HYDROLOGIC AND HYDRAULIC REPORT

FOR

S.R. 0051, SECTION A60
(HUTCHINSON HILL ROAD)
STATION 155+11.00
OVER
FALLEN TIMBER RUN

VOLUME 1

TOWNSHIPS OF ELIZABETH AND FORWARD
ALLEGHENY COUNTY

Prepared For:

**THE PENNSYLVANIA DEPARTMENT
OF TRANSPORTATION**

Prepared By:

**MACKIN ENGINEERING COMPANY
RIDC Park West
117 Industry Drive
Pittsburgh, PA 15275-1015**

AUGUST 2007
REVISED – SEPTEMBER 2007

Mackin

Mackin Engineering Company
R.I.D.C. Park West
117 Industry Drive
Pittsburgh, PA 15275-1015
Phone: (412) 788-0472
Fax: (412) 787-3588

August 6, 2007

Pennsylvania Department of Environmental Protection
Southwest Regional Office
Soils and Waterways Section
400 Waterfront Drive
Pittsburgh, Pennsylvania 15222-4745

RE: Agreement No. E00956
Allegheny County
S.R. 0051, Section A60
Hutchinson Hill Bridge Replacement
H & H Report/PADEP Permit Application
Mackin Project No. 4564-001

Gentlemen:

I, Italo V. Mackin, do hereby certify pursuant to the penalties of 18 Pa. C.S.A., Section 4904 to the best of my knowledge, information and belief, 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 Chapter 105 of the rules and regulations of the Department of Environmental Protection.

Sincerely,

MACKIN ENGINEERING COMPANY

Italo V. Mackin

Italo V. Mackin, P.E.
President

ITALO V. MACKIN
No. 1421-E

IVM/pak

Enclosure
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GENERAL TABLE OF CONTENTS

VOLUME INDEX

I. EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This hydrologic and hydraulic report pertains to the proposed replacement of the Hutchinson Hill Road Bridge located on S.R. 0051 over Fallen Timber Run, in Elizabeth and Forward Townships, Allegheny County. The bridge, owned by the Pennsylvania Department of Transportation, is located approximately 0.7 of a mile south of the bridge crossing over the Monongahela River and 800 feet north of the signalized intersection with Weigle Hill Road (S.R. 2004). The limits of roadway reconstruction will be the minimum required for replacement of the existing structure. Since this is a bridge replacement project, no line and grade changes are required, and the roadway will be reconstructed on the same alignment and typical section as the existing roadway. The proposed project lies within a FEMA detailed flood study area with a regulated floodway; therefore, the project cannot increase the elevation of the 100-year flood. Since S.R. 0051 is a roadway with a classification of Principal Arterial, the bridge must be designed for the 50-year flood with no inundation of the roadway. No wetlands have been identified within the project area.

The table below summarizes the bridge and flood data presented in the report. It is anticipated that the span lengths indicated in the table will be utilized in the TS&L.

Summary of Data for Proposed Bridge		
Structure Type:	P/S Concrete Spread Box Beams	
Span Length: (CL Brg. to CL Brg.)	One Span at 34'-0" ±	
Clear Span (Skewed):	32'-0"	
Clear Span (Normal):	22'-7½"	
Bridge Width (out-to-out)	69'-4½"	
Min. Vertical Clearance (1):	7'-3" ±	
Road Carried:	S.R. 0051	
Functional Classification:	Principal Arterial	
Design Flood:	50-year Flood	
Flood Discharge Data	FEMA	PennDOT
Drainage Area (2):	4.5 sq. mi.	4.26 sq. mi.
Q_{50} Flood Discharge:	940 cfs	1,260 cfs
Q_{50} Flood Elevation:	778.11	778.94
Q_{50} Flood Velocity (Max.):	8.22 fps	9.31 fps
Q_{100} Flood Discharge:	1,100 cfs	1,590 cfs
Q_{100} Flood Elevation:	778.45	779.11
Q_{100} Flood Velocity (Max.):	8.56 fps	10.94 fps
Q_{100} Est. Scour Depth (Max.)	1.77 ft.	
Q_{500} Est. Scour Depth (Max.)	1.10 ft.	

(1) As defined in DM-4 Policies and Procedures Section 1.6.4.11(b).

(2) Drainage Area for FEMA flows measured to Forward Township Corporate Limit.
Drainage Area for PennDOT flows measured to proposed crossing.

II. INTRODUCTION

A. REPORT OVERVIEW AND PURPOSE

Located on the borders of Elizabeth Township and Forward Township, Allegheny County, the Hutchinson Hill Road Bridge carries four lanes of S.R. 0051 over Fallen Timber Run. The structure is a single span reinforced concrete T-Beam bridge constructed in 1948, owned by PennDOT, and is scheduled for replacement. The bridge is situated approximately 0.7 of a mile south of the bridge crossing over the Monongahela River and 800 feet north of the signalized intersection with Weigle Hill Road (S.R. 2004). Numerous businesses are located along this busy section of Route 51 where significant traffic occurs during the AM/PM rush hours. S.R. 51 provides access for many commuters to the City of Pittsburgh and surrounding areas. This report will show that the project is consistent with PennDOT's design guidance regarding waterway structures and all applicable environmental permitting regulations.

Research of PennDOT bridge inspection files indicated a superstructure rating of 4 and a substructure rating of 4. Based on the inspection records and photographic data, the quantity and severity of structural deterioration indicates a condition that warrants replacement of the bridge. The hydraulic studies assume a proposed replacement structure consisting of prestressed concrete spread box beams oriented on a 45-degree skew angle; no other alternatives are considered. This reduced scope of studies with no consideration of alternative structure types is in accordance with recommendations from the BQAD Pro-Team Review Meeting that occurred on October 25, 2007. Minutes of that meeting are included in Appendix G of this report.

The limits of roadway reconstruction will be the minimum required for replacement of the existing structure. Since this is a bridge replacement project, no line and grade changes are required, and the roadway will be reconstructed on the same alignment and typical section as the existing roadway.

The project is located in a FEMA study area, in a designated special flood hazard Zone AE (detailed flood study), and the Flood Insurance Rate Map (FIRM) indicates that Fallen Timber Run has a regulated floodway contained within the channel. The hydraulic analysis with this report extends from a limit approximately 500 feet downstream of Route 51 to a limit approximately 870 feet upstream of Route 51. The modeling is based on a HEC-2 analysis from the FEMA study, converted to HEC-RAS for this study, with cross section modification where required using current survey data and project mapping.

Because the project is situated in a detailed flood study area with a floodway, NFIP regulations prohibit increases in the 100-year flood elevation. Review of the FIS stream profiles revealed that the 100-year flood does not overtop the existing bridge superstructure. Since the proposed bridge opening will not increase FEMA's Base Flood elevation, there is no need to apply for a Conditional Letter of Map Revision (CLOMR) from FEMA. However, FEMA must be informed of a flood study revision according to the PennDOT Design Manual Part 2. Strike-Off-Letter

431-99-20 requires that a copy of the final H&H Report be forwarded to FEMA after all applicable regulatory permits have been issued for the project and after confirming that no further design changes will affect the H&H Report.

This project is limited to replacement of an existing bridge with a new bridge on the same alignment. There are no Base Flood elevation increases and no wetland impacts. The GP-11 Permit, issued by the Pennsylvania Department of Environmental Protection (PADEP), will apply. The GP-11 Permit will be issued in conjunction with the U.S. Army Corps of Engineers PASPGP-3 Statewide Programmatic General Permit. The PASPGP-3 has been issued to address a class of activities which individually and collectively have minimal adverse effect on regulated waters, and it provides Section 404 clearance.

B. EXISTING AND PROPOSED STRUCTURES

Existing Structure

Structure Type: Reinforced Concrete T-Beam Bridge

Span: 29’-0” ± (CL Brg. to CL Brg.)

Clear Span • : 27’-6” (Skewed)
19’-9$^{3}/_{8}$” (Normal)

Structure Width: 67’-3” ft. ± (Normal to Roadway)
93’-6” ft. ± (Along Stream)

Vertical Clearance: 7.85’ ±, Measured to Low Chord (Inlet) at Scour Hole
7.13’ ±, Measured to Low Chord (Outlet)

Skew with Road: 46° Right Hand Ahead

Skew with Stream: 35° ± at Inlet

- - Existing clear span based on electronic field survey.

Proposed Structure

Structure Type: P/S Concrete Spread Box Beams

Span: 34’-0” ± (CL Brg. to CL Brg.)

Clear Span: 32’-0” (Along Skew)
22’-7$^{1}/_{2}$” (Normal to Abutments)

Structure Width: 69’-4$^{1}/_{2}$” ft. (Normal to Roadway)
98’-1$^{3}/_{8}$” ft. (Along Stream)

Vertical Clearance: 7.25’ ±, Measured to Low Chord (Inlet)
7.31’ ±, Measured to Low Chord (Outlet)

Skew with Road: 45° Right Hand Ahead

Skew with Stream: 35° ± at Inlet (High Flows Only)

For more stream and flooding information, see Section A, Site Data, Item 2(b) on Pages A-4 and A-5.

C. TRAFFIC MAINTENANCE

Route 51 is a vital traffic artery, therefore a traffic detour will not be implemented. During construction of the bridge, a single lane of traffic will be maintained in each direction on its respective side, and the contractor will have access to work areas from the roadway. The Final Traffic Control Plans and Construction Phasing will address these needs in detail.

D. HYDROLOGIC SITUATION

Research conducted on the Federal Emergency Management Agency (FEMA) website revealed that a detailed Flood Insurance Study (FIS) is in effect for the project location. Flood insurance information for the project area was extracted from the revised comprehensive Flood Insurance Study for Allegheny County, Pennsylvania dated May 15, 2003. This information includes the FIS Report and the associated maps, floodway data tables, stream profiles and hydraulic analysis (see Appendix F of this report). In the project area, Fallen Timber Run flows through the townships of Elizabeth and Forward, and it continues downstream of the project through the Borough of Elizabeth where it empties into the Monongahela River.

The PennDOT Design Manual Part 2, July 2002 Edition, Change No. 1 states that FEMA discharges should be reviewed and incorporated into the new hydraulic studies. The manual also states that FEMA's flood discharges and hydraulic models should be verified and evaluated according to current design guidance and current modeling practices for sizing highway waterway structures. The original hydrologic analysis was performed using the log-Pearson Type 3 methodology. In accordance with the Design Manual Part 2 Section 10.6.C.2, the FEMA discharges have been compared with new discharges determined by the USGS WRIR 00-4189 method (Appendix A. Hydrology, Pages AP-1 through AP-8 for program output and supporting material for program input). See Section D (Hydrologic Analysis) of this report for tabulated comparisons and discussion of these discharges.

E. STREAM AND WATERSHED CHARACTERISTICS

The following geographic information was extracted from the FEMA Flood Insurance Study report (Reference 1, below) and preliminary environmental studies of the area.

Allegheny County lies within the Allegheny Plateau physiographic region. The watersheds of the area are characterized by V-shaped valleys and steep hillsides.

Soils are generally silt loams that are moderately deep and are well drained to moderately well drained. The topography surrounding the project area includes steep hillsides with forested and rocky terrain, and Fallen Timber Run exhibits a minimal extent of low-lying floodplain areas. Terrestrial vegetation in the area consists of predominantly pole stage deciduous forest cover with a small amount of scrub-shrub.

The climate of Allegheny County is temperate with seasonal variation in temperature. The county is geographically located in a region of variable air mass activity, being subject to both polar and tropical continental and maritime air mass invasion. Measurable precipitation occurs approximately 149 days per year and averages 37 inches annually.

The development of the floodplains of the county and of Fallen Timber Run is primarily residential with some commercial and industrial, and ranges from scarce to moderate development. There are also mining areas and rural areas with large tracts of forest and agricultural land.

Fallen Timber Run flows through the lower half of the watershed through a path that essentially follows Route 51 within a V-shaped valley receiving inflow from several tributaries. Upstream of the existing (and proposed) crossing, the average channel bottom width is 12 to 15 feet and average streambed to top of bank height is approximately 8 to 10 feet on the roadway (right) side and approximately 2.5 to 10 feet on the opposite side at the base of a steep and high hillside. Downstream of the crossing, the average channel bottom width is 10 to 12 feet and average streambed to top of bank height is approximately 6 to 8 feet on the roadway (left) side and approximately 4.5 to 10 feet on the opposite side except near the downstream limit of the modeled stream where the right bank consists of a steep and high hillside.

The channel bottom is composed of sandy and gravelly sediments with 3 inch to 10 or 12 inch smooth flat rocks and cobbles within a relatively clean, straight, channel with no rifts or deep pools (see Photos 5, 9, 10, 25 and 27). Floodplain areas are typically of minimal extent and banks are steep and high on at least one side of the stream with a strip of land or roadway on the other side (see Photos 4, 9, 10 and 20). Fallen Timber Run is not a stocked stream according to the PA Fish and Boat Commission (PFBC) but is classified as a Warm Water Fishery (WWF) in the PA Code, Title 25, Chapter 93 Water Quality Classification.

REFERENCES

Federal Emergency Management Agency, Flood Insurance Study, Allegheny County, Pennsylvania (All Jurisdictions), Washington D.C., Revised May 15, 2003; Flood Study Number 42003CV001A, Page 25.

III. HYDROLOGIC AND HYDRAULIC REPORT

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B. HYDROLOGIC ANALYSIS

C. HYDRAULIC ANALYSIS

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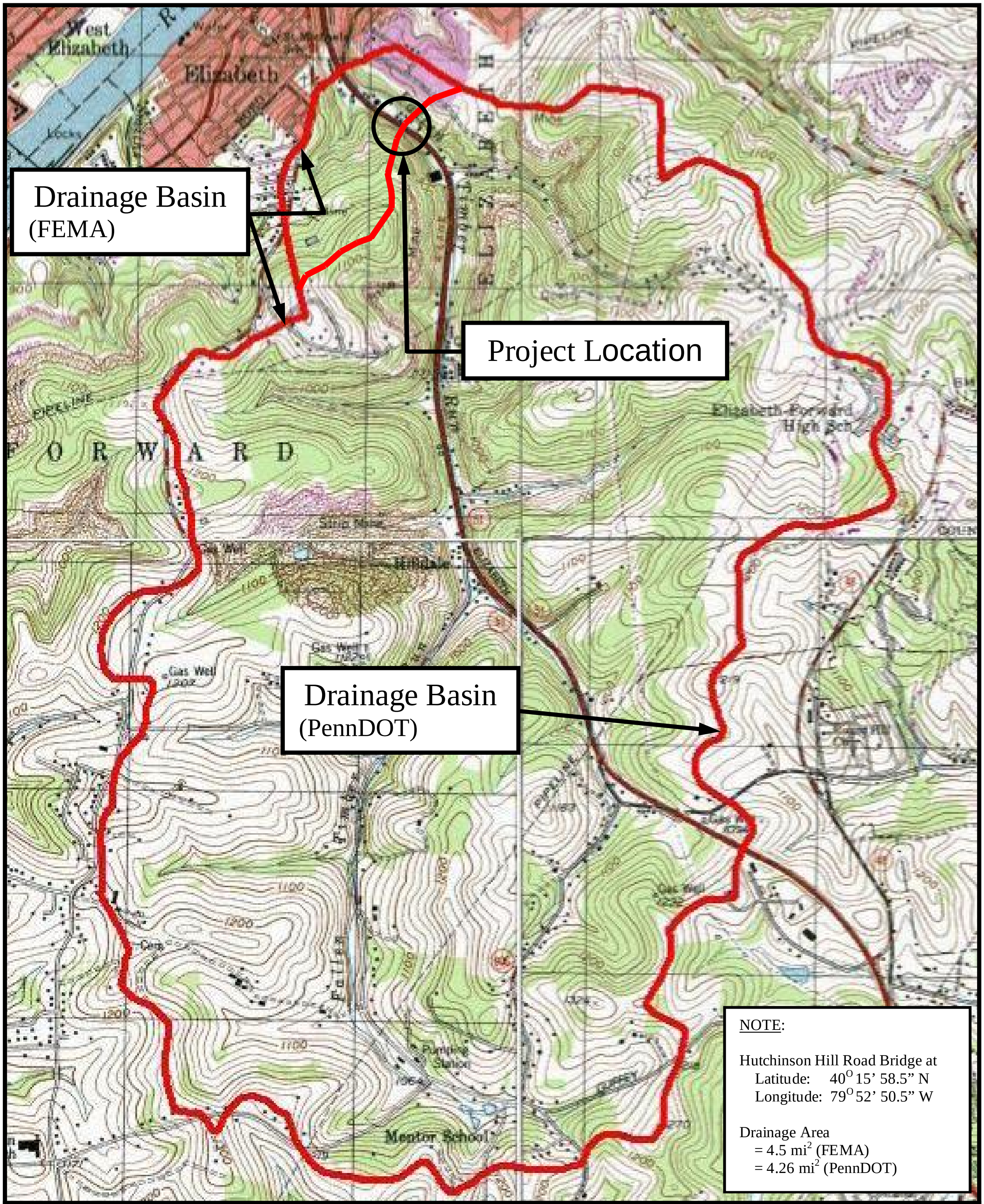
A. SITE DATA



Drainage Basin (FEMA)

Project Location

Drainage Basin (PennDOT)

NOTE:

Hutchinson Hill Road Bridge at
Latitude: 40° 15’ 58.5” N
Longitude: 79° 52’ 50.5” W

Drainage Area
= 4.5 mi^2 (FEMA)
= 4.26 mi^2 (PennDOT)

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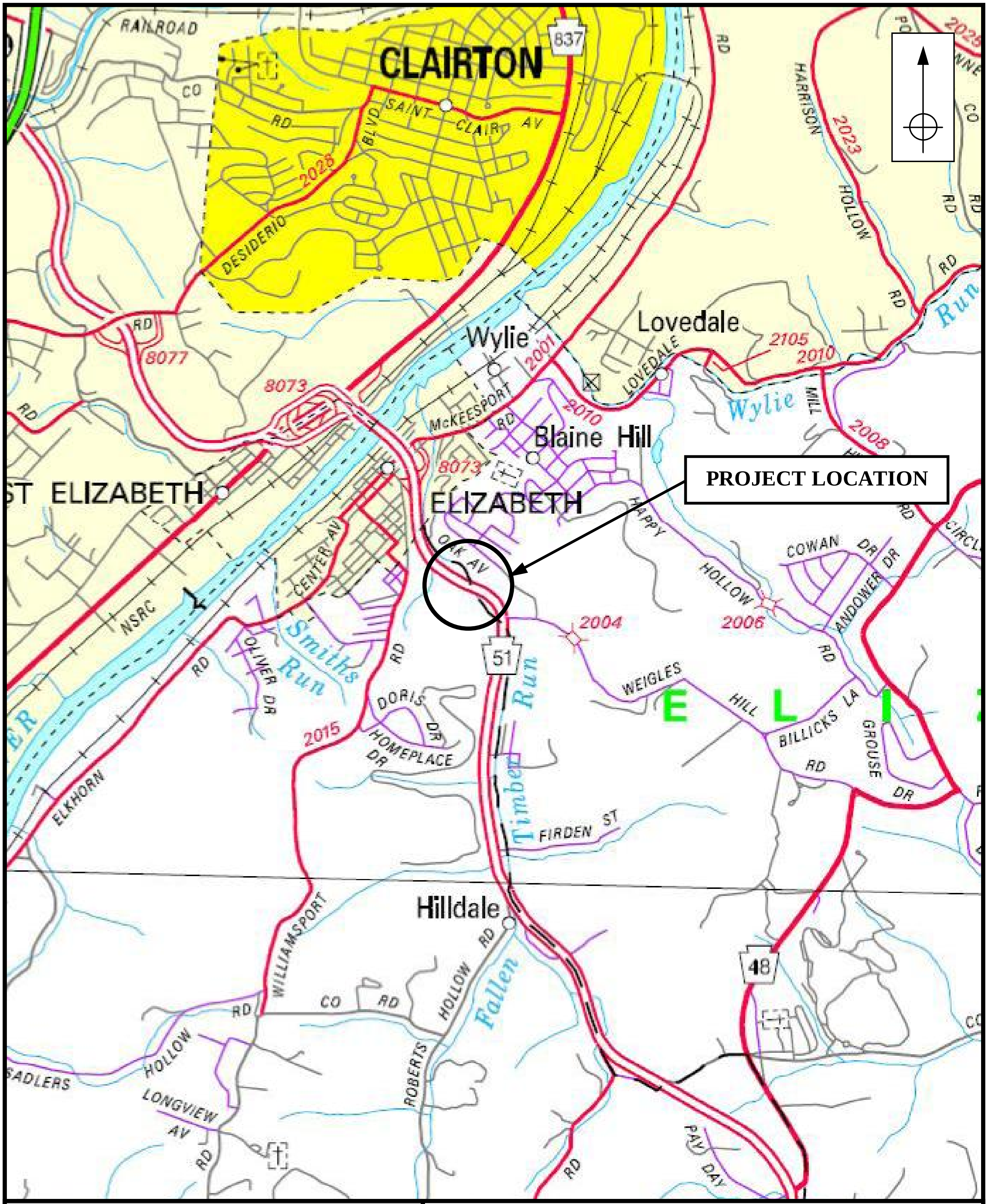
Mackin Engineering Company
Pittsburgh, PA Harrisburg, PA

TOPOGRAPHIC LOCATION MAP

S.R. 0051, Section A60

Route 51 Over Fallen Timber Run

Elizabeth and Forward Townships
Allegheny County
USGS Quads: Glassport, Monongahela, Donora & McKeesport, PA
Map Scale: 1”=2000’



![Mackin logo]

Mackin Engineering Company

Pittsburgh, PA Harrisburg, PA

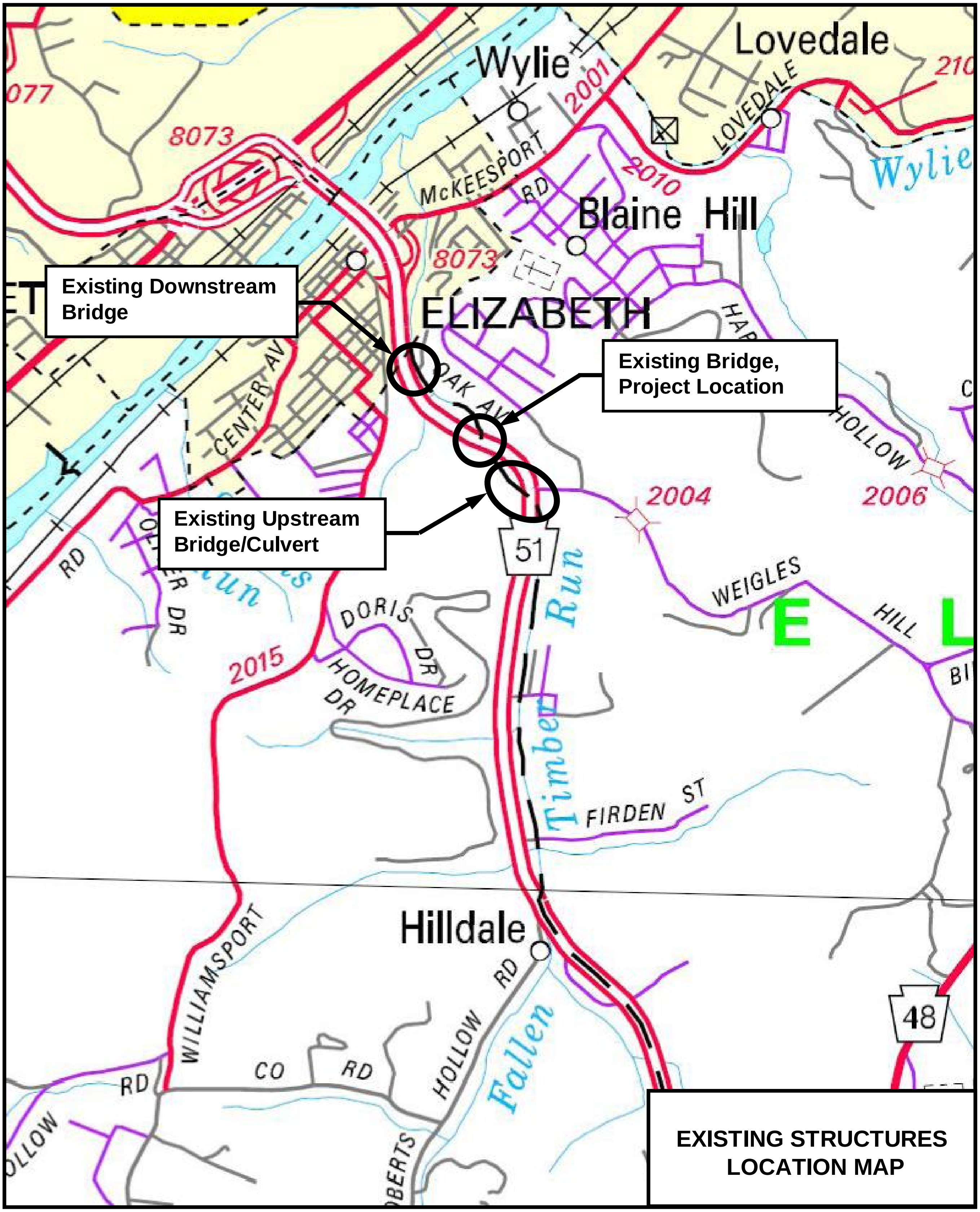
LOCATION MAP

S.R. 0051, Section A60

Route 51 Over Fallen Timber Run

Elizabeth and Forward Townships

Allegheny County



Existing Downstream Bridge

Existing Bridge, Project Location

Existing Upstream Bridge/Culvert

EXISTING STRUCTURES LOCATION MAP

A. SITE DATA

1. Location Map

A project location map is presented on Page A-1 of this report, and a location map for existing structures is presented on Page A-2a.

2. Existing Structures

The following are descriptions of existing structures over Fallen Timber Run at the proposed crossing and upstream and downstream of it. Geometry and stream characteristics are from physical measurements and visual observations taken during the November 3, 2004 field view as well as geometric data from the hydraulic surveys performed by Mackin Engineering.

a) Existing Upstream Structure

- Photographs: Nos. 12, 13 & 14; Pages A-15 & A-16
- Structure Type: Rolled Steel Beam & R.C. T-Beam Bridge/Culvert
- Clear Span • : 27’-5$^{3}/_{8}$” (Skewed) – Inlet
  19’-9” (Normal) – Inlet
  21’-4$^{3}/_{4}$” (Normal) – Outlet

  - - Existing clear span based on electronic field survey.

- Structure Length: 497 ft. ±
- Cross Section at Structure:

  Vertical Clearance: 8.20’ ±, Measured to Low Chord (Outlet)
  12.66’ ±, Measured to Low Chord (Inlet)

  Skew with Road: 46° ± Left Hand Ahead – Upstream
  No Roadway Downstream

  Skew with Stream: Approx. 40° at Inlet
  Normal to Stream at Outlet

  Stream Description:

  Normal water stream flow was several inches deep upstream and downstream of the structure at the time of the H&H Field View. At the upstream right abutment, there is a scour hole where the depth of water was 1.3 ft. Stream width upstream and downstream of the bridge was less than the clear span of the structure—approximately 10 feet. This bridge and its relationship to the stream bears some similarity with the existing bridge that will be replaced. At the upstream face, the span and skew angle of the opening is similar to the bridge to be replaced, but the vertical clearance from the stream to the beams is several feet more. The span and vertical clearance at the downstream face are similar to the bridge to be replaced, but the opening is not skewed at this end.

The banks upstream of the structure are sloped at 1½:1 to approximately 1:1 and exhibit light to moderate vegetation cover (Photos 13 and 15). Downstream of the structure, the banks are similarly sloped and have little vegetation cover within approximately 100 feet of the structure, becoming more vegetated further downstream (Photos 11 and 12). The channel slope is less than 1 percent through the culvert and approximately 7 percent downstream of the structure. Normal flow depth is several inches and channel is comprised of gravelly and fine-grained sediments with small to moderately sized rocks the downstream channel. The span of this structure is comparable to the bridge to be replaced.

- Pier Type: Not applicable
- Pier Orientation: Not applicable
- Roadway Carried: Route 51 (S.R. 0051) at Upstream End Only
- Location: Elizabeth and Forward Townships
- Flood History:

The occupant of a home situated at the right overbank adjacent to the inlet of the structure at the corner of Route 51 and Weigles Hill Road was interviewed briefly during the H&H Field View. The long time resident was questioned concerning past flooding and he stated that Fallen Timber Run has never overflowed its banks at this location nor has the roadway been overtopped.

The structure will remain in place.

b) Existing Structure to Be Replaced

- Photographs: Nos. 3 & 5; Pages A-11 & A-12
- Structure Type: Reinforced Concrete T-Beam Bridge
- Span: 29’-0” ± (CL Brg. to CL Brg.)
- Clear Span • : 27’-6” (Skewed)
  19’-9$^3/_8$” (Normal)

  • - Existing clear span based on electronic field survey.

- Structure Width: 67’-3” ft. ± (Normal to Roadway)
  93’-6” ft. ± (Along Stream)
- Cross Section at Structure:
  Vertical Clearance: 7.85’ ±, Measured to Low Chord (Inlet)
  7.13’ ±, Measured to Low Chord (Outlet)

  Skew with Road: 46° Right Hand Ahead

  Skew with Stream: 35° ± at Inlet

Stream Description:

On the day of the hydraulics field view for this project, low flow through the bridge opening was asymmetrical, flowing against the north abutment at the inlet with a lot of sediment accumulated over the approximately 3/4 of the span. A scour hole has formed at this location (Photo 3) with a depth of approximately 1 foot (approximate flow depth was measured at 2 feet). The maximum sediment depth is approximately 2 feet at the south abutment.

At the upstream approach to the bridge, the width of the stream is approximately 12 to 15 feet and it flows into the wingwall at the northwest corner then under the bridge (Photo 3). At the downstream side after exiting the bridge, the width of the stream is approximately 10 to 12 feet with sediment accumulation covered with vegetation blocking the left side of the channel (Photo 5). The approximate channel slope just upstream and downstream of the bridge is 1 to 1.5 percent and 3 percent, respectively. Under the bridge, the channel slope is less than 1 percent.

- Pier Type: Not applicable
- Pier Orientation: Not applicable
- Roadway Carried: S.R. 0051
- Location: Elizabeth and Forward Townships
- Flood History:

Tom's Body Shop is located approximately 175 feet north of the bridge along Route 51 and adjacent to Fallen Timber Run. The owner of the shop, Tom, and one of his employees, Bill, were interviewed concerning past flooding at this location. Tom's shop has been operating here for 43 years and he stated that in that time, the shop has never been flooded but the flood waters have reached the top of banks during very hard rains. He also said that a house across the stream from his shop was flooded one time (see Photo 29). During Hurricane Agnes (1972), flooding almost reached the roadway but did not inundate the roadway and the bridge was not overtopped nor has it ever been overtopped in his memory. He also stated that when high water events occur, sometimes large tree branches or telephone poles are carried downstream until they become lodged; however, they did pass through the bridge opening.

This structure will removed and replaced with a new bridge.

c) Existing Downstream Structure

- Photographs: Nos. 21 and 22; Page A-20
- Structure Type: Rolled Steel Multi-Beam Bridge
- Span: 33'-0" ± (CL Brg. to CL Brg.)
- Clear Span: 31'-9"
- Structure Width: 23'-10" ft. ± (Out-Out of Deck)

- Cross Section Beneath Structure:

Vertical Clearance:	5.88’ ±, Measured to Low Chord (Upstream Side of Bridge)
Skew with Road:	Abutments 90° to Roadway
Skew with Stream:	90° to Stream Channel

  Stream Description:

  Low flow through the bridge opening was asymmetrical, flowing against the left (west) abutment with extensive sediment accumulation over the approximately 3/4 of the span between the stream and the right (east) abutment. The average channel width at low flow is approximately 9 feet under the bridge as well as upstream and downstream of it. The banks of the channel are uniform with slopes that appear to be 2:1 or less. The left bank, which is immediately adjacent to Route 51, is lined with a stone masonry slope wall with vegetation growth between some of the stones (Photos No. 21). The channel slope was not determined at this location. The stream channel is comprised of gravelly material and fine-grained sediments. The overbanks exhibit thick vegetation cover consisting of scrub shrub, weeds and small trees (Photos 21 and 22). The clear span normal to the stream is approximately 12 feet greater than that of the bridge that is being replaced, but the vertical clearance is somewhat less.

• Pier Type:	Not applicable
• Pier Orientation:	Not applicable
• Roadway Carried:	Penneman Avenue (S.R. 0051)
• Location:	Elizabeth Township
• Functional Classification:	Local Road
• Flood History:	Not Available

The structure will remain in place.

3. <u>High Water Marks and Critical Flood Elevations</u>

During the H&H Field View some bank erosion up to approximately 3 or 4 feet above stream elevation was noted (Photos 26 and 27). No other indications of high water were observed. See accounts of past flooding history under Items 2(a) through 2(c) above. Upstream of the subject bridge the insurable structures that are present are located across Route 51 from Fallen Timber Run and are above the 100-year flood elevation. Downstream of the bridge, there is a two story frame dwelling situated at the right overbank with the base of its foundation at approximate Elevation 772 where it meets ground level (Photo 29). This would place the structure within the 100-year floodplain; however, the inhabited floor appears to be elevated above the 100-year flood.

4. Fish Habitats and Other Environmental Concerns

Fallen Timber Run drains a watershed that is composed of approximately 45 percent forest cover and less than 5 percent urbanization. The stream is not listed as stocked by the PA Fish and Boat Commission (PFBC) but is classified as a Warm Water Fishery (WWF) in the PA Code, Title 25, Chapter 93 Water Quality Classification. WWF streams are maintained for the propagation of fish species and additional flora and fauna, which are indigenous to a warm water habitat. The watershed is not classified as High Quality or Exceptional Value (HQ/EV).

The most current PNDI online review for Threatened and Endangered (T&E) species indicated no special concern species and resources in the project area. In regard to possible wetland impacts, according to the US Fish and Wildlife Services National Wetland Inventory, no NWI wetlands were identified in the project area or immediate vicinity.

5. Drift, Ice, Nature of Stream Bed and Bank Stability

Because of thickly vegetated and steep banks, there is potential for significant amounts of debris and drift masses to move through Fallen Timber Run during high flow events including large tree limbs. In addition, telephone poles have been observed floating in channel during one or more high water events by locals (see Item 2(b) on Page A-5). Some flood debris was noted and photographed in the channel during the H&H Field View (Photo 9).

The stream substrate in the vicinity of and under the bridge consists of sand, gravel, flat stones and cobbles sediments with areas of exposed bedrock upstream (Photos 24 and 25). The banks have a light to moderate cover of weed and scrub vegetation. Bank erosion is present just upstream of the existing Hutchinson Hill Bridge, and scour of the downstream right channel bank is present within approximately 100 feet of the bridge. Just upstream of the bridge, the right bank is eroded beginning at the end of the southwest wingwall and extending back approximately 75 feet (Photos 7 and 8). A number of guiderail posts are gradually losing anchorage and the edge of the asphalt roadway shoulder is exposed as shown in Photo No. 7. Some small gradation riprap (possibly R-3) has been placed at the upstream end of this eroded area (Photo 8). The scour at the downstream right bank is present beneath a timber crib wall over a distance of 75 to 100 feet as shown in Photos 26, 27 and 30, but the crib wall has not been undermined at this point.

6. Photographs

Photographs are presented on Pages A-10 through A-24. A Photograph Index Map showing the location and orientation of each photograph is presented on Page A-10.

7. <u>Factors Affecting High Water Stages</u>

High water near the proposed bridge crossing is influenced only by runoff from the surrounding geography and roadways and several small tributaries empty into Fallen Timber Run upstream of the project. The largest of these tributaries, located in the southeast quadrant of the basin, drains 0.87 square miles of area which is approximately 20 percent of the drainage area for the reach of Fallen Timber Run considered in this report. Urbanization in the watershed is relatively small in the watershed—approximately 3.1 to 3.5 percent of the total drainage area with developed areas dispersed into concentrated pockets.

8. <u>Debris</u>

See Item 5 above.

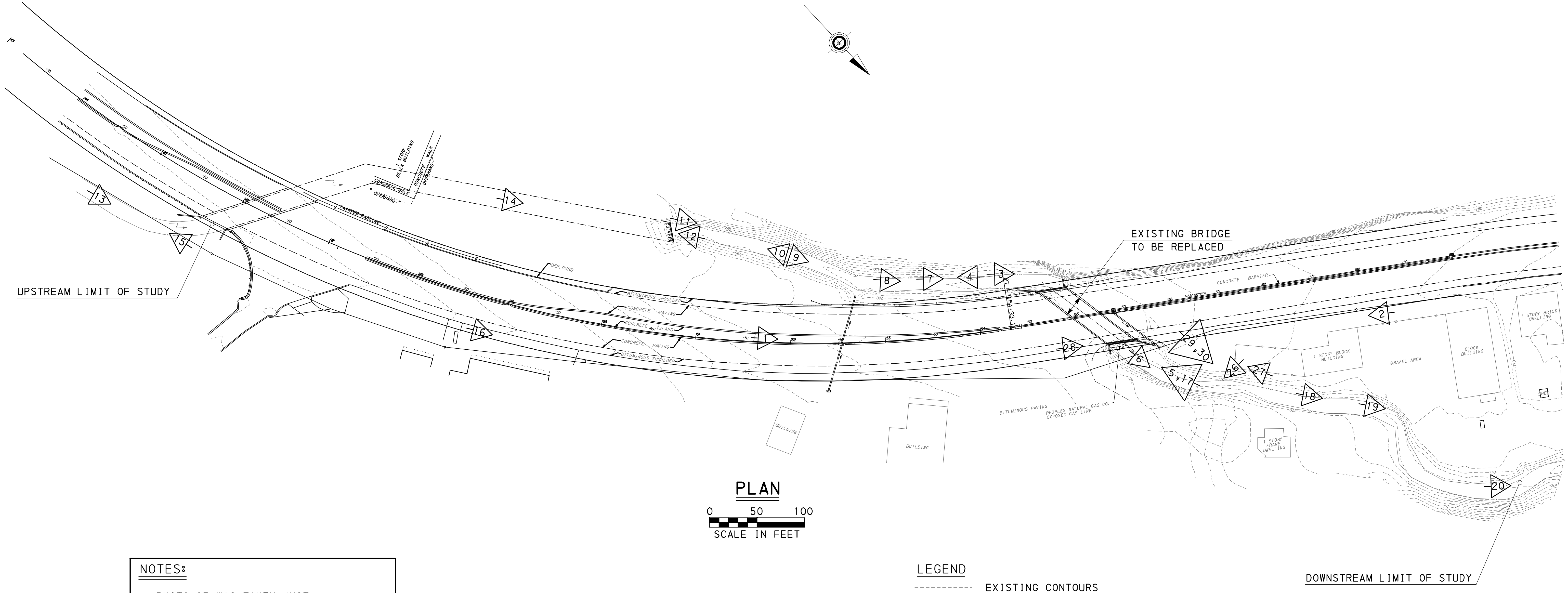
9. <u>Inspection Records</u>

On May 21, 2007, a field view of the project site was conducted by Sherman Bailey and Thomas Johnston. The purpose of the field view included general site observation and collection of information pertinent to the hydrologic and hydraulic analyses.

10. <u>Date of Line and Grade Approval</u>

The District has decided to apply a design procedure that will proceed according to an accelerated final design schedule for this project. This procedure will not require Line and Grade or Design Field View submissions.

MAY 21, 2007 FIELD VIEW PHOTOGRAPHS



PLAN

NOTES:

- PHOTO 23 WAS TAKEN JUST DOWNSTREAM OF PHOTO 8.
- PHOTO 24 WAS TAKEN JUST UPSTREAM OF THE EXISTING BRIDGE NEAR PHOTO 3.
- PHOTO 25 WAS TAKEN AT THE UPSTREAM SIDE OF THE EXISTING BRIDGE.

LEGEND

- - - - - EXISTING CONTOURS

–1▷ PHOTOGRAPH NUMBER

Mark	Description	By	Chk'd.	App'd.	Date

REVISIONS

S.R. PREVIOUSLY KNOWN AS L.R.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

ALLEGHENY COUNTY
S.R. 0051 SECTION A60
SEGMENT OFFSET
S.R. 0051 STA. 155+11.00 OVER FALLEN TIMBER RUN

H. & H. REPORT
PHOTOGRAPH INDEX MAP

PAGE A-9

ITALO V. MACKIN
No. 1421-E

PREPARED BY:
MACKIN ENGINEERING COMPANY
R.I.D.C. PARK WEST
117 INDUSTRY DRIVE
PITTSBURGH, PA. 15275

DATE:

RECOMMENDED ____________________

BRIDGE ENGINEER

DES: S.D.B. DWN: A.D.C. DWG. CHKD: S.D.B.

7/19/2007 9:36:38 AM \DGN\4564001\STR\s155_PHOTOMAP.dgn

<u>PHOTO NO. 1</u>: South Approach Roadway (S.R. 51) to Hutchinson Hill Bridge (Facing North)

<u>PHOTO NO. 2</u>: North Approach Roadway (S.R. 51) to Hutchinson Hill Bridge (Facing South)

PHOTO NO. 3: Upstream Elevation of Existing Hutchinson Hill Bridge at S.R. 51 Over Fallen Timber Run

PHOTO NO. 4: Upstream Channel Seen from End of Right Wingwall of Hutchinson Hill Bridge Over Fallen Timber Run – Note Bedrock in Channel.

PHOTO NO. 5: Downstream Elevation of Existing Hutchinson Hill Bridge at S.R. 51 Over Fallen Timber Run

PHOTO NO. 6: Downstream Channel Seen from Hutchinson Hill Bridge Over Fallen Timber Run

PHOTO NO. 7: Eroded Stream Bank/Roadway Embankment Just Upstream of Hutchinson Hill Bridge

PHOTO NO. 8: Channel Approx. 150 ft. Upstream of
Hutchinson Hill Bridge – Note Rock Protection
on Stream Bank/Roadway Embankment.

PHOTO NO. 9: Channel Approximately 300 ft. Upstream of Hutchinson Hill Bridge – Looking Downstream (Note Flood Debris in Channel)

PHOTO NO. 10: Channel Approximately 300 ft. Upstream of Hutchinson Hill Bridge – Looking Upstream

PHOTO NO. 11: Channel Just Downstream of Culvert Upstream of Hutchinson Hill Bridge

PHOTO NO. 12: Outlet of Bridge/Culvert Structure Upstream of Hutchinson Hill Bridge

PHOTO NO. 13: Inlet of Bridge/Culvert Structure Upstream of Hutchinson Hill Bridge

PHOTO NO. 14: Inside of Bridge/Culvert Structure Looking Upstream at Inlet

PHOTO NO. 15:   Channel Upstream of Bridge/Culvert

PHOTO NO. 16:   Drainage Area Upstream of S.R. 051

PHOTO NO. 17: Vegetated Sediment Accumulation at Left Side of Channel Just Downstream of Hutchinson Hill Bridge

PHOTO NO. 18: Channel Approximately 250 ft. Downstream of Hutchinson Hill Bridge – Looking Downstream

PHOTO NO. 19: Concrete Block Wall at Left Bank Approximately 350 ft. Downstream of Hutchinson Hill Bridge

PHOTO NO. 20: Channel Approximately 500 ft. Downstream of Hutchinson Hill Bridge – Looking Downstream

PHOTO NO. 21: Bridge Structure Downstream of Hutchinson Hill Bridge at Penneman Drive – Upstream Face

PHOTO NO. 22: Channel Upstream of Penneman Drive Bridge

STREAMBED COMPOSITION AND OTHER PHOTOS

PHOTO NO. 23:	Bedrock Channel Bottom Approximately 100 Feet Upstream of Hutchinson Hill Bridge

PHOTO NO. 24:	Bedrock Channel Bottom Just Upstream of Hutchinson Hill Bridge

PHOTO NO. 25: Sediment Under Hutchinson Hill Bridge at Upstream End with Sand, Gravel, Flat Stones and Cobbles

PHOTO NO. 26: Right Bank Scour Approximately 100 ft. Downstream of Hutchinson Hill Bridge; Timber Crib Wall Above.

PHOTO NO. 27: Right Bank Scour Approximately 120 ft. Downstream of Hutchinson Hill Bridge

PHOTO NO. 28: Critical Flood Elevation – Tom's Body Shop Seen from Hutchinson Hill Bridge, Looking North

PHOTO NO. 29:	Critical Flood Elevation – Two Story Frame House Across Stream from Tom's Body Shop

PHOTO NO. 30:	Channel with Bank Scour and Timber Crib Wall Above it at Two Story Frame House Location (Photo 29).

B. HYDROLOGIC ANALYSIS

B. HYDROLOGIC ANALYSIS

1. Drainage Area

The drainage area for Fallen Timber Run above the project is delineated on Page A-1 (Site Data) on the USGS topographic maps for the Glassport, Monongahela, Donora and McKeesport, PA Quadrangles. The current Flood Insurance Study (FIS) reports a drainage area of 4.80 square miles for Fallen Timber Run at the Township of Forward downstream corporate limit in Table 4 – Summary of Discharges (see Page B-6). As a check, electronic drainage area measurements were taken using the digital topographic mapping software Terrain Navigator Pro[1].

Electronic measurements of drainage area above the Township corporate limit yielded a total of 4.50 square miles instead of the 4.80 square miles stated in the FIS. Another measurement taken above the confluence of Fallen Timber Run at the Monongahela River, gave a drainage area 4.80 square miles, which suggests that the 4.80 square mile drainage area referenced to the Township corporate limit in the FIS is incorrect. The correct drainage area above the Township corporate limit is 4.50 square miles. It is noted that the Township corporate limit is approximately 1,350 feet downstream of the existing (and proposed) bridge crossing. The drained area above this point is indicated as 4.26 square miles in a Scour Study for the existing bridge, supplied by PennDOT; this number was verified as correct by measurements taken using Terrain Navigator Pro. A copy of this Scour Study is included in Appendix A. Flood discharges based on the above drainage areas and other watershed parameters are discussed below.

2. Factors Affecting Hydrology

Several small tributaries discharge into Fallen Timber Run upstream of the project. The largest of these tributaries, located in the southeast quadrant of the basin, drains 0.87 square miles of area which is approximately 20 percent of the drainage area for the reach of Fallen Timber Run considered in this report. The geography of the watershed is characterized by V-shaped valleys and steep hillsides with forested and rocky terrain, and Fallen Timber Run exhibits a minimal extent of low-lying floodplain areas. Soils are generally silt loams that are moderately deep and are well drained to moderately well drained. Terrestrial vegetation in the area consists of predominantly pole stage deciduous forest cover with a small amount of scrub-shrub.

The fraction of forest cover was estimated to be approximately 45 percent of the total drainage area, based on the USGS topographic mapping and aerial photography. Using the same sources, watershed urbanization was estimated to be approximately 3.5 percent of the total drainage area. The urbanized areas are dispersed into concentrated pockets along ridges at the north end of the watershed and there are other areas located at the south end of the watershed mainly along Fallen Timber Run and one of the tributaries. The forest cover and urbanization percentages indicated in the PennDOT Scour Study differ from the

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[1] Software reference in Report Section G

values discussed above. The Scour Study utilizes a forest cover fraction of 59 percent and urbanization of 3.1 percent—the latter very close to the 3.5 percent value discussed above.

3. Flood Records

There are no known detailed flood records available for Fallen Timber Run and no information is provided in the current FEMA flood insurance study; however, some flooding history was provided by a local resident and a business owner as discussed in the Section A – Site Data, Pages A-4 and A-5.

4. Design Discharge

The design flood frequency was determined using PennDOT and DEP design criteria. The Design Manual Part 2, Section 10.6.E presents PennDOT guidelines for selection of design flood frequency on the basis of functional roadway classification. S.R. 0051 at the project site is classified as Principal Arterial, so the design flood frequency is 50 years. DEP criteria, contained in Pa. Code Title 25, Section 105.161, also specifies a 50-year design flood frequency since the roadway is in a suburban setting.

5. Flood Discharge Computation Methods

Flood discharges reported in the current FEMA FIS document for Fallen Timber Run were reviewed. Section 3.1 – Hydrologic Analysis of the FIS discusses the detailed analyses conducted for the various communities prior to publication of the countywide study. On Page 45, the FIS states that hydrology for communities including the Township of Elizabeth were developed using the log-Pearson Type-III method as outlined by the Water Resources Council's Bulletins 15, 17, 17A and 17B. On Page 47, the FIS states that the regional frequency method PSU-III was selected as the most applicable hydrology method for communities including the Township of Forward. The report does not specify whether the reported discharges for Fallen Timber Run are based on the PSU-III analysis or the log-Pearson Type-III analysis. However, review of the effective HEC-2 model indicated that the analysis was performed for the Township of Elizabeth, therefore it may be assumed that the discharges are based on the log-Pearson Type III method. Applicable reference material from the FIS is provided in Appendix F of this report.

The FEMA discharges for Fallen Timber Run are summarized on the Page B-4 in Table 4 – Summary of Discharges, taken from Page 54 of the FEMA FIS report. PennDOT's current Design Manual Part 2, Section 10.6.C. states that hydrologic and hydraulic models used in FEMA studies must be evaluated according to current design guidance and current modeling practices for sizing highway waterway structures. Though it appears that the discharges presented in the FIS were generated from a log-Pearson Type-III analysis, which is an acceptable method to PennDOT, that analysis was performed for the Township of Elizabeth in 1976 and therefore needs to be verified.

Since no stream gage is available for this flooding source, regression methods based on the USGS "Techniques for Estimating Magnitude and Frequency of Peak Flows for Pennsylvania Streams", Water-Resources Investigations Report 00-4189 would be applicable for this watershed. Both of the drainage areas discussed above (4.26 and 4.5 mi^2) fall within the recommended 1.5 to 2000 mi^2 range for this method. HEC-1 or HEC-HMS, which are generally applicable up to 150 mi^2, would also be applicable but would require more man-hours. The Pennsylvania regional regression model PSU-IV can be used to compare estimates from other methods but should not be used as the final hydrologic method for flow selection unless there is site flooding history that justifies its use. In accordance with these criteria for applicability, new discharges were computed using the WRIR 00-4189 method and comparative discharges were computed using the PSU-IV method.

Revised estimates of instantaneous peak flows were determined for recurrence intervals of 10, 25, 50 100 and 500 years (annual exceedance probabilities of 0.10, 0.04, 0.02, 0.01 and 0.002, respectively). Comparison of WRIR 00-4189 with FEMA shows that the FEMA discharges are lower over the entire range of flood frequencies, but they are higher than the unfactored PSU-IV discharges except for the 500-year flood. Calculations are included on Pages AP-1 through AP-8 of Appendix A.

A summary of discharges is included in the tabulation below for the USGS WRIR 00-4189 method and PSU-IV methods compared with the FEMA discharges. A log-log scale graphical comparison [2] with the FEMA discharges is also presented on Page B-7.

Table B-1: Summary of Flood Discharges

Return Period (Years)	Method and Discharge (cfs)			
	FEMA FIS	USGS NFF Method 1 (1)	USGS NFF Method 2 (1)	PSU-IV (2)
10	620	777	**679**	632
25	–	1130	**983**	859
50	940	1450	**1260**	1052
100	1,100	1840	**1590**	1268
500	1,400	3040	**2600**	2155

<u>NOTES</u>:

(1) – USGS NFF Method 1 (WRIR 00-4189) is based on drainage area measured from the downstream Corporate Limit of Forward Township—referenced in the

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[2] Software reference in Report Section G

FEMA flood insurance study. The analysis is also based on 45% forest cover and 3.5% urbanization (see Page B-1).

USGS NFF Method 2 (WRIR 00-4189) [3] is based on the PennDOT Scour Study which utilizes a drainage area measured from the proposed crossing at State Route 51. The analysis is based on 59% forest cover and 3.1% urbanization. These discharges are used to design the hydraulic opening.

(2) – PSU-IV [4] discharges provided only for comparison. Discharges are based on 59% forest cover and no urbanization with a 1.30 risk factor adjustment.

The discharges from the four methods shown in the above table were evaluated considering current PennDOT hydrologic modeling standards and the flood history obtained from the business owner and resident presented in Section A – Site Data. Selection of the appropriate discharges in the table for design of the hydraulic opening was based on these considerations. The flood history indicates that Route 51 and the subject bridge have never been inundated over approximately a 50 year period to the present; however flooding from Hurricane Agnes (1972) almost reached the roadway.

Predicted flood elevations in the existing conditions hydraulic model were compared with the minimum bridge deck elevation relative to the eyewitness report about flooding from Hurricane Agnes. The table below presents a comparison of freeboard from the bridge deck to the 50-year flood (Design Flood) and the 100-year flood for the FEMA and two set of USGS NFF discharges. The PSU-IV results are not presented because the discharges by that method are generally the lowest.

Table B-2: Existing Bridge Deck Freeboard to 50-Year and 100-Year Floods

	Bridge Deck Freeboard (ft.)		
Flood Frequency	FEMA FIS	USGS NFF Method 1	USGS NFF Method 2
50-Years (Design Flood)	1.10	(0.59)	(0.16)
100-Years	0.44	(0.56)	0.04

Note: Values enclosed in parentheses indicate bridge deck overtopping at the gutter lines.

With approximately 50 years of flood history at the site and a flood event within this period that nearly reached the roadway elevation, the FEMA discharges may be somewhat low especially with a 100-year flood freeboard of nearly 6 inches. The existing conditions hydraulic model based on USGS Method 1 predicts overtopping by the Design Flood and 100-year flood of over 6 inches. USGS Method 2 model

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[3, 4] Software reference in Report Section G

predicts minor overtopping (2 inches or less) by the Design Flood and virtual overtopping by the 100-year flood. Based on flooding history, engineering judgment suggests that USGS NFF Method 1 would result in an overly conservative design opening for the proposed bridge and the FEMA discharges probably lack sufficient conservatism for design. USGS NFF Method 2, based on the PennDOT Scour Study, would result in a proposed opening with a margin of safety for overtopping compared with the FEMA discharges, and it would result in a less conservative opening than USGS Method 1 discharges. For these reasons USGS Method 2 was selected for design.

6. FEMA Studies

Flood study information for the project area was extracted from the comprehensive Flood Insurance Study (FIS) indicated below.

Flood Study Information: (See Appendix Section G for the selected FIS pages)

• Study Identifier:	Allegheny County, PA; Revised May 15, 2003
• Communities:	Townships of Elizabeth and Forward
• Community Numbers:	420033, 421064
• NFIP Map Panel:	42003C0494 E (Effective Date October 4, 1995)
• Stream Identifier:	Fallen Timber Run
• Applicable Year: Land Use/Cover	Circa 1976 (Hydrologic Analysis Performed)
• Methodology Used:	log-Pearson Type III (Bulletin 17B)
• 100-Year Discharge:	1,100 cfs

7. Flood/Frequency Curve

Flood/Frequency Curves are presented on Page B-8 of this report.

8. Stage/Discharge/Frequency Curve

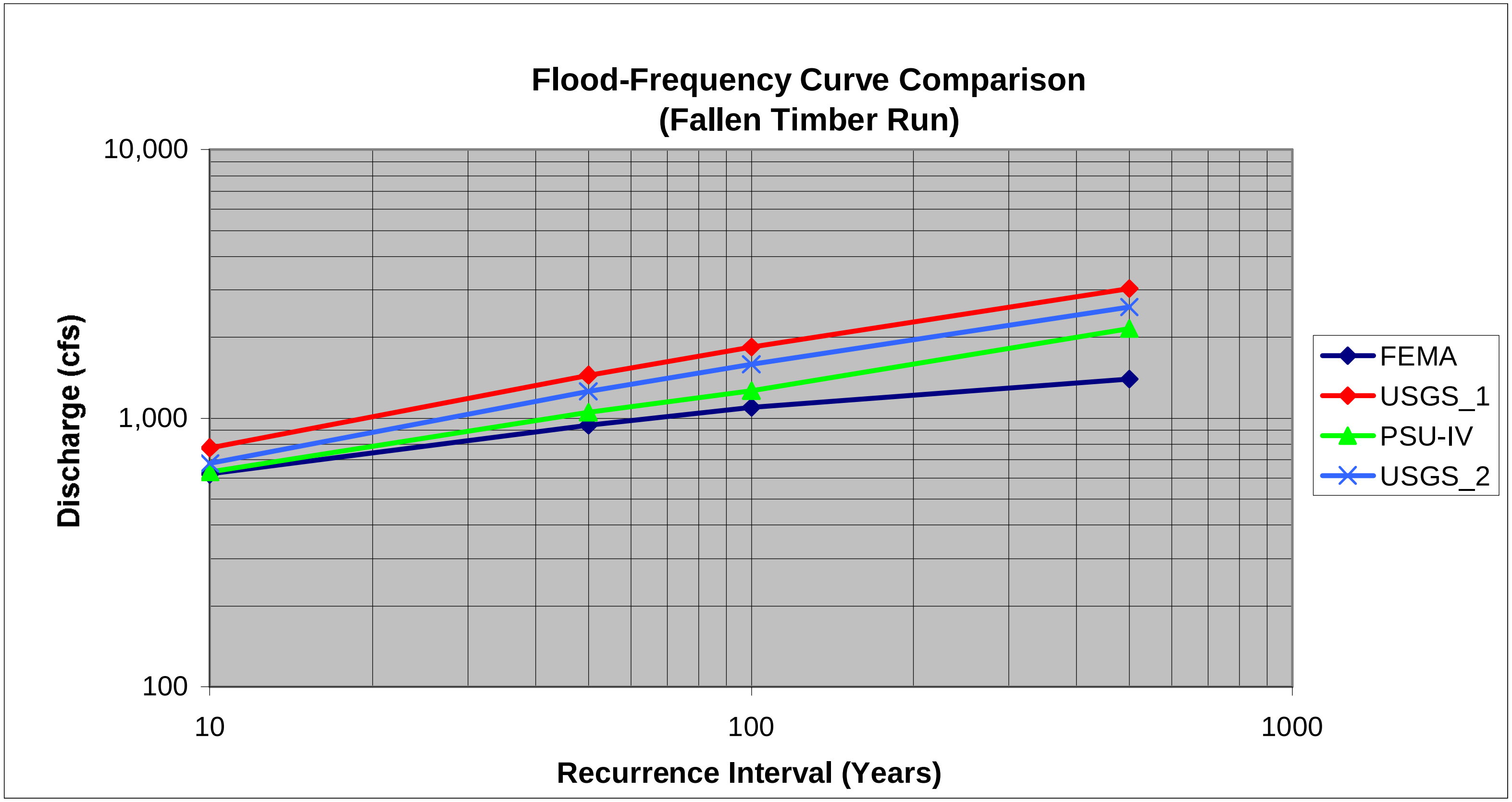
The Stage/Discharge/Frequency Curves for the existing and proposed bridge crossings are presented on Pages B-9 and B-10 of this report.

9. Flood History References

Provided by a local resident and a business owner. See Section A – Site Data, Pages A-4 and A-5.

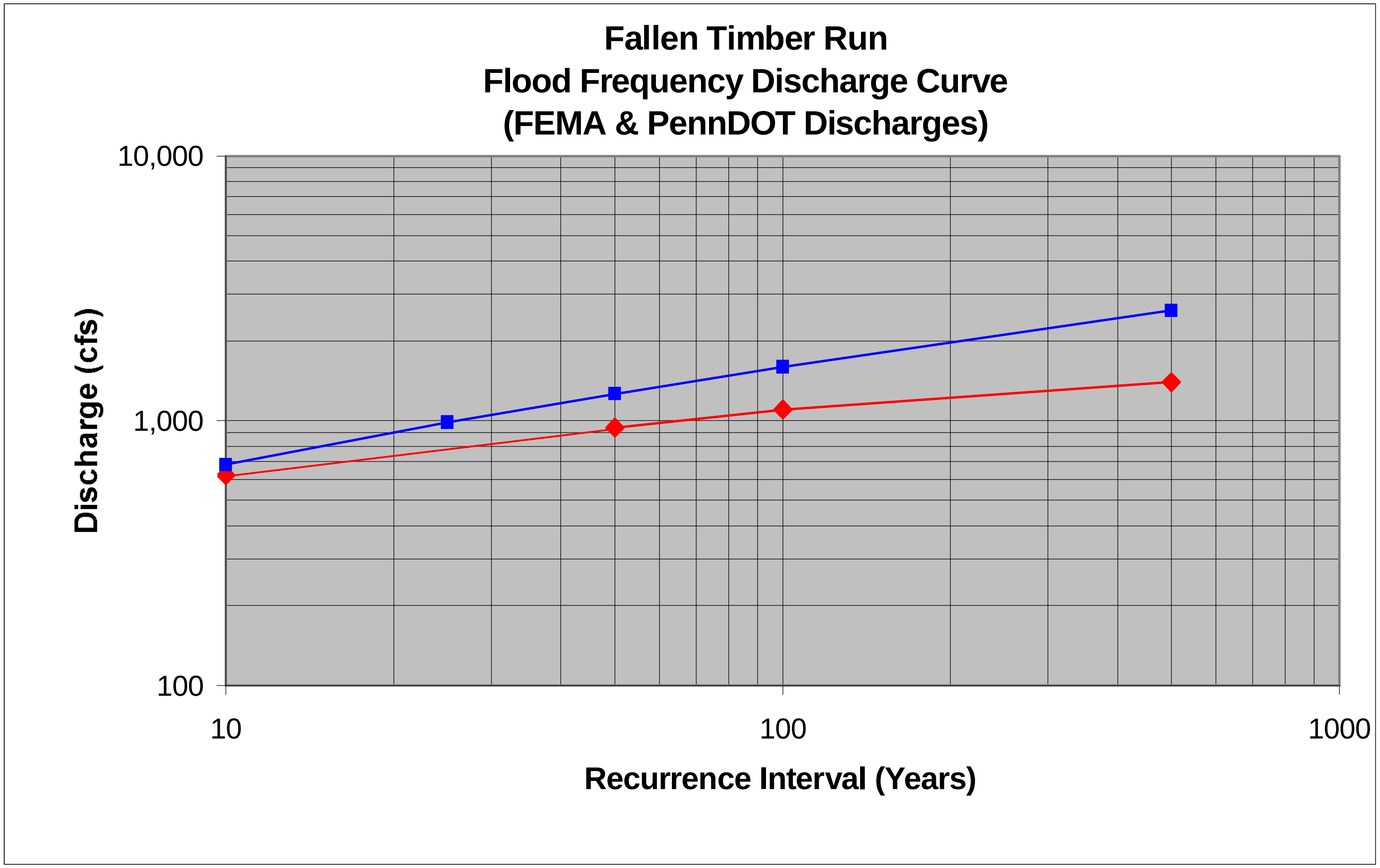
TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-YEAR	50-YEAR	100-YEAR	500-YEAR
CROUSE RUN					
At confluence with Pine Creek	4.32	1,040	1,810	2,180	3,200
Downstream of South Pioneer Road	2.39	640	1,110	1,330	1,980
At confluence of Crouse Run Tributary	1.31	400	690	830	1,210
CROUSE RUN TRIBUTARY					
At confluence with Crouse Run	1.08	340	590	710	1,040
DEER CREEK					
At Township of West Deer downstream corporate limits	17.31	3,380	4,790	6,000	9,290
Upstream of confluence of Dawson Run	12.61	2,280	3,270	4,070	6,340
At confluence of West Branch Deer Creek	3.84	720	1,030	1,350	2,100
DIRTY CAMP RUN					
At confluence with Turtle Creek	3.18	810	1,410	1,690	2,500
Near intersection of Wall Avenue and School Street	2.44	600	1,030	1,240	1,930
At Municipality of Monroeville downstream corporate limits	2.15	600	1,030	1,240	1,930
EAST THOMPSON RUN					
At confluence with Abers Creek	2.51	670	1,180	1,400	2,060
Approximately 1,550 feet above U.S. Route 22 bridge	1.80	520	850	1,070	1,570
FALLEN TIMBER RUN					
At Township of Forward downstream corporate limits	4.80	620	940	1,100	1,400



	Discharge (cfs)				
Frequency, n	10	50	100	500	Drainage Area
FEMA Flows	620	940	1,100	1,400	4.5 sq. mi.
USGS Method 1	777	1,450	1,840	3,040	4.5 sq. mi.
PSU-IV Method	632	1,052	1,268	2,155	4.26 sq. mi.
USGS Method 2	679	1,260	1,590	2,600	4.26 sq. mi.

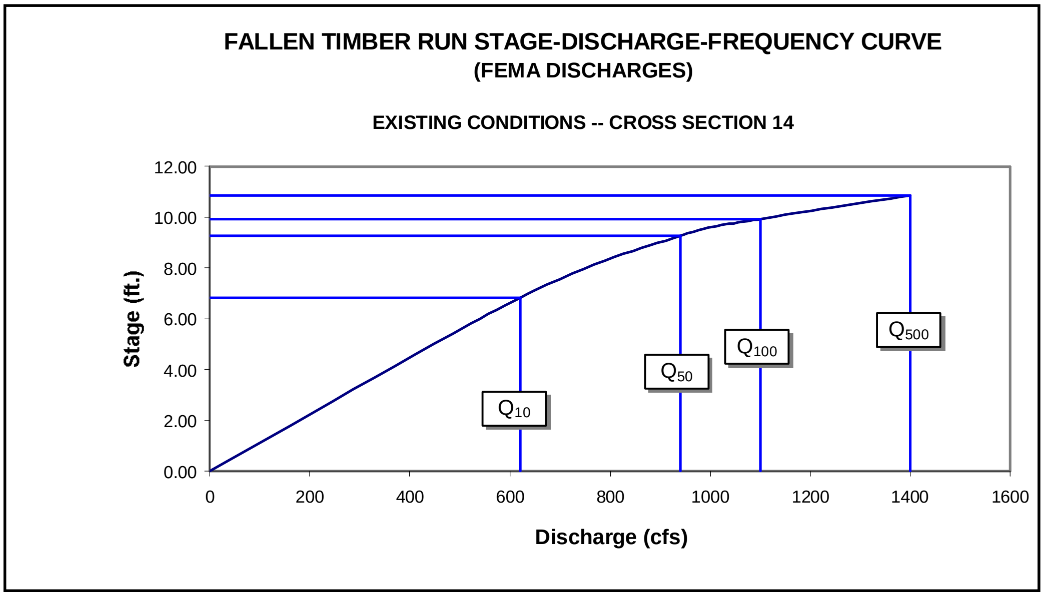
← **(Factored)**



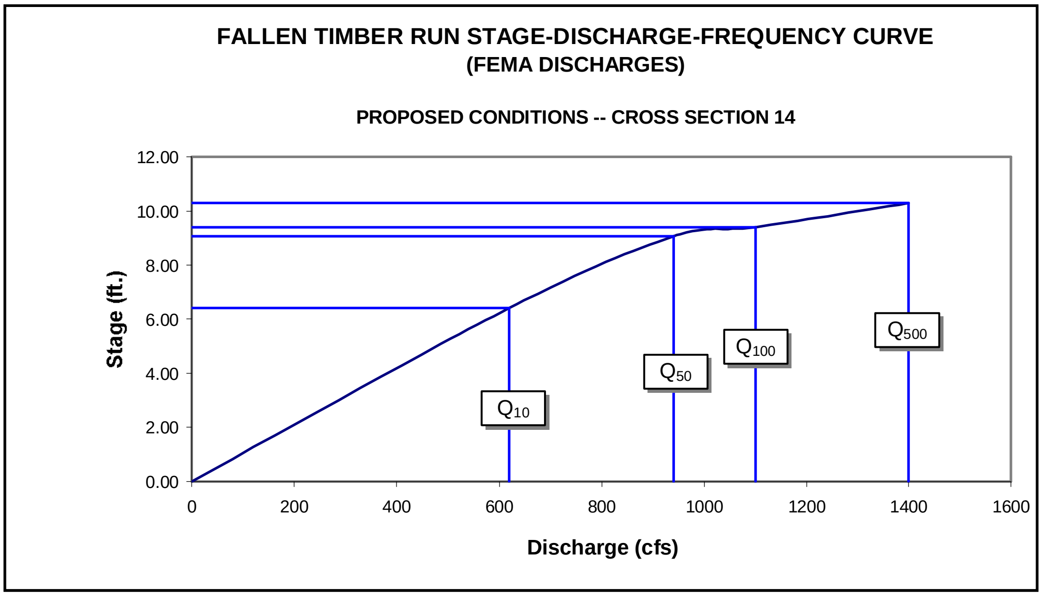
	Discharge (cfs)				
Storm Frequency	**10**	**25**	**50**	**100**	**500**
FEMA Flood Discharges	**620**	—	**940**	**1,100**	**1,400**
PennDOT Flood Discharges	**679**	**983**	**1,260**	**1,590**	**2,600**

LEGEND

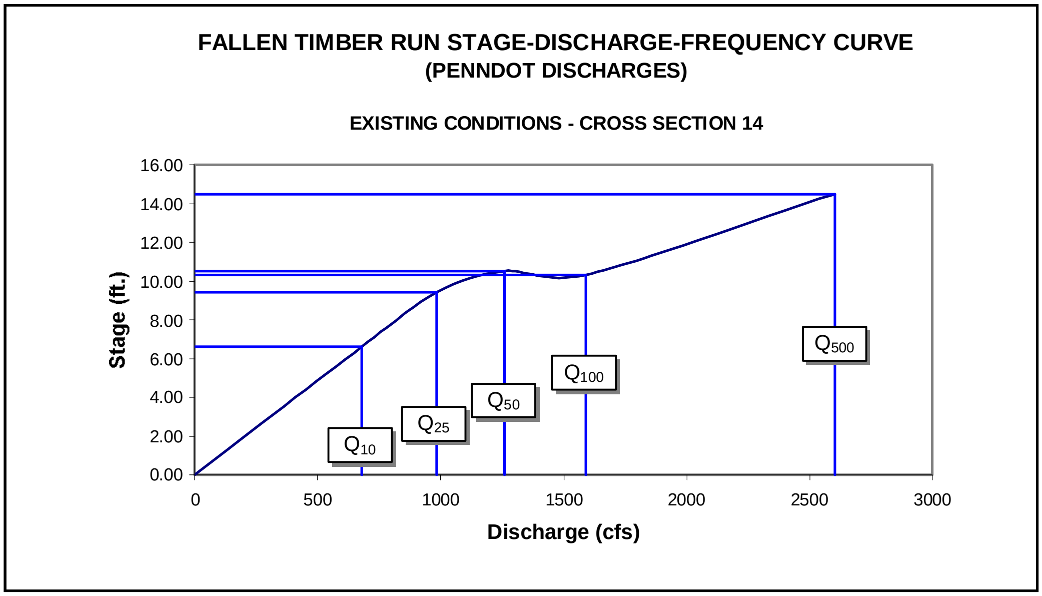
🟥	FEMA Discharges
🟦	PennDOT Discharges



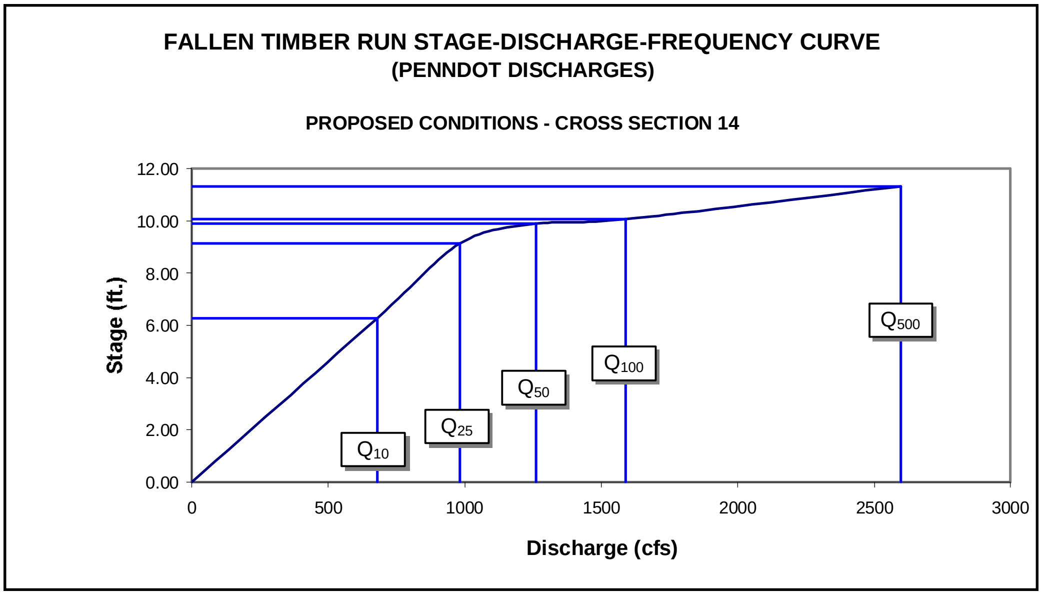
Frequency (Yrs)	Discharge (cfs)	Stage (ft)
0	0	0.00
10	620	6.83
50	940	9.27
100	1,100	9.93
500	1,400	10.86



Frequency (Yrs)	Discharge (cfs)	Stage (ft)
0	0	0.00
10	620	6.41
50	940	9.06
100	1,100	9.40
500	1,400	10.29



Frequency (Yrs)	Discharge (cfs)	Stage (ft)
0	0	0.00
10	679	6.62
25	983	9.43
50	1,260	10.53
100	1,590	10.33
500	2,600	14.51



Frequency (Yrs)	Discharge (cfs)	Stage (ft)
0	0	0.00
10	679	6.27
25	983	9.14
50	1,260	9.89
100	1,590	10.06
500	2,600	11.33

C. HYDRAULIC ANALYSIS

C. HYDRAULIC ANALYSIS

The hydraulic analysis was performed using the software HEC-RAS Version 3.1.3 May 2005) [5]. Cross section data for Fallen Timber Run was imported from the Effective FEMA hydraulic analysis in the HEC-2 format. The FEMA model was truncated approximately 600 ft. downstream of the proposed crossing at S.R. 51 and to the inlet of the next upstream hydraulic structure at Weigles Hill Road. The HEC-2 stream cross sections were compared with electronic survey data collected by Mackin Engineering Company. The surveyed geometry showed significant differences with the HEC-2 geometry at several cross sections including the bridge at the proposed crossing location. These cross sections were modified using the survey data at the stream channel and banks primarily. These differences are discussed below. A few cross sections were added using mapping from the background drawings for added refinement. In addition, a number of cross sections were interpolated between known sections using the HEC-RAS interpolation routines.

It is noted that the original stream section surveys were conducted using a different vertical reference datum than the one used for section surveys performed for this project. All elevations in the original surveys are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29) and elevations referenced in the FIS and on the FIRM are also referenced to it. Elevations from the project surveys are referenced to the North American Vertical Datum of 1988 (NAVD88), which is 0.56 feet lower than NGVD29 within the project area. All of the hydraulic modeling for existing and proposed conditions include datum adjustments that are consistent with NAVD88. Water surface elevations in the summary tables of this report are referenced to the NAVD88 datum.

The narrative that follows begins with discussion of the hydraulic analysis with FEMA discharges for existing and proposed models, followed by discussion of the analysis based on PennDOT discharges for both models. A comparison of FEMA and PennDOT discharge results for existing and proposed conditions is on Pages C-18 and C-19.

The proposed bridge deck with roadway grade equivalent to the existing bridge will be above the elevation of the 50-year (Design) flood, but is overtopped by the 100-year flood as is the existing bridge deck. The proposed bridge configuration is a single span structure with the bottom of the superstructure located slightly above the bottom of the existing T-Beam bridge.

1. Existing Conditions Model – FEMA Discharges

Building the existing conditions hydraulic model began with entering the Effective HEC-2 model input data requested from FEMA into a text file with no modification. Initially, the reproduced FEMA model contained cross sections extending from a point 2090 feet downstream of the existing bridge (Section 1) to a location 920 feet upstream of the existing bridge (Section

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[5] Software reference in Report Section G

8.2), which is the entrance to a long culvert upstream of the existing (and proposed) crossing. The HEC-2 model was run with the EDIT-2 routine to check for modeling errors, and numerous errors were found particularly at BT Card inputs. Modeling errors were corrected, the model was imported into HEC-RAS and then checked to verify contraction and expansion and Mannings roughness coefficients. The coefficients were compared with Table 3.1 in Chapter 3 of the HEC-RAS Hydraulic Reference Manual.

Cross Section Modeling:

After the FEMA model was reproduced and the vertical datum adjustment made, cross sections needed to be verified and a decision was needed regarding the upstream and downstream limits of the hydraulic model. Since the hydraulic model was not being prepared for FEMA, the criteria for determining the model limits do not have to satisfy NFIP Section 65.6(a)(2). Modeling limits were discussed generally with the District 11-0 Permit Coordinator, Rao Chaluvadi, and a decision was then made. The final existing model begins approximately 500 feet downstream of the existing bridge (FEMA Section 6) and ends at the entrance to the culvert upstream (FEMA Section 8.2), which is actually 872 feet upstream (the 920 feet referenced above was an error in the FEMA modeling). The stream model spans a total distance of 1,452 feet between its upstream and downstream limits.

A total of nine cross sections from the FEMA model, numbered successively 10 through 18 (renumbered when imported into HEC-RAS), were utilized in the revised existing model. The distance between successive open-channel cross sections ranged from 149 to 310 feet. Most of the FEMA cross sections were verified by on-site electronic stream surveys conducted by Mackin Engineering Company, including cross sections at the existing bridge that will be replaced and at the upstream culvert structure. The structure cross sections and several of the open channel cross sections were revised based on the new survey data.

Additional cross sections were generated from the project topographic mapping and incorporated into the model to reduce some of the longer cross section intervals. Two of the FEMA sections, 6.1 and 6.2 (renumbered as 11 and 12), were originally modeled as 7 foot wide footbridge (see published FEMA stream profile in Appendix F). During the May 21, 2007 hydraulic field view, no footbridge was present at this location, therefore the bridge model was deleted in the revised existing model.

The streambed is composed of sandy and gravelly sediments with approximately 3 inch to 10 or 12 inch smooth flat rocks and cobbles within a relatively clean, straight, channel with no rifts or deep pools (see Photos 5, 9, 10, 25 and 27). Upstream of the existing (and proposed) bridge crossing, there is exposed bedrock in the channel, some areas with only the bedrock surface with algae coverage and in other areas the bedrock is covered with the gravelly sediments and rocks described above (see Photos 4, 23 and 24). The original FEMA model utilizes channel roughness coefficients of 0.04 and 0.045, and though somewhat conservative, they were retained in the existing conditions model without modification.

The banks and overbank areas typically exhibit moderate to thick vegetation density (see Photos 4 to 6, 9 to 11 and 18 to 20). In these areas, the FEMA model utilizes roughness values that range from 0.07 to 0.10, which are fair representations of the channel overbanks (though somewhat conservative at some locations) and they were retained in the existing model. Left and right bank stations in the FEMA model were also reviewed and most of them were revised to better reflect site conditions with most of the bank areas being covered with vegetation to the edge of the stream or even encroaching upon the waterway. A summary of revisions to the FEMA model is included in Appendix Section B, Pages AP-11 and AP-12.

Boundary Conditions, Computational Options:

Section 10 is the downstream boundary in the hydraulic model, which corresponds with Section 6 in the Effective FEMA HEC-2 model. For the analysis based on FEMA discharges, water-surface elevations at Section 10 were extracted from the effective HEC-2 analysis and were input as the downstream boundary conditions for respective flood profiles. A mixed flow regime was selected which also required the upstream boundary conditions to be set. With Normal Depth selected as the upstream boundary condition, an assumed energy grade slope was entered—equal to the stream slope between the upstream section and the next downstream section.

The existing conditions model was fine-tuned by opting for settings that enable HEC-RAS to automatically select the best computational algorithms for steady flow analysis. The model was set for “Program Selects Appropriate Method” for Friction Slope Method, “Critical Depth Always Calculated” for the Critical Depth Output Option, and “Multiple Critical Depth Search” for Method of Computing Critical Depth.

Bridge and Culvert Modeling:

The existing bridge in the HEC-RAS model reflects cross sections that are normal to the stream alignment based on a 46 degree skew angle (See span lengths, Page A-4 of Site Data). These sections were adjusted manually rather than utilizing the skew adjustment feature in HEC-RAS. The upstream culvert, 497 feet in length, incorporates some special modeling features because of the long length, alignment shift and cross section variation within the structure. The structure is kinked approximately 183 feet downstream of the entrance because of a change in alignment (see attached Hydraulic Plan) and the span of the opening varies from 19’-9” to 21’-4$^3/_4$” between the inlet and outlet. The FEMA original model includes a cross section at the approximate kink point location and divides the hydraulic structure into two Normal Bridge models.

The revised model utilizes the HEC-RAS bridge routine with two end sections (16 and 18) and a cross section in between (Section 17) at the same location as the FEMA model. This approach is consistent with recommended modeling procedures for long culverts presented in Chapter 5 (Page 5-27) of the HEC-RAS Hydraulic Reference Manual. This intermediate section, which would not be treated as a bridge section otherwise, is modeled with a lid which caps the section with a ceiling that represents the low chord of the culvert. The program treats the cross section just like any other cross section except that the area above the lid is subtracted out and wetted perimeter is added if the water surface comes into contact with the lid.

Model Checking:

With the cross sections and other modeling components defined as indicated above, the hydraulic model analysis was performed. Once run, the Errors, Warnings and Notes were checked. No errors were encountered, but numerous warnings and notes were posted. The notes were generally of no consequence; rather they indicate computational routines selected by HEC-RAS for various flow conditions. The warnings generally pertained to computed energy losses, conveyance ratios and velocity heads that were outside of the bounds programmed into the software. For these three types of warnings, the program typically suggests that additional cross sections be added to the model. The solution in some cases was to add cross sections using the interpolation option built into HEC-RAS. A total of 27 interpolated cross sections were generated with cross section spacing ranging from approximately 15 feet to 28 feet. This approach did not eliminate all warning messages. Between Sections 14.625* and 15.75 the water surface profile transitions from subcritical to supercritical flow, and the warning messages that remain appear to be related to this flow condition—no amount of additional sections eliminated these messages. The same thing appears to be occurring between Sections 12 and 12.5625, and a hydraulic jump occurs at Section 11.

Hydraulic Structure Performance:

The existing conditions model indicates that the bridge that will be replaced is not overtopped by the Design Flood nor the 100-year flood, but there is pressure flow for both floods with freeboard from the bridge deck to the floods as indicated in Table B-2 on Page B-4 of this report. The approach roadway is also not overtopped by either flood. Velocities at the bridge opening and within the channel are tabulated on Table C-1 on Page C-9. Cross section plots at the bridge opening (Cross Sections 13 and 14) are located in Section H, Drawings, <u>Existing Cross Sections</u>, <u>50 and 100-Year</u>

Floods – FEMA Flows. Also see the Tables C-3 and C-5 on Pages C-9 and C-10.

100-Year Flood water surface elevations from the Effective, Duplicate Effective, revised Existing and Proposed models are compared in Table C-18 on Page C-29. The tabulation shows increases in flood elevations at the existing Hutchinson Hill Bridge and at one section upstream of it starting with the Duplicate Effective model run on HEC-RAS. The revised Existing and Proposed models also exhibit increases at these locations but they are smaller than for the Duplicate Effective model—possibly because the footbridge that was in place just downstream of the subject (discussed on Page C-2) bridge no longer exists and is absent from these models.

2. Existing Conditions Model – PennDOT Discharges

The hydraulic model is essentially the same as the existing conditions model for the FEMA discharges, discussed above, except for changes in selected Mannings roughness coefficients, particularly in the channel, and different water surface boundary conditions.

Cross Section Modeling:

The roughness coefficients utilized in the FEMA model are generally conservative considering the stream channel composition observed in the field (see Pages C-2 and C-3). Instead of the 0.04 and 0.045 values in the FEMA model, 0.035 is employed in the PennDOT model because it is more representative of the stream conditions. The overbank values were also reduced in some areas, particularly downstream of Section 13, from 0.1 to 0.07 or 0.06. Contraction and expansion coefficients are unchanged.

Boundary Conditions:

In the FEMA model, the starting water surface elevations at the downstream boundary (Section 10) are set to match the flood profile of the Effective model. This would not be appropriate for the PennDOT model since the flood discharges are approximately 40 percent larger for the 50 and 100-year floods. Instead, the “Normal Depth” option was selected as the downstream boundary condition—Normal Depth is also the setting for the upstream boundary condition. The input value for energy grade slope is the approximate stream slope at these locations.

Hydraulic Structure Performance:

The model predicts that the existing bridge is overtopped slightly by both the Design Flood and the 100-year flood as indicated in Tables C-7 and C-9 below. Velocities at the existing bridge opening and within the channel are tabulated in Table C-2 below. Cross section plots at the bridge opening

(Cross Sections 13 and 14) are located in Section H – Drawings, Proposed Cross Sections, 50 and 100-Year Floods – FEMA Flows.

3. Proposed Conditions Model – FEMA Flows

The proposed conditions model used to produce the revised water surface elevations differs from the existing conditions model only in the modification of the bridge opening at Sections 13 and 14. The key objective in designing the new opening was to eliminate overtopping by the design flood at the bridge, which occurs with the PennDOT discharge only, and to avoid increases in the Base (100-year) Flood with the FEMA discharge. Since the proposed roadway profile will not vary from existing conditions, the span of the bridge was adjusted to meet these objectives, as discussed below.

Allowable Velocity:

Allowable velocity at the proposed bridge opening and in the upstream channel was evaluated by taking existing stream velocities into consideration and initial estimates of streambed material size. Table C-1 below shows existing velocities in the stream for the 50 and 100-year floods for the FEMA discharge. The new bridge opening has been sized to minimize increases above the values shown in the table. An estimate of the size of streambed material was used with Equation 5.1 from Section 5.2.1 of the HEC-18 Manual, Fourth Edition, as another way of assessing allowable velocity. Streambed size was estimated from streambed samples obtained by Mackin Engineering during the May 21, 2007 Hydraulics Field View. The estimated mean particle diameter (D50) in the channel at and near the existing bridge is 1 inch.

Based on the assumed mean particle diameter:

Critical Flow Velocity, $V_c = K_u y^{1/6} D^{1/3}$ (HEC-18 Eq. 5.1)

The parameter y, average flow depth is based on the PennDOT discharges.

Substitute $D = D_{50} = 1.0$ in. (estimated mean diameter of bed material)

Estimated Allowable Velocity = 6.93 ft/s

More complete calculations are included on Sheet 5 of 22 in the Scour Analysis, Appendix E. It is noted that this computed velocity does not consider the presence of exposed bedrock in the upstream channel.

TABLE C-1: VELOCITIES – EXISTING CONDITIONS (FEMA FLOWS)

SECTION	LOCATION	50-YEAR FLOOD (fps)	100-YEAR FLOOD (fps)
18	Culvert Inlet/Upstream Limit	9.01	9.45
17	Intermediate Culvert Sect.	8.68	9.18
16	Culvert Outlet	8.70	9.04
15.75	—	11.18	11.92
15	—	8.69	8.98
14.25	—	6.99	7.32
14	**Just U/S of Bridge**	**6.53**	**7.01**
—	**Internal Bridge Sect. (U/S)**	**7.79**	**9.29**
—	**Internal Bridge Sect. (D/S)**	**9.35**	**8.42**
13	**Just D/S of Bridge**	**9.35**	**9.77**
12.75	—	7.24	7.46
12.5	—	11.51	12.73
12	—	9.01	9.49
11	—	10.68	11.00
10.5	—	5.58	6.14
10	Downstream Study Limit	5.34	6.02

TABLE C-2: VELOCITIES – EXISTING CONDITIONS (PENNDOT FLOWS)

SECTION	LOCATION	50-YEAR FLOOD (fps)	100-YEAR FLOOD (fps)
18	Culvert Inlet/Upstream Limit	9.45	7.45
17	Intermediate Culvert Sect.	10.00	9.56
16	Culvert Outlet	9.56	10.24
15.75	—	12.72	13.67
15	—	9.62	12.15
14.25	—	7.77	10.04
14	**Just U/S of Bridge**	**7.47**	**9.65**
—	**Internal Bridge Sect. (U/S)**	**10.24**	**12.83**
—	**Internal Bridge Sect. (D/S)**	**9.24**	**11.29**
13	**Just D/S of Bridge**	**10.88**	**11.49**
12.75	—	7.89	8.19
12.5	—	13.30	14.34
12	—	10.24	17.02
11	—	11.40	16.14
10.5	—	10.14	10.54
10	Downstream Study Limit	11.92	12.81

Permissible Backwater:

The project is situated in a FEMA study area with a detailed flood study in the designated special flood hazard Zone AE. The Flood Insurance Rate Map (FIRM) indicates that the project is also located within a regulated floodway; therefore NFIP regulations prohibit any increases in the 100-year flood elevation determined with the FEMA discharge. Since the proposed project is located in a FEMA detailed study area in a regulated floodway, the FEMA discharge cannot cause backwater increases for the 100-year flood. Various bridge spans were investigated to satisfy this constraint.

Backwater increases were evaluated for several bridge openings. The profile of the roadway will remain as-is and the proposed prestressed concrete spread box beams (36”x 17”) with 8½” deck slab result in a new superstructure depth that is similar to the existing T-Beam superstructure. Consequently, the only option for increasing the size of the opening is to increase the span length.

Trial Bridge Backwater and Velocities:

Design of the bridge opening included a study of three span lengths with a skew of 45 degrees. The clear span of the existing bridge is 27’-6” parallel with the roadway. It is noted that the PennDOT discharges were used to design the hydraulic opening, not the FEMA discharges. The backwater tables that follow present the hydraulic analysis results for the FEMA discharge only as a check. The three alternatives studied are as follows:

Trial No. 1:	Clear span of 30’-0” parallel with the roadway
Trial No. 2:	Clear span of 32’-0” parallel with the roadway
Trial No. 3:	Clear span of 34’-0” parallel with the roadway

Water surface elevations for the three proposed openings are compared with that of the existing opening in Tables C-3 and C-5, and velocities are compared in Tables C-4 and C-6 on the pages that follow. Though the 50-year and 100-year FEMA discharges do not overtop the bridge deck, minimum bridge deck elevations are presented below that represent the overtopping thresholds:

Min. Upstream Deck Elevation = 779.42

Min. Downstream Deck Elevation = 779.19

TABLE C-3: 50-YEAR FLOOD TRIAL BRIDGE BACKWATER (FEMA FLOWS)

HEC-RAS SECTION	FEMA LETTER SECTION	EXISTING 27.5' CL SPAN	PROPOSED 30' CL SPAN	PROPOSED 32' CL SPAN	PROPOSED 34' CL SPAN
18	–	787.37	787.37	787.37	787.37
17	E	785.34	785.34	785.34	785.34
16	–	782.10	782.09	782.09	782.09
15.75	–	780.60	780.59	780.59	780.59
15	D	778.74	778.62	778.52	778.05
14.25	–	778.38	778.22	778.05	776.29
14	–	**778.32**	**778.23**	**778.11**	**776.60**
BR. SECTION	–	**777.15**	**777.40**	**777.40**	**776.59**
BR. SECTION	–	**775.59**	**775.59**	**775.58**	**775.66**
13	–	**775.59**	**775.59**	**775.58**	**775.57**
12.75	–	775.31	775.30	775.31	775.30
12.5	–	773.53	773.54	773.53	773.53
12	–	773.36	773.36	773.36	773.36
11	–	772.72	772.72	772.72	772.72
10.5	–	772.23	772.23	772.23	772.23
10	C	772.00	772.00	772.00	772.00

TABLE C-4: 50-YEAR FLOOD TRIAL BRIDGE VELOCITIES (FEMA FLOWS)

HEC-RAS SECTION	FEMA LETTER SECTION	EXISTING 27.5' CL SPAN	PROPOSED 30' CL SPAN	PROPOSED 32' CL SPAN	PROPOSED 34' CL SPAN
18	–	9.01	9.01	9.01	9.01
17	E	8.68	8.67	8.62	8.68
16	–	8.70	8.74	8.74	8.74
15.75	–	11.18	11.19	11.19	11.20
15	D	8.69	8.90	9.11	10.13
14.25	–	6.99	7.18	7.41	10.72
14	–	**6.53**	**6.13**	**5.82**	**6.90**
BR. OPENING	–	**7.79**	**6.93**	**6.46**	**6.91**
BR. OPENING	–	**9.35**	**8.73**	**8.22**	**7.62**
13	–	**9.35**	**8.73**	**8.22**	**7.76**
12.75	–	7.24	7.26	7.25	7.27
12.5	–	11.51	11.47	11.51	11.51
12	–	9.01	9.01	9.01	9.01
11	–	10.68	10.68	10.68	10.68
10.5	–	5.58	5.58	5.58	5.58
10	C	5.34	5.34	5.34	5.34

TABLE C-5: 100-YEAR FLOOD TRIAL BRIDGE BACKWATER (FEMA FLOWS)

HEC-RAS SECTION	FEMA LETTER SECTION	EXISTING 27.5’ CL SPAN	PROPOSED 30’ CL SPAN	PROPOSED 32’ CL SPAN	PROPOSED 34’ CL SPAN
18	–	787.98	787.98	787.98	787.98
17	E	785.92	785.92	785.92	785.92
16	–	782.71	782.70	782.71	782.71
15.75	–	781.01	781.01	780.99	780.99
15	D	779.36	779.08	778.89	778.77
14.25	–	779.06	778.68	778.37	778.14
14	–	**778.98**	**778.69**	**778.45**	**778.28**
BR. OPENING	–	**778.98**	**777.40**	**777.40**	**777.40**
BR. OPENING	–	**778.98**	**776.20**	**776.20**	**776.20**
13	–	**776.20**	**776.20**	**776.20**	**776.20**
12.75	–	775.98	775.97	775.98	775.97
12.5	–	773.81	773.81	773.81	773.81
12	–	773.79	773.79	773.79	773.79
11	–	773.19	773.19	773.19	773.19
10.5	–	772.57	772.57	772.57	772.57
10	C	772.28	772.28	772.28	772.28

TABLE C-6: 100-YEAR FLOOD TRIAL BRIDGE VELOCITIES (FEMA FLOWS)

HEC-RAS SECTION	FEMA LETTER SECTION	EXISTING 27.5’ CL SPAN	PROPOSED 30’ CL SPAN	PROPOSED 32’ CL SPAN	PROPOSED 34’ CL SPAN
18	–	9.45	9.45	9.45	9.45
17	E	9.18	9.18	9.18	9.18
16	–	9.04	9.09	9.07	9.07
15.75	–	11.92	11.94	11.98	11.98
15	D	8.98	9.47	9.85	10.1
14.25	–	7.32	7.78	8.19	8.53
14	–	**7.01**	**6.75**	**6.50**	**6.23**
BR. OPENING	–	**9.29**	**8.11**	**7.56**	**7.08**
BR. OPENING	–	**8.42**	**9.11**	**8.56**	**8.06**
13	–	**9.77**	**9.11**	**8.56**	**8.06**
12.75	–	7.46	7.48	7.46	7.48
12.5	–	12.73	12.70	12.73	12.73
12	–	9.49	9.49	9.49	9.49
11	–	11.00	11.00	11.00	11.00
10.5	–	6.14	6.14	6.14	6.14
10	C	6.02	6.02	6.02	6.02

The above tabulations show that all three alternatives result in lower proposed water surface elevations for the 50-year flood except at the internal bridge section on the upstream side of the bridge for the 30 ft. and 32 ft. spans. Minor increases occur at this section and a smaller increase occurs for the 34 ft. span at the internal bridge section on the downstream side of the bridge. Considering the 100-year flood, again all three alternatives result in lower proposed water surface elevations except at internal bridge sections. This is not a problem since the increases disappear at Section 14 which is located approximately 1 foot upstream of the bridge opening. It is noted that minor reductions in the Mannings coefficient were made at Sections 12.75 and 13 to eliminate small increases in the 100-year flood at Section 13. This may be justified since the hydraulic opening will be more efficient with fewer beams, and the new beams will replace exposed reinforcement bars and spalled concrete on the existing beams.

Tables C-4 and C-6 show small to insignificant increases in velocity for the three alternatives at Sections 14.25 for the 50 and 100-year floods. The 30 ft. and 32 ft. clear spans result in maximum increases of less than 1 ft./sec. These velocities exceed the calculated critical velocity of 6.93 ft./sec (Page C-6) which would suggest that scour protection should be provided at the new abutments (See Item 5 below for discussion of scour potential).

For reasons that are explained further for the PennDOT model, the 32 ft. clear span was selected as the recommended proposed opening. For the FEMA discharges, it represents a good design with no meaningful flood elevation increases and minor velocity increases.

Cross section plots that illustrate the flow conditions at Sections No. 13 and 14 and other areas in stream reach are located in Section H, Drawings, Proposed Cross Sections, 50 and 100-Year Floods – FEMA Flows. The locations of these cross sections is shown on the attached Hydraulic Plan drawing, Sheet 2. Also refer to the Hydraulic Report Plan, Elevation and Section Drawing in Section H.

Table 6 – Floodway Data from FEMA's Flood Insurance Study (FIS) – is included on Page C-30. The floodway surcharges in this table have not been revised to reflect the modified channel and proposed bridge geometry because the Floodway run of the Effective HEC-2 model was not included with the data received from FEMA. Referring to this table and Table C-18 (Page C-29), the revised Existing Model shows increases above the FEMA elevations only between Sections 14 and 15. This is probably due solely to software differences as indicated by increases at these and other locations for the Duplicate Effective Model. The most important fact to note in Table C-18 is that the Proposed Model exhibits no increases in base flood elevations compared with the revised Existing Model—in fact there are reductions between the Downstream Bridge Section and Section 16, which includes FEMA letter Section D. The proposed bridge does not increase base flood elevations anywhere.

4. Proposed Conditions Model – PennDOT Flows

It was noted in the preceding discussion that the proposed bridge opening was based primarily on the PennDOT discharges—determined by the USGS WRIR 00-4189 Method. The objective was to size the opening at the minimum clear span that would eliminate overtopping of the bridge by the PennDOT Design Flood (50-years) and not increase the 100-year flood determined from the FEMA discharge. Discussion follows.

Allowable Velocity:

Refer to the discussion on Page C-6. Table C-2 above shows existing velocities in the stream for the 50 and 100-year floods for PennDOT discharges.

Permissible Backwater:

The previous discussion of backwater criteria on Page C-8 discussed FEMA criteria for the 100-year flood. As shown in Table C-9 below, all of the proposed clear span alternatives that were evaluated resulted in minor increases at the outlet of the bridge opening (Section 13). This small increase is contained within the channel as shown on the Hydraulic Plan and is acceptable under the PADEP backwater criteria of PA Code Title 25, Chapter 105, Section 105.161(e).

Trial Bridge Backwater and Velocities:

Tables C-7 through C-10 present trial backwater elevations and velocities. One of the trial bridge openings as well as the existing opening exhibited overtopping of the bridge deck. Tabulated water surface elevations that are enclosed in parentheses indicate overtopping of the bridge deck. Minimum bridge deck elevations follow that represent the overtopping thresholds:

Min. Upstream Deck Elevation = 779.42

Min. Downstream Deck Elevation = 779.19

TABLE C-7: 50-YEAR FLOOD TRIAL BRIDGE BACKWATER (PENNDOT FLOWS)

HEC-RAS SECTION	FEMA LETTER SECTION	EXISTING 27.5’ CL SPAN	PROPOSED 30’ CL SPAN	PROPOSED 32’ CL SPAN	PROPOSED 34’ CL SPAN
18	–	788.50	788.50	788.50	788.50
17	E	786.23	786.23	786.23	786.23
16	–	783.16	783.16	783.16	783.16
15.75	–	781.38	781.38	781.38	781.38
15	D	779.75	779.34	779.07	778.84
14.25	–	779.63	779.17	778.81	778.46
14	–	**(779.58)**	**779.21**	**778.94**	**778.68**
BR. OPENING	–	**(779.58)**	**779.21**	**778.94**	**777.40**
BR. OPENING	–	**(779.28)**	**(779.21)**	**778.94**	**776.56**
13	–	**776.36**	**776.43**	**776.50**	**776.56**
12.75	–	776.43	776.43	776.43	776.43
12.5	–	774.32	774.32	774.32	774.32
12	–	774.08	774.08	774.08	774.08
11	–	773.61	773.61	773.61	773.61
10.5	–	770.83	770.83	770.83	770.83
10	C	769.21	769.21	769.21	769.21

TABLE C-8: 50-YEAR FLOOD TRIAL BRIDGE VELOCITIES (PENNDOT FLOWS)

HEC-RAS SECTION	FEMA LETTER SECTION	EXISTING 27.5’ CL SPAN	PROPOSED 30’ CL SPAN	PROPOSED 32’ CL SPAN	PROPOSED 34’ CL SPAN
18	–	9.45	9.45	9.45	9.45
17	E	10.00	10.00	10.00	10.00
16	–	9.56	9.56	9.56	9.56
15.75	–	12.72	12.72	12.72	12.72
15	D	9.62	10.35	10.91	11.42
14.25	–	7.77	8.32	8.79	9.3
14	–	**7.47**	**7.24**	**6.99**	**6.77**
BR. OPENING	–	**10.24**	**9.35**	**8.76**	**8.11**
BR. OPENING	–	**9.24**	**8.57**	**8.20**	**8.68**
13	–	**10.88**	**10.03**	**9.31**	**8.68**
12.75	–	7.89	7.89	7.89	7.89
12.5	–	13.30	13.30	13.30	13.3
12	–	10.24	10.24	10.24	10.24
11	–	11.40	11.40	11.40	11.4
10.5	–	10.14	10.14	10.14	10.14
10	C	11.92	11.92	11.92	11.92

TABLE C-9: 100-YEAR FLOOD TRIAL BRIDGE BACKWATER (PENNDOT FLOWS)

HEC-RAS SECTION	FEMA LETTER SECTION	EXISTING 27.5' CL SPAN	PROPOSED 30' CL SPAN	PROPOSED 32' CL SPAN	PROPOSED 34' CL SPAN
18	–	792.90	792.90	792.90	792.90
17	E	789.94	789.94	789.94	789.94
16	–	784.21	784.21	784.21	784.21
15.75	–	782.25	782.25	782.25	782.25
15	D	779.74	780.13	778.87	778.87
14.25	–	779.47	779.97	778.90	778.73
14	–	**779.38**	**780.00**	**779.11**	**779.05**
BR. OPENING	–	**779.38**	**(780.00)**	**779.11**	**779.05**
BR. OPENING	–	**(779.38)**	**(779.67)**	**779.11**	**779.05**
13	–	**777.50**	**777.59**	**777.68**	**777.75**
12.75	–	777.67	777.67	777.67	777.67
12.5	–	775.23	775.23	775.23	775.23
12	–	772.96	772.96	772.96	772.96
11	–	773.16	773.16	773.16	773.16
10.5	–	771.71	771.71	771.71	771.71
10	C	769.97	769.97	769.97	769.97

TABLE C-10: 100-YEAR FLOOD TRIAL BRIDGE VELOCITIES (PENNDOT FLOWS)

HEC-RAS SECTION	FEMA LETTER SECTION	EXISTING 27.5' CL SPAN	PROPOSED 30' CL SPAN	PROPOSED 32' CL SPAN	PROPOSED 34' CL SPAN
18	–	7.45	7.45	7.45	7.45
17	E	9.56	9.56	9.56	9.56
16	–	10.24	10.24	10.24	10.24
15.75	–	13.67	13.67	13.67	13.67
15	D	12.15	11.36	14.33	14.33
14.25	–	10.04	9.35	10.94	11.24
14	–	**9.65**	**8.32**	**8.64**	**8.15**
BR. OPENING	–	**12.83**	**10.26**	**10.94**	**10.31**
BR. OPENING	–	**11.29**	**9.60**	**10.24**	**9.69**
13	–	**11.49**	**10.59**	**9.82**	**9.16**
12.75	–	8.19	8.19	8.19	8.19
12.5	–	14.34	14.34	14.34	14.34
12	–	17.02	17.02	17.02	17.02
11	–	16.14	16.14	16.14	16.14
10.5	–	10.54	10.54	10.54	10.54
10	C	12.81	12.81	12.81	12.81

The above tabulations show that all three alternatives result in lower proposed water surface elevations for the 50-year except for minor increases at Cross Section 13. Backwater at all other sections is reduced incrementally as the clear span increases. Backwater for the 100-year flood increases at the bridge opening and upstream for the 30 foot clear span, but is incrementally reduced for the 32 and 34 foot clear spans. Again, there are minor increases for these spans at Section 13 as discussed above on Page C-12. Cross section plots that illustrate the flow conditions are included in Section H – Drawings, Proposed Cross Sections, 50 and 100-Year Floods – PennDOT Flows. Also refer to the Hydraulic Report Plan, Elevation and Section Drawing in Section H.

Average velocities for the 50 and 100-year floods exhibit reductions at the bridge opening, which will reduce scour potential at the new structure, but there are increases at Sections 14.25 and 15. The maximum increase occurs at Section 15 where channel velocity is raised from 12.15 to 14.33 ft./sec for the 100-year flood. As Table C-10 shows, increasing the span from 32 ft. to 34 ft. does not reduce that increase. This increase probably occurs because improved hydraulic efficiency with the larger bridge opening. This increased average velocity will not be harmful to the channel because the streambed is composed of bedrock at this location (Photos 23 and 24), and actual velocity will be reduced at the edges of the stream channel as shown in the Velocity Distribution plot on Page C-26.

Considering all the factors presented above, the 32 ft. clear span opening is a reasonable choice since it will reduce all flood elevations except the minor increases at Section 13, whereas the 30 ft. clear span will increase the water surface at the bridge opening and at several upstream sections. The 34 ft. span will not provide significant improvements in these factors.

Other Hydraulic Opening Modifications:

The poor stream alignment at the existing bridge and the scour hole that has formed as a result was discussed in Section A – Site Data, Item 2(b), Page A-5. As the preparation of this report neared completion, there was an in-house discussion about the significant sediment buildup that has shifted the stream location. The decision was made to remove sediment from the stream at the bridge, fill the scour hole and place rock riprap along the edges of the channel to the base of both abutments to redirect low flow through the center of the bridge opening. The channel modification will consist of a 12 ft. bottom and 1 foot high benches on either side of the channel as depicted on the attached Plan, Elevation and Section Drawing and on Page C-28 of this report. In addition, some repositioning of the stream will occur within 20 ft. of the bridge just upstream and within 50 ft. of the bridge just downstream as shown on the same drawing—a total of 163 ft. along the stream.

Rather than revise the entire report based on the new channel, additional proposed conditions hydraulic models were developed and the resulting flood profiles were compared with the proposed model without channel modifications. Tables C-16 and C-17 (Page C-27) below compare proposed 100-year flood backwater results for the revised channel model with the existing conditions and proposed conditions without sediment removal and rock placement. This table shows that the new bridge opening with the improved channel has slightly better results than the new bridge with the unimproved channel, but there are no major changes. Since the preceding summary tables and drawings depict proposed conditions without the improved channel, the information presented therein does not need to be revised.

5. Estimated Scour Depth

A scour analysis was performed for 100 and 500-year flood conditions at the proposed abutments. In accordance with the provisions of Section PP7.2.2 of the PennDOT DM-4, local scour was not evaluated because properly designed rock riprap will be placed at the abutments to a depth of 3 feet below the regraded streambed. This rock protection will be continued out from the ends of the bridges upstream and downstream of the bridge as shown on the attached structure drawing. Channel cleaning and rock placement will be performed within a distance of 50 feet of the bridge at both ends and will be covered under the GP-11 Permit that will be requested for this project.

Scour calculations are presented in Appendix Section E, Sheets 1 through 22. These calculations are based on preliminary streambed material sizes determined by Mackin Engineering Company from streambed samples, and therefore they represent preliminary scour depth estimates. Final scour depths will be determined by the geotechnical consultant for this project from more complete streambed sampling and analysis.

Estimated scour depths are as follows:

	Estimated Scour Depth (feet)	
Type of Scour	**100-Year Flood**	**500-Year Flood**
Aggradation/Degradation	0.00	0.00
Live-bed Contraction - Abut. 1	0.00	0.00
Live-bed Contraction - Abut. 2	0.00	0.00
Clear-water Contraction - Abut. 1	1.77	1.10
Clear-water Contraction - Abut. 2	1.51	0.84
Total Scour at Abutment 1	**1.77**	**1.10**
Total Scour at Abutment 2	**1.51**	**0.84**

The abutments will be protected from scour by R-7 Rock Riprap placed to a depth of 3.5 ft at the abutments. Calculations are provided on Sheet 21 of 22 of the Scour Analysis in Appendix E. The calculations apply a factor of

1.8 to the applicable flow velocity for the 100-year flood as required by the DM-4 Section 7.5.2 for abutments. The flow velocity (8.75 ft./sec) was obtained from a velocity distribution table generated by HEC-RAS, showing the maximum velocity that will occur immediately adjacent to an abutment rather than the average velocity for the hydraulic section. When a 1.8 factor is applied according to the design standard, the resulting design velocity is 15.75 ft./sec and R-7 becomes the minimum required rock size at the abutments. R-7 is a large gradation of rock and the proposed hydraulic opening is relatively small, however District policy will not permit a smaller size to be utilized. A larger rock size, such as R-8, would be impractical.

The nominal placement depth for R-7 is 3 feet. As noted previously, bedrock is visible on the channel bottom just upstream of the existing bridge (Photo 24), therefore the new abutment footings will be founded at shallow depths—possibly as little as 3 or 4 feet below the streambed elevation. In light of this, it is recommended that the rock be installed to a minimum depth of 3.5 feet—deeper if necessary—at both abutments as shown on the attached Plan, Elevation and Section drawing.

6. Economic Analysis

The estimated preliminary cost for construction of the bridge is $883,800. Refer to Section F of this report for additional information.

7. Recommended Bridge Opening

The recommended bridge opening increases the available hydraulic opening under the bridge and decreases the risk of weir flow over the bridge. The structure will pass the Design Flood with no overtopping and the 100-year flood elevation for the FEMA discharge will not increase—a minor increase occurs at the bridge outlet for the PennDOT discharge, but is contained in the channel.

Basic data for the recommended bridge structure is presented below. The information presented here, on the Summary Data Sheet and the hydraulic report drawings is based on preliminary conceptual design. Final beam size and geometric parameters will be determined for the Type, Size and Location Study.

Basic Data for Recommended Bridge Opening:

Structure Type:	P/S Concrete Spread Box Beams (36”x 17”)
Span:	34’-0” ± (CL Brg. to CL Brg.)
Clear Span:	32’-0” (Along Skew) 22’-7$^{1}/_{2}$” (Normal to Abutments)
Structure Width:	69’-4$^{1}/_{2}$” ft. (Normal to Roadway) 98’-1$^{3}/_{8}$” ft. (Along Stream)
Vertical Clearance:	7.25’ ±, Measured to Low Chord (Inlet) 7.31’ ±, Measured to Low Chord (Outlet)

Skew with Road: 45° Right Hand Ahead

Skew with Stream: 35° ± at Inlet

It is noted that the area of the proposed hydraulic opening with the channel improvement is approximately 156.6 S.F. compared with approximately 118.2 S.F. for the existing bridge opening.

Included in Section H of this report are the following drawings [6]:

- Plan, Elevation and Section
- Hydraulic Plan
- Stream Profile (2 sheets)
- Roadway Profile
- Roadway Typical Section

Hydraulic summary tabulations for the recommended bridge opening are provided on the pages that follow. Parentheses indicate overtopping of the bridge deck (see Page C-12).

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[6] Software reference in Report Section G

TABLE C-12: 50-YEAR FLOOD ELEVATION COMPARISON – FEMA FLOWS (RECOMMENDED BRIDGE OPENING)

HEC-RAS SECTION	**FEMA LETTER**	**LOCATION**	**EXISTING (ft.)**	**PROPOSED (ft.)**	**DIFFERENCE (ft.)**
18	–	Culvert Inlet/Upstream Limit	787.37	787.37	+0.00
17	E	Intermediate Culvert Sect.	785.34	785.34	+0.00
16	–	Culvert Outlet	782.10	782.09	-0.10
15.75	–	—	780.60	780.59	-0.01
15	D	—	778.74	778.52	-0.22
14.25	–	—	778.38	778.05	-0.33
14	–	**Just U/S of Bridge**	**778.32**	**778.11**	-0.21
–	–	**Internal Bridge Sect. (U/S)**	**777.15**	**777.40**	+0.25
–	–	**Internal Bridge Sect. (D/S)**	**775.59**	**775.58**	-0.01
13	–	**Just D/S of Bridge**	**775.59**	**775.58**	-0.01
12.75	–	—	775.31	775.31	+0.00
12.5	–	—	773.53	773.53	+0.00
12	–	—	773.36	773.36	+0.00
11	–	—	772.72	772.72	+0.00
10.5	–	—	772.23	772.23	+0.00
10	C	Downstream Study Limit	772.00	772.00	+0.00

TABLE C-13: 100-YEAR FLOOD ELEVATION COMPARISON – FEMA FLOWS (RECOMMENDED BRIDGE OPENING)

SECTION	FEMA LETTER	LOCATION	EXISTING (ft.)	PROPOSED (ft.)	DIFFERENCE (ft.)
18	–	Culvert Inlet/Upstream Limit	787.98	787.98	+0.00
17	E	Intermediate Culvert Sect.	785.92	785.92	+0.00
16	–	Culvert Outlet	782.71	782.71	+0.00
15.75	–	—	781.01	780.99	-0.02
15	D	—	779.36	778.89	-0.47
14.25	–	—	779.06	778.37	-0.69
14	–	**Just U/S of Bridge**	**778.98**	**778.45**	-0.53
–	–	**Internal Bridge Sect. (U/S)**	**778.98**	**777.40**	-1.58
–	–	**Internal Bridge Sect. (D/S)**	**778.98**	**776.20**	-2.78
13	–	**Just D/S of Bridge**	**776.20**	**776.20**	+0.00
12.75	–	—	775.98	775.98	+0.00
12.5	–	—	773.81	773.81	+0.00
12	–	—	773.79	773.79	+0.00
11	–	—	773.19	773.19	+0.00
10.5	–	—	772.57	772.57	+0.00
10	C	Downstream Study Limit	772.28	772.28	+0.00

TABLE C-14: 50-YEAR FLOOD ELEVATION COMPARISON – PENNDOT FLOWS (RECOMMENDED BRIDGE OPENING)

HEC-RAS SECTION	FEMA LETTER	LOCATION	EXISTING (ft.)	PROPOSED (ft.)	DIFFERENCE (ft.)
18	–	Culvert Inlet/Upstream Limit	788.50	788.50	+0.00
17	E	Intermediate Culvert Sect.	786.23	786.23	+0.00
16	–	Culvert Outlet	783.16	783.16	+0.00
15.75	–	—	781.38	781.38	+0.00
15	D	—	779.75	779.07	-0.68
14.25	–	—	779.63	778.81	-0.82
14	–	**Just U/S of Bridge**	**(779.58)**	**778.94**	-0.64
–	–	**Internal Bridge Sect. (U/S)**	**(779.58)**	**778.94**	-0.64
–	–	**Internal Bridge Sect. (D/S)**	**(779.28)**	**778.94**	-0.34
13	–	**Just D/S of Bridge**	**776.36**	**776.50**	+0.14
12.75	–	—	776.43	776.43	+0.00
12.5	–	—	774.32	774.32	+0.00
12	–	—	774.08	774.08	+0.00
11	–	—	773.61	773.61	+0.00
10.5	–	—	770.83	770.83	+0.00
10	C	Downstream Study Limit	769.21	769.21	+0.00

TABLE C-15: 100-YEAR FLOOD ELEVATION COMPARISON – PENNDOT FLOWS (RECOMMENDED BRIDGE OPENING)

HEC-RAS SECTION	FEMA LETTER	LOCATION	EXISTING (ft.)	PROPOSED (ft.)	DIFFERENCE (ft.)
18	–	Culvert Inlet/Upstream Limit	792.90	792.90	+0.00
17	E	Intermediate Culvert Sect.	789.94	789.94	+0.00
16	–	Culvert Outlet	784.21	784.21	+0.00
15.75	–	—	782.25	782.25	+0.00
15	D	—	779.74	778.87	-0.87
14.25	–	—	779.47	778.90	-0.57
14	–	**Just U/S of Bridge**	**779.38**	**779.11**	-0.27
–	–	**Internal Bridge Sect. (U/S)**	**779.38**	**779.11**	-0.27
–	–	**Internal Bridge Sect. (D/S)**	**(779.38)**	**779.11**	-0.27
13	–	**Just D/S of Bridge**	**777.50**	**777.68**	0.18
12.75	–	—	777.67	777.67	+0.00
12.5	–	—	775.23	775.23	+0.00
12	–	—	772.96	772.96	+0.00
11	–	—	773.16	773.16	+0.00
10.5	–	—	771.71	771.71	+0.00
10	C	Downstream Study Limit	769.97	769.97	+0.00

8. Bank Protection

Rock Riprip will be placed following the removal of sediment from the channel as shown on the attached Plan, Elevation and Section Drawing. This rock will be placed along the sides of the channel immediately upstream and downstream of the bridge to establish a new and stable flow pattern that will redirect stream flow away from the abutments and wingwalls. This rock will be placed only along the edges of the channel and will not span the width of the channel bottom to minimize stream impact. The same Riprap will be placed at the new wingwalls for scour protection. The R-7 rock, placed to a depth of 3.5 feet will provide sufficient resistance to the flow velocities of the 50 and 100-year floods, which will peak at approximately 9.3 and 9.8 ft./sec, respectively, just outside the bridge opening (see Tables C-8 and C-10).

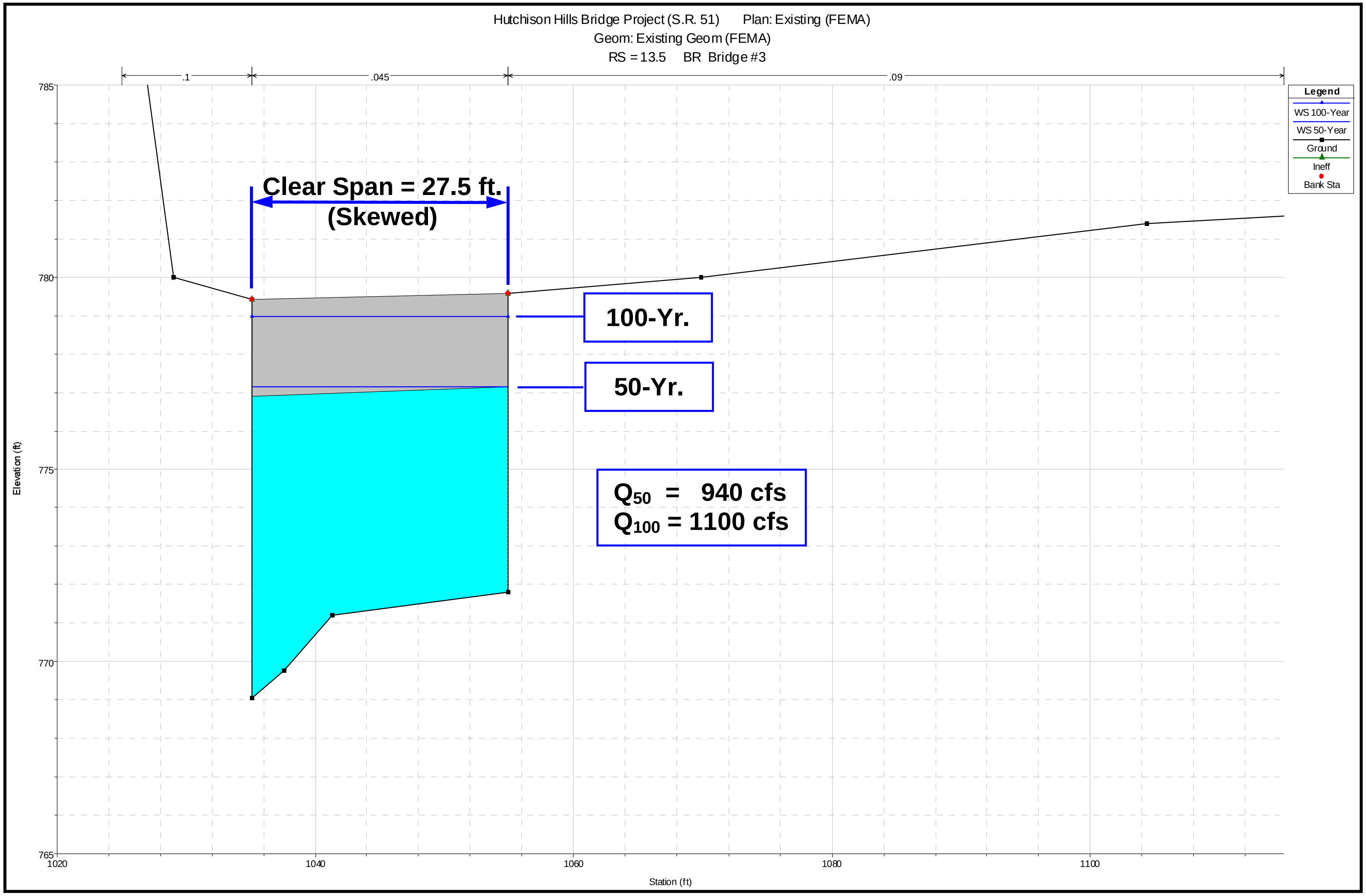
9. Temporary Stream Crossings

A temporary stream crossing will not be required for construction access because the contractor will utilize the roadway under a two phase construction process.

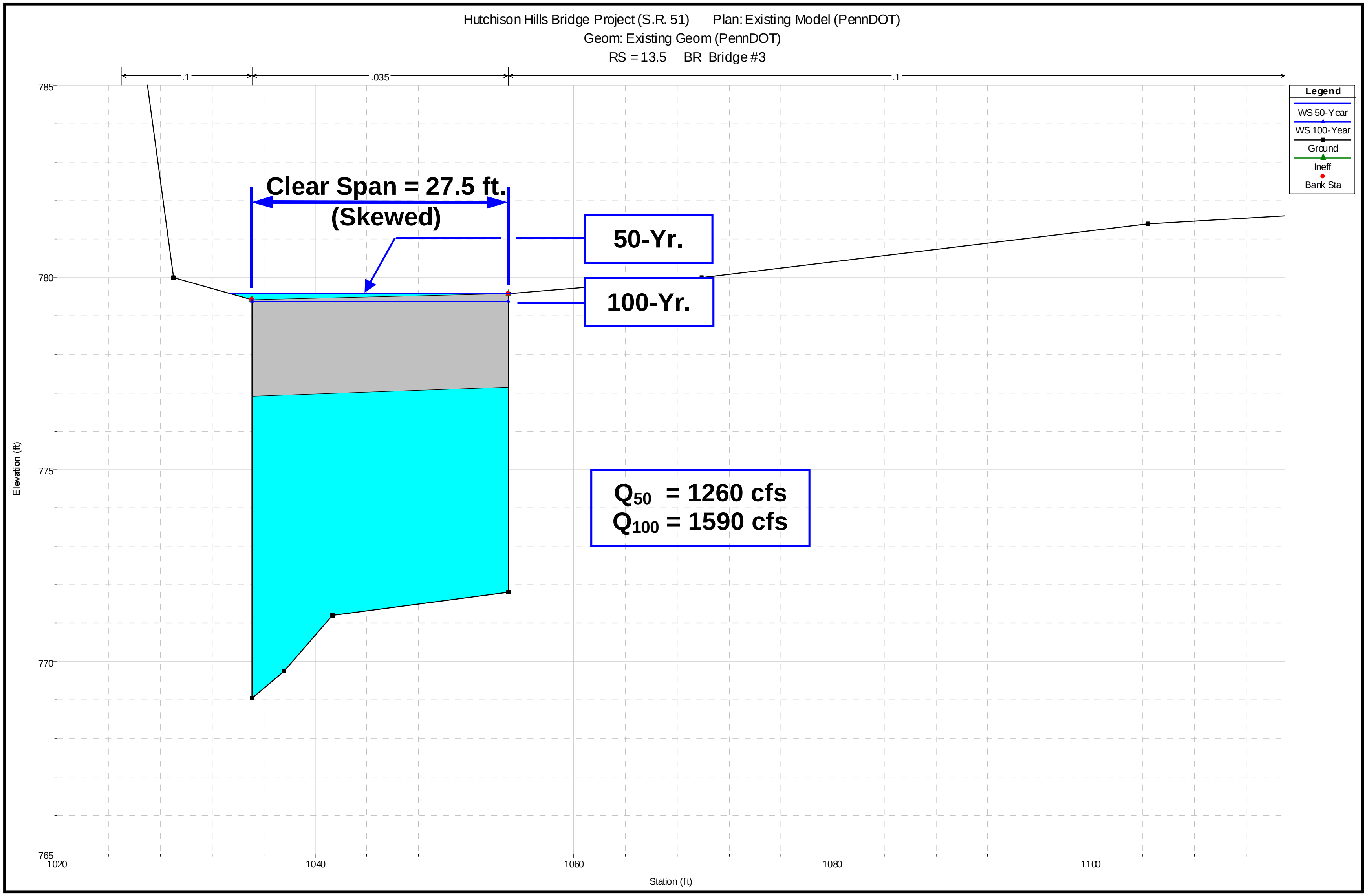
10. Flow Distribution Plots

Flow distribution plots follow on Pages C-22 through C-25.

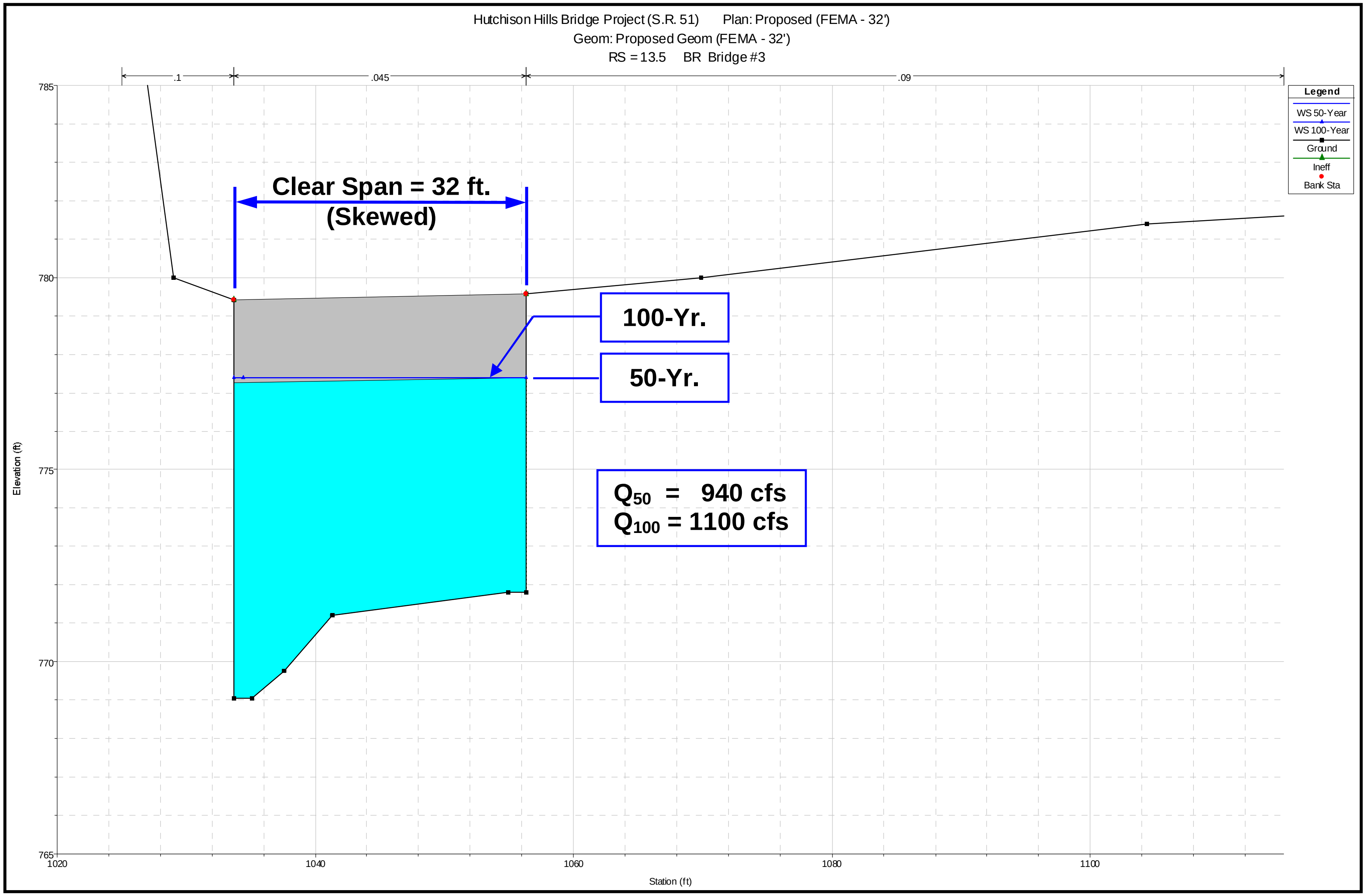
50 & 100-Year Flood Flow Distribution
Bridge Section 13.5 U/S
(Existing Conditions – FEMA Flows)



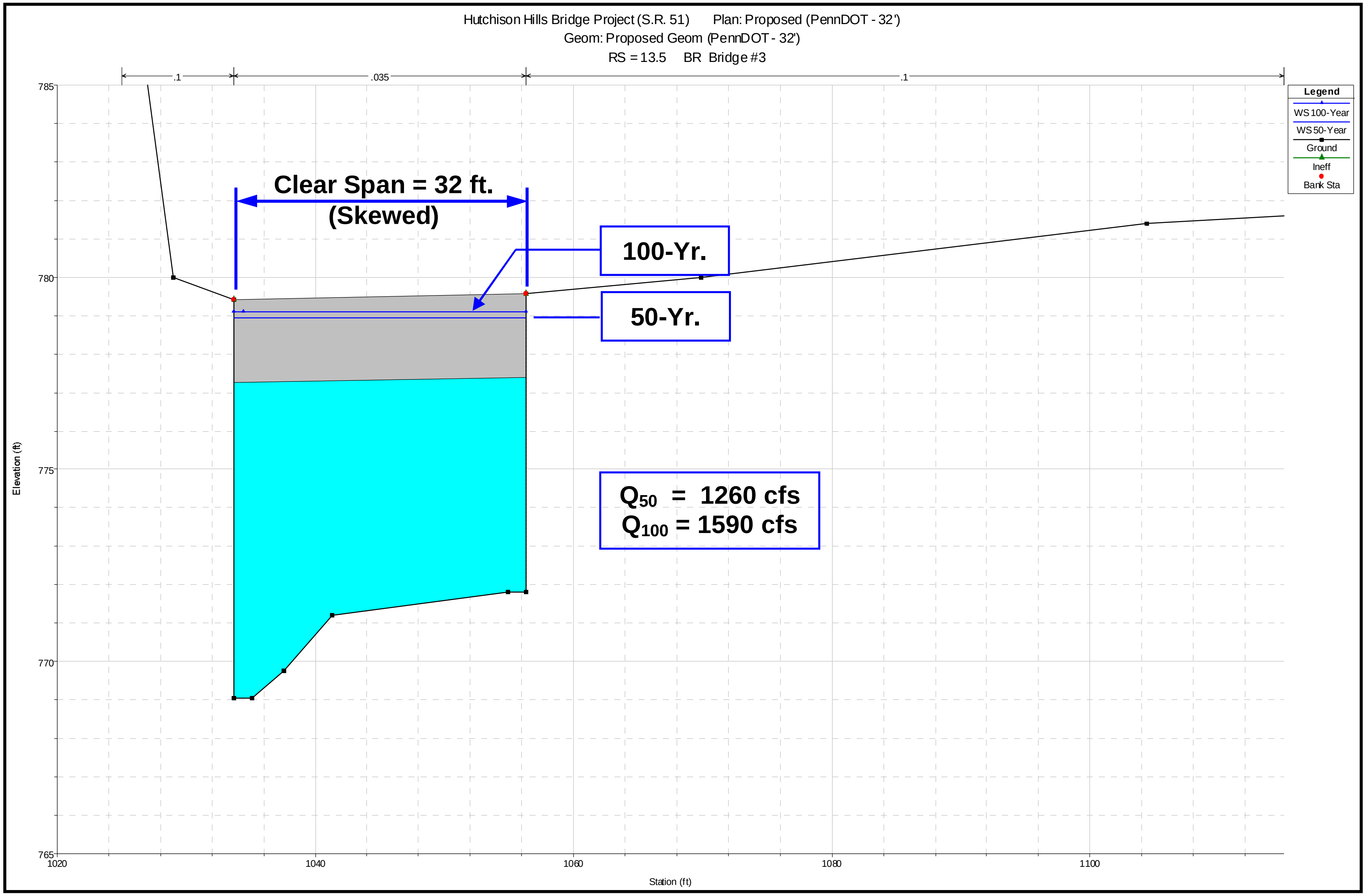
50 & 100-Year Flood Flow Distribution
Bridge Section 13.5 U/S
(Existing Conditions – PennDOT Flows)



50 & 100-Year Flood Flow Distribution
Bridge Section 13.5 U/S
(Proposed Conditions – FEMA Flows)



50 & 100-Year Flood Flow Distribution
Bridge Section 13.5 U/S
(Proposed Conditions – PennDOT Flows)



Clear Span = 32 ft.
(Skewed)

Q_{50} = 1260 cfs
Q_{100} = 1590 cfs

100-Year Flood Velocity Distribution
Upstream Section 14.25
(Proposed Conditions – PennDOT Flows)

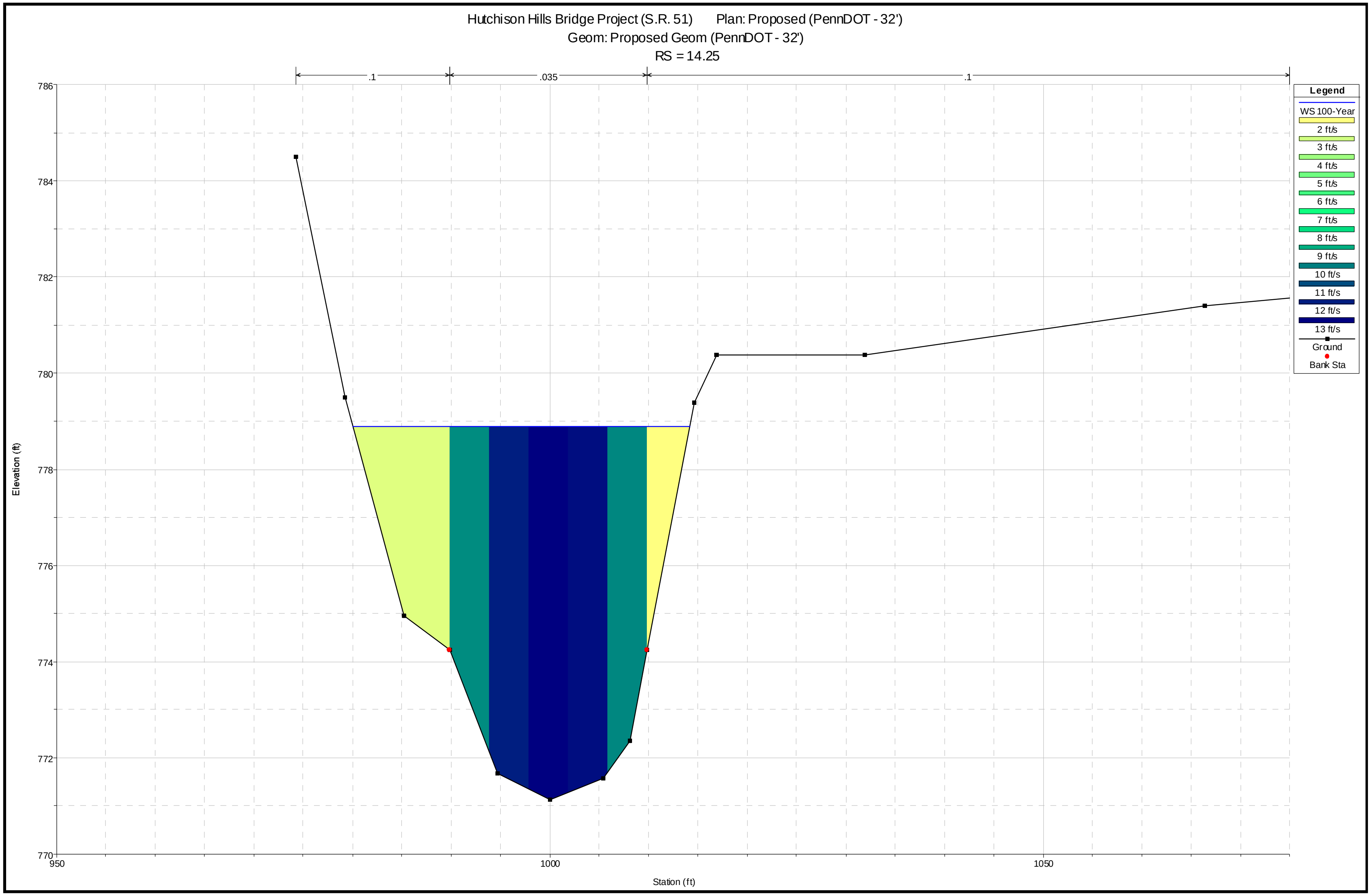


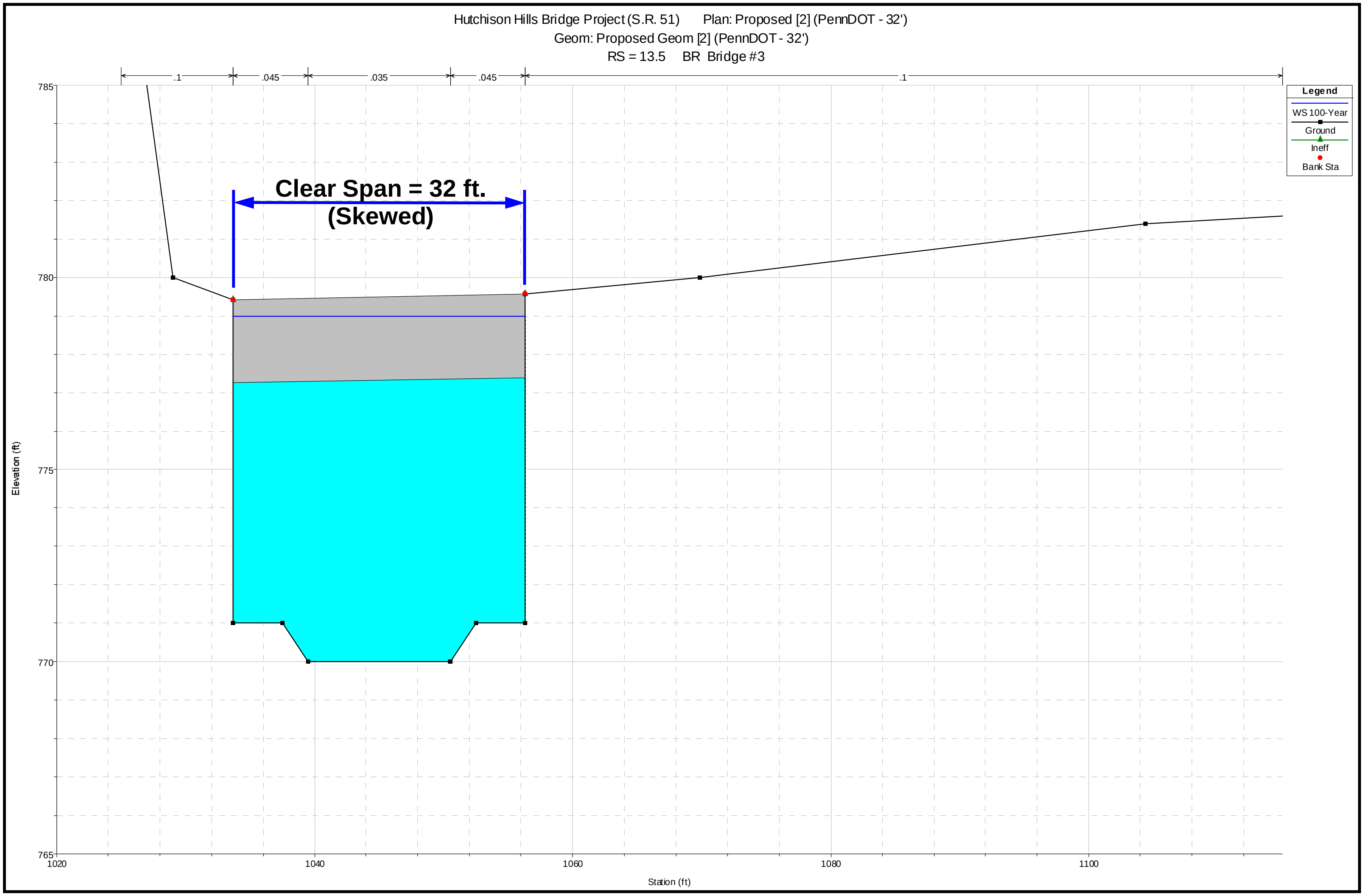
TABLE C-16: 100-YEAR FLOOD ELEVATION COMPARISON – FEMA FLOWS (RECOMMENDED BRIDGE OPENING)

HEC-RAS SECTION	FEMA LETTER	LOCATION	EXISTING FLOOD EL (ft.)	32’ CL SPAN Channel Not Improved (ft.)	32’ CL SPAN Channel Improved (ft.)
17	E	Intermediate Culvert Sect.	785.92	785.92	785.92
16	–	Culvert Outlet	782.71	782.71	782.71
15.75	–	—	781.01	780.99	780.99
15	D	—	779.36	778.89	778.73
14.25	–	—	779.06	778.37	778.06
14	–	**Just U/S of Bridge**	**778.98**	**778.45**	**778.23**
–	–	**Internal Bridge Sect. (U/S)**	**778.98**	**777.40**	**777.40**
–	–	**Internal Bridge Sect. (D/S)**	**778.98**	**776.20**	**776.20**
13	–	**Just D/S of Bridge**	**776.20**	**776.20**	**776.20**
12.75	–	—	775.98	775.98	775.98

TABLE C-17: 100-YEAR FLOOD ELEVATION COMPARISON – PENNDOT FLOWS (RECOMMENDED BRIDGE OPENING)

HEC-RAS SECTION	FEMA LETTER	LOCATION	EXISTING FLOOD EL (ft.)	32’ CL SPAN Channel Not Improved (ft.)	32’ CL SPAN Channel Improved (ft.)
17	E	Intermediate Culvert Sect.	789.94	789.94	789.94
16	–	Culvert Outlet	784.21	784.21	784.21
15.75	–	—	782.25	782.25	782.25
15	D	—	779.74	778.87	778.87
14.25	–	—	779.47	778.90	778.69
14	–	**Just U/S of Bridge**	**779.38**	**779.11**	**779.00**
–	–	**Internal Bridge Sect. (U/S)**	**779.38**	**779.11**	**779.00**
–	–	**Internal Bridge Sect. (D/S)**	**(779.38)**	**779.11**	**779.00**
13	–	**Just D/S of Bridge**	**777.50**	**777.68**	**777.77**
12.75	–	—	777.67	777.67	777.67

U/S Bridge Section With Improved Channel
100-Year Flood Shown
(PennDOT Flows)



MACKIN ENGINEERING COMPANY

Made By: SDB Date: 7/13/07

S.R. 0051, Section A60
Fallen Timber Run
Job No. 4564-001

FALLEN TIMBER RUN BRIDGE

TABLE C-18: HYDRAULIC COMPARISONS – FEMA FLOWS

			100 YEAR FLOOD WSEL			
LOCATION	**HEC-RAS SECTION**	**FEMA LETTER**	**EFF HEC-2**	**DUPL EFF HEC-RAS**	**EXISTING HEC-RAS**	**PROPOSED HEC-RAS**
CULVERT INLET	18	–	789.85	788.96	787.98	787.98
INT. CULVERT SECTION	17	E	787.05	787.60	785.92	785.92
CULVERT OUTLET	16	–	783.21	782.38	782.71	782.59
–	15.75	–	–	–	781.01	780.99
–	15	D	778.76	779.87	779.36	778.89
–	14.25	–	–	–	779.06	778.37
JUST U/S OF BRIDGE	**14**	–	**777.10**	**779.18**	**778.98**	**778.45**
U/S BRIDGE SECTION	–	–	–	–	**778.98**	**777.40**
D/S BRIDGE SECTION	–	–	–	–	**778.98**	**776.20**
JUST U/S OF BRIDGE	**13**	–	**776.36**	**776.97**	**776.20**	**776.20**
–	12.75	–	–	–	775.98	775.98
–	12.5	–	–	–	773.81	773.81
–	12	–	775.49	776.44	773.79	773.79
–	11	–	774.30	774.41	773.19	773.19
–	10.5	–	–	–	772.57	772.57
D/S LIMIT OF STUDY	10	C	772.28	772.28	772.28	772.28

CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Fallen Timber Run								
A	2,914[1]	36	102	8.0	755.0	755.0	755.8	0.8
B	3,466[1]	28	129	8.5	762.8	762.8	762.9	0.1
C	3,945[1]	28	164	6.7	772.3	772.3	772.6	0.3
D	4,672[1]	27	100	11.0	778.8	778.8	778.8	0.0
E	5,261[1]	20	107	10.3	787.0	787.0	787.0	0.0
F	5,918[1]	31	116	9.5	792.7	792.7	792.7	0.0
G	6,518[1]	32	135	8.1	800.8	800.8	800.9	0.1
H	7,179[1]	25	155	10.9	808.5	808.5	808.5	0.0
I	7,601[1]	32	135	7.7	814.9	814.9	815.0	0.1
J	8,148[1]	29	120	9.1	821.2	821.2	821.2	0.0
K	8,795[1]	24	85	10.7	830.5	830.5	830.5	0.0
L	9,600[1]	34	120	7.6	840.7	840.7	841.1	0.4
M	10,332[1]	27	114	7.2	850.1	850.1	850.3	0.2
N	10,855[1]	25	82	10.0	858.7	858.7	858.7	0.0
Georges Run								
A	784[2]	128	2,266	0.6	816.6	816.6	817.2	0.6
F	3,083[2]	95	386	3.4	853.1	853.1	853.2	0.1
G	3,528[2]	20	101	12.9	859.3	859.3	859.3	0.0
H	4,049[2]	67	64	5.6	876.9	876.9	877.1	0.2
I	4,452[2]	87	70	5.1	888.8	888.8	888.8	0.0
J	4,920[2]	27	211	5.2	894.7	894.7	895.3	0.6
K	5,650[2]	24	97	11.4	905.7	905.7	905.7	0.0

[1] Feet above mouth

[2] Feet above confluence with Chartiers Creek

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALLEGHENY COUNTY, PA
(ALL JURISDICTIONS)

FLOODWAY DATA

FALLEN TIMBER RUN - GEORGES RUN

D. RISK ASSESSMENT

D. RISK ASSESSMENT

The proposed bridge replacement project presented in this report is necessary because of the poor condition of the existing structure. The structure type and span length recommended for the new bridge represent a cost effective and responsible use of scarce transportation funds, and will permit phased construction that will minimize traffic disruptions.

Risk Comparison – Existing and Proposed Structures

The existing single span reinforced concrete T-Beam bridge carrying State Route 51 over Fallen Timber Run exhibits serious structural deterioration with severely spalled concrete and exposed reinforcement bars. Research of PennDOT bridge inspection files indicated a superstructure condition rating of 4 and a substructure condition rating of 4. More recent information from the District indicates that the superstructure condition has worsened, and the previous condition rating of 4 has been downgraded. Rehabilitation of this structure is not feasible because of this advanced state of deterioration.

With regard to performance evaluation of the existing structure for overtopping by large floods, a hydraulic analysis was prepared in the late 1970's by FEMA that includes the existing bridge. The hydraulic modeling with revised hydrology prepared for this report utilized methodologies that meet current PennDOT criteria for hydraulic design. The existing conditions model predicts that the existing bridge will be overtopped slightly by the Design Flood, which is the 50-year flood for this particular roadway. The intent of current PennDOT design guidance is to prevent, if possible, inundation of highway traffic lanes by the design flood. A new bridge opening, sized according to current design guidance, will reduce the risk of roadway overtopping and modeling indicates that it will not be overtopped by the design flood.

Local Environmental Impacts

Environmental impacts on local ecology during construction will be limited to the immediate proximity of the proposed bridge and stream channel, and there will be minimal approach roadway reconstruction. Impacts will include excavation required to remove the existing abutments and construct the new abutments, sediment removal from the streambed and the placement of rock riprap at the abutments and wingwalls. Rock will also be placed along the sides of the channel immediately upstream and downstream of the bridge to establish a new flow pattern that will redirect stream flow away from the abutments and wingwalls. This rock will be placed only along the edges of the channel and will not span the width of the channel bottom it to minimize stream impact.

Future Watershed Development

Future development in the watershed above the project area that would increase runoff into Fallen Timber Run is expected to be minimal. A population analysis contained in a report titled *"Elizabeth Township's Recreation Complex Feasibility Study"* indicates that Elizabeth Township's population (13,839 as of the 2000 census) has decreased in size over the past forty (40) years and is projected to do so in the future. The study states that Elizabeth Township is an aging community that will require decreased demand of public services in the future. This analysis leads to the conclusion that future residential and commercial development has reached a plateau. No information on future population growth was found for Forward Township, but the reported population was 3,771 as of the 2000 census.

E. SUMMARY DATA SHEET

Summary Data Sheet

(FEMA Study)

Location Data

District	11-0	Stream	Fallen Timber Run
County	Allegheny	Municipality (Townships)	Elizabeth & Forward
Location - U.S.G.S. Map	Glassport, Monongahela, Donora & McKeesport, PA	State Route - Section	S.R. 0051, Section A60
Latitude	40°15’58.5” N	Station	155+13.03
Longitude	79°52’50.5” W	Segment/Offset	0090, 0091/TBD
Present ADT: 25,193	Year: 2007	Future ADT: 30,232	Year: 2027
River Basin (US-ACOE)	[✓ Ohio], Delaware, Susquehanna, Great Lakes		

Channel Data

Stream Name		Fallen Timber Run	Side Slope (1) (looking downstream)	Left:	1:1 to 2.5:1
				Right:	1.25:1 to 2:1
Stream Slope (ft./ft.) (1)		0.0044	Type of Channel		Natural Perennial Stream
Normal Flow Depth (1)		1.5 ft. Max.	Average Top Width (1)		Approx. 35 ft.
Stream Bed Elevation at Inlet		779.49 (U/S Limit)	Average Bottom Width (2)		Approx. 12 ft.
Stream Bed Elev. ~500' upstream	Exact Dist. (1)	411' U/S of S.R. 0051	Stream Bed Elev. ~500' downstream	Exact Dist. (1)	485' D/S of S.R. 0051
	Elevation (1)	776.23 (Min.)		Elevation (1)	763.91 (Min.)
Average Stream Channel Depth (2)		Approx. 8 ft.	High Water Elev. and Date (3)		779 ±, Yr. 1972

Note 1: Determined from surveyed cross sections. Note 2: Channel Bottom at Stream Edge to Average Top of Bank

Note 3: Approx. High Water Elevation and Date Given Refers to Hurricane Agnes

Hydrology

	PennDOT Study	FEMA (if applicable)	Other:
Hydrology Method Used	(See Page E-2)	log-Pearson Type 3	–
Drainage Area (mi ^{2}) (4)	–	4.5	–
Q_{10} (CFS)	–	620	–
Q_{25} (CFS)	–	785 ± (Est.)	–
Q_{50} (CFS)	–	940	–
Q_{100} (CFS)	–	1,400	–

Note 4: Drainage Area above Forward Township Corporate Limits

Hydraulics (FEMA)

EXISTING STRUCTURE		*PROPOSED STRUCTURE*	
Bridge Type	1-Span Conc. T-Beam	Bridge Type	P/S Conc. Spd Box Bm.
Clear Span - Centerline (Surveyed)	27'-6" ±	Clear Span - Centerline	32’-0"
Clear Span - Normal	19'-9$^{3}/_{8}$" ±	Clear Span - Normal	22’-7$^{1}/_{2}$”
Skew (With Stream)	35° ± At Inlet	Skew (With Stream)	35° ± At Inlet
Minimum Underclearance (5)	7.13' ±	Minimum Underclearance (5)	7.25' ±
Length of Channel Impacted	163'-0"	Length of Channel Impacted	163'-0"
Number of Spans	One	Number of Spans	One
Low Chord Elevation (Min./Max.)	776.85 / 777.35	Low Chord Elevation (Min./Max.)	777.01 / 777.64
Hydraulic Method Used	HEC-RAS	Hydraulic Method Used	HEC-RAS

Return Period	Q (CFS)	WSE	Velocity	Return Period	Q (CFS)	WSE	Velocity
10	620	775.88	6.48 fps	10	620	775.46	6.11 fps
25 (6)	785	–	–	25 (6)	785	–	–
50	940	778.32	6.53 fps	50	940	778.11	5.82 fps
100	1,100	778.98	7.01 fps	100	1,100	778.45	6.50 fps
Overtop (182 Yrs. ±)	1,210	779.42	7.30 fps	Overtop (> 500 Yrs.)	1,430	779.42	7.48 fps

Note 5: Min. Underclearance as defined in the DM-4 Policies and Procedures Section 1.6.4.11(b)

Note 6: Estimate of Discharge Derived By Interpolating Between Known 10-yr and 50-yr Discharges

Summary Data Sheet

(PennDOT Study)

Location Data

District	11-0	Stream	Fallen Timber Run
County	Allegheny	Municipality	Elizabeth & Forward
Location - U.S.G.S. Map	Glassport, Monongahela, Donora & McKeesport, PA	State Route - Section	S.R. 0051, Section A60
Latitude	40°15’58.5” N	Station	155+13.03
Longitude	79°52’50.5” W	Segment/Offset	0090, 0091/TBD
Present ADT: 25,193	Year: 2007	Future ADT: 30,232	Year: 2027
River Basin (US-ACOE)	[✓ Ohio,] Delaware, Susquehanna, Great Lakes		

Channel Data

Stream Name		Loyalhanna Creek	Side Slope $^{(1)}$ (looking downstream)	Left:	1:1 to 2.5:1
				Right:	1.25:1 to 2:1
Stream Slope (ft./ft.) $^{(1)}$		0.0044	Type of Channel		Natural Perennial Stream
Normal Flow Depth $^{(1)}$		1.5 ft. Max.	Average Top Width $^{(1)}$		Approx. 35 ft.
Stream Bed Elevation at Inlet		779.49 (U/S Limit)	Average Bottom Width $^{(2)}$		Approx. 12 ft.
Stream Bed Elev. ~500' upstream	Exact Dist. $^{(1)}$	411' U/S of S.R. 0051	Stream Bed Elev. ~500' downstream	Exact Dist. $^{(1)}$	485' D/S of S.R. 0051
	Elevation $^{(1)}$	776.23 (Min.)		Elevation $^{(1)}$	763.91 (Min.)
Average Stream Channel Depth $^{(2)}$		Approx. 8 ft.	High Water Elev. and Date $^{(3)}$		779 ±, Yr. 1972

Note 1: Determined from surveyed cross sections. Note 2: Channel Bottom at Stream Edge to Average Top/Bank

Note 3: Approx. High Water Elevation and Date Given Refers to Hurricane Agnes

Hydrology

	PennDOT Study	FEMA (if applicable)	Other:
Hydrology Method Used	USGS WRIR 00-4189	(See Page E-1)	–
Drainage Area (mi ^{2}) $^{(4)}$	4.26	–	–
Q_{10} (CFS)	679	–	–
Q_{25} (CFS)	983	–	–
Q_{50} (CFS)	1,260	–	–
Q_{100} (CFS)	1,590	–	–

Note 4: Drainage Area above Hydraulic Opening of Proposed Bridge

Hydraulics (PennDOT Study)

EXISTING STRUCTURE		***PROPOSED STRUCTURE***	
Bridge Type	1-Span Conc. T-Beam	Bridge Type	P/S Conc. Adj. Box Bm.
Clear Span - Centerline (Surveyed)	27'-6" ±	Clear Span - Centerline	32’-0"
Clear Span - Normal	19'-9$^3/_8$" ±	Clear Span - Normal	22’-7$^1/_2$”
Skew (With Stream)	35^o ± At Inlet	Skew (Abuts. and Pier)	35^o ± At Inlet
Minimum Underclearance $^{(5)}$	7.13' ±	Minimum Underclearance $^{(5)}$	7.25' ±
Length of Channel Impacted	163'-0"	Length of Channel Impacted	163'-0"
Number of Spans	One	Number of Spans	Two
Low Chord Elevation (Min./Max.)	776.85 / 777.35	Low Chord Elevation (Min./Max.)	777.01 / 777.64
Hydraulic Method Used	HEC-RAS	Hydraulic Method Used	HEC-RAS

Return Period	Q (CFS)	WSE	Velocity	Return Period	Q (CFS)	WSE	Velocity
10	679	775.67	7.42 fps	10	679	775.32	6.90 fps
25	983	778.48	6.68 fps	25	983	778.19	6.02 fps
50	1,260	779.58	7.47 fps	50	1,260	778.94	6.99 fps
100	1,590	779.38	9.65 fps	100	1,590	779.11	8.64 fps
Overtop (45 Yrs. ±)	1,210	779.42	7.30 fps	Overtop (73 Yrs. ±)	1,430	779.41	7.49 fps

Note 5: Min. Underclearance as defined in the DM-4 Policies and Procedures Section 1.6.1.11(b)

E. SUMMARY DATA SHEET (Continued)

Additional Information

Type of Permit:	GP-11 Permit Application
Wetlands Impacted:	None
Quantity of Deposited Fill Below Ordinary High Water (1):	Approx. 200 C.Y. (Permanent Rock Lining)

Note 1: Ordinary High Water is flooding to the observed top of bank.

F. PRELIMINARY COST ESTIMATE

F. PRELIMINARY COST ESTIMATE

The estimated preliminary cost for construction of the bridge is $883,800. It does not include, required channel easements and utility relocations. This cost will be refined during development of the TS&L for the structure.

G. SOFTWARE REFERENCES

SOFTWARE REFERENCES

1. Terrain Navigator Pro Network Edition Version 7.02 by Maptech, Inc.
2. log-log Graphs created with Microsoft Office Excel 2003
3. National Flood Frequency Program Version 3.0 by the USGS
4. PSU-IV Method Version 4.0 by PennDOT
5. HEC-RAS River Analysis System Version 3.1.3 May 2005 by U.S. Army Corps of Engineers Hydraulic Engineering Center
6. CADD Drawings created with Microstation Version V8 by Bentley Systems, Inc.