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Memo

Project: SCDOT CLRB Package 21

Subject: Preliminary Hydraulics Analysis

Route: Little Choestoea Rd. (S-37-168) Bridge over Tributary to Choestoea Creek

Date: April 21, 2025

To: SCDOT

HNTB is providing a preliminary hydrologic and hydraulic assessment of the Bridge Replacement along (S-37-168) Little Choestoea Rd. in Oconee County, South Carolina. Little Choestoea Rd. is designated as a Secondary Route and provides access to residential and rural areas. The Flood Insurance Study (FIS) for Oconee County and Flood Insurance Rate Map (FIRM) Panel No. 45073C0420C (attached) indicates the project is not located in a Special Flood Hazard Zone.

Model Setup:

There was no existing model flow file for the 2-Yr, 10-Yr, 25-Yr, 50-Yr, and 500 Yr. events for the Tributary to Choestoea Creek therefore one was created based off the USGS Streamstats and used for the existing and proposed plans. USGS flows were compared to SCS hydrograph method, Streamstats (USGS) flows were more conservative and used for the study. The comparison of flows between the SCS Method and the USGS flows that were used for this analysis are shown below.

Design Event (% AEP)	SCS Unit Hydrograph (CFS)	Streamstats USGS Flows (CFS)
2 YR (50% AEP)	185	218
10 YR (10% AEP)	442	521
25 YR (4% AEP)	599	705
50 YR (2% AEP)	738	868
100 YR (1% AEP)	875	1030
500 YR (0.2% AEP)	1199	1410

HEC-RAS V. (Version) 6.3.1 was used in creating the riverine plans, flow file, and geometry for the Tributary to Choestoea Creek. The existing structure dimensions were created from site visits, publicly available LiDAR, and project surveys provided by SCDOT. The model extends approximately 940 feet upstream perpendicular to Shady Grove Ln. and approximately 1,200 feet downstream perpendicular to Brent Thrift Dr. The Manning's roughness values for the channel and floodplain areas in the vicinity of the bridge were set as 0.14 for wooded areas, 0.045 for the hydraulic channel, and 0.03 for open grassed areas based on aerial photography, and the procedure outlined in the SCDOT Requirements for Hydraulic Design Studies.

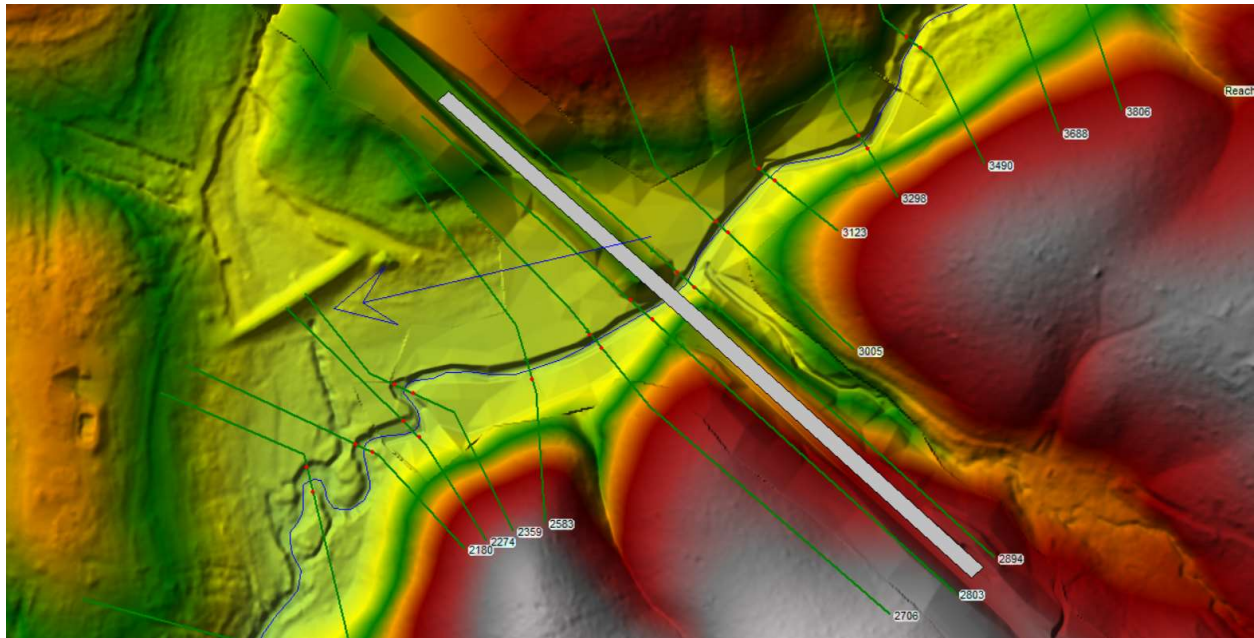


Figure 1: Tributary to Choestoea Creek Model Layout (S-37-168)

A sensitivity analysis was completed on the existing conditions model to verify the extents of the model. The analysis was performed by revising the downstream boundary conditions +/- 3-ft and comparing the resulting water surface elevations near the bridge location. The results of the sensitivity analysis are shown below.

100-Year (1% AEP) Water Surface Elevations-Sensitivity Analysis			
RS	Natural WSE (ft)	+3 Sensitivity (ft)	-3 Sensitivity (ft)
<i>Little Choestoea Rd. (BS 2844)</i>			
2803	731.79	731.78	731.79
2706	730.74	730.74	730.74
2583	729.16	729.16	729.17
2359	728.19	728.20	728.19
2274	727.86	727.88	727.86
2180	727.26	727.37	727.21
1960	725.64	726.84	726.01
1640	723.55	726.55	722.43*

*WSE defaulted to Critical W.S.

The sensitivity analysis indicates that the model has sufficient downstream length to negate any negative effects of fluctuations in the downstream boundary condition at the bridge site (*BS 2844*). -3 and +3 Sensitivity ties into model at *RS 2706*

Design Criteria:

Based on the Flood Insurance Study (FIS) for Oconee County and Flood Insurance Rate Map (FIRM) Panel Number 45073C0420C the project is not located in a Special Flood Hazard Area. As such the bridge will be designed based on the following criteria:

1. The minimum low chord elevation shall be the 25-year (4.0% AEP) water surface elevation plus 2-ft of freeboard.
2. The 100-year (1% AEP) low chord should be set per other hydraulic requirements.
3. The backwater for the 100-year (1% AEP) design event is one (1) foot or less when compared to the unrestricted or natural conditions or that the proposed bridge does not create more backwater than the existing bridge.

Existing Bridge Analysis:

The existing bridge consists of seven (7) 15-ft spans for a total length of approximately 105-ft and is a concrete slab bridge supported by 12-in (1-ft) timber piles over a sandy/gravel channel. The out-to-out width was taken from *SCDOT's Bridge Inspection Form* as 27.60-ft. Ineffective flows upstream and downstream of the proposed bridge were set based approximately on 1.5:1 expansion and 1:1 contraction ratio.

The existing bridge's lowest low chord was estimated around elevation 752.53' based on the project surveys and existing bridge plans.

Preliminary Bridge Analysis:

A 1@ 100', 33" box beam and 1 @ 60', 21" cored slab bridge with a total length of 160-ft and out-to-out width of 30' (12-ft lanes) was assumed for the preliminary design/analysis to span the stream. The bridge consists of a single pier which measures 3' in diameter.

Ineffective flows upstream and downstream of the proposed bridge were set around 1.5:1 expansion and 1:1 contraction ratios and sloping abutments were added. The Little Choestoea Rd. crossing is located at BS 2844.

The table below shows the resulting water surface elevations in the project area for the existing and proposed preliminary bridge for the 25-year (4% AEP) event.

25- Year (4% AEP) Design Event			
RS	Existing Conditions 105' Bridge WSE (ft)	Preliminary Proposed 160' Bridge WSE (ft)	Difference (ft)
3806	743.58	743.58	0.00
3688	742.68	742.68	0.00
3490	739.66	739.66	0.00
3298	735.61	735.61	0.00
3123	733.78	733.75	-0.03
3005	732.81	732.60	-0.21
2894	732.60	732.27	-0.33
<i>Little Choestoea Rd. (BS 2844)</i>			
2803	731.06	731.06	0.00
2706	730.04	730.04	0.00
2583	728.53	728.53	0.00
2359	727.43	727.43	0.00
2274	727.16	727.16	0.00
2180	726.62	726.62	0.00
1960	724.96	724.96	0.00
1640	722.84	722.84	0.00

The resulting water surface elevation upstream of the bridge was used to check the required minimum bridge low chord elevation for the preliminary bridge vs the existing low chord elevation.

Min. Low Chord (preliminary) = $732.27 + 2.0\text{-ft freeboard} = 734.27 \leq$ existing low chord of 752.53.

Based off the proposed roadway profile, a low chord of $\approx 753.92'$ was used for the design. The preliminary low chord was raised from the existing low chord by approximately 1.39'.

In addition to the freeboard requirement, the SCDOT Requirements for Hydraulic Design Studies, states that the proposed bridge must not be subject to pressurized flow for the 100-year design event and produce less than 1' of backwater over natural (unrestricted) conditions or that the proposed bridge does not create more backwater than the existing bridge. The resulting water surface elevations along the stream are presented below. Proposed improvements dropped backwater from 0.77' to 0.19' which meets SCDOT standard.

100- Year (1% AEP) Design Event			
RS	Natural WSE (ft)	Existing Conditions 105' Bridge WSE (ft)	Preliminary Proposed 160' Bridge WSE (ft)
3806	744.25	744.25	744.25
3688	743.16	743.16	743.16
3490	740.53	740.53	740.53
3298	736.54	736.54	736.54
3123	734.79	734.75	734.76
3005	733.19	733.73	733.30
2894	732.83	733.60	733.02
<i>Little Choestoea Rd. (BS 2844)</i>			
2803	731.79	731.79	731.79
2706	730.74	730.74	730.74
2583	729.16	729.16	729.16
2359	728.19	728.19	728.19
2274	727.86	727.86	727.86
2180	727.26	727.26	727.26
1960	725.64	725.64	725.64
1640	723.55	723.55	723.55

The 100-year (1.0% AEP) event was investigated to determine the viability of setting the proposed low chord below the existing water surface elevation. To maintain the existing roadway grades with the increased structure height, the preliminary minimum low chord elevation was higher than the 100-yr WSEL.

The existing and proposed 100-year backwater along with the low chord criteria checks are summarized in the following table.

Design Criteria Summary (WSEs at RS 2894)							
Prelim. Bridge (4% AEP) WSE (ft)	Minimum Required Freeboard (ft)	Prelim. Bridge Min. Low Chord (ft)	Existing Low Chord Elevation (ft)	Prelim. Bridge (1% AEP) WSE (ft)	Prelim. (1% AEP) Backwater (ft)	Existing (1% AEP) Backwater (ft)	100-Year (1.0% AEP) WSE Check (ft)
732.27'	2	734.27'	752.53'	733.02'	0.19'	0.77'	733.02' < LC

The preliminary bridge configuration meets the SCDOT design criteria for backwater and is an improvement from the 0.77-ft backwater that the existing is currently showing. The proposed roadway profile grade is raised about 3' and the preliminary low chord meets the 2' of freeboard requirement from the 25-year event.

Design Considerations:

The preliminary bridge opening conveys the 100-year (1.0% AEP) event below the low chord of the bridge with approximately 20.90-ft of freeboard between the water surface and the proposed low chord. There is approximately 21.65-ft of freeboard between the water surface and proposed low chord for the 25-year (4% AEP). There is no skew with the bridge and the angle of the bridge is 90 degrees. Based off the proposed roadway grade, the proposed low chord for the bridge is around 753.92', with bench elevations of 757' on the LOB & 749' on the ROB, one pier (meets offset from existing piers), and 5' abutment setbacks based off of the *"Supplemental Design Criteria For Low Volume Bridge Replacement Projects."* For the 100-year, existing velocities within the bridge section max at 8.29 fps and the proposed bridge produces a 100-year velocity of 8.24 fps. Rip rap abutment protection is recommended for the final design. Contraction scour would be limited based on observation from the field visit.