



Memo

Project: SCDOT CLRB Package 21

Subject: Preliminary Hydraulic Analysis

Route: Road S-42-197 (Old Spartanburg Hwy.) Bridge over South Tyger River (Asset ID 5624)

Date: April 17, 2025

To: SCDOT

McCormick Taylor is providing preliminary hydrologic and hydraulic assessment of the South Tyger River Bridge Replacement along Road S-42-197 (Old Spartanburg Hwy.) in Spartanburg County, South Carolina. Old Spartanburg Highway in the vicinity of South Tyger River is designated as a Secondary Route and provides access to residential and rural areas. The Flood Insurance Study (FIS) for Spartanburg County and Flood Insurance Rate Map (FIRM) Panel No. 45083C0359D (attached) indicates the project is located in a Special Flood Hazard Area Zone AE with regulatory floodway.

Model Setup:

A HEC-RAS model was provided by the SCDOT for South Tyger River. However, the vicinity of the S-197 bridge was not included in the model extents. Therefore, HEC-RAS v6.5 was used to construct the existing conditions, unrestricted conditions, and proposed conditions models using publicly available LiDAR and surveys provided by SCDOT. The model extends approximately 5,800 feet downstream and approximately 400 feet upstream of the bridge. The main channel roughness was assumed to be $n=0.04$. Manning's roughness in the floodplain was determined by land cover from the 2019 USGS National Land Cover Database.

The USGS Rural and Urban regression equations using the StreamStats web application was used to estimate flow rates for a drainage area of 135 square miles at the bridge. The SCS Unit Hydrograph method was used to develop the watershed flows using land cover and soils data from the NLCD and USDA, respectively, to compare with the USGS flow rates. The flows used for this analysis are shown in Table 1. The USGS flows were used for the analysis.

Table 1: Comparison of flows

Design Event (% AEP)	FEMA Effective (cfs)	SCS Unit Hydrograph (cfs)	USGS StreamStats (cfs)
2 YR (50% AEP)	-	3,952	3,580
10 YR (10% AEP)	-	8,892	7,730
25 YR (4% AEP)	-	12,889	10,100
50 YR (2% AEP)	-	16,573	12,200
100 YR (1% AEP)	10,217	21,284	14,100
500 YR (0.2% AEP)	-	-	18,800

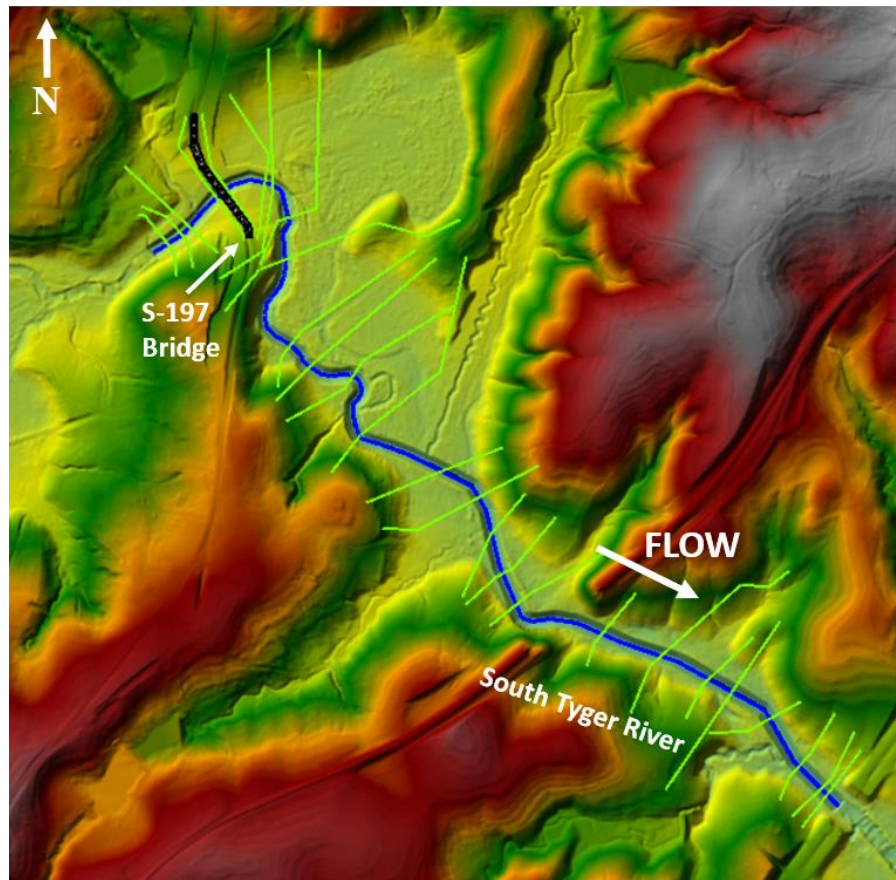


Figure 1: South Tyger River model layout (S-42-197)

A sensitivity analysis was completed on the unrestricted 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 (RS 5790). The results of the sensitivity analysis are shown below.

Table 2: Sensitivity analysis

100-Year (1% AEP) Water Surface Elevations – Sensitivity Analysis			
RS	Unrestricted WSE (ft)	+3-ft WSE (ft)	-3-ft WSE (ft)
6207	574.86	574.85	574.84
6111	574.75	574.73	574.73
6051	574.52	574.50	574.50
5831	574.29	574.27	574.26
5790	S-42-197 Bridge		
5750	574.22	574.20	574.19
5524	574.60	574.58	574.57
5473	574.62	574.61	574.60
5264	574.58	574.56	574.56
5017	574.16	574.14	574.14
4441	574.09	574.07	574.06
4271	574.01	573.99	573.98
4018	573.95	573.93	573.92
3638	573.84	573.81	573.80
3139	573.51	573.49	573.48
2878	573.31	573.28	573.27
2659	573.01	572.98	572.97
2428	572.60	572.57	572.56
2237	572.53	572.50	572.48
1685	570.90	570.86	570.83
1338	570.90	570.86	570.84
1039	570.22	570.17	570.14
893	570.27	570.21	570.19
630	568.78	568.68	568.63
315	567.40	567.22	567.14
141	563.12	565.90	*563.68
93	*563.12	566.12	*563.12

*Flow depth defaulted to critical depth

The sensitivity analysis indicates that the model has sufficient downstream length to negate any effects of fluctuations in the downstream boundary condition to the water surface elevations at the project site.

Design Criteria:

Old Spartanburg Hwy. is classified as a secondary route. Secondary route crossings should be designed based on the 25-year design event as indicated in the *SCDOT Requirements for Hydraulic Design Studies*. Based on the Flood Insurance Study (FIS) for Fairfield County and Flood Insurance Rate Map (FIRM) Panel No. 45083C0359D the project is located in a Special Flood Hazard Area Zone AE. The bridge will therefore be designed based on the following criteria:

1. The minimum low chord elevation shall be the 25-year (4% AEP) water surface elevation plus 2-ft of freeboard.
2. The 100-year (1% AEP) should not overtop, while maintaining free-surface flow.
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.
4. The proposed bridge should not create more backwater than the existing bridge.

It is preferred by the SCDOT that all structures and roadway components meet the requirements for a finding of “No Impact”. The S-197 bridge over South Tyger River is located within a FEMA Flood Zone AE with floodways. Thus there can be no increase in the 1% AEP flood profile and floodway width at published and unpublished cross sections.

Existing Bridge Analysis:

The existing bridge consists of seven (7) 15 ft end spans and a three (3) 30 ft main channel spans for a total bridge length of 195 ft. The bridge had a breadth of 27.5 ft and a deck thickness of 2.7 ft, supported by 1.167 ft diameter treated timber piers with concrete caps. Ineffective flows upstream and downstream of the proposed bridge were set based on assumed 1.5:1 expansion and 1:1 contraction ratio.

The existing roadway profile was extracted from surveys provided by SCDOT. Based on the project surveys and existing bridge plans, the existing bridge low chord was estimated to be 574.17.

Preliminary Bridge Analysis:

A three-span bridge with total length 210 ft is proposed consisting of a 100-ft central box beam span across the main channel and a cored slab span on each side (50 ft and 60 ft). The preliminary bridge has a width of 36 ft and the low chord was set to an elevation of 575.18. The Road S-42-197 crossing is located at RS 5790.

Ineffective flows upstream and downstream of the proposed bridge were set based on assumed 1.5:1 expansion and 1:1 contraction ratios and sloping abutments were added.

Table 3 shows the resulting water surface elevations in the project area for the existing and preliminary bridge for the 25-year (4% AEP) event.

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.

Existing minimum low chord $(574.17) < 572.32 + 2.0 \text{ ft F.B.}$

Proposed minimum low chord $(575.18) > 572.24 + 2.0 \text{ ft F.B.}$

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. The resulting water surface elevations along the stream are presented in Table 4.

Table 3: 25-year design event water surface elevations

25-Year (4% AEP) Design Event			
RS	Existing 195' Bridge WSE (ft)	Preliminary 210' Bridge WSE (ft)	Difference (ft)
6207	572.91	572.83	-0.08
6111	572.81	572.73	-0.08
6051	572.63	572.55	-0.08
5831	572.32	572.24	-0.08
5790	Road S-42-197		
5750	571.67	571.66	-0.01
5524	571.87	571.87	0.00
5473	571.91	571.91	0.00
5264	571.85	571.85	0.00
5017	571.42	571.42	0.00
4441	571.27	571.27	0.00
4271	571.19	571.19	0.00
4018	571.11	571.11	0.00
3638	570.97	570.97	0.00
3139	570.65	570.65	0.00
2878	570.39	570.39	0.00
2659	570.19	570.19	0.00
2428	569.76	569.76	0.00
2237	569.60	569.60	0.00
1685	568.22	568.22	0.00
1338	568.13	568.13	0.00
1039	567.43	567.43	0.00
893	567.42	567.42	0.00
630	565.63	565.63	0.00
315	564.04	564.04	0.00
141	561.05	561.05	0.00
93	560.81	560.81	0.00

Table 4: 100-year water surface elevations and backwater comparison

100-Year (1% AEP) Design Event					
RS	Natural WSE (ft)	Existing 195' Bridge WSE (ft)	Existing Backwater (ft)	Preliminary 210' Bridge WSE (ft)	Preliminary Backwater (ft)
6207	574.90	575.79	+0.89	575.59	+0.69
6111	574.79	575.70	+0.91	575.50	+0.71
6051	574.56	575.53	+0.97	575.32	+0.76
5831	574.34	575.38	+1.04	575.15	+0.81
5790	Road S-42-197				
5750	574.27	574.42	+0.15	574.28	+0.01
5524	574.65	574.62	-0.03	574.62	-0.03
5473	574.67	574.65	-0.02	574.65	-0.02
5264	574.63	574.61	-0.02	574.61	-0.02
5017	574.22	574.19	-0.03	574.19	-0.03
4441	574.14	574.11	-0.03	574.11	-0.03
4271	574.07	574.04	-0.03	574.04	-0.03
4018	574.01	573.98	-0.03	573.98	-0.03
3638	573.89	573.86	-0.03	573.86	-0.03
3139	573.57	573.54	-0.03	573.54	-0.03
2878	573.37	573.34	-0.03	573.34	-0.03
2659	573.08	573.05	-0.03	573.05	-0.03
2428	572.68	572.64	-0.04	572.64	-0.04
2237	572.61	572.57	-0.04	572.57	-0.04
1685	571.02	570.96	-0.06	570.96	-0.06
1338	571.02	570.97	-0.05	570.97	-0.05
1039	570.37	570.31	-0.06	570.31	-0.06
893	570.41	570.34	-0.07	570.34	-0.07
630	569.04	568.92	-0.12	568.92	-0.12
315	567.81	567.63	-0.18	567.63	-0.18
141	562.58	562.28	-0.30	562.28	-0.30
93	562.94	562.86	-0.08	562.86	-0.08

The FEMA floodway analysis is summarized in Table 5. The existing and proposed 100-year backwater along with the low chord criteria checks are summarized in Table 6.

Table 5: FEMA floodway summary

FEMA 100-Year (1% AEP) Floodway Summary								
RS	FEMA Lettered XS	Effective BFE	Existing FEMA Floodway WSE	Proposed FEMA Floodway WSE	Difference in WSE	Existing FEMA Floodway Width (ft)	Proposed Floodway Width (ft)	Difference in Width (ft)
6207			573.33	573.22	-0.11	173	173	0.00
6111			573.23	573.11	-0.12	179	179	0.00
6051	BC	578.20	573.11	572.99	-0.12	190	190	0.00
5831			572.87	572.75	-0.12	255	255	0.00
5790	Road S-42-197							
5750			572.16	572.15	-0.01	226	226	0.00
5524			571.83	571.83	0.00	263	263	0.00
5473	BB	577.90	571.91	571.91	0.00	300	300	0.00
5264			571.91	571.91	0.00	429	429	0.00
5017	BA	577.80	571.74	571.74	0.00	480	480	0.00
4441			571.54	571.54	0.00	698	698	0.00
4271	AZ	577.60	571.46	571.46	0.00	665	665	0.00
4018			571.37	571.37	0.00	621	621	0.00
3638	AY	577.60	571.24	571.24	0.00	650	650	0.00
3139	AX	577.40	570.92	570.92	0.00	410	410	0.00
2878			570.45	570.45	0.00	299	299	0.00
2659	AW	577.10	570.37	570.37	0.00	280	280	0.00
2428			569.98	569.98	0.00	271	271	0.00
2237			569.74	569.74	0.00	278	278	0.00
1685			568.45	568.45	0.00	179	179	0.00
1338	AV	576.50	568.35	568.35	0.00	212	212	0.00
1039			567.46	567.46	0.00	219	219	0.00
893	AU	576.40	567.39	567.39	0.00	212	212	0.00
630			565.61	565.61	0.00	179	179	0.00
315			564.14	564.14	0.00	210	210	0.00
141			561.10	561.10	0.00	228	228	0.00
93	AT	575.80	560.87	560.87	0.00	220	220	0.00

Since the S-42-197 bridge is located within a regulatory floodway, to meet the FEMA “No Impact” criteria there cannot be an increase in the 1% AEP flood and floodway profiles. Additionally, there can be no increase in floodway width at published and unpublished cross sections. There was no increase in the water surface elevation for the 1% AEP for the preliminary bridge in both the flood and floodway profiles. The preliminary bridge also did not cause any changes to floodway widths at published or unpublished cross sections therefore, the model supports a finding of “No Impact”.

Table 6: Design criteria summary

Design Criteria Summary							
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 Bridge (1% AEP) Backwater (ft)	Existing (1% AEP) Backwater (ft)	500-Year (0.2% AEP) WSE Check (ft)
572.24	2.0	575.18	574.17	575.15	+0.81	+1.04	578.01

The preliminary bridge configuration meets SCDOT design criteria for freeboard based and the requirement of 1 ft maximum increase in water surface elevations when compared to natural (unrestricted) conditions. The results of the preliminary bridge analysis support the finding of “No-Impact” in accordance with the SCDOT Requirements for Hydraulic Design Studies and HDB 2019-4. The preliminary bridge low chord elevation is controlled by the roadway grade and structure depth.

Design Considerations:

Scour protection should be provided on both abutments and scour potential due to flow contraction as well as local scour at internal bents should be evaluated and included with the final design. Additionally, upstream of the crossing to the northwest is a residential community. Care should be taken in design to avoid adverse flood impacts to the community.

In the preliminary analysis, channel bathymetry downstream of the survey limits was approximated using published LiDAR, FEMA Flood Insurance Study (FIS) report profiles, and channel characteristics within the surveyed area. Consideration should be made as to the need for additional bathymetric survey to support design calculations.

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