HYDROLOGIC AND HYDRAULIC REPORT

S.R. 0044, SECTION 045
SEGMENT 0110, OFFSET 1103

OVER MCKEE RUN

ANTHONY TOWNSHIP
MONTOUR COUNTY

"We do hereby certify that the information contained in the accompanying plans, specifications, and reports has been prepared in accordance with accepted engineering practice, is true and correct, and is in conformance with the standards and requirements of the Department of Environmental Protection."

Hydrologic/Hydraulic Analysis and Assessments, Plans and Specifications
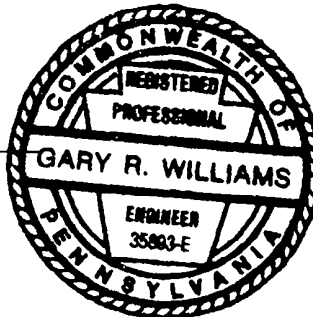
Signature _____*Gary R. Williams*_____, P.E.
District Bridge Engineer

Date _____*May 8, 2008*_____

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OVER MCKEE RUN

ANTHONY TOWNSHIP

MONTOUR COUNTY, PA

PENNDOT

Pennsylvania Department of Transportation
District 3-0
P.O. Box 218, 715 Jordan Avenue
Montoursville, PA 17754

Prepared by District 3-0 Bridge Unit

WATERSHED CHARACTERISTICS

Area = 1.30 square miles
Shape = irregular
Terrain = forest, fields
Elevation Range =556 ft. to 1240 ft.
Land Use = Forest, Cropland & Pasture
Forest = 6%

The project is not located within a detailed FEMA Study Area and no gage data exists for McKee Run. Therefore, the hydrologic analysis is performed in accordance with the procedures in PennDOT Design Manual, Part 2 for non-FEMA and un-gaged watersheds.

WATERSHED DESCRIPTION

The terrain is composed of rolling hills of cropland & pasture and forested mountains. Elevation ranges from 556 to 1240 ft. Approximately 6% of the watershed is forest.

The drainage area is taken from the Washingtonville, PA quadrangle of the USGS 7.5-Minute Series Maps. A privately owned structure is approximately 95' upstream with a normal clear span of 12', an average underclear of 5.55', and its length along the stream alignment is approximately 26'.

CHANNEL CHARACTERISTICS

Top Width = 18 ft.
Bottom Width = 8 ft.
Bank Height = 3 ft.
Alignment = Good – the proposed structure will be constructed on the existing 75° skew.
Stability = Good
Vegetation on Bank = Grasses
Channel = Stones and Sediment throughout
Stream Slope = 0.063 ft. /ft.
Water Quality = Good
High Water – See Flood History

CHANNEL DESCRIPTION

The channel has an average top width of 18 ft. and an average depth of 3 ft. The average stream flow width varies due to seasonal changes, with an average width of 8 ft. and normal flow depth of 8 inches. Bank erosion does not exist upstream or downstream of the existing structure.

FLOOD HISTORY

During the 1996 high water event, the high water surface elevation was 2 feet below the bottom of beam at the near left corner.   The approximate water surface elevation in 1996 was 563.70 ft. The water surface elevation during the 1972 high water event reached 3.2 feet below the BM disk at elev. 566.033. The approximate elevation was 562.85 ft.

PROJECT DESCRIPTION

The subject project is located on State Route 44 at Segment 0110 Offset 1103 over a McKee Run in Anthony Township, Montour County, PA. The exact location of the project is presented in Attachment C.

The existing structure is a single span, concrete slab bridge built in 1930 with a 75° skew and a curb-to-curb width of 32.0 ft. The structure has a normal clear span of 16 ft. and exhibits a maximum under clear of 6.08 ft. Photographs of the project site are presented in Attachment J.

The proposed structure is a precast reinforced concrete box culvert, placed with a 75° skew with a guide rail to guide rail width of 32.0 ft.

 The disturbed channel at the inlet and outlet will be reconstructed using R-8 rock. The inlet and outlet channel's final grade and cross section will provide a defined channel upstream, downstream, and through the structure.

The following list of work items is proposed:

Replace the existing single span concrete slab bridge with the proposed 16 ft. x 7.5 ft. precast concrete box culvert. The box culvert will be depressed 1 ft. to allow a natural streambed to form through the structure, for a hydraulic opening of 16 ft. x 6.5 ft. The inlet and outlet wings of the proposed structure will be precast sections.

Rock protection will be placed at all wings.

A detour will be used during construction of the bridge replacement project. The existence of a viable detour near S.R. 44 makes a detour the most feasible alternative for maintaining traffic.

TEMPORARY CHANNEL

During construction the stream flow will be pumped through the project site. Details are in the Erosion and Sediment Control Plan. See Attachment I.

HYDROLOGIC ANALYSIS

The project is located in a non-FEMA area and within an un-gaged watershed. Therefore, the hydrologic analysis is performed in accordance with the procedures in PennDOT Design Manual, Part 2 for non-FEMA and un-gaged watersheds.

The drainage area is calculated to be 1.30 mi.^{2} using the Washingtonville, PA USGS map. HEC-1 is used in obtaining the peak discharge values for the watershed. TR-55 and the NFF methods are used as comparative methods only. The results are summarized below.

	2 year	5 year	10 year	25 year	50 year	100 year	500 year
HEC-1	272 cfs	416 cfs	572 cfs	851 cfs	1115 cfs	1418 cfs	2413 cfs
TR-55	349 cfs	540 cfs	753 cfs	1143 cfs	1521 cfs	1961 cfs	3454 cfs
NFF	--	--	286 cfs	432 cfs	589 cfs	737 cfs	1275 cfs

Utilizing soils maps, an average CN value of 76 is calculated for the entire drainage area composed of forested mountains, cropland, and pasture. The SCS methodology is used in the HEC-1 model in WMS v. 8.0. The NRCS Type-II 24-hour storm is input for the precipitation, with the following rainfall amounts for Tioga County:

2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
2.8 in.	3.4 in.	4.0 in.	5.0 in.	5.9 in.	6.9 in.	10.1 in.

The drainage area centroid is approximately located at latitude 41°06'26" and longitude 76°42 18".

The Pennsylvania Department of Transportation Design Manual, Part 2 in Section 10.12 and Strike-Off Letter 439-99-11 (April 21, 1999:page 15) specifies a 25-year design flow with consideration given to the rural location of the project site and the improbability of property damage. The 100-year flow was also checked.

HYDRAULIC ANALYSIS

Flow depths, overtopping frequency, and water velocities for the existing and proposed conditions are determined using the HEC-RAS 3.1.3 computer program. A field study is performed to obtain existing stream and roadway cross-sections and profiles. Manning's 'n' roughness coefficients are determined from field observations. FHWA Culvert Analysis program HY-8, Version 6.1 was also used for hydraulic analysis producing comparable results. The fact that the upstream bridge may be removed sometime in the future was also considered but it is believed it will have no adverse impact on hydraulics after evaluating this possibility.

Existing Conditions

- The hydraulic opening of the existing structure is 16 ft. wide with a maximum depth of 6.08 ft., for a total area of 96 ft^2. Roughness Coefficient is 0.045 for the channel, 0.09 for the right and left overbanks. The existing low chord elevation at the inlet is 564.00 ft.

- The 25-year flow of 432 cfs results in a water surface elevation of 562.61 ft. just upstream of the bridge that is approximately 1.39 ft. below the existing low chord. The 25-year flow causes a backwater condition upstream of the bridge, however this in large part is due to the existing upstream structure.

- The 100-year flow of 737 cfs results in a water surface elevation of 565.40 ft. just upstream of the bridge that is approximately 1.40 ft. above the existing low chord. The roadway is not overtopped by the 100-year flow. The 100-year flow causes a backwater condition upstream of the bridge, however this in large part is due to the existing upstream structure.

Proposed Conditions

- Proposed conditions (16.0 ft. span x 7.5 ft. maximum rise box culvert) provide a hydraulic opening of 96 ft². The hydraulic opening remains the same. Roughness Coefficient is 0.013 for the structure surface and 0.045 for the natural stream bed through the culvert. The proposed inlet low chord elevation is 563.87 ft. Lowering the low chord by 0.13 ft. will not adversely impact the hydraulic performance of the structure.

- The proposed conditions pass the 25-year design storm with a headwater elevation of 561.76 ft., which is 2.15 ft. below the low chord elevation of the proposed structure. The proposed structure reduces the backwater condition upstream for the 25-year flow. Backwater still exists due in large part to the existing upstream structure.

- The 100-year flow results in a water surface elevation of 563.66 ft., that is approximately 0.21 ft. below the proposed low chord. The roadway is not overtopped by the 100-year flow. The proposed structure reduces the backwater condition upstream for the 100-year flow. Backwater still exists due in large part to the existing upstream structure.

- The proposed structure reduces the 25-year water surface elevation by 0.85 ft. and the 100-year water surface elevation by 1.74 ft. immediately upstream of the structure. The proposed flow will not overtop the road at the structure.

STORMWATER MANAGEMENT

The proposed bridge will be constructed on a 75° skew. The project will produce very little to no change in the watershed hydrology. The project will improve the hydraulics within the project area, and McKee Run will not be impacted due to the replacement of this structure.

Currently, no stormwater management plan exists for this area in Anthony Township. The township and county have been notified of the proposed project in accordance with PA ACT 14, P.L. 834. No objections have been raised concerning this project.

FLOODPLAIN MANAGEMENT ANALYSIS

The project is not a part of a FEMA Flood Insurance Study for Anthony Township; therefore, it is not a detailed FEMA study area. HEC-1 is used to obtain the design flows. The 25-year and 100-year storms are modeled using HEC-RAS for both the existing and proposed conditions. The models show that the proposed structure would reduce both the 25-year and 100-year storm's water surface elevations, as shown in the Hydraulic Data Table on the Summary Data Sheet.

The Township and County officials have been notified and no concerns have been raised.

RISK ASSESSMENT

The proposed structure will reduce the flood risk of both the 25-year and the 100-year flood. The proposed structure reduces the 25-year water surface elevation just upstream of the inlet from 562.61 ft. to 561.76 ft. The 100-year water surface is reduced from 565.40 ft. to 563.66 ft. The construction of the proposed structure should reduce the risk of flooding in the adjacent area.

Given the rural location of the structure and the short detour, no adverse economic or social impacts are expected with the replacement of this structure.

EROSION AND SEDIMENT CONTROL

An erosion and sedimentation plan will be used on this project. This plan is attached for your review (See Attachment I).

WETLAND INVOLVEMENT

Wetlands are not present in the proposed worksite location.

ALTERNATIVES ANALYSIS

The alternatives to replacing this structure are to do nothing (no build alternative) or to rehabilitate the existing structure. The existing single span concrete slab bridge, built in 1930, is in poor condition due to severe deterioration of the abutments and superstructure. The existing structure has a curb-to-curb width of 30.0 ft. This width is considered substandard and unsafe by current highway design standards. The rehabilitation alternative will prove to be costly and will not provide any benefit relative to providing a safer roadway or improving the hydraulic capacity of the structure. Replacing this bridge will be less costly, provide a wider and safer roadway crossing with a longer design life, and improve the crossing's hydraulic capacity. Therefore, the replacement alternative is selected because it provides the best cost-benefit ratio to the Commonwealth's taxpayers.

CONCLUSION

The proposed precast concrete box culvert will replace the existing single span concrete slab bridge. Hydraulic computations show that an improvement in the hydraulic capacity for both the 25-year and 100-year flow events will occur. The proposed structure will have no adverse impacts and will reduce the risks to public safety. No fill below ordinary high water will be placed, and no cultural resource or

endangered species impacts or conflicts is expected.

Proper erosion and sediment pollution control measures will be employed during construction. The Pennsylvania State Programmatic General Permit 11 (PASPGP-3) applies to the proposed activities.

In view of the hydrologic studies, approval is recommended for the proposed structure replacement.

Existing Conditions - 25 year flow					
Upper Reach			Lower Reach		
Station	W.S. Elevation	Velocity	Station	W.S. Elevation	Velocity
	(ft.)	(ft./s)		(ft.)	(ft./s)
1055	564.22	6.17	480	561.19	5.65
1030	564.20	5.33	455	561.08	5.51
1005	564.26	4.05	430	560.97	5.30
980	564.17	4.05	405	560.41	6.96
955	564.11	4.16	380	560.10	3.88
930	564.10	3.56	355	560.07	2.89
905	564.05	3.32	330	559.93	3.69
880	563.97	3.45	305	559.57	5.20
855	563.94	2.97	280	559.32	4.84
830	563.95	2.27	255	559.18	4.36
805	563.93	2.06	230	558.99	4.35
780	563.92	1.99	205	558.88	3.57
755	563.90	2.06	180	558.78	3.41
730	563.84	2.56	155	558.60	4.16
705	563.81	2.63	130	558.46	4.39
680	563.74	3.07	105	558.34	4.31
655			80	557.98	5.59
630	562.58	5.72	55	557.79	4.97
605	562.62	4.44	30	557.54	5.75
580	562.61	3.76	5	557.31	5.59
555	562.61	3.16			
Bridge					

Existing Conditions - 100 year flow					
Upper Reach			Lower Reach		
Station	W.S. Elevation	Velocity	Station	W.S. Elevation	Velocity
	(ft.)	(ft./s)		(ft.)	(ft./s)
1055	565.59	6.00	480	561.91	7.17
1030	565.66	4.85	455	561.81	6.78
1005	565.75	3.58	430	561.69	6.50
980	565.75	3.27	405	561.09	8.03
955	565.74	3.14	380	559.55	12.34
930	565.75	2.42	355	560.48	3.58
905	565.74	2.29	330	560.34	4.32
880	565.74	2.05	305	559.94	5.90
855	565.73	1.98	280	559.70	5.33
830	565.73	1.98	255	559.57	4.79
805	565.73	1.66	230	559.41	4.63
780	565.72	1.61	205	559.32	3.90
755	565.72	1.60	180	559.22	3.90
730	565.70	1.94	155	559.04	4.79
705	565.70	1.85	130	558.88	5.16
680	565.68	2.18	105	558.74	5.19
655			80	558.34	6.61
630	565.24	5.61	55	558.20	5.77
605	565.37	3.41	30	557.85	6.99
580	565.40	2.62	5	557.61	6.61
555	565.40	2.45			
Bridge					

Proposed Conditions - 25 year flow					
Upper Reach			Lower Reach		
Station	W.S. Elevation	Velocity	Station	W.S. Elevation	Velocity
	(ft.)	(ft./s)		(ft.)	(ft./s)
1055	564.67	5.04	480	561.19	5.64
1030	564.67	4.33	455	561.08	5.51
1005	564.71	3.41	430	560.97	5.30
980	564.69	3.26	405	560.41	6.96
955	564.67	3.08	380	560.10	3.88
930	564.68	2.52	355	560.07	2.89
905	564.67	2.24	330	559.93	3.69
880	564.65	2.13	305	559.57	5.20
855	564.64	1.92	280	559.32	4.84
830	564.64	1.57	255	559.18	4.36
805	564.64	1.48	230	558.99	4.35
780	564.63	1.43	205	558.88	3.57
755	564.62	1.44	180	558.78	3.41
730	564.60	1.77	155	558.60	4.16
705	564.60	1.72	130	558.46	4.39
680	564.48	2.83	105	558.34	4.31
655			80	557.98	4.97
630	560.53	13.01	55	557.79	4.97
605	561.84	6.27	30	557.54	5.75
580	561.78	5.39	5	557.31	5.59
555	561.76	4.48			
Bridge					

Proposed Conditions - 100 year flow					
Upper Reach			Lower Reach		
Station	W.S. Elevation	Velocity	Station	W.S. Elevation	Velocity
	(ft.)	(ft./s)		(ft.)	(ft./s)
1055	567.00	2.94	480	561.91	7.17
1030	567.01	2.64	455	561.08	5.51
1005	565.75	3.58	430	561.69	6.50
980	567.02	2.02	405	561.09	8.03
955	567.02	1.93	380	559.55	12.34
930	567.02	1.46	355	560.48	3.58
905	567.02	1.42	330	560.34	4.32
880	567.02	1.25	305	559.94	5.90
855	567.02	1.26	280	559.70	5.33
830	567.02	1.11	255	559.57	4.79
805	567.02	1.10	230	559.41	4.63
780	567.02	1.06	205	559.32	3.90
755	567.02	1.04	180	559.22	3.86
730	567.01	1.20	155	559.04	4.79
705	567.01	1.13	130	558.88	5.16
680	567.01	1.26	105	558.74	5.19
655			80	558.34	6.61
630	561.00	16.23	55	558.20	5.77
605	563.69	4.87	30	557.85	6.99
580	563.66	4.34	5	557.61	6.61
555	563.66	3.84			
Bridge					

Summary Data Sheet

Location Data

County	Montour	Municipality	Anthony Twnshp.
Location - U.S.G.S. Map	Washingtonville	State Route - Section	0044-045
Latitude	41^06'25.2"	Station	12+88.00
Longitude	76^42'17.5"	Segment/Offset	0110/1103
Present ADT: 757	Year: 2008	Future ADT: 2079	Year: 2059
River Basin (US-ACOE)	Susquehanna		

Channel Data

Stream Name	McKee Run	Side Slope (looking downstream)	Left:	0.30 ft/ft
			Right:	0.30 ft/ft
Stream Slope	0.063 ft/ft	Type of Channel		Trapezoidal
Normal Stream Flow Depth	1.5 ft.	Average Top Width		18
Stream Bed Elevation at Inlet	557.37'	Average Bottom Width		8
Stream Bed Elev. ~500' upstream	Exact Dist.	44.27	Stream Bed Elev. ~500' downstream	Exact Dist.	30.5
	Elevation	557.68'		Elevation	556.87'
Average Stream Channel Depth	3 ft.	High Water Elev. and Date		563.70' in 1992

Hydrology

	PennDOT Study	FEMA (if applicable)	Other:
Hydrology Method Used	NFF		
Drainage Area	1.30 sq. mi.		
Q10 (CFS) *	286		
Q25 (CFS)	432		
Q50 (CFS)	589		
Q100 (CFS)	737		

Hydraulics

EXISTING STRUCTURE				*PROPOSED STRUCTURE*			
Bridge Type	Concrete Slab			Bridge Type	P.C. Box Culvert		
Clear Span - Centerline	16.5'			Clear Span - Centerline	16.56'		
Clear Span - Normal	16'			Clear Span - Normal	16'		
Skew	75^			Skew	75^		
Minimum Underclearance			6.08	Minimum Underclearance	6.5'		
Length of Channel Impacted	34.3'			Length of Channel Impacted	53.62'		
Number of Spans			1	Number of Spans	1		
Low Chord Elevation	564'			Low Chord Elevation	563.87'		
Hydraulic Method Used	NFF			Hydraulic Method Used	NFF		
Return Period*	Q	WSE	Velocity	Return Period*	Q	WSE	Velocity
10	286	561.60'	3.2	10	286	560.72'	4.7
25	432	562.61'	3.16	25	432	561.19'	5.65
50	589	563.46'	3.14	50	589	561.55'	6.36
100	737	565.40'	2.45	100	737	561.91'	7.17
Overtopping				Overtopping			

*Indicate Design Return Period with a ✓ at the appropriate year. Or if year is not shown, fill in Design Return Period in blank row.