Preliminary Stormwater Management Design Report

Carolina Crossroads Design-Build Preparation On-Call Phase 3C

Richland & Lexington Counties, SC

June 2024

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Appendix List

1.0

Project Summary

1.1 Project Summary

The South Carolina Department of Transportation (SCDOT) proposes significant improvements to the I-26 / I-20 / I-126 interchanges as part of the Carolina Crossroads Project, to the northwest of Columbia, SC (see Figure A.01: Vicinity Map in Appendix A). The project is located in both Richland and Lexington Counties. The project includes adding a travel lane in each direction to each of the three interstates, adding Collector-Distributer (C-D) lanes, as well as improving various interchanges and side roads. The Department has contracted with HDR, Inc. to complete the drainage and outfall field surveys, pipe inspections, and preliminary hydraulic design in order to support the Department with preparation of the design-build package.

The three interstates within the project area are all east-west interstate routes. I-26 runs along the western limits of Columbia, I-20 runs along the northern limits of Columbia, and I-126 provides a direct connection from I-26 to downtown Columbia. Within the project limits, the interstates currently range from a four- to ten-lane divided freeway with median barrier walls. The posted speed limits of the interstates vary from 55 mph to 60 mph.

FEMA Flood Insurance Rate Map (FIRM) Panels 45063C0133G, 45063C0134G, 45063C0142G, 45063C0144G, 45063C0161G, 45063C0163G, 45079C0091H, 45079C0210K, 45079C0236K, & 45079C0237K show the various floodplains associated with the project area. They were overlaid onto the project site in CAD, and can be seen in Appendix A as Figures A.04.1 & A.04.2.

Topographic survey data and USGS quadrangle maps (see Figure A.02: USGS Topographic Quad Map in Appendix A) were used to identify drainage patterns. Within the project limits, the larger water bodies crossing I-26 include the Moccasin Branch, Kinley Creek Tributary K-2, Stoop Creek, the Saluda River, Saluda River Tributary SR-1, and the Senn Branch. Those crossing I-20 include the Saluda River and Stoop Creek.

Mead & Hunt located and verified sizes of the existing cross-line drainage structures and also evaluated the conditions of several of the existing cross lines in a Video Pipe Inventory (VPI) survey. Section 5 of this report discusses the VPI survey in more detail, and reports for the VPI survey can be found in Appendix G.

STV, Inc. performed the hydraulic analysis of major cross-lines in the project. Section 6 of this report discusses the cross-line analysis in more detail, and the calculations are shown in Appendix H.

1.2 Existing Drainage Infrastructure

The existing drainage infrastructure at the project site was pieced together in CAD from aerial survey data and imagery (see Figures A.03, A.03.1, & A.03.2 in Appendix A), topographic field survey, pipe video inventory survey, and field inspection. Many of the pipes were not field-located but were hand-drawn by referencing as-builts of past projects, and some field verification during construction will be required.

For use in reference with regards to this report, plans were developed showing the location and layout of the existing drainage infrastructure at the project site. These plans are attached as Appendix B.

Significant culvert crossings were identified and are labeled in the plans as existing pipes (EP-####) or existing box culverts (EC-####). Other pertinent existing drainage elements such as outfalls, channels, inlets, bridges, etc., are shown in these plans as Sites. As with the pipe crossings, each Site has been assigned a four digit identification number. The first two digits of the IDs indicate the plan sheet number on which they are shown.

Those Sites which require some contractor action are detailed in Section 7 of this report. Photos and notes describing each Site are shown in Appendix I.

1.3 Pre Versus Post Summary

49 specific analysis points were studied in a Pre-Construction conditions versus Post-Construction conditions analysis. Detailed descriptions of the associated basins are found in Section 4.4, and basin delineation maps are shown in Appendix D. A summary of the peak flows for both Pre- and Post-Construction conditions for the various basins throughout the project is shown below.

Modified NRCS WinTR-55 Basins (640 Acres > Area > 100 Acres)

Basin ID	Pre-Developed Basin Area (acre)	Post-Developed Basin Area (acre)	Design Storm Event	Pre-Developed Flows (cfs)	Post-Developed Flows (cfs)	% Flow Increase
BSH-1	149.1	149.0	2-Year	148.1	159.0	7.30
			10-Year	275.3	288.4	4.76
			50-Year	421.8	435.9	3.34
BSH-2	107.7	107.6	2-Year	119.3	129.2	8.25
			10-Year	226.5	238.0	5.08
			50-Year	351.2	362.9	3.34
MWR-1	340.0	339.9	2-Year	352.6	358.4	1.65
			10-Year	617.8	623.7	0.96
			50-Year	915.4	924.9	1.04

Table 1.3.2: Summary of Peak Flows at NRCS Basin Analysis Points

Rational Method Basins (Area < 100 Acres)

Basin ID	Pre-Developed Basin Area (acre)	Post-Developed Basin Area (acre)	Design Storm Event	Pre-Developed Flows (cfs)	Post-Developed Flows (cfs)	% Flow Increase
20W-1	19.7	19.6	2-Year	31.5	33.3	5.70
			10-Year	39.9	42.2	5.70
			50-Year	58.8	62.2	5.70
RCW-1	94.1	94.0	2-Year	134.9	136.4	1.08
			10-Year	170.5	172.3	1.08
			50-Year	251.0	253.7	1.08

Table 1.3.3: Summary of Peak Flows at Rational Basin Analysis Points

As shown in the tables above, construction of the project will generally increase runoff flows. This is primarily due to the expansion of impervious surface as the result of new roadway construction throughout the project.

While portions of the Post-Construction Basin Delineations were modified to account for the changes in roadway geometry, for the purposes of this report it was assumed that they will closely resemble the Pre-Construction Delineations. Potential methods for mitigation of increased flows are detailed in Section 4.4. A detailed discussion of the stormwater analysis is in Sections 3.0 & 4.0.

2.0

Soils Information

2.1 Soils Information Overview

The Carolina Crossroads Project is located in the Sand Hills Region of South Carolina. The land use adjacent to the project corridor is a mix of residential, commercial, and undeveloped. Soil surveys were obtained from the Natural Resources Conservation Service for Richland County (Version 18, Dec 23, 2013) and Lexington County (Version 15, Sep 27, 2016) in order to determine the predominate soil types along the project corridor. The maps were overlaid onto the project area as shown in Figure A.05.1 & A.05.2 in Appendix A. The on-site project soils depicted in those figures are listed below in Table 2.1.

Map Unit Symbol	Map Unit Name	Soil Group	Acres in AOI	Percent of AOI
AtA	Altavista silt loam, 0 to 2 % slopes	A/D	73.9	3.6%
Cd	Chastain silty clay loam	C/D	8.6	0.4%
CeB	Cecil fine sandy loam, 2 to 6 % slopes	B	58.7	2.9%
CeC	Cecil fine sandy loam, 6 to 10 % slopes	B	54.3	2.7%
CeD	Cecil fine sandy loam, 10 to 15 % slopes	B	35.4	1.7%
CfC	Cecil-Urban land complex, 0 to 8 % slopes		2.7	0.1%
CfD	Cecil-Urban land complex, 8 to 15 % slopes		30.1	1.5%
Ch	Chenneby silty clay loam	B/D	2.9	0.1%
Ck	Chenneby soils	B/D	9.9	0.5%
Co	Congaree loam	C/D	11.8	0.6%
Co	Congaree silt loam	C	16.5	0.8%
CvA	Craven fine sandy loam, 0 to 2 % slopes	C	5.4	0.3%
DoB	Dothan loamy sand, 2 to 6 % slopes	B	66.2	3.3%
DwB	Dothan-Urban land complex, 0 to 6 % slopes	B	21.7	1.1%
EnB	Enon silt loam, 2 to 6 % slopes	D	102.6	5.0%
Eo	Enoree silt loam, 0 to 2 % slopes, frequently flooded	A/D	12.8	0.6%
FaB	Faceville sandy loam, 2 to 6 % slopes	B	9.9	0.5%
GeB	Georgeville silt loam, 2 to 6 % slopes	B	30.9	1.5%
GeB	Georgeville very fine sandy loam, 2 to 6 % slopes	B	14.1	0.7%
GeC	Georgeville silt loam, 6 to 10 % slopes	B	90.9	4.5%
GeC	Georgeville very fine sandy loam, 6 to 10 % slopes	B	42.9	2.1%
GeD	Georgeville very fine sandy loam, 10 to 15 % slopes	B	35.7	1.8%
GoA	Goldsboro sandy loam, 0 to 2 % slopes	B	4.3	0.2%
HeB	Herndon silt loam, 2 to 6 % slopes	B	124	6.1%
HeC	Herndon silt loam, 6 to 10 % slopes	C	42.5	2.1%
HnB	Herndon-Urban land complex, 2 to 6 % slopes	C	50	2.5%
HrB	Herndon silt loam, 2 to 6 % slopes	B	24.7	1.2%
JO	Johnston soils	A/D	13.7	0.7%
MeC	Mecklenburg silt loam, 6 to 10 % slopes	D	18.8	0.9%
NaB	Nason silt loam, 2 to 6 % slopes	B	79	3.9%

NaC	Nason silt loam, 6 to 10 % slopes	B	29.5	1.4%
NaD	Nason silt loam, 6 to 15 % slopes	C	116.1	5.7%
OaB	Orange loam, 0 to 4 % slopes	C/D	67.6	3.3%
ObB	Orangeburg loamy sand, 2 to 6 % slopes	B	0.4	0.0%
OgB	Orangeburg-Urban land complex, 2 to 6 % slopes	B	191.4	9.4%
OgD	Orangeburg-Urban land complex, 6 to 15 % slopes	B	28.9	1.4%
OrB	Orangeburg loamy sand, 2 to 6 % slopes	A	43.5	2.1%
OrC	Orangeburg loamy sand, 6 to 10 % slopes	A	17.3	0.9%
PeB	Pelion loamy sand, 2 to 6 % slopes	C/D	0.6	0.0%
PeC	Pelion loamy sand, 6 to 10 % slopes	C/D	7.5	0.4%
PkD	Pickens slaty silt loam, 6 to 15 % slopes	D	18.3	0.9%
Ra	Rains sandy loam	A/D	44.3	2.2%
Sm	Smithboro loam	C/D	21	1.0%
StA	State sandy loam, 0 to 2 % slopes	B	97.4	4.8%
TaE	Tatum silt loam, 15 to 25 % slopes	C	101.4	5.0%
To	Toccoa loam	B	11	0.5%
Ud	Udorthents	B	18.5	0.9%
W	Water		24.9	1.2%
WeB	Wedowee loamy sand, 2 to 6 % slopes	C	8.6	0.4%
WeE	Wedowee loamy sand, 10 to 30 % slopes	C	91.6	4.5%
Totals for AOI			**2034.7**	**100.0%**

Table 2.1: Hydrologic Soil Group Summary

The survey indicates that soils classified as being in hydrologic group B comprise the majority (53%) of the soils throughout the on-site project area. These soils have a moderate infiltration rate when wet. The soil group descriptions are included in the following section.

The same soils surveys were overlaid on the total drainage basin of the project and differentiated by soil group for use in hydrologic calculations. A map showing the soil groups in relation to the project area can be found in Appendix A as Figure A.06: Hydrologic Soil Group Map.

2.2 Hydrologic Soil Group Descriptions

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These mainly consist of deep, well-drained to excessively-drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These chiefly consist of moderately deep or deep, moderately well-drained or well-drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These chiefly consist of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These chiefly consist of clays that have a high shrink / swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

3.0

Stormwater Analysis

3.1 Stormwater Analysis Overview

The hydrologic analysis for this project was performed in accordance with SCDOT's *Requirements for Hydraulic Design Studies*, dated May 26, 2009.

Drainage areas were delineated using survey data provided by SCDOT, drainage survey data provided by Mead & Hunt, Google Earth aerial imaging, and USGS 7.5' Quadrangles for Irmo, Columbia North, Lexington and Southwest Columbia (see Figure A.02: USGS Topographic Quad Map in Appendix A). The hydrologic methods used to determine peak discharges were selected based upon watershed area and consisted of the Rational Method and the modified NRCS WinTR-55 Method. Times of concentration were computed using the SCS methodology outlined in the WinTR-55 manual, with a minimum time of concentration of 5 minutes.

For uniformity and ease of calculation, the entire project (including the portions within Lexington County) was analyzed using rainfall data for Columbia and for Richland County. The project was also analyzed as being wholly in the Piedmont Physiographic Region. This method is conservative, yielding greater flows than using rainfall data from Lexington County and from the Upper Coastal Plain Physiographic Region.

Drainage paths, flow lengths, and watercourse slopes were determined using surveyed contours and the USGS Quad maps. Runoff coefficients and Manning's *n* values were estimated from aerial photography and from field investigations.

As there are multiple classifications of roadways throughout this project, a single set of drainage criteria cannot be applied. The primary roadways in the project were broken down into three categories, and are listed below:

Primary Road High Volume Design Speed > 45 mph	**Primary Road High Volume Design Speed ≤ 45 mph**	**Secondary Road Collector Design Speed ≤ 45 mph**
Interstate 26	System Ramps & Loops	Berryhill Dr.
Interstate 20	Service Ramps & Loops	Browning Rd.
Interstate 126	Broad River Rd.	Burning Tree Rd.
Interstate C-Ds	Bush River Rd.	Fernandina Rd. (NE of Beatty Rd.)
	Colonial Life Blvd.	Saturn Pkwy.
	Fernandina Rd. (SW of Beatty Rd.)	
	Harbison Rd.	
	Jamil Rd.	
	Lake Murray Blvd.	
	Piney Grove Rd.	
	St. Andrews Rd.	

Drainage design criteria for each of the above categories is shown in Appendix C.

3.2 Rainfall Depths (SCS Method)

Rainfall depths used in determining peak discharges through the SCS Method were obtained from the South Carolina DHEC Storm Water Management BMP Handbook. The 24-hour storm event rainfall depths for Richland County are shown below.

Return Period (years)	Depth (inches)
1	3.1
2	3.6
5	4.5
10	5.3
25	6.4
50	7.3
100	8.3

Table 3.2: 24-Hour Rainfall Depths for Richland County

3.3 Rainfall Intensity Values (Rational Method)

Coefficients used in the rational method for calculating rainfall intensity values (in/hr) were provided by SCDOT. The coefficients for Columbia are shown below.

Frequency (years)	a	b	c
2	244.34492	34.95806	1.03155
5	258.50572	32.75684	1.01773
10	267.54247	31.39986	1.00904
25	279.77346	29.59043	0.99735
50	288.71309	28.26125	0.98879
100	296.66217	27.04859	0.98111

Table 3.3: Rainfall Intensity Coefficients for Columbia, SC

The coefficients are utilized in the following equation to calculate rainfall intensities.

Rainfall intensity equation: $i = \frac{a}{(b+tc)^c}$

4.0

Pre- Versus Post-Construction Flow Analysis

4.1 Basin Definition / List

49 distinct analysis points were chosen within the total drainage basin of the project, and the drainage basins flowing to those analysis points were established. The analysis points and their associated basins were assigned 3-letter and 1-numeral identifiers, typically associated with a geographic characteristic within the basin. The basins are listed below, by their corresponding major watershed.

Saluda River Watershed

These individual basins flow to the Saluda River (see Section 4.4.5). Basins below are generally listed from west to east:

RCW-1: Basin to the south of the Saluda River along I-20, towards the southwest limit of the project, draining under Riverchase Way to an unnamed tributary of the Saluda River.

MWR-1: Basin to the south of the Saluda River along I-20 draining to the crossing under Merry Wood Road of an unnamed tributary of the Saluda River.

20W-1: Basin to the north of the Saluda River, adjacent to the CSX Railroad, draining to a crossing under a berm by an unnamed tributary of the Saluda River.

BSH-2 & **BSH-1**: Basins adjacent to Bush River Road, draining to just upstream of the crossing under the CSX Railroad of an unnamed tributary of the Saluda River.

4.2 Off-site Areas - Zoning Groups of Similar Surface Cover

In determining runoff flows from off-site areas for the Pre- Versus Post-Construction Analysis, fully-developed conditions were assumed. A second assumption was that there will be no upstream detention upon development of the off-site areas. This method yields relatively large flows for those basins with substantial off-site areas.

In order to simulate fully-developed conditions, off-site areas were delineated based on the zoning for the following municipalities: Richland County, Lexington County, the City of Columbia, the City of West Columbia, the Town of Irmo and the Town of Lexington. Using the respective municipal websites, zoning maps for the off-site drainage basin areas were developed, scaled, and overlaid upon the project area in Microstation (see Figure A.07: Zoning Municipality Map in Appendix A). For ease of calculations, some of the zoning districts were assumed to have similar surface cover and were grouped together accordingly (see Figure A.08: Zoning Groups Map in Appendix A). Those groups are listed below:

Zoning Group 1

Richland County Zones: Residential, Single Family - Low Density District; Residential, Single Family - Medium Density District; Planned Development District

Lexington County Zones: Planned Development; Low Density Residential; Development

City of Columbia Zones: Development District; Single-Family Residential District (RS-1 & RS-1A); Residential Planned Unit Development District - Large Scale; Residential Planned Unit Development District

City of West Columbia Zones: Low-Density Residential; Medium-Density Residential; Planned Unit Development - Residential

Town of Irmo Zones: Single-Family Residential District; Planned Development District

Town of Lexington Zones: Protected Residential

Zoning Group 2

Richland County Zones: Residential, Single Family - High Density District; Residential, Multi-Family - Medium Density District; Neighborhood Commercial District; Light Industrial District

Lexington County Zones: Limited Commercial; Neighborhood Commercial; Medium Density Residential; High Density Residential; Restrictive Development

City of Columbia Zones: Single-Family Residential District (RS-2 & RS-3); Neighborhood Commercial District; General Residential District (RG-1); Light Industrial District; Commercial Planned Unit Development District; Planned Unit Development District - Large Scale

City of West Columbia Zones: Light Manufacturing; High Density Residential

Town of Irmo Zones: General Residential District; Neighborhood - Commercial District; Light Manufacturing District

Town of Lexington Zones: Protected Residential Two; Neighborhood Commercial; Limited Commercial

Zoning Group 3

Richland County Zones: Residential, Multi-Family - High Density District; Office & Institutional District; General Commercial District; Heavy Industrial District

Lexington County Zones: General Commercial; Intensive Development

City of Columbia Zones: General Residential District (RG-2); Office & Institutional District; General Commercial District; Heavy Industrial District

City of West Columbia Zones: General Commercial; Restrictive Commercial

Town of Irmo Zones: Office - Commercial District; General - Commercial District

Town of Lexington Zones: High Density Residential; Office Commercial; General Commercial; Industrial

Zoning Group 4

Richland County Zones: Rural District

Lexington County Zones: Recreational / Agricultural

Town of Irmo Zones: Fringe Agricultural District

Surface cover characteristics were assigned to each of the four zoning groups based on district ordinances and are detailed in the three sub-sections below.

4.2.2 Curve Number by Zoning Group

Basins with a total area between 100 acres and 640 acres (NRCS Basins) were modeled using the modified NRCS WinTR-55 method. In accordance with NRCS methods, curve numbers (*CN*s) were determined for each drainage basin by delineating areas of different soil type and surface cover, for Pre-Construction conditions and Post-Construction conditions alike.

The soil group delineations were determined through maps obtained from the Natural Resources Conservation Service, which were overlaid onto the project area. Refer to Appendix A for Figure A.06: Hydrologic Soil Group Map.

Composite *CN*s were calculated for each of the NRCS Basins based on surface cover and soil class. For off-site areas, the zoning groups described earlier were assigned *CN*s for each soil type (see Table 4.2.2 below).

	Curve Number per Hydrologic Soil Group			
Zoning Group #	A	B	C	D
1	77	85	90	92
2	57	72	81	86
3	89	92	94	95
4	49	69	79	84

Table 4.2.2: Curve Number per Zoning Group / Hydrologic Soil Group

See Appendix E for Composite Curve Number calculations for the NRCS Basins.

4.2.3 *C* Value by Zoning Group

Basins with a total area of less than 100 acres (Rational Basins) were modeled using the Rational Method. Composite *C* Values were calculated for each of the Rational Basins based on total surface cover. For off-site areas, the zoning groups described earlier were assigned *C* Values (see Table 4.2.3 below).

Zoning Group #	*C* Value
1	0.55
2	0.40
3	0.80
4	0.20

Table 4.2.3: C Value by Zoning Group

See Appendix F for Composite *C* Value calculations for the Rational Basins.

4.3 Hydrologic Method Used For Each Basin

The NRCS Basins for this project are as follows: BSH-1, BSH-2, & MWR-1. As the WinTR-55 program only computes flow calculations with whole number *CN*s, flows corresponding to more precise and fractional composite *CN*s had to be interpolated. To do this, two sets of flow calculations were run for each situation, with a high integer and a low integer on either side of the fractional composite *CN*, and the precise flow was interpolated from them. See Appendix E for time of concentration and peak flow interpolation calculations within these basins.

The Rational Basins for this project are as follows: 20W-1 & RCW-1. See Appendix F for time of concentration and peak flow calculations within these basins.

4.4 Pre- and Post-Construction Basin Flow Analysis

The below section details the Pre- and Post-Construction Analyses for the following watershed: Saluda River. This basin is described within the sub-sections below.

4.4.5 Pre- and Post-Construction Flow Analysis – Saluda River Watershed

Basin RCW-1
Analysis Point Location: Approximately 130 LF downstream of the outfall beyond Riverchase Way of EC-3201.

See Figure D.03 and Figure D.03A in Appendix D for Basin Delineation Maps in Pre-Construction Conditions and Post-Construction Conditions, respectively, as well as Analysis Point location.

Basin RCW-1 is comprised mostly of land to the southeast of I-20. Runoff within this basin typically flows to the north and crosses I-20 and Riverchase Way via a 4’ x 6’ box culvert (EC-3201) before flowing to an unnamed tributary of the Saluda River. The most remote point in the basin is approximately 3,115 feet from the analysis point. Soils in this watershed are primarily classified as being in hydrologic soil groups B & C, with some D soils.

A summary of the Pre- and Post-Construction Flows for Basin RCW-1 is shown in the table below:

	Pre-Developed	Post-Developed	% Flow Increase
Basin Area (ac)	94.07	93.97	n/a
Composite "C" Value	0.57	0.57	n/a
Time of Concentration (hr)	0.82	0.82	n/a
2-Year Design Storm Flow (cfs)	134.9	136.4	1.08
5-Year Design Storm Flow (cfs)	155.9	157.6	1.08
10-Year Design Storm Flow (cfs)	170.5	172.3	1.08
25-Year Design Storm Flow (cfs)	211.2	213.5	1.08
50-Year Design Storm Flow (cfs)	251.0	253.7	1.08
100-Year Design Storm Flow (cfs)	282.1	285.2	1.08

Basin MWR-1
Analysis Point Location: Immediately upstream of the crossing under Merry Wood Road of an unnamed tributary of the Saluda River.

See Figure D.03 and Figure D.03A in Appendix D for Basin Delineation Maps in Pre-Construction Conditions and Post-Construction Conditions, respectively, as well as Analysis Point location.

Basin MWR-1 is comprised mostly of land to the southeast of I-20. Runoff within this basin typically flows to the north and crosses I-20 via a 6’ x 6’ box culvert (EC-3501), then crosses an access road via four 48” RCPs, then crosses Merry Wood Road with a single 48” corrugated metal pipe (CMP), before flowing to the Saluda River. The most remote point in the basin is approximately 7,755 feet from the analysis point. Soils in this watershed are primarily classified as being in hydrologic soil group B, with some C & D soils.

A summary of the Pre- and Post-Construction Flows for Basin MWR-1 is shown in the table below:

	Pre-Developed	Post-Developed	% Flow Increase
Basin Area (ac)	339.96	339.87	n/a
Composite Curve Number	85.68	86.04	n/a
Time of Concentration (hr)	1.49	1.48	n/a
2-Year Design Storm Flow (cfs)	352.6	358.4	1.65
5-Year Design Storm Flow (cfs)	490.4	496.4	1.22
10-Year Design Storm Flow (cfs)	617.8	623.7	0.96
25-Year Design Storm Flow (cfs)	779.2	785.0	0.74
50-Year Design Storm Flow (cfs)	915.4	924.9	1.04
100-Year Design Storm Flow (cfs)	1,054.5	1,062.6	0.77

Basin 20W-1
Analysis Point Location: Immediately upstream of crossing under a berm of an unnamed tributary of the Saluda River.

See Figure D.09 and Figure D.09A in Appendix D for Basin Delineation Maps in Pre-Construction Conditions and Post-Construction Conditions, respectively, as well as Analysis Point location.

Basin 20W-1 is comprised of land to the west of I-20, adjacent to the Saluda River, generally bound by Rolling Pines Road to the west. Runoff within this basin typically flows to the south, crossing the CSX Railroad via a culvert adjacent to the planned bridge of I-20 over the Saluda River, to which the basin drains. The most remote point in the basin is approximately 1,920 feet from the analysis point. Soils in this watershed are primarily classified as being in hydrologic soil group D, with some A, B, & C soils.

A summary of the Pre- and Post-Construction Flows for Basin 20W-1 is shown in the table below:

	Pre-Developed	Post-Developed	% Flow Increase
Basin Area (ac)	19.66	19.60	n/a
Composite "C" Value	0.58	0.62	n/a
Time of Concentration (hr)	0.71	0.71	n/a
2-Year Design Storm Flow (cfs)	31.5	33.3	5.70
5-Year Design Storm Flow (cfs)	36.4	38.5	5.70
10-Year Design Storm Flow (cfs)	39.9	42.2	5.70
25-Year Design Storm Flow (cfs)	49.4	52.3	5.70
50-Year Design Storm Flow (cfs)	58.8	62.2	5.70
100-Year Design Storm Flow (cfs)	66.2	69.9	5.70

Basin BSH-2

Analysis Point Location: Site 3721, immediately downstream of the crossing under I-20 of an unnamed tributary of the Saluda River.

See Figure D.09 and Figure D.09A in Appendix D for Basin Delineation Maps in Pre-Construction Conditions and Post-Construction Conditions, respectively, as well as Analysis Point location.

Basin BSH-2 is comprised of land along Bush River Road, to the west of I-20, including that interstate's interchange with Bush River Road. Runoff within this basin typically flows to the east, crossing the southern portion of the interchange via a 4' x 6' box culvert (EC-3701). This basin then drains to Basin BSH-1. The most remote point in the basin is approximately 3,625 feet from the analysis point. Soils in this watershed are primarily classified as being in hydrologic soil groups A & B, with some D soils.

A summary of the Pre- and Post-Construction Flows for Basin BSH-2 is shown in the table below:

	Pre-Developed	Post-Developed	% Flow Increase
Basin Area (ac)	107.73	107.65	n/a
Composite Curve Number	79.51	81.49	n/a
Time of Concentration (hr)	0.94	0.93	n/a
2-Year Design Storm Flow (cfs)	119.3	129.2	8.25
5-Year Design Storm Flow (cfs)	174.5	185.7	6.38
10-Year Design Storm Flow (cfs)	226.5	238.0	5.08
25-Year Design Storm Flow (cfs)	293.2	305.5	4.21
50-Year Design Storm Flow (cfs)	351.2	362.9	3.34
100-Year Design Storm Flow (cfs)	408.6	421.1	3.06

Basin BSH-1

Analysis Point Location: Immediately upstream of the crossing under the CSX Railroad of an unnamed tributary of the Saluda River.

See Figure D.09 and Figure D.09A in Appendix D for Basin Delineation Maps in Pre-Construction Conditions and Post-Construction Conditions, respectively, as well as Analysis Point location.

Sub-basins within Basin: BSH-2

Basin BSH-1 is comprised of sub-basin BSH-2, as well as the land to the southeast of the Bush River Road / I-20 interchange. Runoff within this basin typically flows to the south, eventually crossing the CSX Railroad and flowing to the Saluda River. The most remote point in the basin is approximately 5,180 feet from the analysis point. Soils in this watershed are primarily classified as being in hydrologic soil group A, with some B, C, & D soils.

A summary of the Pre- and Post-Construction Flows for Basin BSH-1 is shown in the table below:

	Pre-Developed	Post-Developed	% Flow Increase
Basin Area (ac)	149.05	148.98	n/a
Composite Curve Number	81.16	82.85	n/a
Time of Concentration (hr)	1.25	1.23	n/a
2-Year Design Storm Flow (cfs)	148.1	159.0	7.30
5-Year Design Storm Flow (cfs)	213.9	226.0	5.66
10-Year Design Storm Flow (cfs)	275.3	288.4	4.76
25-Year Design Storm Flow (cfs)	353.7	367.7	3.94
50-Year Design Storm Flow (cfs)	421.8	435.9	3.34
100-Year Design Storm Flow (cfs)	488.4	504.3	3.25

5.0

Video Pipe Inventory Survey of Existing Pipes & Culverts

5.1 Video Pipe Inventory Survey of Existing Pipes & Culverts

Mead & Hunt evaluated the conditions of several of the existing pipes in the project area. Reports were produced which include both the findings of the VPI and recommendations for each given pipe. Of those surveyed, box culverts as well as pipes 48" and larger in diameter are included in Phase 2A, and pipes 42" and smaller in diameter are included in Phase 2B.

The pipes to be surveyed were initially identified and scoped based off of as-built plans of previous projects in the area. The stationing in the reports reference the RPA geometry of this project.

A table listing those pipes included in the VPI is shown below.

Carolina Crossroads - Video Inspection Summary - Phase 3C

Culvert ID	RPA Alignment	Station	# Of Barrels	Pipe Size (D or WxH)	Length (ft) per Field Survey	Recommendations for Pipe Based on Video Inspection Report
EC-3201	I20000X	36+45	1	4'x6'	322	Repair / seal cracking or replace existing pipe.
EP-3202	I20000X	41+60	1	18"	274	Slip line or replace existing pipe. Segment C-D (which crosses Riverchase Way), was not inspected due to obstruction. Contractor to verify conditions.
EP-3203	I20000X	46+10	1	18"	153	Slip line or replace existing pipe.
EP-3301	I20000X	55+95	1	18"	254	Remove & replace first 12 LF of existing pipe east of the drop inlet in the Westbound I-20 shoulder. Retain remainder of existing pipe and seal with approved method first pipe joint southeast of the I-20 median inlet.
EP-3302	I20000X	58+85	1	18"	276	Remove & replace existing pipe beneath Riverchase Way between the two drop inlets. Remove & replace first 16 LF of existing pipe west of the outfall in the Eastbound I-20 shoulder. Slip line or replace remainder of existing pipe.
EP-3303	I20000X	48+80	1	18"	142	Replace existing pipe.

EP-3401	I20000X	68+30	1	18"	160	Remove & replace first 16 LF of existing pipe east of the drop inlet in the Westbound I-20 shoulder. Remove & replace first 16 LF of existing pipe west of the outfall in the Eastbound I-20 shoulder. Slip line or replace remainder of existing pipe beneath I-20.
EC-3501	I20000X	77+35	1	6' x 6'	220	Repair / seal cracks or replace.
EP-3502	I20000X	85+80	1	18"	96	Remove & replace first 16 LF of existing pipe eastward of I-20 median inlet. Remove & replace first 24 LF of existing pipe westward from outfall. Slip line or replace remainder of existing pipe.
EC-3701	I20000X	119+70	1	4' x 6'	974	Clear culvert of debris. Grout and seal around in-wall pipe connection at approx. 200 LF from west culvert end. Seal transverse crack at approx. 416 LF from west culvert end. Repair in-wall pipe connection at approx. 560 LF from west culvert end. Replace approx. 20 LF of in-wall pipe and repair connection at approx. 664 LF from west culvert end.

Table 5.1.1: Culverts / Pipes Included in VPI

See Appendix G for VPI reports and Video Inspection Summary table.

6.0

Cross-Line Hydraulic Analysis

6.1 Cross-Line Hydraulic Analysis

STV, Inc. performed a hydraulic analysis of the major drainage crossings. Analyses for those culverts which cross roadways were based on a maximum 1.2 headwater to depth (HW/D) ratio for the 50-year storm event.

The results of the analyses are shown in Appendix H.

The pipes included in the cross-line hydraulic analysis are listed in the table below:

Culvert ID	RPA Alignment	Station
EC-3501	I20000X	77+35
EC-3701	I20000X	119+70

Table 6.1.1: Culverts / Pipes Included in Cross-Line Hydraulic Analysis

7.0

Existing Sites Requiring Contractor Action

7.1 Existing Sites Requiring Contractor Action

A field investigation of the project site was performed over several days in late spring of 2018. The location of those Sites inspected is shown in Appendix B: Plans of Existing Drainage Infrastructure. Photographs and notes from the field investigation are shown in Appendix I: Field Investigation Notes.

Some of the Sites will require some contractor action in order to optimize the overall hydraulic function of the project. They, and the respective recommended action, are listed below.

(Note: This list is based on the RPA geometry, and assumes that each particular Site is to be retained. Subsequent changes to the proposed roadway geometry may render some of the Sites obsolete and in need of replacement or relocation.)

SITE ID	SITE TYPE	RPA ALIGNMENT	RPA STATION	SIDE (LT / RT)	ACTION ITEM
3702	channel	BSHRF1P	4124+90	LT	The channel will need some realignment according to RPA geometry.

Table 7.1.1: Existing Sites Requiring Contractor Attention

8.0

HEC-RAS Analysis

8.1 Saluda River Bridges

The existing I-20 and I-26 Bridges over the Saluda River were studied (based on the available data) to determine the feasibility of retaining the existing bridge geometry and to also determine the extent of improvements necessary for compliance with SCDOT Requirements.

The I-20 and I-26 Bridges are located downstream of Lake Murray and the Saluda River Dam, which regulates flow within the Saluda River before its confluence with the Broad River to form the Congaree River. Preliminary hydraulic models were obtained from Richland and Lexington County to complete the assessment of the existing bridges. A summary of the provided data is below:

- Richland County: Preliminary HEC-RAS study for FIS dated December 21, 2017. FIRM Panel No. 45079C0238L
- Lexington County: Effective HEC-2 model output data dated May 1991. Preliminary FIRM Panel No. 45063C0163J (I-26) and 45063C0144J (I-20)

The preliminary models were updated based on aerial mapping and surveys within the vicinity of the bridges. The bridge modeling techniques utilized in HEC-2 were updated for use in HEC-RAS version 4.1.0. The Lexington County and Richland County models were combined to study the effects of the river conditions on both bridges. Bridge geometry was updated based on existing bridge plans and field investigations.

Peak discharges were studied based on available USGS Gage Site No. 02169000: SALUDA RIVER NEAR COLUMBIA, SC. This gauge is Site 5203, and is located downstream of I-26 and known release rates from the Saluda River Dam operated by South Carolina Electric & Gas. Peak discharges for the 2015 flood event were approximately 56,000 cfs at the Saluda River Dam and 60,800 cfs at USGS Gage 02169000. Peak discharges were compared with the FEMA published flows and known flooding events. The FEMA provided flows in the Preliminary Richland County Flood Insurance Study are comparable to the observed flows for the 2015 flood event. The flows used for this analysis are provided below.

Design Storm	Richland County FIS Flow (cfs)
10	29,600
25	39,400
50	48,300
100	58,600
500	89,900

The HEC-RAS model was used to study the existing bridges along the Saluda River and calibrated using known flooding information from the October 2015 flood. The existing conditions model indicated that the I-26 Bridge experiences pressure flow conditions for the design storm, with the resulting water surface elevation reaching the low chord of the bridge. The October 2015 flood resulted in the closure of the I-26 Bridge for several days due to flood waters reaching the top of the pile caps.

The existing bridge study results are shown below for both the I-26 and the I-20 bridges over the Saluda River.

<u>I-26</u>
50-Year Storm HW Elev. = 177.49 (NAVD 88)
Q_{50} = 48,300 cfs
$Vel._{50}$ = 4.91 ft/s
100-Year Storm HW Elev. = 179.16
Q_{100} = 58,600 cfs
$Vel._{100}$ = 5.83 ft/s

<u>I-20</u>
50-Year Storm HW Elev. = 182.60 (NAVD 88)
Q_{50} = 48,300 cfs
$Vel._{50}$ = 5.15 ft/s
100-Year Storm HW Elev. = 184.54
Q_{100} = 58,600 cfs
$Vel._{100}$ = 5.58 ft/s

Minimum bridge low chord elevations were set based on the information above assuming the same bridge opening area as the existing conditions. The minimum bridge low chord elevations are listed below.

Bridge	Minimum Low Chord (NAVD 88)	Existing Low Chord (NAVD 88)
I-26	179.49	176.82
I-20	184.60	187.42

The analysis of the Saluda River indicates that the I-20 Bridge has sufficient freeboard for the design storm based on FEMA published flow rates and it is recommended that the existing low chord be maintained at a minimum. The I-26 Bridge does not currently meet SCDOT design criteria for riverine bridges based on the study. The I-26 Bridge should be raised approximately, 2.67 feet, at a minimum to satisfy SCDOT design criteria based on the FEMA published flows.