

FINAL REPORT

Appendix D Fairfax County Stormwater Planning Hydraulic Model Memorandum

**Appendix D FAIRFAX COUNTY STORMWATER PLANNING
HYDRAULIC MODEL MEMORANDUM**





County of Fairfax, Virginia

MEMORANDUM

DATE: December 3, 2020

TO: File

FROM: Joni Calmbacher, Project Manager II *JMC*
Watershed Projects Implementation Branch - South
Stormwater Planning Division

SUBJECT: Stormwater Planning Division Hydraulic Model Runs for Tripps Run at Barrett Road Flood Mitigation Study

Background:

A section of Barrett Road along Tripps Run is an area of historic flooding that has also been identified as one of the County's twenty-one repetitive loss areas based on FEMA's list of properties that have experienced repetitive loss from flooding. The general area encompasses a 3,700 linear foot segment of Tripps Run and adjacent properties between Annandale Road and Sleepy Hollow Road.

In March 2020, the county authorized a task order for Stantec Consulting Services, Inc. (Stantec) to analyze and develop conceptual designs for two flood mitigation scenarios. These scenarios included the acquisition of flood-prone properties along with restorative stream enhancements to develop an environmental corridor. In July 2020, another task order was authorized for Stantec to evaluate and analyze two additional scenarios that did not involve property acquisition to ensure that these logical alternatives were preliminarily evaluated and documented, rather than assumed to be ineffective options and dismissed.

Part of Stantec's scope was to develop an existing conditions hydraulic model using HEC-RAS. The modeling results indicated that during the 1-percent annual chance storm event, the bridge at Sleepy Hollow Road constricted flow, resulting in a large volume of water ponding upstream of the bridge. Investigation of alterations to the bridge at Sleepy Hollow Road was not included in Stantec's authorized scope. The bridge is owned by VDOT and classified as a minor arterial road; therefore, any modification to the bridge would involve a complex and lengthy design and coordination process. Nevertheless, staff recognized the need to obtain a more concrete understanding of the bridge's impact before completely dismissing the possibility of a bridge modification. Using Stantec's developed model, staff conducted an internal model run with the Sleepy Hollow bridge deck completely removed so that water surface elevations (WSELs) with and without the bridge deck could be compared.

Additionally, staff speculated whether the 1-percent annual chance storm event could be contained within the channel if there were only minimal constraints related to channel enlargement. Upstream of Annandale Road, Tripps Run flows through a 35-foot wide concrete-

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lined trapezoidal channel. As a result, staff also developed several model runs that incorporated concrete channels of various volume capacities with the goal of conveying the 1-percent annual chance storm event within the channel.

The scenarios presented in this memorandum were performed in an attempt to exhaust all relatively reasonable potential mitigation efforts to reduce flooding along the Tripps Run project corridor.

Modeling:

The hydraulic modeling for the scenarios presented in this memorandum was completed using HEC-RAS 5.0.7 and subcritical flow. The base model used was developed by Stantec for the Tripps Run at Barrett Road Flood Mitigation study. The model developed by Stantec was based on the hydraulic modeling obtained from the FEMA study of Tripps Run completed in 2017. This model will be released as part of the FEMA preliminary map products in December of 2020. Updates were made to the FEMA model to ensure adequate detail to provide a comparison between the flood mitigation scenarios. For a list of the updates, please see Stantec's report entitled *Flood Mitigation along Tripps Run near Barrett Road*. The model incorporates the effective FEMA discharges (FEMA, 2010), which are based on a model developed using the Massachusetts Institute of Technology catchment model (MITCAT) to determine discharges (Harley 1975).

Removal of Sleepy Hollow Bridge Deck:

The model that removed the bridge deck at Sleepy Hollow Road was completed by deleting the bridge deck/roadway data in the HEC-RAS model. The upstream and downstream approach and exit cross-sections remained in the model to ensure a straightforward comparison to the existing conditions model.

Increased Channel Size:

The model that included incorporation of concrete channels of varying widths (three different scenarios) in an attempt to contain the 1-percent annual chance storm event was completed by creating a typical channel section with a specified width of 70 or 100 feet, a depth of 10 feet, and near vertical sides. In two of the three scenarios floodplain grading and the removal of the Holloway Road Bridge was included. The existing terrain dictated where the typical channel was placed in the cross-section. Existing invert elevations remained the same for proposed conditions.

Results:

Comparison tables presenting the results for these model runs can be found attached to this memorandum. All documented WSELs are associated with the 1-percent annual chance storm event.

Removal of Sleepy Hollow Bridge Deck:

The removal of the Sleepy Hollow Road bridge deck decreases the 1-percent annual chance WSEL by over 5 feet just upstream of its former location. As expected, the elevation decrease resulting from the deck removal diminishes in the upstream direction. At a location just upstream of Holloway Road, approximately 2,000 feet upstream of Sleepy Hollow Road, the difference between the base conditions and deck removal profiles is only 1-inch. (See Table 1 for the WSEL comparison and Figure 1 for the associated profile.)

Scenario Description	Result
100-ft wide Concrete Channel without any Floodplain Grading	Maximum decrease compared to existing conditions is 7.5 ft just downstream of Annandale Road. Of the residential structures between Annandale Road and Sleepy Hollow Road in the existing 1-percent annual chance floodplain, approximately 50% would remain within the floodplain or the channel would be extremely close to the structure.
70-ft wide Concrete Channel with Floodplain Grading (with grading similar to Scenario 4 in the Stantec Report) and the Holloway Road Bridge Removed	Maximum decrease compared to existing conditions is 7.0 ft at a location 450 feet downstream of Annandale Road. Of the residential structures between Annandale Road and Sleepy Hollow Road in the existing 1-percent annual chance floodplain, approximately 50% would remain within the floodplain or be acquired for grading.
100-ft wide Concrete Channel with Floodplain Grading (with grading similar to Scenario 4 in the Stantec Report) and the Holloway Road Bridge Removed	Maximum decrease compared to existing conditions is 8.1 ft just downstream of Annandale Road. Of the residential structures between Annandale Road and Sleepy Hollow Road in the existing 1-percent annual chance floodplain, approximately 50% would remain within the floodplain or be acquired for grading.

Increased Channel Size:

Three different channel geometry versions or scenarios were used to evaluate the impact converting the project section of Tripps Run between Annandale Road and Sleepy Hollow Road to a concrete lined channel:

See Tables 2 and 3 for resultant WSELs and comparison to existing conditions.

Conclusion:

Removal of Sleepy Hollow Bridge Deck:

The most at-risk properties, the ones which experienced a significant amount damage after the July 2019 and July 2020 storm events, are just upstream of Holloway Road. Since only a 1-inch

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difference in WSEL is seen at this location, the associated benefit of the deck removal would be categorized as low. Any modification and/or elevation of the Sleepy Hollow bridge would be a substantial cost.

Increased Channel Size:

The purpose of these scenarios was to determine a channel size that would contain the 1-percent annual chance storm event. Several different scenarios were evaluated and none of them resulted in the channel containing the volume of water necessary to prevent flooding of adjacent residential structures. Even with a 100-ft wide channel and adjacent floodplain grading, residential structures would remain within the 1-percent annual chance floodplain based on county obtained elevation certificates and floodplain boundary mapping. In addition, numerous other constraints would impact the ability to construct a 70 or 100-ft wide channel. The width would be significantly wider than the existing channel upstream of Annandale Road (35-ft), require additional easements, substantially impact adjacent properties, and likely result in increased downstream velocities and discharges that could negatively impact downstream properties. A channel of this size would be out of place in a residential neighborhood and unlikely to receive support. Design and construction would have a considerable price tag and it is anticipated that the associated costs would outweigh the benefits, not to mention the ecological degradation associated with a concrete trapezoidal channel.

Attachment(s): As stated

cc: Craig Carinci, Director, Stormwater Planning Division (SWPD), Department of Public Works and Environmental Services (DPWES)
Emma Gutzler, Branch Chief, Watershed Projects Implementation Branch-South, SWPD, DPWES

TABLE 1: EXISTING VS. REMOVAL OF SLEEPY HOLLOW BRIDGE DECK COMPARISON TABLE

1%-Annual-Chance Water Surface Elevations (NAVD88)

Station	Existing Conditions (ft)	Removal of Sleepy Hollow Road Bridge Deck (ft)	Difference (ft)
11807		<i>Annandale Road</i>	
11749	246.32	246.31	0.01
11570	244.67	244.67	0.00
11353	243.47	243.46	0.01
11210	243.05	243.04	0.01
11032	242.79	242.77	0.02
10853	241.96	241.93	0.03
10763	241.93	241.89	0.04
10563	240.71	240.65	0.06
10398	240.27	240.19	0.08
10277	239.84	239.75	0.09
10222		<i>Holloway Road</i>	
10170	238.23	237.96	0.27
10099	237.89	237.53	0.36
9982	237.84	237.45	0.39
9727	236.35	235.17	1.18
9454	235.86	234.08	1.78
9055	235.36	232.00	3.36
8630	235.21	231.24	3.97
8410	235.16	231.07	4.09
8199	234.72	229.26	5.46
8159		<i>Sleepy Hollow Road</i>	
8103	228.93	228.93	0.00
7960	227.03	227.03	0.00

FIGURE 1: EXISTING VS. REMOVAL OF SLEEPY HOLLOW BRIDGE DECK COMPARISON PROFILE

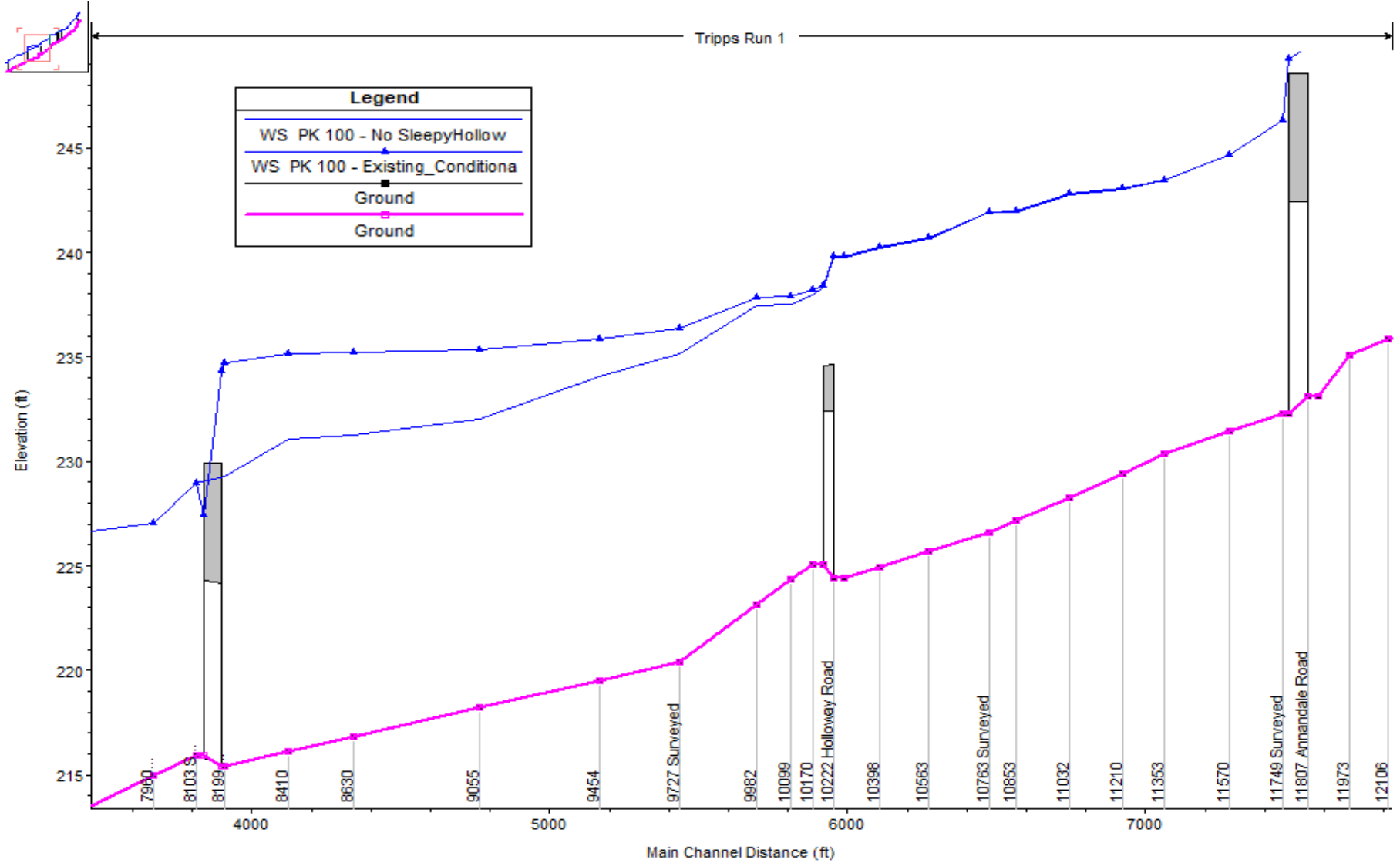


TABLE 2: INCREASED CHANNEL SIZE RESULTS TABLE

1%-Annual-Chance Water Surface Elevations (NAVD88)

Station	Existing Conditions	100-ft Wide Channel w/o Floodplain Grading	Scenario 4 Floodplain Grading, Stream Enhancements	70-ft Wide Channel with FP Grading, w/o Holloway Bridge	100-ft Wide Channel with FP Grading, w/o Holloway Bridge
11807	<i>Annandale Road</i>				
11749	246.32	238.74	245.9	240.31	238.25
11570	244.67	238.01	244.69	239.42	237.55
11353	243.47	237.27	240.75	236.43	236.11
11210	243.05	236.96	238.74	236.45	235.96
11032	242.79	236.7	238.5	236.48	235.95
10853	241.96	236.52	238.32	236.33	235.83
10763	241.93	236.45	238.17	236.16	235.69
10563	240.71	236.3	237.81	236.02	235.58
10398	240.27	236.21	237.75	236.01	235.58
10277	239.84	236.14	237.69	235.97	235.55
10222	<i>Holloway Road</i>	<i>Holloway Road*</i>	<i>No Bridge</i>	<i>No Bridge</i>	<i>No Bridge</i>
10170	238.23	235.40	237.65	235.94	235.53
10099	237.89	235.37	237.62	235.92	235.52
9982	237.84	235.36	237.6	235.91	235.5
9727	236.35	235.22	236.27	235.27	235.22
9454	235.86	235.17	235.86	235.2	235.17
9055	235.36	235.12	235.35	235.11	235.12
8630	235.21	235.12	235.21	235.11	235.12
8410	235.16	235.11	235.16	235.11	235.11
8199	234.72	234.72	234.72	234.72	234.72
8159	<i>Sleepy Hollow Road</i>				
8103	228.93	228.93	228.93	228.93	228.93
7960	227.03	227.03	227.03	227.03	227.03

*Bridge altered to span the channel, but not elevated

**Removed for floodplain grading

TABLE 3: INCREASED CHANNEL SIZE COMPARISON

1%-Annual-Chance WSEL (NAVD88) - Difference from Existing Condition

Station	Existing Conditions	100 ft Wide Channel w/o Floodplain Grading	Scenario 4 - Floodplain Grading, Stream Enhancements	70-ft Wide Channel with FP Grading, w/o Holloway Bridge	100 ft Wide Channel with FP Grading, w/o Holloway Bridge
11807	<i>Annandale Road</i>				
11749	246.32	-7.58	-6.01	-6.01	-8.07
11570	244.67	-6.66	-5.25	-5.25	-7.12
11353	243.47	-6.20	-7.04	-7.04	-7.36
11210	243.05	-6.09	-5.73	-6.60	-7.09
11032	242.79	-6.09	-5.41	-6.31	-6.84
10853	241.96	-5.44	-4.68	-5.63	-6.13
10763	241.93	-5.48	-4.77	-5.77	-6.24
10563	240.71	-4.41	-3.65	-4.69	-5.13
10398	240.27	-4.06	-3.21	-4.26	-4.69
10277	239.84	-3.70	-2.81	-3.87	-4.29
10222	<i>Holloway Road</i>	<i>Holloway Road*</i>	<i>No Bridge</i>	<i>No Bridge</i>	<i>No Bridge</i>
10170	238.23	-2.83	-2.29	-2.29	-2.70
10099	237.89	-2.52	-1.97	-1.97	-2.37
9982	237.84	-2.48	-1.93	-1.93	-2.34
9727	236.35	-1.13	-1.08	-1.08	-1.13
9454	235.86	-0.69	-0.66	-0.66	-0.69
9055	235.36	-0.24	-0.25	-0.25	-0.24
8630	235.21	-0.09	-0.10	-0.10	-0.09
8410	235.16	-0.05	-0.05	-0.05	-0.05
8199	234.72	0.00	0.00	0.00	0.00
8159	<i>Sleepy Hollow Road</i>				
8103	228.93	0.00	0.00	0.00	0.00
7960	227.03	0.00	0.00	0.00	0.00

*Bridge altered to span the channel, but not elevated