1042.00		1022.88	1152.43
HD25	597.27	0.93323			929.90	1049.17	741.00	896.00		929.90	1049.17
HD26	79.71	0.12455	246.42	286.38						246.42	286.38
HD27	1660.20	2.59406			1535.47	1735.41				1535.47	1735.41
HD28	120.96	0.18900			355.57	406.99				355.57	406.99
HD29	107.22	0.16753			330.68	378.90				330.68	378.90
HD30	637.80	0.99656			967.38	1090.82	558.00	675.00		967.38	1090.82
HD31	508.56	0.79463			844.11	953.75				844.11	953.75
HD32	1476.61	2.30720			1430.87	1618.91	1152.00	1393.00		1430.87	1618.91
HD33	812.09	1.26889			1118.82	1258.84				1118.82	1258.84
HD34	55.23	0.08630	209.79	243.81						209.79	243.81
HD35	52.37	0.08183	196.84	228.76						196.84	228.76
HD37	964.80	1.50750			1241.11	1394.27	579.00	700.00		1241.11	1394.27
HD38	44.60	0.06969	170.94	198.66						170.94	198.66
HD39	36.37	0.05683	142.45	165.55						142.45	165.55
HD40	114.13	0.17833			343.35	393.20				343.35	393.20
HD41	24.00	0.03750	103.60	120.40						103.60	120.40
HD42	67.33	0.10520	246.05	285.95						246.05	285.95
HD43	20.29	0.03170	85.47	99.33						85.47	99.33
HD44	25.85	0.04039	108.78	126.42						108.78	126.42
HD45	60.77	0.09495	225.33	261.87						225.33	261.87
HD46	18.74	0.02928	80.29	93.31						80.29	93.31
HD47	16.13	0.02520	69.93	81.27						69.93	81.27
HD48	3039.75	4.74961			2209.90	2484.11	2903.00	3512.00		2903.00	3512.00
HD49	549.30	0.85828			884.19	998.35	748.00	905.00		884.19	998.35
HD51	40.29	0.06295	155.40	180.60						155.40	180.60
HD52	47.76	0.07463	181.30	210.70						181.30	210.70
HD54	26.18	0.04091	108.78	126.42						108.78	126.42
HD55	100.53	0.15708	308.58	358.62	318.10	364.70				318.10	364.70
HD56	31.27	0.04886	124.32	144.48						124.32	144.48
HD57	59.36	0.09275	214.97	249.83						214.97	249.83
HD59	15396.70	24.05734			4998.08	5622.78				4998.08	5622.78
JB1	25634.98	40.05466			6793.43	7607.55	7552.00	9138.00		7552.00	9138.00
JB2	22985.21	35.91439			6361.56	7130.92	7384.00	8934.00		7384.00	8934.00
JD1	60.17	0.09402	217.56	252.84						217.56	252.84
JD2	28.38	0.04434	108.78	126.42						108.78	126.42
JD3	57.20	0.08938	207.20	240.80						207.20	240.80
JD4	3142.88	4.91075			2254.73	2533.75	2477.00	2997.00		2477.00	2997.00
JD5	58.05	0.09070	207.20	240.80						207.20	240.80
JD6	711.37	1.11152			1033.10	1163.77	776.00	938.00		1033.10	1163.77
JD7	148.34	0.23178			402.05	459.34	776.00	938.00		776.00	938.00
JD8	214.08	0.33450			501.40	570.96				501.40	570.96
JD9	1511.29	2.36139			1451.01	1641.35				1451.01	1641.35
JD10	246.52	0.38519			545.85	620.79				545.85	620.79
JD11	231.10	0.36109			525.03	597.46				525.03	597.46
JD12	71.97	0.11245	248.64	288.96						248.64	288.96

TABLE 2 - HYDROLOGIC CALCULATION SUMMARY

CULVERT ID	CATCHMENT AREA (ac)	CATCHMENT AREA (sq mi)	NCDOT RUNOFF Q_{50} (cfs)	NCDOT RUNOFF Q_{100} (cfs)	USGS URBAN Q_{50} ANALYSIS (cfs)	USGS URBAN Q_{100} ANALYSIS (cfs)	FEMA RUNOFF Q_{50} (cfs)	FEMA RUNOFF Q_{100} (cfs)		DESIGN FLOW Q_{50} (cfs)	DESIGN FLOW Q100 (cfs)
JD13	16.67	0.02605	69.93	81.27						69.93	81.27
JD14	45.79	0.07155	170.94	198.66						170.94	198.66
JD15	57.98	0.09059	209.79	243.81						209.79	243.81
JD16	323.52	0.50550			642.89	729.37				642.89	729.37
JD17	3066.38	4.79122			2221.53	2496.99	2477.00	2997.00		2477.00	2997.00
JD18	39.31	0.06142	145.04	168.56						145.04	168.56
JD19	475.52	0.74300			810.65	916.51				810.65	916.51
JD20	145.98	0.22809			398.18	454.99				398.18	454.99
JD21	471.26	0.73634			806.27	911.63				806.27	911.63
JD22	323.11	0.50486			642.40	728.82				642.40	728.82
JD23	79.22	0.12378	237.54	276.06						237.54	276.06
JD24	104.07	0.16261			324.79	372.26				324.79	372.26
JD25	19.00	0.02969	77.70	90.30						77.70	90.30
JD26	36.39	0.05686	134.68	156.52						134.68	156.52
JD27	78.61	0.12283	239.76	278.64						239.76	278.64
JD28	275.36	0.43025			583.44	662.88				583.44	662.88
JD29	2224.59	3.47592			1831.25	2064.27	2865.00	2466.00		2865.00	2466.00
JD30	385.60	0.60250			714.55	809.38				714.55	809.38
JD31	468.52	0.73206			803.45	908.48				803.45	908.48
JD32	141.37	0.22089			390.57	446.41				390.57	446.41
JD33	70.24	0.10975	246.05	285.95						246.05	285.95
JD34	29.12	0.04550	111.37	129.43						111.37	129.43
JD35	55.37	0.08652	199.43	231.77						199.43	231.77
JD36	61.44	0.09600	217.56	252.84						217.56	252.84
JD37	100.35	0.15680	293.04	340.56	317.76	364.31				317.76	364.31
JD39	19.81	0.03095	80.29	93.31						80.29	93.31
JD40	29.27	0.04573	113.96	132.44						113.96	132.44
JD41	22.60	0.03531	90.65	105.35						90.65	105.35
JD42	23.41	0.03658	90.65	105.35						90.65	105.35
JD43	21.50	0.03359	85.47	99.33						85.47	99.33
JD44	30.99	0.04842	116.55	135.45						116.55	135.45
JD45	28.77	0.04495	111.37	129.43						111.37	129.43
JD46	29.95	0.04680	116.55	135.45						116.55	135.45
JD47	51.59	0.08061	189.07	219.73						189.07	219.73
JD48	39.60	0.06188	145.04	168.56						145.04	168.56
JD49	50.32	0.07863	183.89	213.71						183.89	213.71
JD50	153.57	0.23995			410.52	468.87				410.52	468.87
JD51	43.14	0.06741	155.40	180.60						155.40	180.60
JD52	48.40	0.07563	176.12	204.68						176.12	204.68
JD53	36.14	0.05647	134.68	156.52						134.68	156.52
JD54	27.80	0.04344	108.78	126.42						108.78	126.42
JD55	46.31	0.07236	168.35	195.65						168.35	195.65
KB1	15728.43	24.57567			5062.63	5694.31	29364.00	35530.00		29364.00	35530.00
KB2	11806.04	18.44694			4259.69	4803.58				4259.69	4803.58
KB3	15878.57	24.81027			5091.67	5726.48	29364.00	35530.00		29364.00	35530.00
KB4	12758.65	19.93539			4463.40	5029.78				4463.40	5029.78
KB5	13873.09	21.67670			4694.18	5285.86	29364.00	35530.00		29364.00	35530.00
KB6	11059.41	17.28033			4095.42	4621.04				4095.42	4621.04
KB7	13525.23	21.13317			4622.96	5206.86	29364.00	35530.00		29364.00	35530.00
KD1	202.17	0.31589			484.42	551.91				484.42	551.91
KD2	1069.81	1.67158			1320.75	1482.36	977.00	1183.00		1320.75	1482.36
KD3	16146.43	25.22880			5143.20	5783.57	8619.00	10428.00		8619.00	10428.00
KD4	141.41	0.22095			390.63	446.49				390.63	446.49
KD5	37.67	0.05886	139.86	162.54						139.86	162.54
KD6	46.38	0.07247	160.58	186.62						160.58	186.62
KD7	600.04	0.93756			932.49	1052.05				932.49	1052.05
KD8	90.80	0.14188	255.30	296.70						255.30	296.70
KD9	25.66	0.04009	95.83	111.37						95.83	111.37
KD10	20.44	0.03194	77.70	90.30						77.70	90.30
KD11	72.69	0.11358	238.28	276.92						238.28	276.92
KD12	346.06	0.54072			669.50	759.09				669.50	759.09
KD13	25.98	0.04059	95.83	111.37						95.83	111.37
KD14	49.51	0.07736	168.35	195.65						168.35	195.65
KD15	84.72	0.13238	241.98	281.22						241.98	281.22
KD16	859.59	1.34311			1157.77	1302.00				1157.77	1302.00
KD17	16142.47	25.22261			5142.44	5782.73	8619.00	10428.00		8619.00	10428.00
KD18	35.30	0.05516	129.50	150.50						129.50	150.50

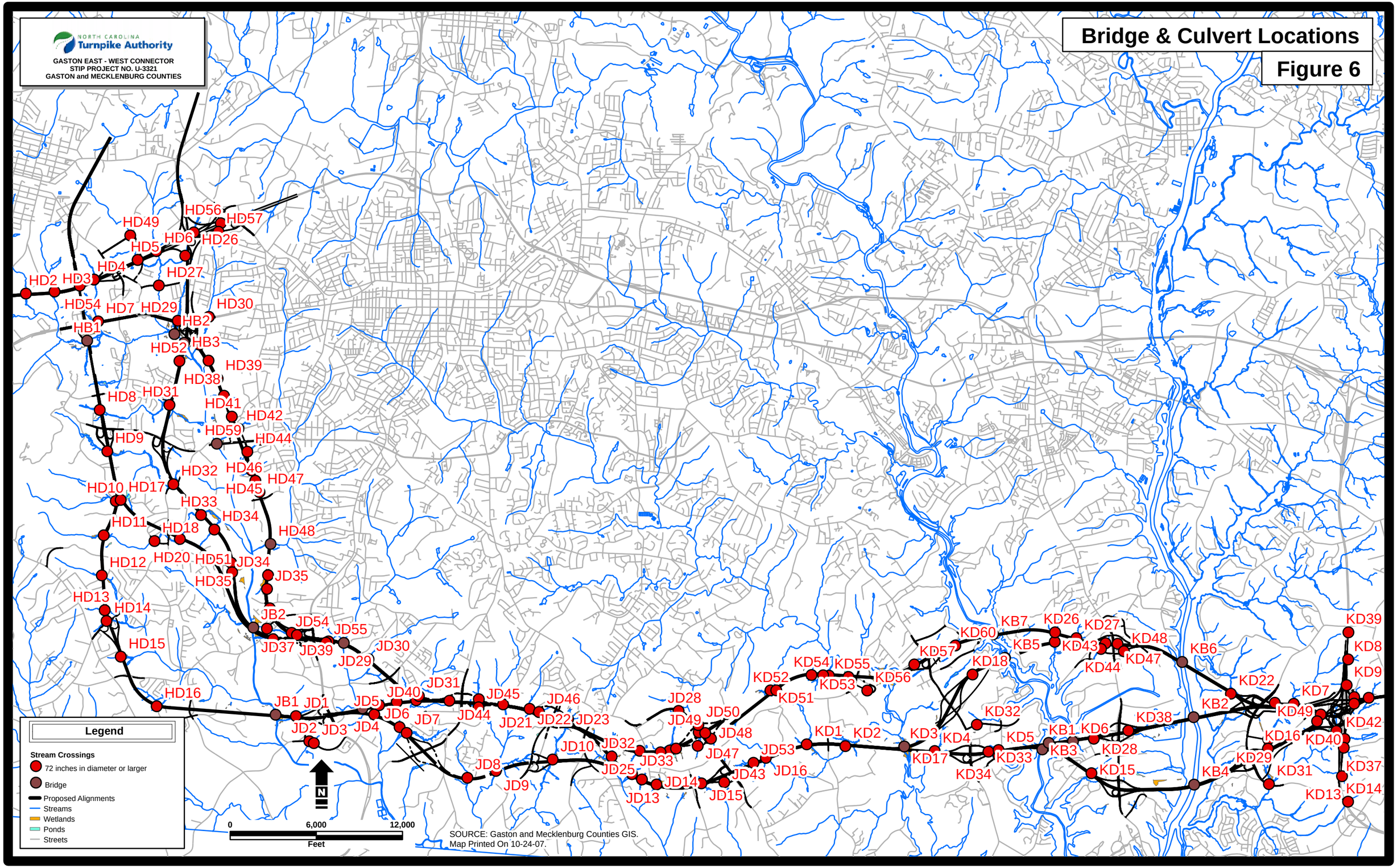
TABLE 2 - HYDROLOGIC CALCULATION SUMMARY

CULVERT ID	CATCHMENT AREA (ac)	CATCHMENT AREA (sq mi)	NCDOT RUNOFF Q_{50} (cfs)	NCDOT RUNOFF Q_{100} (cfs)	USGS URBAN Q_{50} ANALYSIS (cfs)	USGS URBAN Q_{100} ANALYSIS (cfs)	FEMA RUNOFF Q_{50} (cfs)	FEMA RUNOFF Q_{100} (cfs)		DESIGN FLOW Q_{50} (cfs)	DESIGN FLOW Q100 (cfs)
KD19	207.98	0.32497			492.75	561.26				492.75	561.26
KD20	107.71	0.16830			331.59	379.93				331.59	379.93
KD22	20.21	0.03158	77.70	90.30						77.70	90.30
KD24	59.79	0.09342	204.61	237.79						204.61	237.79
KD25	15254.83	23.83567			4970.30	5592.00	8228.00	9955.00		8228.00	9955.00
KD26	204.69	0.31983			488.04	555.98				488.04	555.98
KD27	96.44	0.15069	268.62	312.18						268.62	312.18
KD28	39.92	0.06238	142.45	165.55						142.45	165.55
KD29	821.41	1.28345			1126.53	1267.39				1126.53	1267.39
KD31	2069.75	3.23398			1753.42	1977.82				1753.42	1977.82
KD32	28.02	0.04378	103.60	120.40						103.60	120.40
KD33	16.87	0.02636	67.34	78.26						67.34	78.26
KD34	18.58	0.02903	72.52	84.28						72.52	84.28
KD35	19.19	0.02998	72.52	84.28						72.52	84.28
KD36	56.20	0.08781	194.25	225.75						194.25	225.75
KD37	204.47	0.31948			487.73	555.62				487.73	555.62
KD38	18.18	0.02841	69.93	81.27						69.93	81.27
KD39	34.36	0.05369	124.32	144.48						124.32	144.48
KD40	18.14	0.02834	69.93	81.27						69.93	81.27
KD42	31.69	0.04952	116.55	135.45						116.55	135.45
KD43	23.27	0.03636	88.06	102.34						88.06	102.34
KD44	37.44	0.05850	132.09	153.51						132.09	153.51
KD47	38.30	0.05984	132.09	153.51						132.09	153.51
KD48	53.78	0.08403	183.89	213.71						183.89	213.71
KD49	17.37	0.02714	64.75	75.25						64.75	75.25
KD51	31.36	0.04900	113.96	132.44						113.96	132.44
KD52	19.60	0.03063	75.11	87.29						75.11	87.29
KD53	17.43	0.02723	64.75	75.25						64.75	75.25
KD54	58.46	0.09134	196.84	228.76						196.84	228.76
KD55	16.89	0.02639	64.75	75.25						64.75	75.25
KD56	18.59	0.02905	72.52	84.28						72.52	84.28
KD57	16.11	0.02517	64.75	75.25						64.75	75.25
KD60	47.57	0.07433	163.17	189.63						163.17	189.63

3.3 Field Investigations

During the scope development for this project, the project team identified 144 potential "major stream crossings" (10 bridges and 134 culverts) located within the proposed right-of-way alignments of the DSAs. These potential locations for field visits were selected based on the presence of a stream line designation on the USGS Quad Map, which is generally an indicator of a significant perennial stream. Given that this is a planning study and due to the sheer number of locations, it was decided that a field visit would be performed on only ten percent (10%) of the potential culvert locations (approximately 14) and all of the ten (10) bridge locations, for a total of twenty-four (24) field visits. During the initial hydrologic analysis, 167 potential major crossing locations were identified, and it appeared that many more of these would likely need to be bridges (approximately 7 additional bridges, for a total of 17 bridges). The culvert and bridge locations are shown on **Figure 6 – Bridge & Culvert Locations**.

Identification of those crossings that were more critical, and thus more deserving of a field visit, involved not only the peak flow, but also a review of the data gathered by the field biologists in the vicinity of the crossings. The field biologists, in most cases, identified the stream classification (ephemeral, intermittent, or perennial), the presence of wetlands, classification of wetland significance, and the presence of ponds. PBS&J also looked at potential linear stream relocations and considered that in the selection of critical crossings. Based on this information, it was decided that a total of 31 crossing locations would be field investigated; 17 bridge locations (three of which involved multiple alignments), and 14 culvert locations. These locations are shown on **Figure 7 – Field Visit Locations** and in **Table 3**. Field evaluation forms and photographs of the critical crossings can be found in **Appendix B**.


NORTH CAROLINA
Turnpike Authority
GASTON EAST - WEST CONNECTOR
STIP PROJECT NO. U-3321
GASTON and MECKLENBURG COUNTIES
Bridge & Culvert Locations
Figure 6
HD49
HD56
HD57
HD6
HD26
HD5
HD4
HD27
HD2
HD3
HD54
HD7
HD29
HD30
HB1
HB2
HB3
HD52
HD39
HD38
HD8
HD31
HD41
HD42
HD59
HD9
HD44
HD32
HD46
HD47
HD10
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HD18
HD48
HD12
HD20
HD51
JD34
HD35
JD35
HD13
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JB2
JD54
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JD39
JD30
JD29
HD16
JD31
JB1
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JD16
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KD16
KD42
KD49
KD7
KD22
KB2
KD38
KD9
KD8
KD39
KB6
KD47
KD44
KD48
KD27
KD43
KB5
KD26
KB7
KD18
KD57
KD60
Legend
Stream Crossings
72 inches in diameter or larger
Bridge
Proposed Alignments
Streams
Wetlands
Ponds
Streets
N
0
6,000
12,000
Feet
SOURCE: Gaston and Mecklenburg Counties GIS.
Map Printed On 10-24-07.

TABLE 3 - PRELIMINARY CROSSING SIZES AND FIELD VISIT LOCATIONS

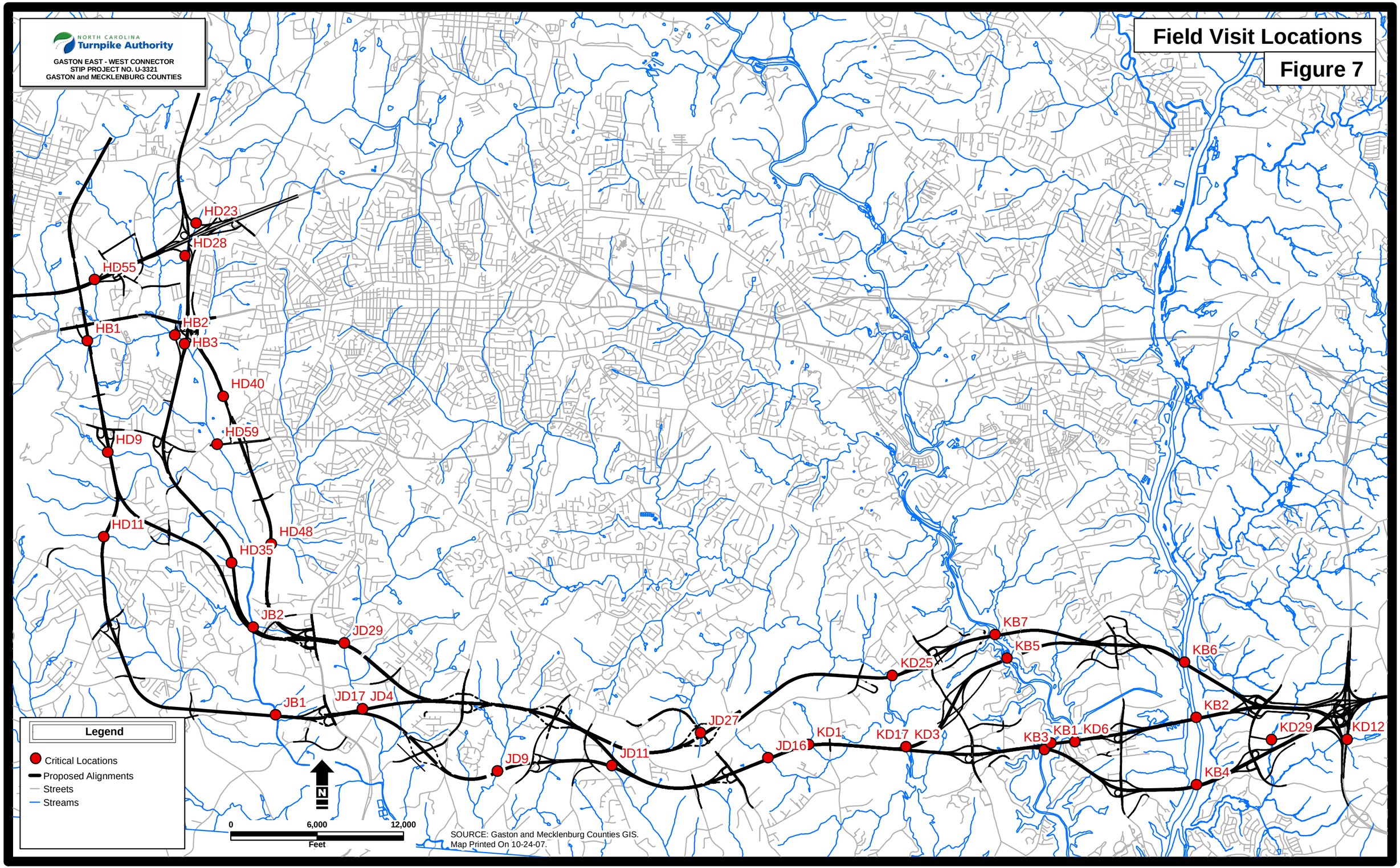
CULVERT ID	CATCHMENT AREA (ac)	CATCHMENT AREA (sq mi)	DESIGN FLOW (Q_{50} cfs)	CULVERT SIZE	BRIDGE	72" & LARGER	60" & 66" CULVERTS	54" & SMALLER	STREAM, WETLAND, OR POND ID	STREAM NAME	RECOMMEND SITE VISIT?	NOTES	JUSTIFICATION FOR FIELD VISIT
HB1	10078.47	15.74761	4311.00	BRIDGE	1				S14	Crowders Creek	YES		Bridge Location
HB2	12858.22	20.09097	4788.00	BRIDGE	1				S14	Crowders Creek	YES		Bridge Location - Same as HB3
HB3	13026.95	20.35461	4788.00	BRIDGE	1				S14	Crowders Creek	YES		Bridge Location - Same as HB2
HD2	769.61	1.20252	1083.21	2-(8'x8') RCB		1			S2, W1		NO		
HD3	404.72	0.63238	735.68	7'x12' RCB		1			S4		NO		
HD4	108.47	0.16948	332.99	6'X7' RCB		1			S9, W3		NO		
HD5	698.05	1.09070	1021.41	2-(7'x8') RCB		1			S5		NO		
HD6	489.02	0.76409	824.43	2-(7'x7') RCB		1			S25	Bessemer Branch	NO		
HD7	283.79	0.44342	594.13	6'X12' RCB		1			S9, W8		NO		
HD8	109.37	0.17089	334.65	6'X7' RCB		1			S59		NO		
HD9	274.18	0.42841	581.94	6'X12' RCB		1			S70		YES		Ephemeral/Intermittent w/High Wetland Rating
HD10	642.13	1.00333	971.33	2-(7'x8') RCB		1			S79		YES		Perennial Stream, High Wetland Rating
HD11	268.61	0.41970	574.79	6'X12' RCB		1			S96, W90		NO		
HD12	248.97	0.38902	549.11	6'X12' RCB		1			S104	McGill Branch	NO		
HD13	57.73	0.09020	217.56	72" RCP		1			S109		NO		
HD14	43.33	0.06770	165.76	66" RCP			1		S112		NO		
HD15	59.01	0.09220	220.15	72" RCP		1			S115, W115		NO		
HD16	66.15	0.10336	246.05	72" RCP		1			S120		NO		
HD17	659.49	1.03045	987.06	2-(7'x8') RCB		1			S79		YES		Same as HD10
HD18	546.44	0.85381	881.41	2-(7'x7') RCB		1			S96		NO		
HD20	615.45	0.96164	946.83	2-(7'x8') RCB		1			S96		NO		
HD24	699.72	1.09331	1022.88	2-(7'x8') RCB		1			S24	Oates Branch	NO		
HD25	597.27	0.93323	929.90	2-(7'x8') RCB		1			S25	Bessemer Branch	NO		
HD26	79.71	0.12455	246.42	72" RCP		1			S28		NO		
HD27	1660.20	2.59406	1535.47	3-(6'x10') RCB		1			See Note	Bessemer Branch	NO	D/S of S25. Outside of study corridor.	
HD28	120.96	0.18900	355.57	6'X7' RCB		1			S28		YES		Perennial Stream, High Wetland Rating
HD29	107.22	0.16753	330.68	6'X7' RCB		1			S46		NO		
HD30	637.80	0.99656	967.38	2-(7'x8') RCB		1			S52		NO		
HD31	508.56	0.79463	844.11	2-(7'x7') RCB		1			S59		NO		
HD32	1476.61	2.30720	1430.87	3-(6'x10') RCB		1			S70		NO		
HD33	812.09	1.26889	1118.82	2-(8'x8') RCB		1			S96		NO		
HD34	55.23	0.08630	209.79	72" RCP		1			S103		NO		
HD35	52.37	0.08183	196.84	66" RCP			1		S123, W96		YES		Perennial Stream, High Wetland Rating
HD37	964.80	1.50750	1241.11	2-(8'x8') RCB		1			S52		NO		
HD38	44.60	0.06969	170.94	66" RCP			1		S57, W58		NO		
HD39	36.37	0.05683	142.45	60" RCP			1		S58		NO		
HD40	114.13	0.17833	343.35	6'X7' RCB		1			S69, W78, W79		YES		Perennial Stream, High Wetland Rating
HD41	24.00	0.03750	103.60	54" RCP				1	See Note		NO	Not noted as jurisdictional resource.	
HD42	67.33	0.10520	246.05	72" RCP		1			S85		NO		
HD43	20.29	0.03170	85.47	48" RCP				1	S89		NO		
HD44	25.85	0.04039	108.78	54" RCP				1	S89		NO		
HD45	60.77	0.09495	225.33	72" RCP		1			S92		NO		
HD46	18.74	0.02928	80.29	48" RCP				1	See Note		NO	Not noted as jurisdictional resource.	
HD47	16.13	0.02520	69.93	48" RCP				1	See Note		NO	Not noted as jurisdictional resource.	
HD48	3039.75	4.74961	2903.00	3-(10'x10') RCB		1			S135	Blackwood Creek	YES		Bridge Location
HD49	549.30	0.85828	884.19	2-(7'x7') RCB		1			S22		NO		
HD51	40.29	0.06295	155.40	60" RCP			1		S124, W97		NO		
HD52	47.76	0.07463	181.30	66" RCP			1		S56, W56		NO		
HD54	26.18	0.04091	108.78	54" RCP				1	S8		NO		
HD55	100.53	0.15708	318.10	6'X7' RCB		1			S9, W3		YES		Perennial Stream, High Wetland Rating
HD56	31.27	0.04886	124.32	60" RCP			1		S36		NO		
HD57	59.36	0.09275	214.97	72" RCP		1			S36		NO		
HD59	15396.70	24.05734	4998.08	BRIDGE	1				S14, W84	Crowders Creek	YES		Bridge Location
JB1	25634.98	40.05466	7552.00	BRIDGE	1				S14, W127	Crowders Creek	YES		Bridge Location
JB2	22985.21	35.91439	7384.00	BRIDGE	1				S14, W103	Crowders Creek	YES		Bridge Location, near JD51, Linear Relocation
JD1	60.17	0.09402	217.56	72" RCP		1			S138, W128		NO		
JD2	28.38	0.04434	108.78	54" RCP				1	S140		NO		
JD3	57.20	0.08938	207.20	72" RCP		1			S141		NO		

TABLE 3 - PRELIMINARY CROSSING SIZES AND FIELD VISIT LOCATIONS

CULVERT ID	CATCHMENT AREA (ac)	CATCHMENT AREA (sq mi)	DESIGN FLOW (Q_{50} cfs)	CULVERT SIZE	BRIDGE	72" & LARGER	60" & 66" CULVERTS	54" & SMALLER	STREAM, WETLAND, OR POND ID	STREAM NAME	RECOMMEND SITE VISIT?	NOTES	JUSTIFICATION FOR FIELD VISIT
JD4	3142.88	4.91075	2477.00	3-(8'x12') RCB		1			S146		YES		Bridge Location - Same as JD17
JD5	58.05	0.09070	207.20	72" RCP		1			S155, W134		NO		
JD6	711.37	1.11152	1033.10	2-(7'x8') RCB		1			S156		NO		
JD7	148.34	0.23178	776.00	7'x12' RCB		1			S163		NO		
JD8	214.08	0.33450	501.40	6'X10' RCB		1			S171		NO		
JD9	1511.29	2.36139	1451.01	3-(6'x10') RCB		1			S178		YES		Large Culvert
JD10	246.52	0.38519	545.85	6'X12' RCB		1			S196, W146		NO		
JD11	231.10	0.36109	525.03	6'X12' RCB		1			S213, W162	Mill Creek	YES		Pond near crossing - may be sensitive
JD12	71.97	0.11245	248.64	72" RCP		1			S220, W178		NO		
JD13	16.67	0.02605	69.93	48" RCP				1	S222, W188		NO		
JD14	45.79	0.07155	170.94	66" RCP			1		S223, W189		NO		
JD15	57.98	0.09059	209.79	72" RCP		1			S238, W217, W218		NO		
JD16	323.52	0.50550	642.89	7'X10' RCB		1			S237		YES		Possible Linear Stream Relocation
JD17	3066.38	4.79122	2477.00	3-(8'x12') RCB		1			S146		YES		Bridge Crossing - Same as JD4
JD18	39.31	0.06142	145.04	60" RCP			1		S162		NO		
JD19	475.52	0.74300	810.65	2-(7'x7') RCB		1			S156		NO		
JD20	145.98	0.22809	398.18	6'X8' RCB		1			S177		NO		
JD21	471.26	0.73634	806.27	2-(7'x7') RCB		1			S178		NO		
JD22	323.11	0.50486	642.40	7'X10' RCB		1			S181		NO		
JD23	79.22	0.12378	237.54	72" RCP		1			S196, W147		NO		
JD24	104.07	0.16261	324.79	6'X7' RCB		1			S213, W168	Mill Creek	NO		
JD25	19.00	0.02969	77.70	48" RCP				1	S220, W186		NO		
JD26	36.39	0.05686	134.68	60" RCP			1		S228		NO		
JD27	78.61	0.12283	239.76	72" RCP		1			S233		YES		Pond near crossing - may be sensitive
JD28	275.36	0.43025	583.44	6'X12' RCB		1			S226, W203		NO		
JD29	2224.59	3.47592	2865.00	3-(8'x12') RCB		1			S146		YES		Bridge Location
JD30	385.60	0.60250	714.55	7'x12' RCB		1			S147		NO		
JD31	468.52	0.73206	803.45	2-(7'x7') RCB		1			S156		NO		
JD32	141.37	0.22089	390.57	6'X8' RCB		1			S213, W166	Mill Creek	NO		
JD33	70.24	0.10975	246.05	72" RCP		1			S220, W178		NO		
JD34	29.12	0.04550	111.37	54" RCP				1	S129?, W99		NO		
JD35	55.37	0.08652	199.43	66" RCP			1		S129		NO		
JD36	61.44	0.09600	217.56	72" RCP		1			S130		NO		
JD37	100.35	0.15680	317.76	6'X7' RCB		1			S131, W107		NO		
JD39	19.81	0.03095	80.29	48" RCP				1	S132, W109		NO		
JD40	29.27	0.04573	113.96	54" RCP				1	S155		NO		
JD41	22.60	0.03531	90.65	48" RCP				1	S226, W194, W195, W196		NO		
JD42	23.41	0.03658	90.65	48" RCP				1	S230, W201		NO		
JD43	21.50	0.03359	85.47	48" RCP				1	S241		NO		
JD44	30.99	0.04842	116.55	54" RCP				1	S161		NO		
JD45	28.77	0.04495	111.37	54" RCP				1	S174, W142		NO		
JD46	29.95	0.04680	116.55	54" RCP				1	S182		NO		
JD47	51.59	0.08061	189.07	66" RCP			1		S233, W208		NO		
JD48	39.60	0.06188	145.04	60" RCP			1		S234, W206		NO		
JD49	50.32	0.07863	183.89	66" RCP			1		S234, W205		NO		
JD50	153.57	0.23995	410.52	6'X8' RCB		1			S233		NO		
JD51	43.14	0.06741	155.40	60" RCP			1		S133, W106		NO		
JD52	48.40	0.07563	176.12	66" RCP			1		S145		NO		
JD53	36.14	0.05647	134.68	60" RCP			1		S242		NO		
JD54	27.80	0.04344	108.78	54" RCP				1	S131		NO		
JD55	46.31	0.07236	168.35	66" RCP			1		S145		NO		
KB1	15728.43	24.57567	29364.00	BRIDGE	1				South Fork Catawba	South Fork Catawba	YES		Bridge Location
KB2	11806.04	18.44694	4259.69	BRIDGE	1				Catawba	Catawba	YES		Bridge Location
KB3	15878.57	24.81027	29364.00	BRIDGE	1				South Fork Catawba	South Fork Catawba	YES		Bridge Location
KB4	12758.65	19.93539	4463.40	BRIDGE	1				Catawba	Catawba	YES		Bridge Location
KB5	13873.09	21.67670	29364.00	BRIDGE	1				South Fork Catawba	South Fork Catawba	YES		Bridge Location
KB6	11059.41	17.28033	4095.42	BRIDGE	1				Catawba	Catawba	YES		Bridge Location
KB7	13525.23	21.13317	29364.00	BRIDGE	1				South Fork Catawba	South Fork Catawba	YES		Bridge Location

TABLE 3 - PRELIMINARY CROSSING SIZES AND FIELD VISIT LOCATIONS

CULVERT ID	CATCHMENT AREA (ac)	CATCHMENT AREA (sq mi)	DESIGN FLOW (Q_{50} cfs)	CULVERT SIZE	BRIDGE	72" & LARGER	60" & 66" CULVERTS	54" & SMALLER	STREAM, WETLAND, OR POND ID	STREAM NAME	RECOMMEND SITE VISIT?	NOTES	JUSTIFICATION FOR FIELD VISIT
KD1	202.17	0.31589	484.42	6'X10' RCB		1			S270, W236		YES		Wetland & Pond - May be sensitive location
KD2	1069.81	1.67158	1320.75	3-(6'x10') RCB		1			S237		NO		
KD3	16146.43	25.22880	8619.00	BRIDGE	1				S259, W246, W247, W248	Catawba Creek	YES		Bridge Location - Same as KD17
KD4	141.41	0.22095	390.63	6'X8' RCB		1			S268		NO		
KD5	37.67	0.05886	139.86	60" RCP			1		S288		NO		
KD6	46.38	0.07247	160.58	BRIDGE	1				S295A		YES		Bridge Location - To span a section of the cove
KD7	600.04	0.93756	932.49	2-(7'x8') RCB		1			S312A, W321	Beaverdam Creek	NO		
KD8	90.80	0.14188	255.30	6'X6' RCB		1			S323		NO		
KD9	25.66	0.04009	95.83	54" RCP				1	S326, W323		NO		
KD10	20.44	0.03194	77.70	48" RCP				1	S339		NO		
KD11	72.69	0.11358	238.28	72" RCP		1			S321, W333A	Legion Lake Stream	NO		
KD12	346.06	0.54072	669.50	7'x12' RCB		1			S335		YES		Possible Linear Stream Relocation
KD13	25.98	0.04059	95.83	54" RCP				1	S330		NO		
KD14	49.51	0.07736	168.35	66" RCP			1		See Note		NO	Crosses I-485 outside of study corridor.	
KD15	84.72	0.13238	241.98	72" RCP		1			S296A, W304B		NO		
KD16	859.59	1.34311	1157.77	2-(8'x8') RCB		1			S312A, W317, W316D	Beaverdam Creek	NO		
KD17	16142.47	25.22261	8619.00	BRIDGE	1				S259, W246, W247, W248	Catawba Creek	YES		Bridge Location - Same as KD3
KD18	35.30	0.05516	129.50	60" RCP			1		See Note		NO	Not noted as jurisdictional resource.	
KD19	207.98	0.32497	492.75	6'X10' RCB		1			S296		NO		
KD20	107.71	0.16830	331.59	6'X7' RCB		1			S297, W285		NO		
KD22	20.21	0.03158	77.70	48" RCP				1	S312		NO		
KD24	59.79	0.09342	204.61	72" RCP		1			S252A, W268		NO		
KD25	15254.83	23.83567	8228.00	BRIDGE	1				S259, W275	Catawba Creek	YES		Bridge Location
KD26	204.69	0.31983	488.04	6'X10' RCB		1			S296		NO		
KD27	96.44	0.15069	268.62	6'X6' RCB		1			S297, W275		NO		
KD28	39.92	0.06238	142.45	60" RCP			1		S294A		NO		
KD29	821.41	1.28345	1126.53	2-(8'x8') RCB		1			S312A, W317, W316D	Beaverdam Creek	YES		Perennial Stream and Wetland
KD31	2069.75	3.23398	1753.42	3-(6'x12') RCB		1			S321, W315		NO		
KD32	28.02	0.04378	103.60	54" RCP				1	See Note		NO	Not noted as jurisdictional resource.	
KD33	16.87	0.02636	67.34	48" RCP				1	S289		NO		
KD34	18.58	0.02903	72.52	48" RCP				1	S289		NO		
KD35	19.19	0.02998	72.52	48" RCP				1	S318		NO		
KD36	56.20	0.08781	194.25	66" RCP			1		S340		NO		
KD37	204.47	0.31948	487.73	6'X10' RCB		1			S332		NO		
KD38	18.18	0.02841	69.93	48" RCP				1	W301		NO		
KD39	34.36	0.05369	124.32	60" RCP			1		See Note		NO	Crosses I-485 outside of study corridor.	
KD40	18.14	0.02834	69.93	48" RCP				1	S328		NO		
KD42	31.69	0.04952	116.55	54" RCP				1	S339, W329		NO		
KD43	23.27	0.03636	88.06	48" RCP				1	S300, W288		NO		
KD44	37.44	0.05850	132.09	60" RCP			1		S300, W287		NO		
KD47	38.30	0.05984	132.09	60" RCP			1		S304, W289		NO		
KD48	53.78	0.08403	183.89	66" RCP			1		S304		NO		
KD49	17.37	0.02714	64.75	42" RCP				1	S328		NO		
KD51	31.36	0.04900	113.96	54" RCP				1	S250		NO		
KD52	19.60	0.03063	75.11	48" RCP				1	S251, W260		NO		
KD53	17.43	0.02723	64.75	42" RCP				1	S250A		NO		
KD54	58.46	0.09134	196.84	66" RCP			1		S251A, W268		NO		
KD55	16.89	0.02639	64.75	42" RCP				1	P42, See Note		NO	Trib. To P42, W270, S258	
KD56	18.59	0.02905	72.52	48" RCP				1	See Note		NO	Trib. to P43, W272, S259A	
KD57	16.11	0.02517	64.75	42" RCP				1	S263		NO		
KD60	47.57	0.07433	163.17	66" RCP			1		S285, W279		NO		
					17	83	29	38					


NORTH CAROLINA
Turnpike Authority
GASTON EAST - WEST CONNECTOR
STIP PROJECT NO. U-3321
GASTON and MECKLENBURG COUNTIES
Field Visit Locations
Figure 7
HD23
HD28
HD55
HB1
HB2
HB3
HD40
HD59
HD9
HD11
HD48
HD35
JB2
JD29
JB1
JD17
JD4
JD9
JD11
JD27
JD16
KD1
KD17
KD3
KD25
KB7
KB5
KB6
KB3
KB1
KD6
KB2
KB4
KD29
KD12
Legend
Critical Locations
Proposed Alignments
Streets
Streams
N
0
6,000
12,000
Feet
SOURCE: Gaston and Mecklenburg Counties GIS.
Map Printed On 10-24-07.

3.4 Research at NCDOT Hydraulics Unit

To supplement the field reconnaissance, PBS&J conducted research at the NCDOT Hydraulics Unit in Raleigh, NC to evaluate the history and performance of existing drainage structures and, consequently, make appropriate recommendations. Although many of the drainage structures were identified on the NCDOT maps, only limited data was available and NCDOT was not able to locate any Bridge Survey Reports (BSR's) for any of the structures that were identified. The preparation of BSR's is a relatively new requirement, and a BSR would only have been prepared if the structure in question had either been constructed recently at a new location, or had been recently replaced at an existing location. NCDOT Hydraulics Unit does not have BSR's on the majority of older existing structures in the state. Following identification of the drainage structure, the structure numbers and locations were provided to NCDOT Hydraulics staff, who researched their files to determine whether any additional information was available on these structures. Although some basic structure data (size, length, etc.) was available in their computer system, no BSRs, scour analyses, or other data seem to be available on any of these structures. The computer printouts provided by NCDOT are included in **Appendix A**.

3.5 Hydraulic Computations

During the field investigations, there were several locations where an existing structure was present some distance upstream and/or downstream of the proposed crossing. In those cases, the approximate size and location of the structure was noted on the field visit forms and this information was then used as an aid in selecting the proposed size for the crossing.

According to the methodology spelled out in the NCDOT guidelines, the peak runoff was computed at each location using one or more methods. The results of the peak flow calculations were compared, and the highest value at each location was chosen as the design value for the proposed crossing. Using this design flow, the preliminary size of the crossing was chosen based on inlet control calculations using HDS-5 methodology. The sizing guideline in the scope-of-work is as follows:

> *Size preliminary box culverts for total head loss less than or equal to 1.0 foot for the 100-year flood. Inlet control HW/D = 1.2 or less for Design Year Flood. Size preliminary bridges to provide equal or greater conveyance.*

The first of these guidelines can only be strictly followed if a hydraulic analysis is performed (since you need to compare the proposed water surface with the normal water

surface elevation to determine the increase in backwater). Preliminary culvert sizing is done using HDS-5 calculations which do not compute backwater. Since any culvert designed with an HW/D of 1.2 for the design year event will, by definition, cause backwater in both the design event and the 100-year event, it should be noted that the culvert sizes determined in this analysis may not account for the impact of backwater or ponding on the upstream side of the culvert and a larger structure may be recommended uring final design to address this concern. NCDOT hydraulics unit recommended that all culverts be sized for the 50-year event assuming an HW/D of 1.2.

It is important to note that the purpose of the Preliminary Hydraulic Tech Memo is to determine a preliminary drainage structure size which can then be used, in conjunction with many other factors, to evaluate the Detailed Study Alternatives. It is important, at this level, to determine whether the drainage structure will be a pipe culvert, a box culvert, or a bridge; to determine an approximate length; and to estimate the amount of fill which will be required. The purpose of this analysis is not to determine the final drainage structure size since there is insufficient information to do so at this time. Once the LEDPA has been selected, a detailed hydrologic and hydraulic analysis will be performed for each crossing location to determine the actual size and configuration of the structure. Also, for all new locations on FEMA regulated streams, a CLOMR and LOMR must be prepared and submitted.

In order to facilitate the preliminary sizing, it was necessary to clarify the analysis criteria. Although the revised criteria are different from that contained in the scope-of-work, they have been altered in such a way that the guidelines are clearer, and the resulting structures will be sized in accordance with NCDOT guidelines.

Pipe Culverts: HW/D is less than or equal to 1.2 for the 50-year discharge. Drainage area is typically less than 100 acres. The maximum size will be 72” RCP; larger crossings will require a box culvert. The inverts of all pipe culverts over 48” will be buried 1 foot below grade.

Box Culverts: HW/D is less than 1.2 for the 50-year flow. Drainage area is typically between 100 acres and 10 square miles. The inverts of all box culverts will be buried 1 foot below grade. The minimum size will be a single barrel 6x6 RCB and the maximum size will be a triple barrel 12x12 RCB; larger crossings will require a bridge.

Bridges: The drainage area for bridge crossings is typically greater than 10 square miles. If the crossing is in a FEMA detailed study area, bridge should

span the floodway/floodplain and no-rise criteria will apply. If the crossing is not in a detailed study area, 1 foot of backwater is permitted and bridge length will be determined based on field investigation (upstream and downstream structures) and/or a profile along the proposed roadway alignment, and/or aerial photography. Since bridge hydraulics are not being performed for preliminary design, the length and number of spans will be estimated based on the above data. When determining bridge length, it is no longer necessary to bridge the buffer zones on bridge crossings for the Catawba River Basin.

In order to maintain consistency, a range of flows was established for which a given culvert size was appropriate and any crossing whose peak flow fell within that range utilized the same culvert size. Potential crossings included single-barrel circular culverts, single- and double-barrel box culverts, and bridges. The largest box culvert size considered was a triple 12-foot by 12-foot RCB (Reinforced Concrete Box) and any crossing that required more than that was assumed to be a single- or multi-span bridge. The culvert hydraulic calculations included in this report are for inlet control only and reflect the actual hydraulic opening required for the given flow. The adjusted culvert size (taking into account upstream and downstream structures and other non-hydraulic constraints) is also presented in the attached table, but hydraulic calculations were not performed using this larger size.
The Corps of Engineers NWP requirement that the invert of all box culverts and all pipe culverts exceeding 48 inches in diameter be buried 1 foot below grade is in addition to the size shown in the accompanying tables. This means that the 60-inch and 66-inch culverts identified in this analysis would be subject to such a requirement and would, therefore, have to be increased to 72 inches or greater in size (60 inches will be increased to 72 inches, 72 inches will be increased to a 6x6 RBC). All but four (4) structures identified in this study are larger than 48” in size, they will all be subject to the requirement of a 1’ buried invert. Therefore, 129 of the 167 crossings identified and analyzed in this study would be 72 inches or larger and would qualify as major crossings. Of the remaining 38 locations identified, many of these may require larger structures and, especially with the 1’ buried requirement, may qualify as “major” crossings once additional, more detailed, analysis is performed (since they will be within ½ to 1 pipe size increment of the 72” requirement.

During final design, the NCDOT Hydraulics Unit will require that the analysis of any crossing which has a total span of more than 20 feet be to the same level of detail as a bridge crossing (a BSR may be required, but at minimum, a HEC-RAS analysis will be performed in addition to the preparation of the CSR). These locations will also become part of the NCDOT Bridge Inventory and will be subject to regular inspection by bridge maintenance

personnel. This will include many of the double- and triple-barrel culverts identified in our analysis.

It should be noted, as shown in Table 4, that there were several locations where the HDS-5 calculations indicated that a box culvert would meet the hydraulic requirements, but field investigation and/or research at NCDOT showed that there was a single or multi-span bridge either upstream or downstream of the crossing. In these cases, it was assumed that a bridge similar to or larger than the existing one would be required and the recommended structure was changed appropriately.

4 SUMMARY OF RESULTS

Please refer to **Table 4** for a summary of the preliminary size assigned to each crossing location.

A total of 167 crossing locations were identified, analyzed, and assigned a preliminary crossing size and type. Of these crossing locations, 17 were bridges, 83 were major culvert crossings (larger than 72 inches in diameter), 29 were 60" or 66" pipe culverts, and 38 were 54" inch or smaller pipe culverts. After accounting for the Corps requirement that all culverts larger than 48 inches be buried 1 foot below grade, however, all of the crossings over 60" were increased in size and 29 additional crossings became major crossings. Thus, 129 of the 167 crossings studied qualify as major crossings.

Table 4 identifies many parameters which should be useful as alternatives are considered such as preliminary culvert size and length, approximate bridge length, fill height at the crossing location, and floodplain width (if the alignment crosses a detailed study area). Each crossing location was assigned a unique crossing ID and, in addition to this ID, the Segment ID and the Detailed Study Alternative ID are also included in the table.

TABLE 4 - RECOMMENDED PRELIMINARY CROSSING SIZES

CULVERT ID	Segment ID	Detailed Study Alternative ID	CATCHMENT AREA (ac)	CATCHMENT AREA (sq mi)	DESIGN FLOW (Q_{50} cfs)	CULVERT SIZE	BRIDGE	72" & LARGER	60" & 66" CULVERTS	54" & SMALLER	Existing Structure At, U/S, or D/S?	Existing Structure Type & Size	Flood Plain Width	Fill Height	Recommended Preliminary Structure (incl. 1' buried)	Culvert/RCB/Bridge Length
HB1	H1A	58,64,65,68,76,77,78,81	10078.47	15.74761	4311.00	BRIDGE	1				At, D/S	At-51.5' 1-span, D/S-120 ft. 3-span	808	44	120 ft, 3-span BRIDGE	120
HB2	H2B	22,23,24,27	12858.22	20.09097	4788.00	BRIDGE	1				--		1429	37	160 ft, 3-span BRIDGE	160
HB3	H2B	22,23,24,27	13026.95	20.35461	4788.00	BRIDGE	1				--		650	73	160 ft, 3-span BRIDGE	160
HD2			769.61	1.20252	1083.21	2-(8'x8') RCB		1			--		115		2 - (9'x8') RCB	332
HD3	H1A	58,64,65,68,76,77,78,81	404.72	0.63238	735.68	7'x12' RCB		1			--			80	8'x12' RCB	1385
HD4	H1A	58,64,65,68,76,77,78,81	108.47	0.16948	332.99	6'X7' RCB		1			--			17	7'x7' RCB	
HD5	H1A	58,64,65,68,76,77,78,81	698.05	1.09070	1021.41	2-(7'x8') RCB		1			--		506	55	2 - (8'x8') RCB	713
HD6	H2A	4,5,6,9,22,23,24,27	489.02	0.76409	824.43	2-(7'x7') RCB		1			--		495	30	2 - (8'x7') RCB	846
HD7			283.79	0.44342	594.13	6'X12' RCB		1			--				7'x12' RCB	237
HD8	H1A	58,64,65,68,76,77,78,81	109.37	0.17089	334.65	6'X7' RCB		1			--			27	7'x7' RCB	256
HD9	H1A	58,64,65,68,76,77,78,81	274.18	0.42841	581.94	6'X12' RCB		1			--			60	7'x12' RCB	500
HD10	H1B	64,65,68	642.13	1.00333	971.33	2-(7'x8') RCB		1			D/S	72" CMP		47	2 - (8'x8') RCB	320
HD11	H1C	58,64,65,68	268.61	0.41970	574.79	6'X12' RCB		1			--			47	7'x12' RCB	319
HD12	H1C	58,64,65,68	248.97	0.38902	549.11	6'X12' RCB		1			--		102	78	7'x12' RCB	521
HD13	H1C	58,64,65,68	57.73	0.09020	217.56	72" RCP		1			--			60	6'x6' RCB	400
HD14	H1C	58,64,65,68	43.33	0.06770	165.76	66" RCP			1		--			41	6'x5' RCB	539
HD15	H1C	58,64,65,68	59.01	0.09220	220.15	72" RCP		1			--			28	6'x6' RCB	258
HD16	H1C	58,64,65,68	66.15	0.10336	246.05	72" RCP		1			--			27	6'x6' RCB	434
HD17	HX2	76,77,78,81	659.49	1.03045	987.06	2-(7'x8') RCB		1			--			30	2 - (8'x8') RCB	262
HD18	HX2	76,77,78,81	546.44	0.85381	881.41	2-(7'x7') RCB		1			--			8	2 - (8'x7') RCB	107
HD20	H1C	58,64,65,68	615.45	0.96164	946.83	2-(7'x8') RCB		1			--			39	2 - (8'x8') RCB	287
HD24			699.72	1.09331	1022.88	2-(7'x8') RCB		1			--		506		2 - (8'x8') RCB	713
HD25	H2A	4,5,6,9,22,23,24,27	597.27	0.93323	929.90	2-(7'x8') RCB		1			--		495		2 - (8'x8') RCB	846
HD26	H2A	4,5,6,9,22,23,24,27	79.71	0.12455	246.42	72" RCP		1			--			53	6'x6' RCB	728
HD27	H2A	4,5,6,9,22,23,24,27	1660.2	2.59406	1535.47	3-(6'x10') RCB		1			--		209	45	3-(7'x10') RCB	216
HD28	H2A	4,5,6,9,22,23,24,27	120.96	0.18900	355.57	6'X7' RCB		1			--			70	7'x7' RCB	1383
HD29	H2B	22,23,24,27	107.22	0.16753	330.68	6'X7' RCB		1			--			4	7'x7' RCB	207
HD30	H2B	22,23,24,27	637.80	0.99656	967.38	2-(7'x8') RCB		1			--		110	6	2 - (8'x8') RCB	244
HD31	H2C	22,23,24,27	508.56	0.79463	844.11	2-(7'x7') RCB		1			--			24	2 - (8'x7') RCB	414
HD32	H2C	22,23,24,27	1476.61	2.30720	1430.87	3-(6'x10') RCB		1			--		330	44	3-(7'x10') RCB	314
HD33	H2C	22,23,24,27	812.09	1.26889	1118.82	2-(8'x8') RCB		1			--			53	2 - (9'x8') RCB	331
HD34	H2C	22,23,24,27	55.23	0.08630	209.79	72" RCP		1			--			33	6'x6' RCB	284
HD35	H2C	22,23,24,27	52.37	0.08183	196.84	66" RCP			1		--			23	6'x5' RCB	254
HD37	H3	4,5,6,9	964.80	1.50750	1241.11	2-(8'x8') RCB		1			--		214	44	2 - (9'x8') RCB	1419
HD38	H3	4,5,6,9	44.6	0.06969	170.94	66" RCP			1		--			26	6'x5' RCB	263
HD39	H3	4,5,6,9	36.37	0.05683	142.45	60" RCP			1		--			30	72" RCP	240
HD40	H3	4,5,6,9	114.13	0.17833	343.35	6'X7' RCB		1			--			13	7'x7' RCB	209
HD41	H3	4,5,6,9	24.00	0.03750	103.60	54" RCP				1	--			25	66" RCP	562
HD42	H3	4,5,6,9	67.33	0.10520	246.05	72" RCP		1			--			25	6'x6' RCB	611
HD43	H3	4,5,6,9	20.29	0.03170	85.47	48" RCP				1	--			8	60" RCP	191
HD44	H3	4,5,6,9	25.85	0.04039	108.78	54" RCP				1	--			33	66" RCP	558
HD45	H3	4,5,6,9	60.77	0.09495	225.33	72" RCP		1			--			18	6'x6' RCB	354
HD46	H3	4,5,6,9	18.74	0.02928	80.29	48" RCP				1	--			6	60" RCP	205
HD47	H3	4,5,6,9	16.13	0.02520	69.93	48" RCP				1	--			16	60" RCP	208
HD48	H3	4,5,6,9	3039.75	4.74961	2903.00	3-(10'x10') RCB		1			--		628	50	3-(11'x10') RCB	251
HD49			549.30	0.85828	884.19	2-(7'x7') RCB		1			--		173		2 - (8'x7') RCB	75
HD51	H2C	22,23,24,27	40.29	0.06295	155.40	60" RCP			1		--			15	72" RCP	210
HD52	H2B	22,23,24,27	47.76	0.07463	181.30	66" RCP			1		--			44	6'x5' RCB	491
HD54	H1A	58,64,65,68,76,77,78,81	26.18	0.04091	108.78	54" RCP				1	--			90	66" RCP	720
HD55			100.53	0.15708	318.10	6'X7' RCB		1			At	72" CMP		17	7'x7' RCB	SAME AS HD4
HD56	H2A	4,5,6,9,22,23,24,27	31.27	0.04886	124.32	60" RCP			1		--			26	72" RCP	550
HD57	H2A	4,5,6,9,22,23,24,27	59.36	0.09275	214.97	72" RCP		1			--			43	6'x6' RCB	202
HD59	H3	4,5,6,9	15396.7	24.05734	4998.08	BRIDGE	1				At	115 ft 3-span	974	30	120 ft, 3-span BRIDGE	120
JB1	J1A	58,64,65,68	25634.98	40.05466	7552.00	BRIDGE	1				D/S	45 ft 1-span	638	40	160 ft, 3-span Bridge	160
JB2	J3	22,23,24,27	22985.21	35.91439	7384.00	BRIDGE	1				D/S	160 ft 4-span	1728	30	160 ft, 3-span Bridge	160
JD1	J1A	58,64,65,68	60.17	0.09402	217.56	72" RCP		1			--			44	6'x6' RCB	274
JD2			28.38	0.04434	108.78	54" RCP				1	--				66" RCP	101
JD3			57.20	0.08938	207.20	72" RCP		1			--				6'x6' RCB	104
JD4	J1B	64,65,68	3142.88	4.91075	2477.00	3-(8'x12') RCB		1			D/S	90 ft 3-span 1320 ft D/S	580	90	100 ft, 3-span BRIDGE	100
JD5	J1B	64,65,68	58.05	0.09070	207.20	72" RCP		1			--			90	6'x6' RCB	404
JD6	J1C	64,65,68	711.37	1.11152	1033.10	2-(7'x8') RCB		1			--			20	2 - (8'x8') RCB	666
JD7	J1C	64,65,68	148.34	0.23178	776.00	7'x12' RCB		1			--			20	8'x12' RCB	888
JD8	J1C	64,65,68	214.08	0.33450	501.40	6'X10' RCB		1			--			42	7'x10' RCB	307
JD9	J1C	64,65,68	1511.29	2.36139	1451.01	3-(6'x10') RCB		1			D/S	120" CMP on Private Drive 700 ft D/S		20	3-(7'x10') RCB	305
JD10	J1C	64,65,68	246.52	0.38519	545.85	6'X12' RCB		1			--			16	7'x12' RCB	1746
JD11	J1D	64,65,68	231.10	0.36109	525.03	6'X12' RCB		1			--			35	7'x12' RCB	293
JD12	J1D	64,65,68	71.97	0.11245	248.64	72" RCP		1			--			27	6'x6' RCB	256
JD13	J1D	64,65,68	16.67	0.02605	69.93	48" RCP				1	--			15	60" RCP	212
JD14	J1D	64,65,68	45.79	0.07155	170.94	66" RCP			1		--			10	6'x5' RCB	216
JD15	J1F	5,6,9,23,24,27,64,65,68,77,78,81	57.98	0.09059	209.79	72" RCP		1			--			10	6'x6' RCB	464
JD16	J1F	5,6,9,23,24,27,64,65,68,77,78,81	323.52	0.50550	642.89	7'X10' RCB		1			D/S	2-66" CMP 3500' D/S, 96"x144" CMP 4000' D/S		63	8'x10' RCB	427
JD17	JX1	58	3066.38	4.79122	2477.00	3-(8'x12') RCB		1			D/S	90 ft 3-span 1320 ft D/S	580	95	100 ft, 3-span BRIDGE	100
JD18	JX1	58	39.31	0.06142	145.04	60" RCP			1		--			20	72" RCP	220
JD19	JX1	58	475.52	0.74300	810.65	2-(7'x7') RCB		1			--			48	2 - (8'x7') RCB	484

TABLE 4 - RECOMMENDED PRELIMINARY CROSSING SIZES

CULVERT ID	Segment ID	Detailed Study Alternative ID	CATCHMENT AREA (ac)	CATCHMENT AREA (sq mi)	DESIGN FLOW (Q_{50} cfs)	CULVERT SIZE	BRIDGE	72" & LARGER	60" & 66" CULVERTS	54" & SMALLER	Existing Structure At, U/S, or D/S?	Existing Structure Type & Size	Flood Plain Width	Fill Height	Recommended Preliminary Structure (incl. 1' buried)	Culvert/RCB/Bridge Length
JD20	J2D	4,5,6,9,22,23,24,27,58,76,77,78,81	145.98	0.22809	398.18	6'X8' RCB		1			--			33	7'x8' RCB	1145
JD21	J2D	4,5,6,9,22,23,24,27,58,76,77,78,81	471.26	0.73634	806.27	2-(7'x7') RCB		1			--			19	2 - (8'x7') RCB	244
JD22	J2D	4,5,6,9,22,23,24,27,58,76,77,78,81	323.11	0.50486	642.40	7'X10' RCB		1			--			32	8'x10' RCB	1203
JD23	J2D	4,5,6,9,22,23,24,27,58,76,77,78,81	79.22	0.12378	237.54	72" RCP		1			--			34	6'x6' RCB	2133
JD24	J5A	4,22,58,76	104.07	0.16261	324.79	6'X7' RCB		1			--			40	7'x7' RCB	307
JD25	J5A	4,22,58,76	19.00	0.02969	77.70	48" RCP				1	--			5	60" RCP	212
JD26	J5A	4,22,58,76	36.39	0.05686	134.68	60" RCP			1		--			32	72" RCP	616
JD27	J5A	4,22,58,76	78.61	0.12283	239.76	72" RCP		1			--			15	6'x6' RCB	426
JD28	J5A	4,22,58,76	275.36	0.43025	583.44	6'X12' RCB		1			--			13	7'x12' RCB	170
JD29	J2B	5,6,9,76,77,78,81	2224.59	3.47592	2865.00	3-(8'x12') RCB		1			D/S	40 ft 1-span on Forbes Rd.	385	40	50 ft, 1-span BRIDGE	311
JD30	J2C	4,5,6,9,22,23,24,27,78,77,78,81	385.6	0.60250	714.55	7'x12' RCB		1			--			40	8'x12' RCB	262
JD31	J2C	4,5,6,9,22,23,24,27,78,77,78,81	468.52	0.73206	803.45	2-(7'x7') RCB		1			--			50	2 - (8'x7') RCB	353
JD32	JX4	5,6,9,23,24,27,77,78,81	141.37	0.22089	390.57	6'X8' RCB		1			--			30	7'x8' RCB	412
JD33	JX4	5,6,9,23,24,27,77,78,81	70.24	0.10975	246.05	72" RCP		1			--			24	6'x6' RCB	274
JD34	J4A	4,5,6,9	29.12	0.04550	111.37	54" RCP				1	--			82	66" RCP	261
JD35	J4A	4,5,6,9	55.37	0.08652	199.43	66" RCP			1		--			63	6'x5' RCB	233
JD36	J4A	4,5,6,9	61.44	0.09600	217.56	72" RCP		1			--			60	6'x6' RCB	225
JD37	J4A	4,5,6,9	100.35	0.15680	317.76	6'X7' RCB		1			--				7'x7' RCB	395
JD39	J4A	4,5,6,9	19.81	0.03095	80.29	48" RCP				1	--			105	60" RCP	279
JD40	JX1	58	29.27	0.04573	113.96	54" RCP				1	--			40	66" RCP	416
JD41			22.6	0.03531	90.65	48" RCP				1	--				60" RCP	308
JD42	J5A	4,22,58,76	23.41	0.03658	90.65	48" RCP				1	--			30	60" RCP	648
JD43	J1F	5,6,9,23,24,27,64,65,68,77,78,81	21.5	0.03359	85.47	48" RCP				1	--			17	60" RCP	110
JD44	J2C	4,5,6,9,22,23,24,27,78,77,78,81	30.99	0.04842	116.55	54" RCP				1	--			20	66" RCP	108
JD45	J2D	4,5,6,9,22,23,24,27,58,76,77,78,81	28.77	0.04495	111.37	54" RCP				1	--			42	66" RCP	890
JD46	J2D	4,5,6,9,22,23,24,27,58,76,77,78,81	29.95	0.04680	116.55	54" RCP				1	--			37	66" RCP	1466
JD47	J5A	4,22,58,76	51.59	0.08061	189.07	66" RCP			1		--			20	6'x5' RCB	120
JD48	J5A	4,22,58,76	39.60	0.06188	145.04	60" RCP			1		--			10	72" RCP	112
JD49	J5A	4,22,58,76	50.32	0.07863	183.89	66" RCP			1		--			42	6'x5' RCB	327
JD50	J5A	4,22,58,76	153.57	0.23995	410.52	6'X8' RCB		1			--			18	7'x8' RCB	155
JD51	J2A	76,77,78,81	43.14	0.06741	155.40	60" RCP			1		--			43	72" RCP	259
JD52	J2B	5,6,9,76,77,78,81	48.40	0.07563	176.12	66" RCP			1		--			40	6'x5' RCB	630
JD53	J1F	5,6,9,23,24,27,64,65,68,77,78,81	36.14	0.05647	134.68	60" RCP			1		--			63	72" RCP	373
JD54	J2A	76,77,78,81	27.80	0.04344	108.78	54" RCP				1	--			55	66" RCP	186
JD55	J4B	4	46.31	0.07236	168.35	66" RCP			1		--			92	6'x5' RCB	686
KB1	K1D	6,24,65,78	15728.43	24.57567	29364.00	BRIDGE	1				--		864	48	BRIDGE	800
KB2	K1D	6,24,65,78	11806.04	18.44694	4259.69	BRIDGE	1				--		869	56	BRIDGE	800
KB3	K4A	5,23,64,77	15878.57	24.81027	29364.00	BRIDGE	1				--		937	35	BRIDGE	850
KB4	K4A	5,23,64,77	12758.65	19.93539	4463.40	BRIDGE	1				--		656	50	BRIDGE	600
KB5	K3A	9,27,68,81	13873.09	21.67670	29364.00	BRIDGE	1				--		456	45	BRIDGE	400
KB6	K3C	4,9,22,27,58,68,76,81	11059.41	17.28033	4095.42	BRIDGE	1				--		514	45	BRIDGE	450
KB7	K2A	4,22,58,78	13525.23	21.13317	29364.00	BRIDGE	1				--		656	70	BRIDGE	600
KD1	K1A	5,6,9,23,24,27,64,65,68,77,78,81	202.17	0.31589	484.42	6'X10' RCB		1			--			42	7'x10' RCB	272
KD2	K1A	5,6,9,23,24,27,64,65,68,77,78,81	1069.81	1.67158	1320.75	3-(6'x10') RCB		1			--		253	63	3-(7'x10') RCB	387
KD3	K3A	9,27,68,81	16146.43	25.22880	8619.00	BRIDGE	1				--		514	47	BRIDGE	160
KD4	K1B	5,6,23,24,64,65,77,78	141.41	0.22095	390.63	6'X8' RCB		1			--			44	7'x8' RCB	289
KD5	K1C	5,6,23,24,64,65,77,78	37.67	0.05886	139.86	60" RCP			1		--			47	72" RCP	654
KD6	K1D	6,24,65,78	46.38	0.07247	160.58	BRIDGE	1				--		285	57	BRIDGE	
KD7	K3C,K1D	4,6,9,22,24,27,58,65,68,76,78,81	600.04	0.93756	932.49	2-(7'x8') RCB		1			--		248	35	2 - (8'x8') RCB	977
KD8	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	90.80	0.14188	255.30	6'X6' RCB		1			--			13	7'x6' RCB	136
KD9	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	25.66	0.04009	95.83	54" RCP				1	--			10	66" RCP	1416
KD10	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	20.44	0.03194	77.70	48" RCP				1	--			20	60" RCP	808
KD11	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	72.69	0.11358	238.28	72" RCP		1			--			65	6'x6' RCB	450
KD12	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	346.06	0.54072	669.50	7'x12' RCB		1			At	66" RCP		76	8'x12' RCB	487
KD13	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	25.98	0.04059	95.83	54" RCP				1	--				66" RCP	414
KD14	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	49.51	0.07736	168.35	66" RCP			1		--				6'x5' RCB	570
KD15	K4A	5,23,64,77	84.72	0.13238	241.98	72" RCP		1			--			55	6'x6' RCB	1102
KD16	K4A	5,23,64,77	859.59	1.34311	1157.77	2-(8'x8') RCB		1			--		456	46	2 - (9'x8') RCB	744
KD17	K1B	5,6,23,24,64,65,77,78	16142.47	25.22261	8619.00	BRIDGE	1				--		514	28	BRIDGE	160
KD18	K3A	9,27,68,81	35.30	0.05516	129.50	60" RCP			1		--			27	72" RCP	546
KD19	K3A	9,27,68,81	207.98	0.32497	492.75	6'X10' RCB		1			--			70	7'x10' RCB	415
KD20	K3A	9,27,68,81	107.71	0.16830	331.59	6'X7' RCB		1			--			46	7'x7' RCB	399
KD22	K3C	4,9,22,27,58,68,76,81	20.21	0.03158	77.70	48" RCP				1	--			58	60" RCP	538
KD24	K2A	4,22,58,78	59.79	0.09342	204.61	72" RCP		1			--			20	6'x6' RCB	212
KD25	K2A	4,22,58,78	15254.83	23.83567	8228.00	BRIDGE	1				U/S	126 ft 3-span 2200 ft U/S	495	37	150 ft, 3-span BRIDGE	278
KD26	K2A	4,22,58,78	204.69	0.31983	488.04	6'X10' RCB		1			--			49	7'x10' RCB	299
KD27	K2A	4,22,58,78	96.44	0.15069	268.62	6'X6' RCB		1			--			39	7'x6' RCB	343
KD28	K1D	6,24,65,78	39.92	0.06238	142.45	60" RCP			1		--			43	72" RCP	912
KD29	K1D,K3C	4,6,9,22,24,27,58,65,68,76,78,81	821.41	1.28345	1126.53	2-(8'x8') RCB		1			--		444	38	2 - (9'x8') RCB	201
KD31	K4A	5,23,64,77	2069.75	3.23398	1753.42	3-(6'x12') RCB		1			--		510	37	3-(7'x12') RCB	162
KD32	K3A	9,27,68,81	28.02	0.04378	103.60	54" RCP				1	--			16	66" RCP	95
KD33	K1C	5,6,23,24,64,65,77,78	16.87	0.02636	67.34	48" RCP				1	--			43	60" RCP	896
KD34	K1C	5,6,23,24,64,65,77,78	18.58	0.02903	72.52	48" RCP				1	--			29	60" RCP	156
KD35	K1D,K3C	4,6,9,22,24,27,58,65,68,76,78,81	19.19	0.02998	72.52	48" RCP				1	--			40	60" RCP	355

TABLE 4 - RECOMMENDED PRELIMINARY CROSSING SIZES

CULVERT ID	Segment ID	Detailed Study Alternative ID	CATCHMENT AREA (ac)	CATCHMENT AREA (sq mi)	DESIGN FLOW (Q_{50} cfs)	CULVERT SIZE	BRIDGE	72" & LARGER	60" & 66" CULVERTS	54" & SMALLER	Existing Structure At, U/S, or D/S?	Existing Structure Type & Size	Flood Plain Width	Fill Height	Recommended Preliminary Structure (incl. 1' buried)	Culvert/RCB/Bridge Length
KD36	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	56.2	0.08781	194.25	66" RCP			1		--			30	6'x5' RCB	502
KD37	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	204.47	0.31948	487.73	6'X10' RCB		1			--			73	7'x10' RCB	1156
KD38	K1D	6,24,65,78	18.18	0.02841	69.93	48" RCP				1	--			15	60" RCP	460
KD39	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	34.36	0.05369	124.32	60" RCP			1		--				72" RCP	240
KD40	K4A	5,23,64,77	18.14	0.02834	69.93	48" RCP				1	--			40	60" RCP	3740
KD42	K3C,K1D,K4A	4,5,6,9,22,23,24,27,58,64,65,68,76,77,78,81	31.69	0.04952	116.55	54" RCP				1	--			46	66" RCP	1028
KD43	K3A,KX1	4,9,22,27,58,68,76,81	23.27	0.03636	88.06	48" RCP				1	--			34	60" RCP	338
KD44	K3A,KX1	4,9,22,27,58,68,76,81	37.44	0.05850	132.09	60" RCP			1		--			40	72" RCP	176
KD47	K3B	4,9,22,27,58,68,76,81	38.3	0.05984	132.09	60" RCP			1		--			24	72" RCP	234
KD48	K3B	4,9,22,27,58,68,76,81	53.78	0.08403	183.89	66" RCP			1		--			15	6'x5' RCB	138
KD49	K3C,K1D	4,6,9,22,24,27,58,65,68,76,78,81	17.37	0.02714	64.75	42" RCP				1	--			10	42" RCP	508
KD51	K2A	4,22,58,78	31.36	0.04900	113.96	54" RCP				1	--			20	66" RCP	237
KD52	K2A	4,22,58,78	19.6	0.03063	75.11	48" RCP				1	--			20	60" RCP	219
KD53	K2A	4,22,58,78	17.43	0.02723	64.75	42" RCP				1	--			18	42" RCP	294
KD54	K2A	4,22,58,78	58.46	0.09134	196.84	66" RCP			1		--			20	6'x5' RCB	267
KD55	K2A	4,22,58,78	16.89	0.02639	64.75	42" RCP				1	--			16	42" RCP	206
KD56	K2A	4,22,58,78	18.59	0.02905	72.52	48" RCP				1	--			8	60" RCP	68
KD57	K2A	4,22,58,78	16.11	0.02517	64.75	42" RCP				1	--			30	42" RCP	232
KD60	K2A	4,22,58,78	47.57	0.07433	163.17	66" RCP			1		--			44	6'x5' RCB	1312
							17	83	29	38						