Appendix J: Additional Studies

- Independent Utility Memo – March 22, 2016
- Environmental Justice Mapping and Census Data
- Hydraulic Report– Approved August 25, 2017

INDIANA DEPARTMENT OF TRANSPORTATION
Driving Indiana's Economic Growth

100 North Senate Avenue
Room N758
Indianapolis, Indiana 46204

PHONE: (317) 234-0796
FAX: (317) 233-4929

Michael R. Pence, Governor
Brandye L. Hendrickson, Commissioner

March 22, 2016

Michelle Allen
Planning and Environmental Specialist
FHWA, Indiana Division
575 N Pennsylvania St
Room 254
Indianapolis, IN 46204

Re: Independent Utility of Regional Transportation Projects in Clark County, Indiana

Dear Ms. Allen:

The purpose of this letter is to summarize several current transportation projects in Clark County in southern Indiana that are in various stages of completion. Each of the projects is generally located in the vicinity of the SR 265 corridor east of SR 62 and north of the City of Jeffersonville. Please see the attached Regional Projects Map for location of the projects.

Recently, FHWA requested additional information regarding the evaluation of the corridor under NEPA, specifically with respect to the independent utility of each of the projects.

According to 23 CFR § 771.111(f):

In order to ensure meaningful evaluation of alternatives and to avoid commitments to transportation improvements before they are fully evaluated, the action evaluated in each EIS or finding of no significant impact (FONSI) shall:

(1) Connect logical termini and be of sufficient length to address environmental matters on a broad scope;
(2) Have independent utility or independent significance, i.e., be usable and be a reasonable expenditure even if no additional transportation improvements in the area are made; and
(3) Not restrict consideration of alternatives for other reasonably foreseeable transportation improvements.

The FHWA request is addressed for each of the projects below:

<u>Louisville-Southern Indiana Ohio River Bridges Project – East End Crossing</u>

The Louisville-Southern Indiana Ohio River Bridges Project (LSIORBP) is an approximately $2.3 billion project currently under construction under a Record of Decision approved on June 20, 2012. The purpose of the LSIORBP is to improve cross-river mobility and safety and to reduce traffic congestion in the Louisville Metropolitan Area. The LSIORBP is bifurcated into two separate procurements: (1) the Downtown Crossing (DTC), a KYTC contract for design and construction of new roadway and a new cross-river bridge connecting downtown Louisville and Jeffersonville, and (2) the East End Crossing (EEC), a P3 contract between the Indiana Finance Authority (IFA) and a developer, WVB East End Partners, LLC (WVB) to design, build, finance, operate and maintain the EEC, consisting of new roadway and a new cross-river bridge connecting KY 841 near Prospect, KY with SR 265 near Utica, IN.

Construction of the EEC began in June of 2013 and it is scheduled to be open to traffic in late 2016. The budget of the EEC is $1.05 billion. The LSIORBP has Federal and state funding and oversight.

Old Salem Road Improvement

Logical Termini

Old Salem Road currently has 8-foot wide travel lanes with no shoulders. The road is very steeply sloping just northwest of the town of Utica and immediately after the Lentzier Creek crossing. Sight distances and grades are not compliant with current design criteria. The need for the project is the sub-standard and unsafe roadway conditions along the route.

The purpose of the project is to improve safety for the increased traffic that will utilize Old Salem Road as the connection between the Town of Utica and the new SR 265 alignment, being constructed as part of the LSIORBP. The project limits are from 4^{th} St in Utica to the southern limits of the new Old Salem Rd interchange at SR 265.

Independent Utility

Old Salem Road currently terminates at a dead end approximately 1.0 miles northeast of 4^{th} St. in Utica. Approximately 16 residents live along the route and generate all of the current traffic volume for Old Salem Rd. When the new interchange with SR 265 is opened to traffic in late 2016, Old Salem Rd will become the connection for Utica commuters to and from the new freeway. Traffic volumes are expected to increase from less than 100 vehicles per day now to over 1,000 vehicles per day by 2030. The functional classification of Old Salem Rd. was upgraded to Urban Minor Arterial in 2013. The improvement to Old Salem Rd. will not accommodate heavy vehicles or any significant volume of truck traffic. Development of the project includes methods to reduce truck traffic on Old Salem Road by use of signs and roadway geometry.

Project Funding and Schedule

The Old Salem Road improvement project is an INDOT and Clark County project under DES 1382057 that was documented as a Level 3 Categorical Exclusion and approved July 21, 2015. The project budget is $3.7 million and has Federal and state funding and oversight. The project is currently in the right-of-way acquisition stage and is scheduled for letting in August of 2016. That date will likely move to January 2017 to allow completion of right-of-way acquisition.

Heavy Haul Transportation Corridor

The Heavy Haul Transportation Corridor (HHTC) is a combination of three independent projects that will connect the Ports of Indiana-Jeffersonville (Port) with SR 62 through the River Ridge Commerce Center (RRCC) via the new interchange of SR 265 and Old Salem Rd being constructed as part of the LSIORBP EEC. Currently, trucks travelling between the Port and RRCC travel on Port Road to SR 62 through the SR 265 interchange. None of these roads are designed to accommodate heavy vehicles, and reaching the interior of RRCC requires further travel to the east from SR 62. The HHTC makes two improvements to the local network: (1) a northern project (Project B) which will connect SR 62 to SR 265, through RRCC, on a facility compatible with a high volume of heavy vehicle traffic, and (2) a southern project (Project A) which will connect the Port to SR 265 on a facility compatible with a high volume of heavy vehicle traffic. A third project (Project C) is being proposed to acquire R/W for a future rail connection between the Port and RRCC.

The projects, each with its own funding, are being facilitated by INDOT under DES 1382162 through an inter-local agreement between INDOT, Clark County, the City of Jeffersonville, the Port and the River Ridge Development Authority. The projects are identified in the inter-local agreement as Segment A, Segment B and Segment C for identification purposes only. However, each project has its own independent utility as described below:

Project A

Logical Termini

The existing road network between SR 265 and the Port requires heavy vehicles to access Port Rd via the SR 265/SR 62 interchange, which was not specifically designed for heavy vehicle traffic. Project A will connect SR 265 directly to the Port via the SR 265/Old Salem Rd interchange and New Middle Road.

Independent Utility

The exiting road network between the Port and SR 265 was not specifically designed for heavy vehicles and is seeing a significant increase in commuter traffic due to development along the Port Rd and SR 62 corridors. Project A will provide a fully functional heavy haul route between SR 265 and the Port without the construction of the Old Salem Road improvement project or any other aspect of the HHTC.

Project Funding and Schedule

Project A is being funded through a combination of Federal, state, local and private funds and will have Federal and state oversight.

An Environmental Assessment is currently under way for Project A and is expected to be complete by the beginning of 2017. Right-of-way acquisition will be done in 2018 with a contract letting in 2019 for construction completion by end of 2020. The project budget is $18.6 million.

Project B

Logical Termini

The existing road network between RRCC and SR 265 requires heavy vehicles to access SR 265 via the SR 62 corridor, which was not specifically designed for heavy vehicle traffic. Project B will connect RRCC directly to SR 265 via the SR 265/Old Salem Rd interchange.

Independent Utility

Project B of the HHTC will provide a fully functional heavy haul roadway independent of any other aspect of the HHTC or the Old Salem Road improvement. The project will provide direct access for heavy haul vehicles from RRCC to SR 265 on a road specifically designed for heavy vehicles and will reduce the need for heavy trucks to use the already congested SR 62 corridor.

Project Funding and Schedule

Project B is being financed without Federal or state highway funding and has no Federal or state oversight. The project, currently under construction, was bid by River Ridge Development Authority in August 2015 and is scheduled to open to traffic by the end of 2016 to coincide with opening of the LSIORBP, which includes the SR 265/Old Salem Rd interchange. The project budget is $10.5 million.

Project C

Logical Termini

Project C is a separate project to acquire right-of-way for a new direct, grade separated rail connection between the Port and RRCC.

Independent Utility

The current rail connection between the Port and RRCC requires the use of two at-grade crossings on SR 62 and use of the CSX mainline. A new direct rail connection will function as an independent mode of freight movement utilizing a rail line to move goods and services between the Port and RRCC without at-grade crossings and use of a rail mainline. The rail line route will be analyzed separately from any road corridor projects, and will function as an independent project.

In late 2015, the Port announced it had received a TIGER grant for $10 million to improve rail connections within the Port. That project by the Port will be entirely within the Port's property and is independent of and separate from the HHTC Project C project.

Project Funding and Schedule:

Project C will require a separate environmental document and will include Federal, state and local funding and oversight. The project is only intended to acquire right-of-way with design and construction to follow later under a separate project. The right-of-way for Project C is not a part of any right-of-way being obtained for Project A or B of the HHTC. The project budget is $1.3 million.

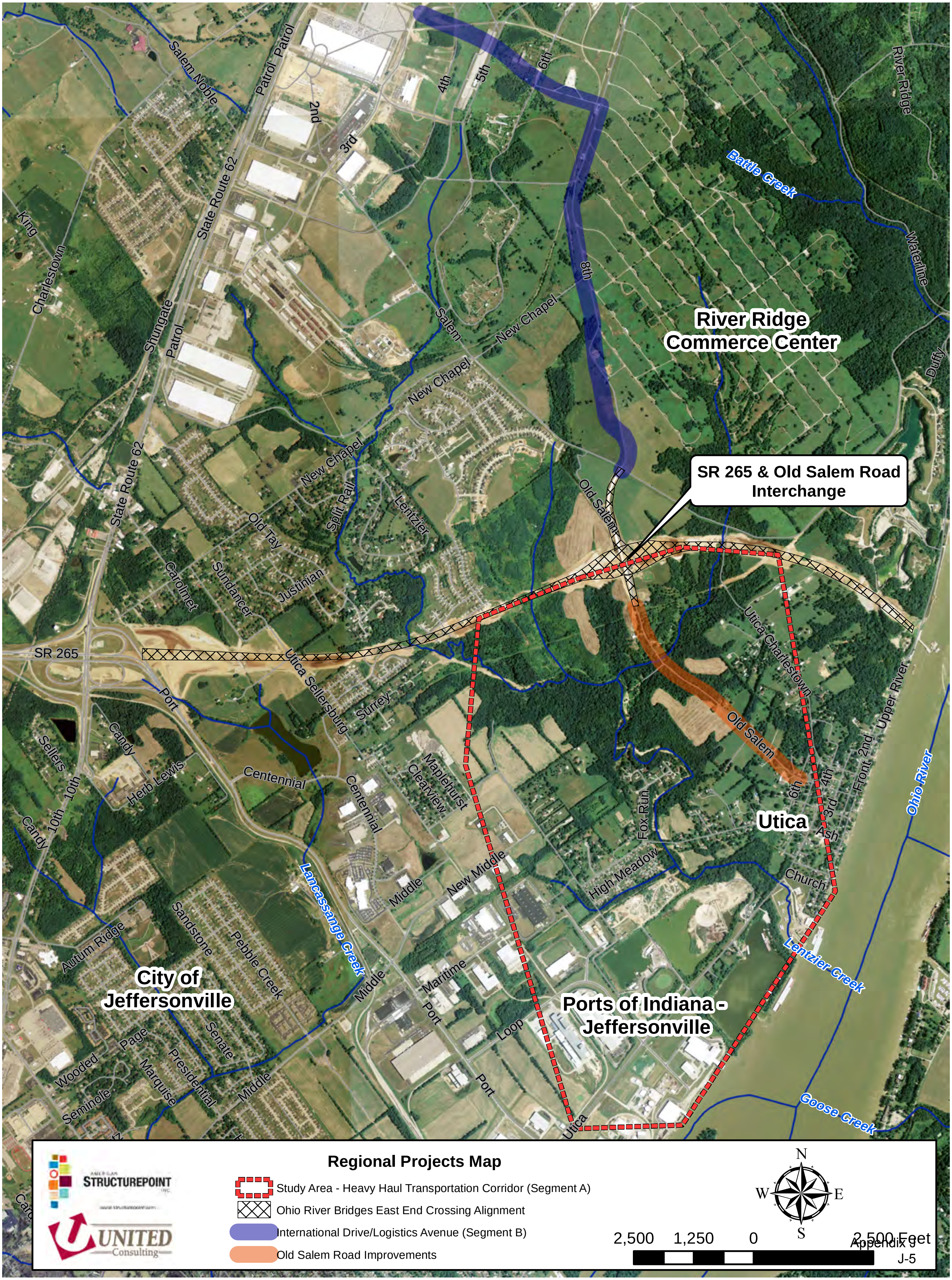
Please let me know if you require any further information in regards to any of the projects discussed above.

Sincerely,

Ronald Heustis, P.E. (Indiana)
INDOT Senior Project Manager

Cc: Mohammad, Hajeer, Ron Bales, Laura Hilden, file

Attachment (1)



River Ridge Commerce Center
SR 265 & Old Salem Road Interchange
City of Jeffersonville
Ports of Indiana - Jeffersonville
Utica
Ohio River
Battle Creek
Lancassange Creek
Lentzier Creek
Goose Creek
SR 265
State Route 62
Regional Projects Map
Study Area - Heavy Haul Transportation Corridor (Segment A)
Ohio River Bridges East End Crossing Alignment
International Drive/Logistics Avenue (Segment B)
Old Salem Road Improvements
2,500 1,250 0 2,500 Feet
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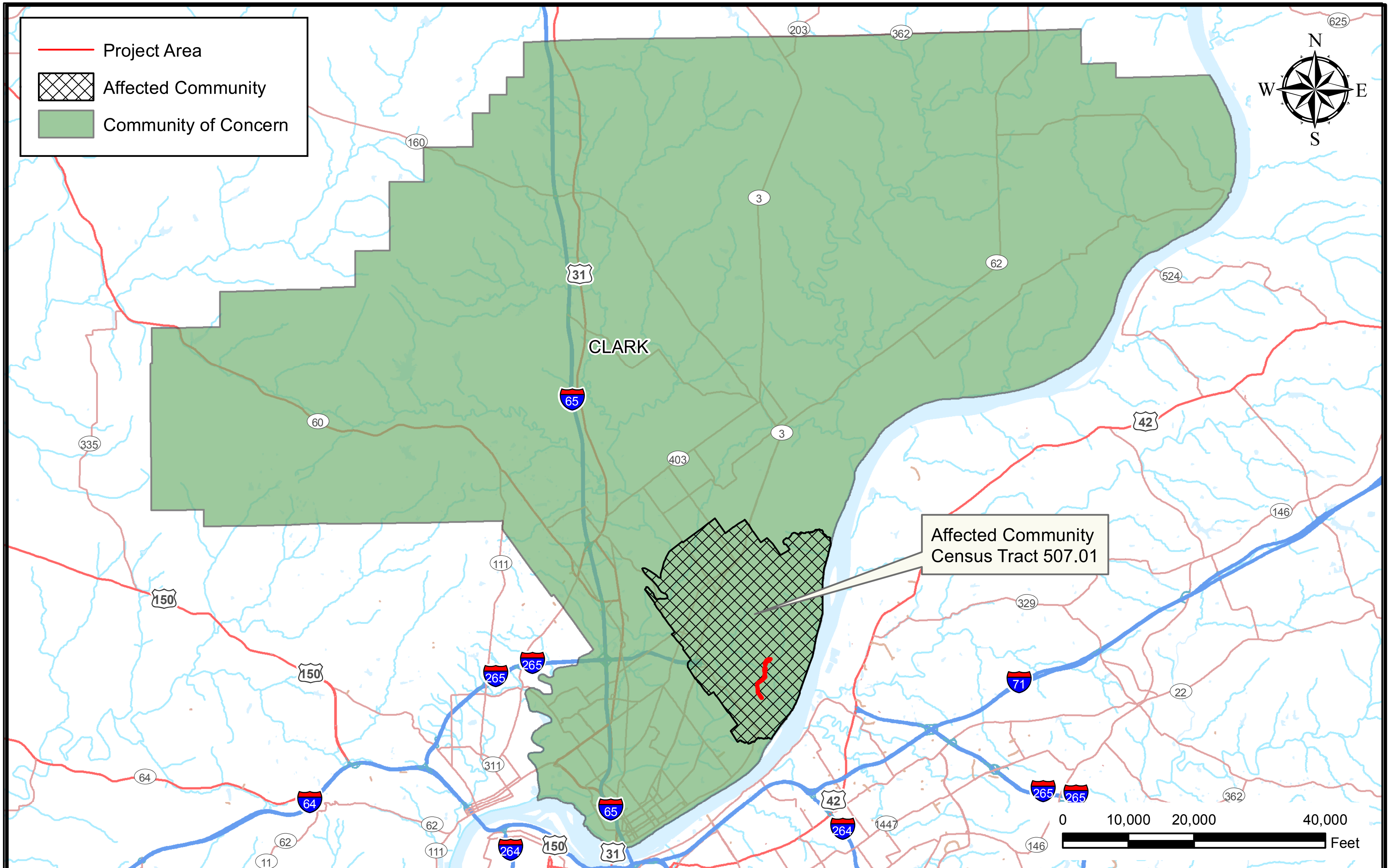
STRUCTUREPOINT
UNITED Consulting

Path: P:\2013\01857\D. Drawings\ArcView\Exhibits\Environmental Justice\2013.01857.EV.EnvironmentalJustice.Landscape.kaj.mxd Date:1/19/2018 User:kjones



Environmental Justice Mapping

Indiana Department of Transportation
Central Office
100 North Senate Avenue
Indianapolis, Indiana 46204

AMERICAN STRUCTUREPOINT INC.

Heavy Haul Transportation Corridor
Des. No. 1382612

Location: Jeffersonville
Township: Utica
County: Clark
State: Indiana

Date: 01/19/2018

B03002

HISPANIC OR LATINO ORIGIN BY RACE

Universe: Total population
2012-2016 American Community Survey 5-Year Estimates

Supporting documentation on code lists, subject definitions, data accuracy, and statistical testing can be found on the American Community Survey website in the Data and Documentation section.

Sample size and data quality measures (including coverage rates, allocation rates, and response rates) can be found on the American Community Survey website in the Methodology section.

Tell us what you think. Provide feedback to help make American Community Survey data more useful for you.

Although the American Community Survey (ACS) produces population, demographic and housing unit estimates, it is the Census Bureau's Population Estimates Program that produces and disseminates the official estimates of the population for the nation, states, counties, cities and towns and estimates of housing units for states and counties.

	Clark County, Indiana		Census Tract 507.01, Clark County, Indiana	
	Estimate	Margin of Error	Estimate	Margin of Error
Total:	113,993	*****	5,521	+/-253
Not Hispanic or Latino:	108,160	*****	5,314	+/-272
White alone	96,063	+/-89	4,582	+/-355
Black or African American alone	7,876	+/-331	417	+/-114
American Indian and Alaska Native alone	83	+/-64	1	+/-4
Asian alone	876	+/-288	3	+/-5
Native Hawaiian and Other Pacific Islander alone	15	+/-24	0	+/-16
Some other race alone	83	+/-91	0	+/-16
Two or more races:	3,164	+/-489	311	+/-282
Two races including Some other race	12	+/-20	0	+/-16
Two races excluding Some other race, and three or more races	3,152	+/-489	311	+/-282
Hispanic or Latino:	5,833	*****	207	+/-200
White alone	4,443	+/-493	195	+/-198
Black or African American alone	41	+/-42	0	+/-16
American Indian and Alaska Native alone	55	+/-67	0	+/-16
Asian alone	15	+/-25	0	+/-16
Native Hawaiian and Other Pacific Islander alone	0	+/-27	0	+/-16
Some other race alone	1,170	+/-458	0	+/-16
Two or more races:	109	+/-70	12	+/-22
Two races including Some other race	65	+/-52	0	+/-16
Two races excluding Some other race, and three or more races	44	+/-47	12	+/-22

Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. The margin of error can be interpreted roughly as providing a 90 percent probability that the interval defined by the estimate minus the margin of error and the estimate plus the margin of error (the lower and upper confidence bounds) contains the true value. In addition to sampling variability, the ACS estimates are subject to nonsampling error (for a discussion of nonsampling variability, see Accuracy of the Data). The effect of nonsampling error is not represented in these tables.

While the 2012-2016 American Community Survey (ACS) data generally reflect the February 2013 Office of Management and Budget (OMB) definitions of metropolitan and micropolitan statistical areas; in certain instances the names, codes, and boundaries of the principal cities shown in ACS tables may differ from the OMB definitions due to differences in the effective dates of the geographic entities.

Estimates of urban and rural population, housing units, and characteristics reflect boundaries of urban areas defined based on Census 2010 data. As a result, data for urban and rural areas from the ACS do not necessarily reflect the results of ongoing urbanization.

Source: U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates

Explanation of Symbols:

1. An '**' entry in the margin of error column indicates that either no sample observations or too few sample observations were available to compute a standard error and thus the margin of error. A statistical test is not appropriate.
2. An '-' entry in the estimate column indicates that either no sample observations or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest interval or upper interval of an open-ended distribution.
3. An '-' following a median estimate means the median falls in the lowest interval of an open-ended distribution.
4. An '+' following a median estimate means the median falls in the upper interval of an open-ended distribution.
5. An '***' entry in the margin of error column indicates that the median falls in the lowest interval or upper interval of an open-ended distribution. A statistical test is not appropriate.
6. An '*****' entry in the margin of error column indicates that the estimate is controlled. A statistical test for sampling variability is not appropriate.
7. An 'N' entry in the estimate and margin of error columns indicates that data for this geographic area cannot be displayed because the number of sample cases is too small.
8. An '(X)' means that the estimate is not applicable or not available.

B17001

POVERTY STATUS IN THE PAST 12 MONTHS BY SEX BY AGE

Universe: Population for whom poverty status is determined
2012-2016 American Community Survey 5-Year Estimates

Supporting documentation on code lists, subject definitions, data accuracy, and statistical testing can be found on the American Community Survey website in the Data and Documentation section.

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	Clark County, Indiana		Census Tract 507.01, Clark County, Indiana	
	Estimate	Margin of Error	Estimate	Margin of Error
Total:	112,188	+/-321	5,483	+/-253
Income in the past 12 months below poverty level:	11,153	+/-1,142	230	+/-128
Male:	5,181	+/-622	124	+/-91
Under 5 years	562	+/-180	0	+/-16
5 years	128	+/-65	0	+/-16
6 to 11 years	640	+/-176	10	+/-17
12 to 14 years	244	+/-104	0	+/-16
15 years	139	+/-104	33	+/-51
16 and 17 years	198	+/-103	0	+/-16
18 to 24 years	451	+/-166	0	+/-16
25 to 34 years	700	+/-190	0	+/-16
35 to 44 years	639	+/-156	27	+/-30
45 to 54 years	706	+/-205	46	+/-55
55 to 64 years	401	+/-99	3	+/-5
65 to 74 years	212	+/-84	5	+/-6
75 years and over	161	+/-86	0	+/-16
Female:	5,972	+/-665	106	+/-55
Under 5 years	498	+/-156	2	+/-3
5 years	132	+/-80	0	+/-16
6 to 11 years	434	+/-142	9	+/-16
12 to 14 years	305	+/-143	0	+/-16
15 years	38	+/-37	0	+/-16
16 and 17 years	201	+/-97	17	+/-16
18 to 24 years	499	+/-166	6	+/-10
25 to 34 years	1,026	+/-208	6	+/-8
35 to 44 years	555	+/-159	0	+/-16
45 to 54 years	757	+/-163	3	+/-4
55 to 64 years	819	+/-206	16	+/-19
65 to 74 years	389	+/-106	0	+/-16
75 years and over	319	+/-104	47	+/-42
Income in the past 12 months at or above poverty level:	101,035	+/-1,194	5,253	+/-270
Male:	49,135	+/-691	2,542	+/-231

	Clark County, Indiana		Census Tract 507.01, Clark County, Indiana	
	Estimate	Margin of Error	Estimate	Margin of Error
Under 5 years	3,083	+/-195	169	+/-91
5 years	534	+/-158	57	+/-69
6 to 11 years	3,624	+/-293	282	+/-110
12 to 14 years	2,163	+/-266	103	+/-79
15 years	600	+/-138	28	+/-32
16 and 17 years	1,188	+/-165	54	+/-40
18 to 24 years	3,990	+/-170	158	+/-59
25 to 34 years	6,789	+/-269	434	+/-145
35 to 44 years	7,024	+/-206	390	+/-131
45 to 54 years	7,006	+/-222	330	+/-98
55 to 64 years	6,702	+/-141	328	+/-96
65 to 74 years	4,154	+/-94	105	+/-46
75 years and over	2,278	+/-79	104	+/-51
Female:	51,900	+/-769	2,711	+/-237
Under 5 years	3,023	+/-163	111	+/-61
5 years	817	+/-181	29	+/-31
6 to 11 years	3,465	+/-302	309	+/-122
12 to 14 years	1,931	+/-275	104	+/-69
15 years	650	+/-155	70	+/-57
16 and 17 years	1,408	+/-163	44	+/-32
18 to 24 years	4,091	+/-238	217	+/-150
25 to 34 years	6,888	+/-244	380	+/-142
35 to 44 years	7,155	+/-219	445	+/-122
45 to 54 years	7,127	+/-237	327	+/-98
55 to 64 years	7,129	+/-236	423	+/-120
65 to 74 years	4,852	+/-112	99	+/-46
75 years and over	3,364	+/-166	153	+/-74

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August 25, 2017

TO: Coordinator 8

FROM: Alex Schwinghamer, E.I.
Hydraulics Engineer

THROUGH: Shahriar Shahnaz, PE
Sr. Hydraulics Engineer

SUBJECT: Hydraulic Review

Str. #:	TBD
Des. #:	1382612
County:	Clark
Location:	New Road – Heavy Hall Rd 0.30 miles west of Old Salem Rd
Crossing:	Lentzier Cr
Consultant:	United Consulting

After review of the above noted project, the following hydraulic sizing parameters are recommended:

Drainage Area	= 5.30	sq. mi.
Q100	= 1700	cfs
Elevation @ Q100	=452.95	ft.
Approximate Skew	= 45	deg.

Proposed Conditions:

Proposed Backwater	= 0.12	ft.
Velocity @ Q100	= 2.58	ft./sec.
Proposed Waterway Opening Below Q100 Elevation (Str.)	= 762	sq. ft.
Proposed Road Overflow Waterway Area	= 0.00	sq. ft.
Proposed Low Structure Elevation	= 488.5	ft.

The scour analysis for the proposed bridge is approved. The application of revetment riprap on the spill slopes should be used to a depth of 1.5 ft with a key trench at the toe that has a depth and width of 2.5 ft.

Q100	= 1700	cfs.
Q100 Elevation	= 452.95	ft.
Q100 Contraction Scour	= 0.00	ft.
Q100 Total Scour	= 7.49	ft.
Q100 Low Scour Elevation	= 434.67	ft.
Q100 Max Velocity	= 6.07	ft/s.

Q500	= 2380	cfs.
Q500 Elevation	= 454.15	ft.
Q500 Contraction Scour	= 0.00	ft.
Q500 Total Scour	= 7.81	ft.
Q500 Low Scour Elevation	= 434.35	ft.
Q500 Max Velocity	= 6.43	ft/s.

Scour data is based on a flowline of 442.16 ft. and erodible material and a pier width of 5 ft. was assumed due to the proposed height of the bridge. The original model was for DNR Permit FW-26753. Discharge was obtained from a FARA Discharge letter. A Construction-in-a-Floodway (CIF) permit will be needed for this project.

If you have any questions or comments, please contact me at (317) 233-2273.

AJS
cc: file

The assignment of the Bridge Des. Number is being coordinated with Ron Heustis, INDOT Project Manager.

HYDRAULIC REPORT

BRIDGE FILE NUMBER: TBD

NBI NUMBER: TBD

ROAD DESIGNATION NUMBER: 1382612

ROUTE IDENTIFICATION AND FEATURE CROSSED:
Heavy Haul Road over Lentzier Creek

Picture From 2016 Google Earth Image

PROJECT LOCATION: 0.30 mile west of Old Salem Rd in Section 16, T-44-N, R-16-E, Utica Township, Clark County, Indiana

REFERENCE POINT: TBD

PREPARED BY: Nick J. Kocher, P.E., United Consulting

DATE: July 27, 2017

NICHOLAS J. KOCHER REGISTERED No. PE11100665 STATE OF INDIANA PROFESSIONAL ENGINEER

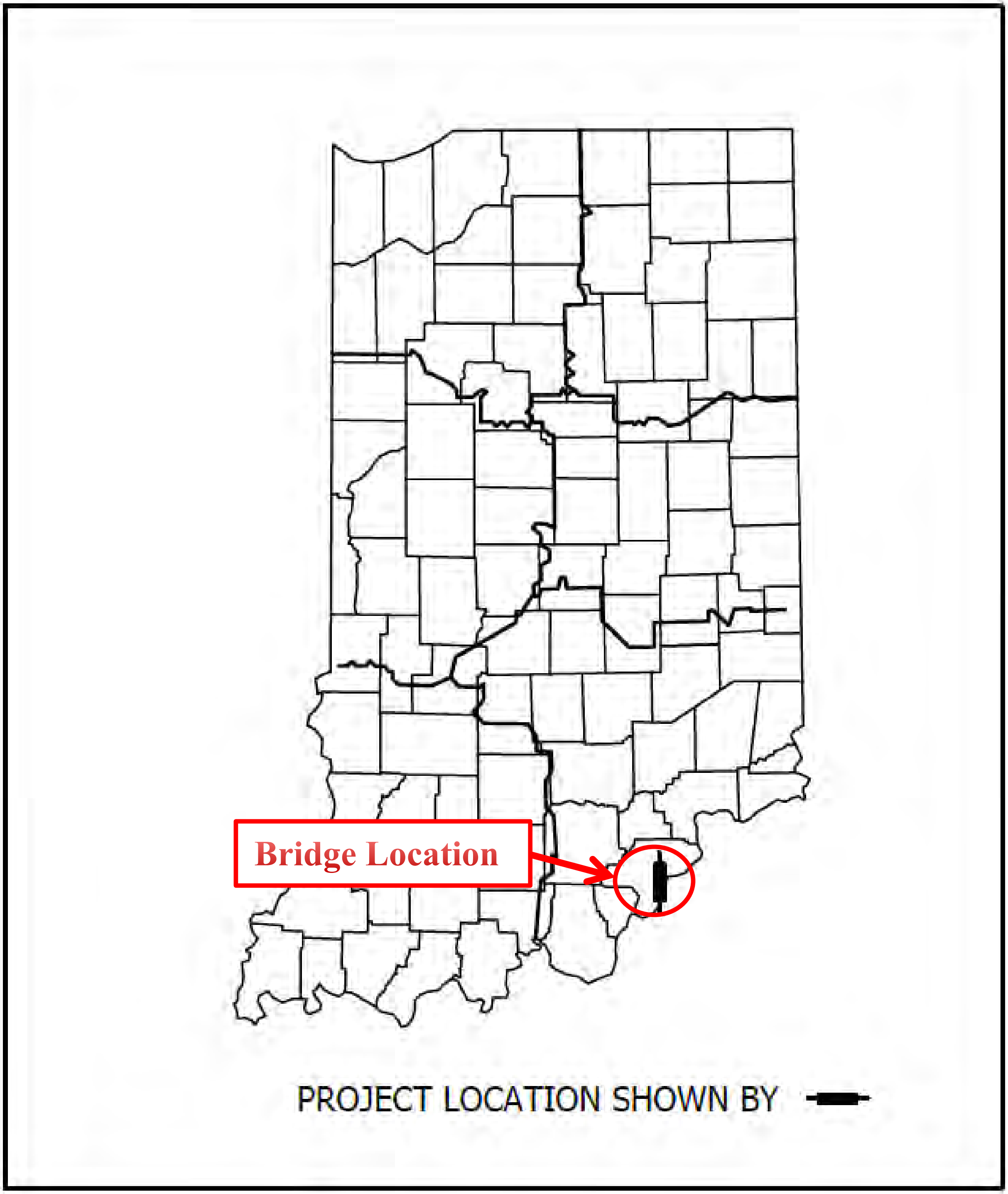
Nicholas J. Kocher
7/27/2017

UNITED Consulting

HEAVY HAUL ROAD OVER LENTZIER CREEK
Hydraulic Report
Index

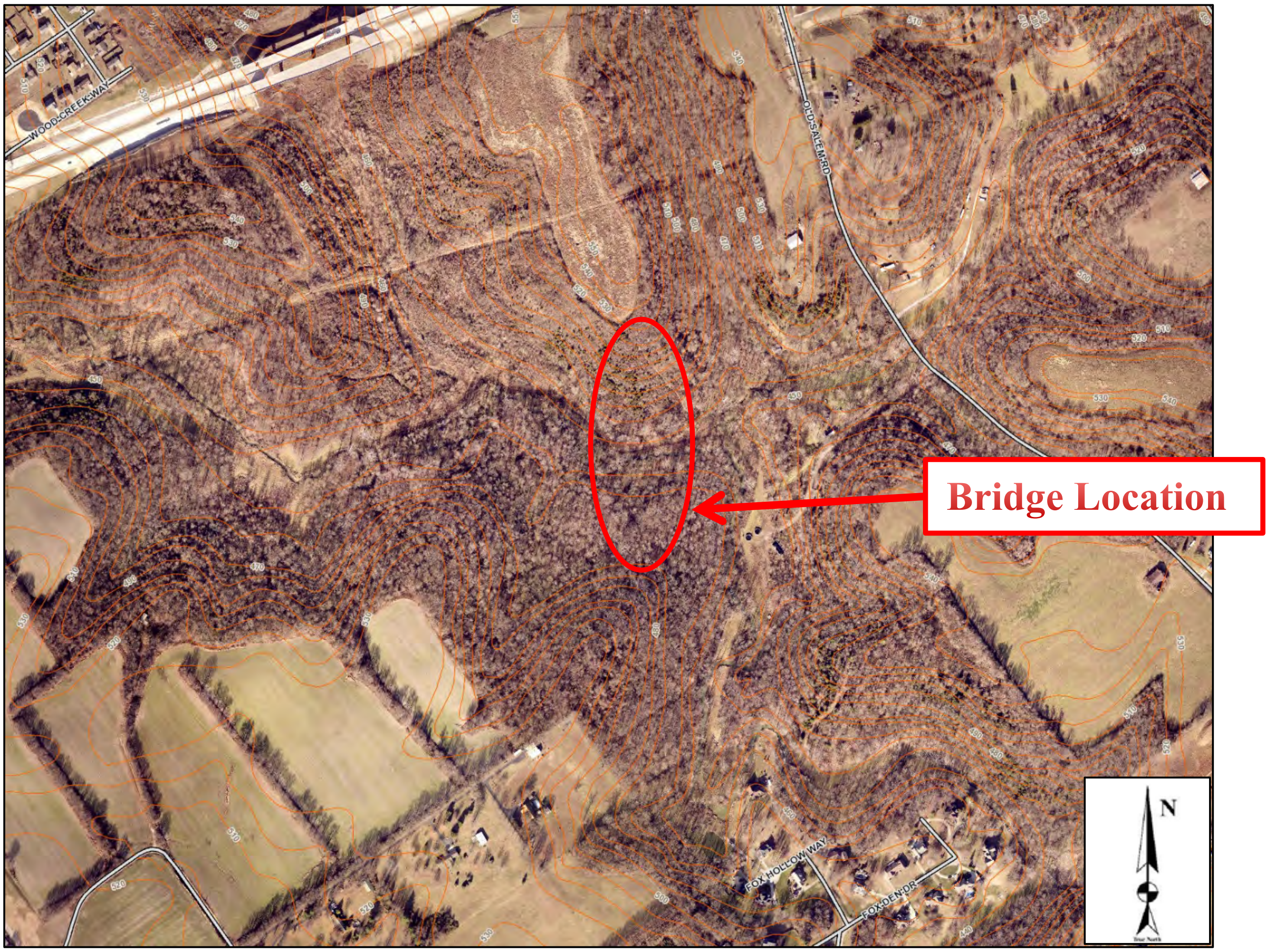
NARRATIVE

UNITED
Consulting



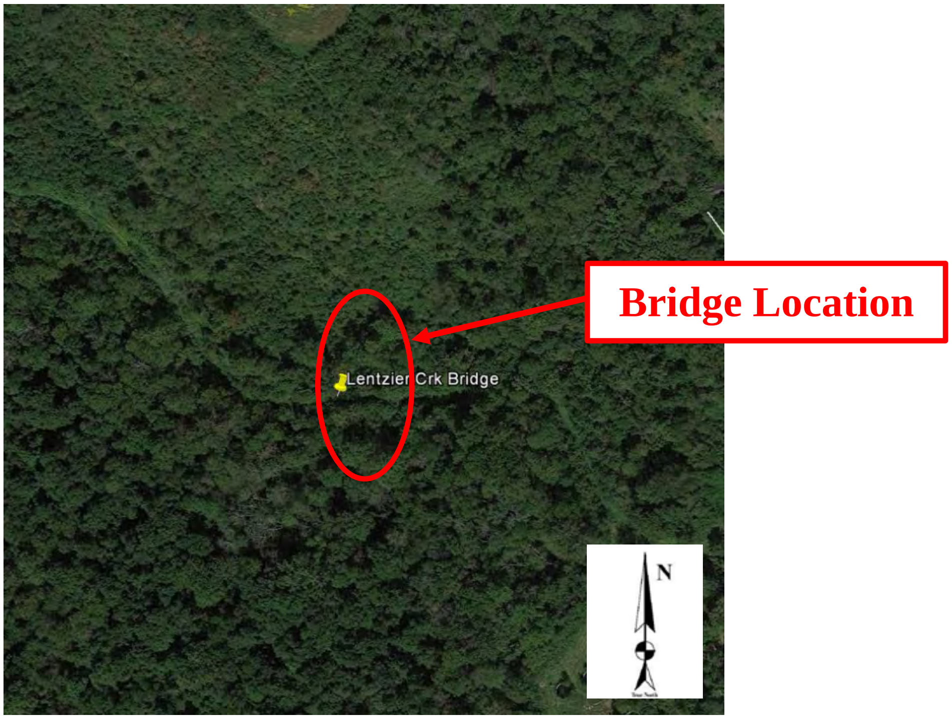
LATITUDE: 38°20'32"N LONGITUDE: 85°40'10"W

Project Location Map



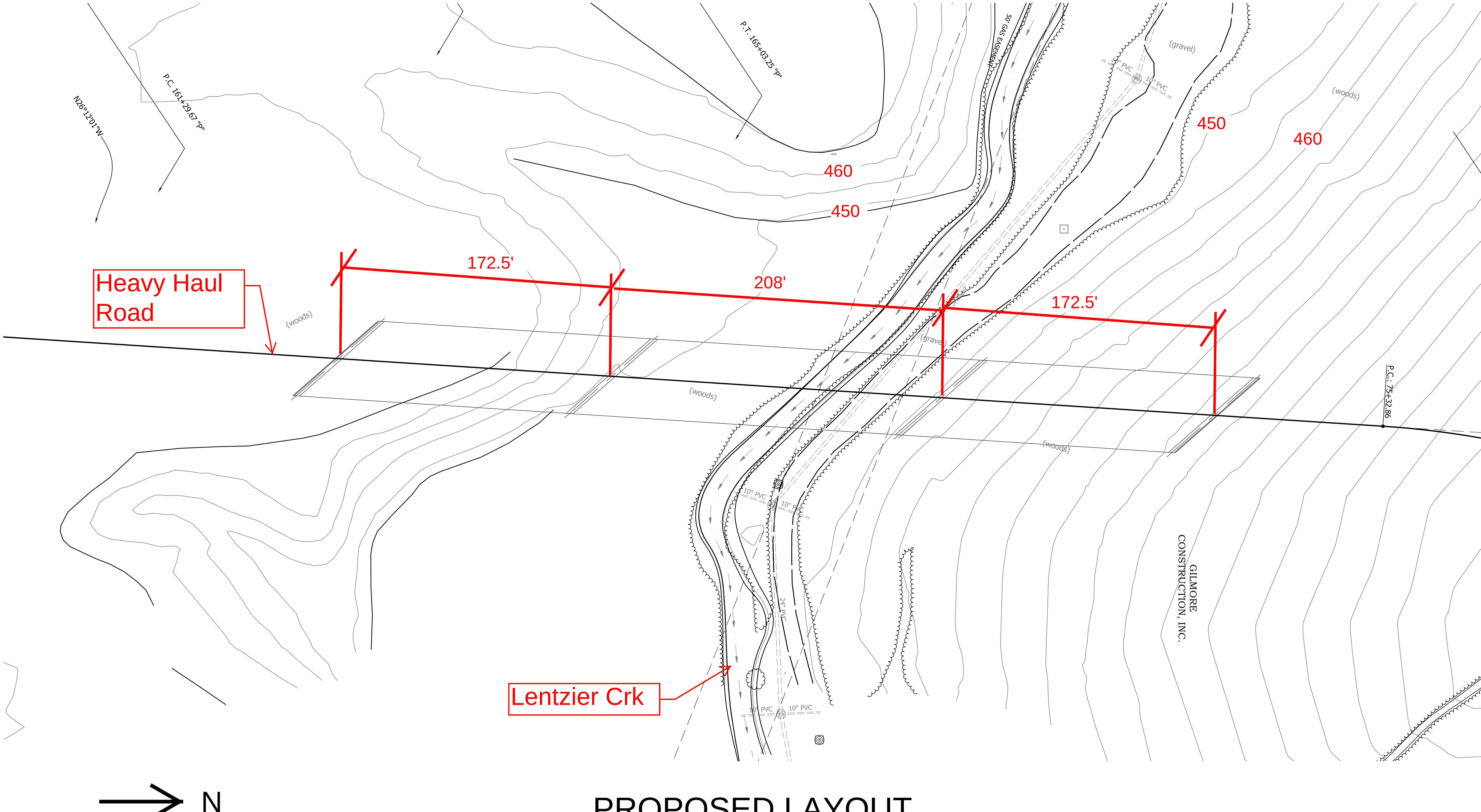
Clark County GIS

Project Location Maps



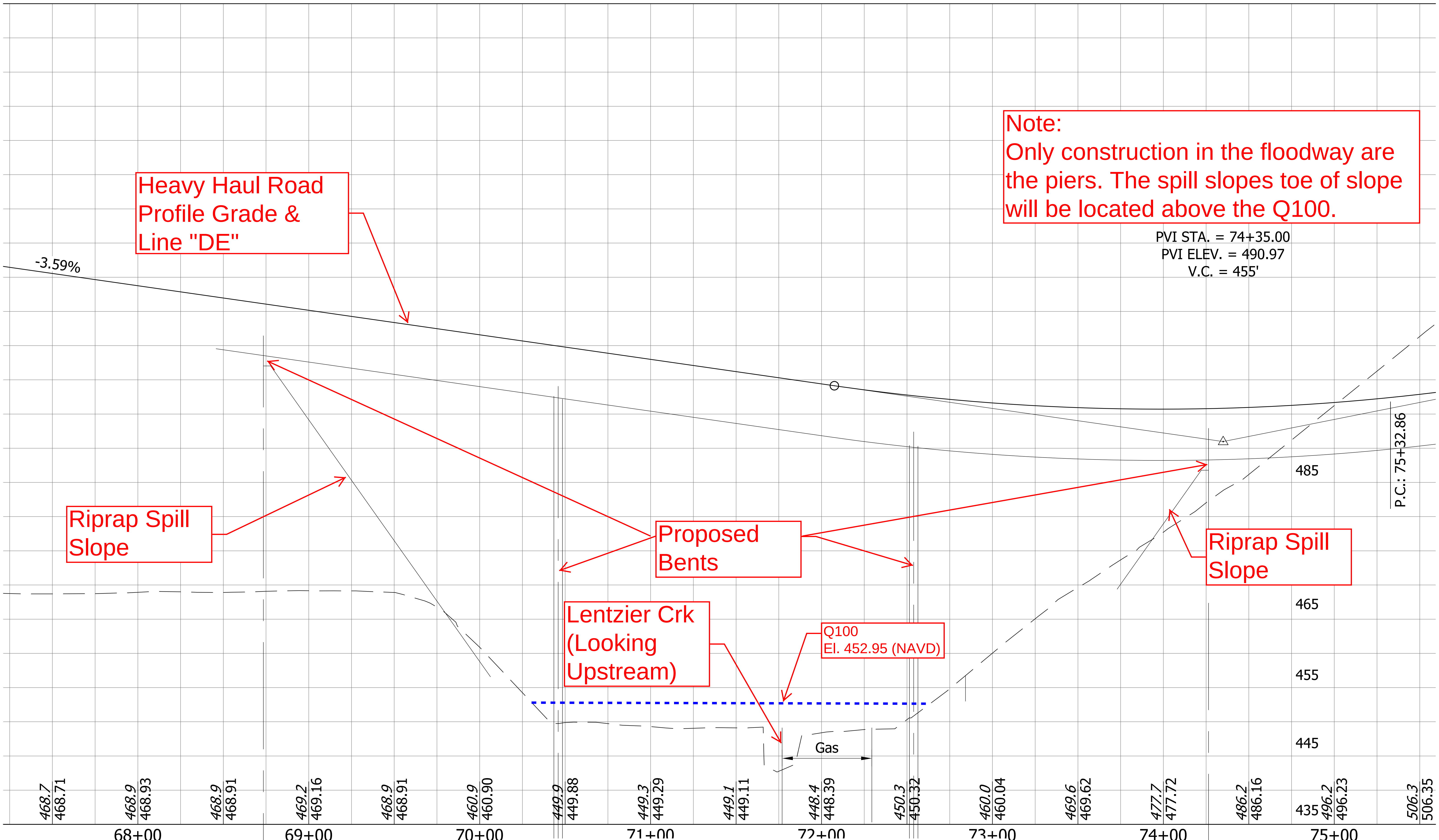
2017 Google Aerial

IDNR Floodplain Portal

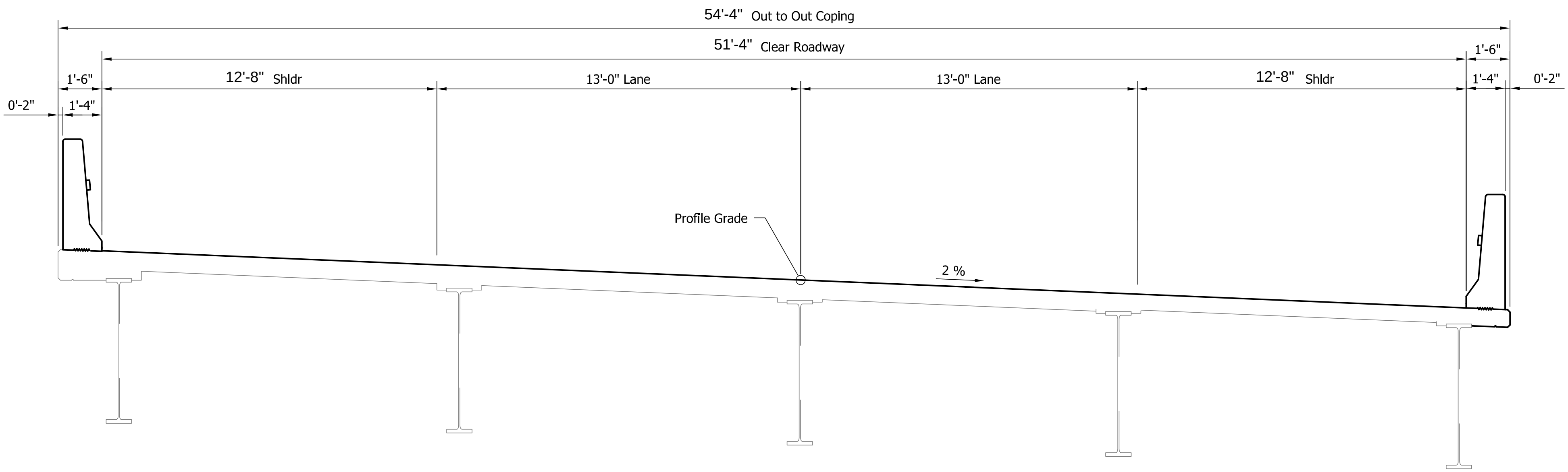


PROPOSED LAYOUT

(5' Contours)



PROPOSED ELEVATION



TYPICAL SECTION

Heavy Haul Road over Lentzier Creek

Introduction & Project Summary

A hydraulic analysis of the proposed Heavy Haul Road Bridge over Lentzier Creek has been completed to determine the effects of the proposed construction in a floodway. The following analysis has determined that the Heavy Haul Road over Lentzier Creek Bridge will produce 0.12 ft. of backwater due to the proposed piers, which is below the acceptable backwater of 0.14 ft. for new construction on a new roadway alignment per IDM 203-3.02(01). A submittal to IDNR for the construction in a floodway permit will be completed following this submittal.

The Heavy Haul Road over Lentzier Creek Bridge is part of a new roadway corridor from the Port of Indiana in Utica, IN and Jeffersonville, IN and ends at Old Salem Road, south of the newly constructed I-265 interchange. The proposed Heavy Haul Road is to support development of the River Ridge Commerce Center and the Port of Indiana. The proposed Heavy Haul Road is classified as urban with rolling terrain.

The roadway alignment crosses Lentzier Creek at a 45 degree skew right. The proposed roadway profile has the proposed bridge crossing Lentzier Creek approximately 50.0 ft. above the creek. The proposed bridge has a 54.33 ft. out-to-out coping width, a 51.33 ft. clear bridge width, and a 553.0 ft. out-to-out bridge length. The anticipated superstructure is steel plate girders. The bridge has three spans: 172.5 ft., 208.0 ft., and 172.5 ft. The substructures consist of two reinforced concrete wall piers that are placed parallel to the direction of Lentzier Creek's flow.

The floodway naturally expands from cross section 3 to 2. The proposed toe of slopes from the bridge's spill slopes will be placed outside of the naturally occurring expansion. The proposed toe of slopes will also be placed above the Q100 elevations. The only proposed element of the bridge that will be placed within the floodplain will be the two concrete piers. Due to the bridge height the piers were conservatively modeled as 5 ft. wide.

The floodway width varies over 150 ft. from cross section 3 and 2 of the bridge. Lentzier Creek at the Heavy Haul Road crossing has a narrow floodplain upstream. The right overbank floodplain widens just upstream of the Heavy Haul Road crossing and continues to widen downstream of the proposed bridge.

Engineering judgement indicates that the soil consists of ten feet of loam before reaching competent rock. Survey has been completed for the stream and proposed roadway alignment. The channel survey limits extended approximately 2,000 ft. upstream and 275 ft. downstream of the crossing. An existing surface in CAD was created which was used to create and import new cross sections into HEC-RAS.

The Heavy Haul Road Bridge is located 2.2 miles above the confluence with the Ohio River. The bridges and approaches do not get overtopped.

Hydrologic Data

Starting HEC-RAS Model:
There is no official Flood Insurance Study (FIS) hydraulic model available for this location. The Clark County FIS from April 16, 2014 is the latest information available (18019CV000A) but did not contain flood data for Lentzier Creek. Coordination with Charles Dewes, at IDNR revealed that IDNR had a Zone A approximate model for this location. Mr. Dewes provided the HEC-RAS model and stated the model might be a good start but is not required. This model was used in developing the Natural Condition model.

The HEC-RAS version used for this model is 5.0.3.

Research:
A search of existing permits found two permits: FW-21357 and FW-26753. Both permits were found to be outside of the project location's reach length and were not incorporated into the model. Permit FW-26753 is the nearest permit to the bridge crossing at over 5,400 ft. upstream. Permit FW-26753 was completed in 2012 and has a HEC-RAS model. The FW-26753 Permit's HEC-RAS model was used for comparing boundary conditions and determining a reach length.

Manning Values:
Manning's values were provided in the IDNR HEC-RAS model and verified with aerial photography. The overbank manning values ranged from 0.1 to 0.06 for downed trees, and little undergrowth or cleared land with heavy growth. The channel manning value is 0.06 for clean winding stream with weeds and stones.

Vertical Datum:
The hydraulic model data, county reference elevations, and field survey were all completed in the NAVD 1988. There is no need to use a conversion factor within this report because all elevations are NAVD 1988.

Reach Length:
The reach length calculated based on the DNR General Guidelines equation 3.5.1 is 3,050 ft. The average hydraulic depth was determined from the FW-26753 Permit's HEC-RAS model. The slope was calculated based on USGS 10 ft. contours.

The reach length upstream is at a point where backwater effects begin to dissipate which was found to be 4,300 ft. upstream from the bridge.

Discharges:
The Q100 was determined from the Coordinated Discharge Graph for Lentzier Creek dated October 2005. There are two unnamed tributaries of Lentzier Creek, one located 700 ft. upstream and one located 600 ft. downstream. An IDNR letter of discharge was requested for the structure which recommended a Q100 discharge of 1700 cfs. at the

structure. The HEC-RAS model contains three discharges of 1500 cfs. for the upstream reach limit, 1700 cfs. downstream of the upstream unnamed tributary, and 2100 downstream of the downstream unnamed tributary.

The Q500 discharge for the scour analysis is determined by a multiplier of 1.4 of the Q100 discharge because there are no discharges published in the FIS or in a coordinated discharge curve. The Q500 discharge used in this model for the scour analysis is 2,380 cfs.

Drainage Area:
The drainage area at the Heavy Haul Road crossing was determined to be 5.3 square miles. There is no published drainage areas for this location. The drainage areas were determined using the Indiana StreamStats and cross referenced with the IDNR letter of discharge and the Jeffersonville USGS Quadrangle map.

Boundary Conditions:
The Q100 and Q500 starting water surface elevations are 447.08 (NAVD) and 448.51 (NAVD) respectively at cross section 1.688. The starting water surface elevations were determined by running the Natural HEC-RAS model with a normal slope boundary condition of 0.0015 ft/ft. The water surface elevation, given above, at the downstream reach cross section was used for the proposed boundary condition.

The downstream Q100 and Q500 base flood elevations are 452.95 and 454.15 respectively. The base flood elevations were taken from this HEC-RAS model natural conditions at the downstream face of the bridge.

Hydraulic Model

Natural Model:
The natural model is a copy of the IDNR approximate model, with the discharges adjusted as discussed above. Cross sections 2.204 and 2.199 were added upstream and downstream of the proposed bridge to better represent the terrain near the proposed crossing. Due to the 150 ft. of floodplain change between these cross sections, interpolated cross sections were added (see email correspondence with INDOT hydraulics regarding interpolated cross sections). The channel elevations were revised for the cross sections within the surveyed limits, which consisted of cross sections 2.411 and 2.253. On average, the IDNR model's channel elevations were 1.25 ft. higher than the surveyed channel elevations. This 1.25 ft. difference was thought to be the water depth, which is common for cross sections produced with LiDAR survey. Therefore all of the remaining cross section's thalweg points were lowered 1.25 ft. Finally the model was truncated to the location's reach lengths; cross sections 3.015 and 1.688.

Existing Model:
There is no existing structure, so the existing model is the same as the natural model.

Proposed Model:
The proposed model is a copy of the natural model. A bridge was added at cross section 2.201. The high chord was estimated based on the preliminary roadway profile. The low chord was estimated based on a 9.0 ft. structure depth. The low chord is over 30 ft. above the Q100. The proposed bridge has a 54.33 ft. out-to-out coping width and a 553.0 ft. out-to-out bridge length. The bridge width of 54.33 ft. was skewed along the stream and inputted as 78.0 ft. The anticipated bridge spans are 172.5 ft., 208.0 ft., and 172.5 ft. but was modeled as three equal spans of 184 ft. The three 184 ft. spans measured along the road were skewed perpendicular to the stream and inputted as three 130.0 ft. spans. The wall piers were placed outside of the main channel, within the floodplain, and assumed to be 5.0 ft. in width. The spill slopes at the end bents will be placed outside of the floodplain, graded at 2:1, and protected with riprap. The toe of the spill slopes started at El. 455.0 (above the Q100).

Scour Countermeasures

The proposed pier foundations will be placed below the low scour elevation. The maximum flow velocity is less than 6.5 fps; therefore, the abutments will be protected with revetment riprap. The riprap will only be extended five feet above the Q500 elevation to limit the amount of riprap placed on the tall spill slopes.

HYDRAULICS SUMMARY TABLE

HYDRAULIC DATA (NAVD 1988 DATUM)

Drainage Area	= 5.3 sq. mi.
Flowline Elevation	= 442.16

Existing Structure Summary

N/A

Proposed Structure Summary

Low Structure Elevation	= 488.5
Structure Skew	= 45 degrees
Q100 Discharge	= 1,700 cfs
Q100 Elevation	= 452.95
Q100 Headwater Elevation	= 453.26
Q100 Gross Waterway Area	= 762 sft
Q100 Road-Overflow Area	= 0.0 sft
Q100 Average Velocity	= 2.58 fps
Q100 Backwater	= 0.12 ft
Scour Data:	
Q100 Maximum Velocity	= 6.07 fps
Q100 Contraction Scour	= 0.0 ft
Q100 Total Scour	= 8.0 ft
Q100 Low Scour Elevation	= 434.16
Q500 Discharge	= 2,380 cfs
Q500 Elevation	= 454.15
Q500 Headwater Elevation	= 454.44
Q500 Gross Waterway Area	= 1,001 sft
Q500 Road-Overflow Area	= 0.0 sft
Q500 Average Velocity	= 2.78 fps
Q500 Backwater	= 0.14 ft
Scour Data:	
Q500 Maximum Velocity	= 6.43 fps
Q500 Contraction Scour	= 0.0 ft
Q500 Total Scour	= 8.0 ft
Q500 Low Scour Elevation	= 434.16

Heavy Haul Road over Lentzier Creek

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
LOCATION DESCRIPTION			MODELING RESULTS				COMPARISONS*			
Model Cross Section	Location Description	PUBLISHED OR EFFECTIVE DATA (Ft. NGVD)	Duplicate Effective Model (Ft. NGVD)	Corrected Effective Model (Ft. NGVD)	Existing Pre-project Model (Ft. NGVD)	Proposed Post-Project Model (Ft. NGVD) (same as Existing)	Cumulative Impacts w/o Project (ft.) (6)-(5)	Cumulative Impacts with Project (ft.) (7)-(5)	Project Impacts (ft.) (7)-(6)	NOTES
3.015				456.70	456.70	456.71	0.00	0.01	0.01	
2.807				455.84	455.84	455.86	0.00	0.02	0.02	
2.717				455.55	455.55	455.58	0.00	0.03	0.03	
2.611				455.15	455.15	455.18	0.00	0.03	0.03	
2.411				454.39	454.39	454.45	0.00	0.06	0.06	
2.253				453.82	453.82	453.90	0.00	0.08	0.08	
2.204				453.35	453.35	453.46	0.00	0.11	0.11	
2.20328				453.21	453.21	453.33	0.00	0.12	0.12	
2.20257				453.14	453.14	453.26	0.00	0.12	0.12	
2.201	New Bridge									
2.20042				452.81	452.81	452.81	0.00	0.00	0.00	
2.19971				452.72	452.72	452.72	0.00	0.00	0.00	
2.199				452.71	452.71	452.71	0.00	0.00	0.00	
2.155				452.08	452.08	452.08	0.00	0.00	0.00	
2.016				450.84	450.84	450.84	0.00	0.00	0.00	
1.917				450.23	450.23	450.23	0.00	0.00	0.00	
1.866				449.34	449.34	449.34	0.00	0.00	0.00	
1.688				447.08	447.08	447.08	0.00	0.00	0.00	

NOTES: **Project is a new bridge on a new alignment. There is no published FIS. Therefore the Corrected Eff. Model is the same as the Existing Pre-project model.**

* Project is considered permittable if maximum surcharges outside the property are no more than 0.14 feet in both columns (9) and (10). If the maximum surcharge outside the applicants property exceeds 0.14 feet in columns (8) and (9), the project may still be permittable if the project impacts shown under column (10) do not exceed 0.00 feet outside the applicant's property.

Appendix A

- □ Correspondence
- □ Hydraulic QA Checklist
- □ IDNR Hydraulic Checklist
- □ Pictures

UNITED Consulting

Email Correspondence:

The following email is in regard to the use of interpolated cross sections located around the proposed bridge.

From:	Bailey, Mark
To:	Ridens, Jay
Cc:	Kocher, Nick
Subject:	FW: Heavy Haul Transportation Corridor - Lentzier Creek Hydraulics
Date:	Wednesday, July 19, 2017 1:09:04 PM
Attachments:	image001.png

Jay,

We agree with your proposed use of interpolated cross sections.

Let me know if you have any additional questions,

-Mark

From: Finley, David
Sent: Wednesday, July 19, 2017 10:56 AM
To: Bailey, Mark <MBailey1@indot.IN.gov>
Subject: RE: Heavy Haul Transportation Corridor - Lentzier Creek Hydraulics

Mark:

Yes, it does look like the interpolated cross section in the natural model are the right approach.

Here is some reasoning on why it could be allowed: In the natural model without the interpolated sections, it looks like cross section 3 would likely default to critical depth because of the difference in conveyance between the two cross sections. When the bridge is put into that model, it would kick XS 3 out of critical and return a water surface that is a lot higher – may be the 6 inches mentioned in United's e-mail. Thus, the interpolated cross sections are needed to resolve the critical depth issue in the natural model and get a more accurate analysis of the bridge model.

Thanks.

David Finley, PE
Hydraulic Engineer
INDOT Division of Bridges
100 N. Senate Avenue, Room N642-BR
Indianapolis, IN 46204
(317) 232-5228
DFinley@indot.IN.gov

From: Bailey, Mark
Sent: Wednesday, July 19, 2017 9:40 AM
To: Finley, David <DFinley@indot.IN.gov>
Subject: FW: Heavy Haul Transportation Corridor - Lentzier Creek Hydraulics

Hopefully that all makes sense. If not, or if you would like to meet to get more information, just let me know.

Thanks Mark!

Jay N. Ridens, P.E.
Project Team Leader
Bridge Department

UNITED CONSULTING
1625 N. Post Road
Indianapolis, IN 46219
Phone: (317) 895-2585
Fax: (317) 895-2596

Hydraulics QA Checklist

Route: Heavy Haul Road Des No. TBD
County: Clark City or Town: Utica
Description: New road and bridge construction over Lentzier Creek
Designer: Nick Kocher, P.E. Reviewer: Jay N. Ridens, P.E.

MAPS

- ☒ USGS Quad. Scale 1:24000 Date 1993
- ☐ ARC GIS Date
- ☐ Flood-Insurance Firm and FHBM
- ☐ Soils Map
- ☒ Aerial Photos Scale NTS Date 10/2015

STUDIES BY EXTERNAL AGENCIES

- ☐ FEMA Flood-Insurance Studies
- ☐ NRCS Watershed Studies
- ☐ USGS Gages and Studies
- ☒ Interim Floodplain Studies

STUDIES BY INTERNAL SOURCES

- ☐ Office Records
- ☐ Flood Record (High Water, Newspaper)

☐ **BRIDGE INSPECTION REPORTS** Gaging Da

CALIBRATION OF HIGH-WATER DATA

- ☐ Discharge and Frequency of H.W. el.
- ☐ Influences Responsible for H.W. el. - Check Maps for Larger Streams Nearby that May Backwater the Site
- ☐ Analyze Hydraulic Performance of Existing Facility for 100-Year Flood
- ☒ Analyze Hydraulic Performance of Proposed Facility for 100-Year Flood
- ☐ Field Reconnaissance Revisions Report

DESIGN APPURTENANCES

- ☒ Dissipators, Riprap
- ☒ Scour Analysis/Evaluation

TECHNICAL RESOURCES

- ☒ *Indiana Design Manual*, Part II
- ☒ Other <u>IDNR *General Guidelines for the Hydrologic-Hydraulic Assessment of Floodplains in Indiana*</u>

DISCHARGE CALCULATIONS

- ☐ Drainage Area Delineation
- ☒ Drainage Areas of IN Streams
- ☒ DNR Discharge Letter
- ☐ Rational Formula
- ☐ HEC-HMS / TR-20
- ☐ NRCS
- ☐ Regional Analysis
- ☒ Coordinated Discharges of IN Streams
- ☐ Log-Pearson Type III Gage Rating

HIGH-WATER ELEVATIONS

- ☐ INDOT Survey
- ☐ Plans for Existing Structure
- ☐ DNR Historic Flood Profiles
- ☐ Maintenance Records
- ☐ External Sources
- ☐ Personal Reconnaissance

ENVIRONMENTAL REPORTS

☐ INDOT

TECHNICAL AIDS

☒ *Indiana Design Manual*, Part II
☐ INDOT and FHWA Directives
☐ FHWA Publications

COMPUTER PROGRAMS

☐ HY8
☒ HEC-RAS River Analysis System
☐ Log-Pearson Type III Analysis
☐ WSPRO Water-Surface Profile
☐ PFP-HYDRA
☐ HEC-HMS / TR 20
☒ HEC-RAS Scour Analysis

☐ Other____________________

Designed by: [signature] **Date:** 7/26/17

Reviewed by: [signature] **Date:** 7/26/17

HYDRAULIC Modeling Checklist

State Form 52882 (5-14)
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER

This checklist will assist the staff at the Division of Water in the review of modeling for the definition of the floodway, for evaluation of a Construction in a Floodway permit application, for state concurrence of a Letter of Map Revision or a Flood Insurance Study or any other modeling that is submitted for review. The checklist items are based on the document "General Guidelines for the Hydrologic-Hydraulic Assessment of Floodplains in Indiana." The modeler should be familiar with this document and any discrepancies between the general guidelines and the submitted modeling should be discussed with the Division of Water Engineering Services staff prior to submittal.

This completed checklist must be submitted to the Division of Water along with your models. The Division of Water will not review any modeling submittal that is not accompanied by a completed checklist.

Please keep in mind that these questions were written primarily for the application of HEC-RAS computer models. HEC-RAS is preferred by the Division of Water, however, other modeling programs may be used provided their use has been discussed previously with Division of Water Staff. Should you have any questions, please contact Division of Water staff at (317) 232–4160 or toll free at (877) 928-3755.

1. **General Information**
   a. Preparer Name: Nick Kocher, P.E.
   b. Preparer Firm: United Consulting
   c. Date: July 20, 2017

2. **Project Location and Background Information**
   a. Waterbody Name: Lentzier Creek
   b. Location Description: Proposed crossing of Lentzier Creek is 2.2 miles upstream of the Ohio River mouth.
   c. Nearest Town/City: Utica, IN
   d. County: Clark

Waterbody Name: Lentzier Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

e. Modeling Study Reach: Downstream Limit 1.688 miles *(unit of distance)*

Upstream Limit 3.015 miles *(unit of distance)*

f. Reach Length Equation $L = \frac{150\ HD^{0.8}}{S}$ 3,000 ft

Comments The model study reach extends 4,300 ft. upstream at a point where backwater effects dissipate.

g. Type of Model

- [x] HEC-RAS
- [ ] HEC-2
- [ ] WSPRO
- [ ] WSP2
- [ ] HY-8

Other ________________

Program Version: ________________

h. Base Model

- [ ] FIS
- [ ] IDNR Model
- [x] New See correspondence

i. H&H Model Library Stream Name: ________________

j. Models used for Cumulative Impacts:

Previous FARA/Floodway Permits within study reach

	Permit or FARA Number	H&H Model Library Stream Name	Comment
1	FW-21357	Lentzier Creek	Outside of reach; I-265 crossing; 11/13/01
2	FW-26753	Lentzier Creek	Outside of reach; 1-265 crossing; 2/7/13
3			
4			
5			

Waterbody Name: Lentzier Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

3. Model Purpose

Please indicate for what purpose the models are submitted for review and approval:

- ☐ Floodway / Base Flood Elevation Determination (FARA)
- ☒ Construction in a Floodway Application
- ☐ Letter of Map Revision (LOMR)
- ☐ Flood Insurance Study modeling
- ☐ Other (*please describe*) ______

4. Discharges

The source of the 1% annual chance flood discharges used in a hydraulic model need to be fully documented by completing the questions listed below.

It is strongly suggested that a preparer-determined 1% annual chance discharge be submitted for approval prior to the submittal of hydraulic models. Discharge determinations and hydraulic models are considered to be separate items, each subject to review.

a. What is the source of the discharges used in the submitted model *(Please check one.)*:

- ☒ Curve published in "Coordinated Discharges of Selected Streams in Indiana" *(Please attach copy of applicable graph.)*
- ☒ Determination approved by the Department of Natural Resources *(Please attach copy of letter from IDNR.)*
- ☐ Hydrologic analyses submitted with this application
- ☐ Flood Insurance Study
- ☐ Other modeling *(Indicate source.)* ______

b. Table of Discharges used in the model *(Expand table as needed.)*

Location Name	Drainage Area (sq. mi.)	Flow Rate (cfs)	Cross Section range on Stream Reach
Upstream Reach Limit		1350	3.015 to 2.611
Upstream Reach Limit	4.55	1500	2.611 to 2.253
Mouth of U/S UNT of Lentzier	5.33	1700	2.253 to 2.016
Mouth of D/S UNT of Lentzier	6.87	2100	2.016 to 1.688

c. Are discharges unchanged from base condition model to other model plans (corrected effective, proposed, etc.)?

☒ Yes ☐ No

Waterbody Name: Lentzier Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

d. Comments regarding discharge determination:

The discharges were determined based on the Coordinated Discharge Graph and the drainage area within the reach. The IDNR model had only one discharge for the entire creek (2100 cfs). There is an UNT upstream and downstream of the proposed crossing. Therefore it was determined that the proposed model should have flow rates that change at each UNT.

5. Starting Elevation / Boundary Conditions

Complete the following section fully to document the starting elevations and boundary conditions for starting the model:

a. Boundary condition used to derive starting elevations: *(Please check one.)*

- ☐ Known water surface *(Indicate source.):* _____
- ☐ Energy slope estimated from historic flood profile *(Indicate date.):* _____
- ☒ Energy slope estimated from stream thalweg *(Indicate mapping used.):* County GIS
- ☐ Other *(Please Describe.):* _____

b. Datum (*if applicable*) NAVD88

c. Description (*show any calculations*):

6. Manning's Roughness Coefficients ("n" Values)

Complete the following section fully to document the Manning's roughness coefficients:

a. How were the roughness coefficients estimated? *(Check all that apply.)*

- ☐ Flood Insurance Study
- ☒ Other modeling
- ☐ Field inspection
- ☐ Site photos
- ☒ Aerial photography or mapping
- ☐ Calibration
- ☐ Other *(Describe)* _____

b. What is the range of the roughness coefficients?

Left Overbank	Minimum 0.06	Maximum 0.1
Channel	Minimum 0.06	Maximum 0.06
Right Overbank	Minimum 0.06	Maximum 0.1

Waterbody Name: Lentzier Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

c. Are proposed roughness coefficients different from the base roughness coefficients?

☐ Yes ☒ No

d. Description of "n" values

"n" of 0.06 for the stream is for clean winding stream with weeds and stones. "n" of 0.06 for the floodplain is for cleared land with heavy growth and sprouts. "n" of 0.1 for the floodplain is for heavy stand of timber, downed trees, little undergrowth, and flood stage below branches.

e. Is Check-RAS output submitted with this checklist?

☒ Yes ☐ No

Waterbody Name: Lentzier Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

7. **Cross Sections**

The following questions have to do with the cross section information that is the basis of the submitted modeling:

a. What is the source of the cross section information *(Check all that apply.)*:
   - ☐ Flood Insurance Study
   - ☒ Field survey *(Date)* 5/20/2014
   - ☐ Detailed topographic mapping *(Date)* ______
   - ☒ Other modeling *(Indicate source.)* IDNR model
   - ☐ Other *(Please specify.)* ______

b. Vertical Datum: NAVD 1988
   Conversion factor (*if necessary*): not applicable

c. Are cross sections stationed increasing from left to right looking downstream?
   ☒ Yes ☐ No

d. How are sections labeled *(check one)* (Note: The following list is in order of preference)
   - ☐ Consistent with FIS / other studies
   - ☒ Miles above mouth
   - ☐ Feet above other landmark *(Please specify landmark.)* ______
   - ☒ Other *(Please specify.)* IDNR model was labeled as miles above mouth of Ohio River

e. Are sections oriented perpendicular to flow at all portions of the cross section?
   ☒ Yes ☐ No

f. Are the full cross section extents shown on submitted mapping?
   ☒ Yes ☐ No

g. Do the cross sections extend fully across the floodplain *(above expected 1% annual chance flood elevations)*?
   ☒ Yes ☐ No

h. Do the cross sections represent average conditions in the reach at which they are located?
   ☒ Yes ☐ No

i. Are areas of blocked or ineffective flow indicated on the submitted cross sections?
   ☒ Yes ☐ No ☐ N/A

j. Are cross sections located at places where discharge values change along the stream reach?
   ☒ Yes ☐ No ☐ N/A

k. Are cumulative reach lengths the same in different plans or model runs?
   ☒ Yes ☐ No

Waterbody Name: Lentzier Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

l. For any "No" answers above, please provide an explanation:

m. Are interpolated sections used anywhere in the model (*If yes, state reasons for using interpolated sections.)*

☒ Yes ☐ No

Reason:

Interpolated cross section were used between the proposed bridge cross sections 2 & 3 due to the change in floodplain width. The interpolated cross sections were adjusted per field survey after their creation and adjusted for proposed bridge spillslopes. See email correspondence with INDOT Hydraulics regarding these interpolated cross sections.

n. Is Check-RAS output submitted with this checklist?

☒ Yes ☐ No

Waterbody Name: Lentzler Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

8. Stream Crossings

The following questions should be answered for each bridge in the model being submitted. Use a separate sheet for additional stream crossings.

Name of stream Crossing	Heavy Haul Road	
Type of Crossing	Bridge	
Stream crossing section locations		
Section 1 Cross section number:	2.155	
Section 2 Cross section number:	2.199	
Section 3 Cross section number:	2.204	
Section 4 Cross section number:	2.253	
This crossing is in support of a construction in a floodway application	☒	☐
The same number of sections are used in the existing (pre-project) and the proposed (post-project)	☒	☐
Cross sections extend across the entire valley to the 1% annual chance flood elevation	☒	☐
Cross section 1 is located at a 2:1 flow expansion ratio downstream of the bridge face	☒	☐
Cross section 4 is located at a 1:1 flow contraction ratio upstream of the bridge face	☒	☐
Expansion/Contraction coefficients have been adjusted to reflect the effects of the bridge	☒	☐
Ineffective flow limits are set a sections 2 and 3	☒	☐
Selected low flow modeling method	Energy	
Selected high flow modeling method	Energy	
The approach roadway profile data extend across the full valley cross section	☒	☐
Bridges piers are included at this crossing	☒	☐
HEC-RAS default embankment side slopes were applied at all stream crossings in the model	☒	☐

For all unmarked answers above, please explain.

The ineffective flow stations and elevations do not change from the existing to the proposed conditions. The bridge's side slopes do not restrict the floodplain. The topography of the crossing and the structure size does not allow typical contraction and expansion. There is no left ineffective flow due to the topography. The right ineffective flow is due to the upstream natural restrictive flow and not due to the bridge.

Is Check-RAS output submitted with this checklist?

☒ Yes ☐ No

Waterbody Name: Lentzier Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

Stream Crossings (cont.)

The following questions should be answered for each bridge in the model being submitted. Use a separate sheet for additional stream crossings.

Name of stream Crossing		
Type of Crossing		
Stream crossing section locations		
Section 1 Cross section number:		
Section 2 Cross section number:		
Section 3 Cross section number:		
Section 4 Cross section number:		
This crossing is in support of a construction in a floodway application	☐	☐
The same number of sections are used in the existing (pre-project) and the proposed (post-project)	☐	☐
Cross sections extend across the entire valley to the 1% annual chance flood elevation	☐	☐
Cross section 1 is located at a 2:1 flow expansion ratio downstream of the bridge face	☐	☐
Cross section 4 is located at a 1:1 flow contraction ratio upstream of the bridge face	☐	☐
Expansion/Contraction coefficients have been adjusted to reflect the effects of the bridge	☐	☐
Ineffective flow limits are set a sections 2 and 3	☐	☐
Selected low flow modeling method		
Selected high flow modeling method		
The approach roadway profile data extend across the full valley cross section	☐	☐
Bridges piers are included at this crossing	☐	☐
HEC-RAS default embankment side slopes were applied at all stream crossings in the model	☐	☐

For all unmarked answers above, please explain.

Is Check-RAS output submitted with this checklist?

☐ Yes ☐ No

Waterbody Name: Lentzier Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

9. Floodways

Has floodway determination been done in accordance with Section 8.14 of the Guidelines?

☐ Yes ☐ No ☒ N/A

10. Model Output

For all model outputs review the "errors and warnings" and address those comments not already addressed.

A conveyance ratio warning is given at cross section 3.015, 2.253, 2.199, and 2.155. The cross sections were reviewed and determined accurate. Multiple critical depth warnings were given for most cross sections through the bridge. The terrain of Lentzier Creek is rocky with abrupt drops along the banks.

11. Documentation

Submitted documentation *(Check all that apply.)*:

- ☒ Narrative regarding modeling
- ☒ Project Evaluation Results *(Mandatory – See Figure 3.1)*
- ☐ Application Forms and/or LOMR Application Forms
- ☒ Pictures of stream reach *(w/ orientation map)*
- ☐ FIS map / profile
- ☒ Check-RAS output
- ☒ Cross Section plots
- ☒ HEC-RAS "Standard Table 1"
- ☐ HEC-RAS "Encroachment 1" table *(only for floodways)*
- ☐ Profile plots (only for LOMR and FIS)
- ☐ Floodplain mapping including:
  - ☐ Stream in question
  - ☐ Roads *(With street names)*
  - ☐ Existing features *(Buildings, parking lots, woods, etc.)*

Waterbody Name: Lentzier Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

- ☐ The full extent of each cross section included in the model, with each cross section clearly labeled *(Include the location of initial and end points as used in the model.)*
- ☐ Topographic data *(If available)*
- ☐ Property limits *(Approximate property limits are acceptable only if surcharges are 0.14' or less at all cross sections.)*
- ☐ North arrow
- ☐ Scale *(Numerical and graphical)*
- ☐ Horizontal and vertical control benchmark used *(See Section 5.3 of the Guidelines for benchmark guidance.)*
- ☐ Horizontal and vertical datums
- ☐ Delineated flood fringe and floodway limits

☒ Computer Model Plans submitted *(Check all that apply.)*

HEC-RAS project name LentzierHvyHaul .prj

- ☐ Base Condition (FIS, IDNR Regulatory) Plan name: n/a
- ☐ Duplicate Effective Plan name: n/a
- ☒ Corrected Effective Plan name: LentzierHvyHaul.p01
- ☐ Existing (Pre-project) Plan name: n/a
- ☒ Proposed (Post-project) Plan name: LentzierHvyHaul.p02

Waterbody Name: Lentzier Creek
Preparer: Nick Kocher, P.E.
Date: July 20, 2017

12. Affirmation

By signing this document you are indicating that the submitted models have been developed and reviewed in accordance with accepted Division of Water guidelines. Should the Division of Water find inconsistencies between your submitted models and the checklist or other deficiencies in the submittal, you will be notified in writing of the deficiencies and given a limited number of days to correct these problems. If you cannot correct the deficiencies in the given time, you must contact the Division to avoid closure of the file or denial of the permit application due to lack of supporting information.

July 20, 2017
Date:

Signature

Nick Kocher, P.E.
Name

United Consulting
Firm

Photo 1: Looking Upstream

Photo 2: Looking Downstream

Appendix B

- □ Reach Length
- □ Permit Research
- □ Drainage Area
- □ Discharge
- □ Manning "n" Values
- □ Supplemental Support Information

Determine Reach

3.4.3 *Revisions to Published Studies*

The process to revise a FIS is referred to as a Letter of Map Revision (LOMR). LOMR application forms (referred to as the MT2 forms) are available on the FEMA website (http://www.fema.gov/). Required modeling submittals are explained in Section 3.5 of this chapter, while the process for review and approval of a LOMR is described in Section 3.7 of this chapter.

3.5 Models Required for IDNR Approval of a Permit or Map Revision Request

3.5.1 *Defining the Study Reach*

The total study reach, or the area of revision, is defined by an effective tie-in or transition of the reach of interest with reaches immediately upstream and downstream. For streams that require a detailed study, the study reach should begin downstream at a point where there is currently no cumulative flood surcharge effect from previously permitted or allowed floodway encroachments, or where the cumulative flood surcharge effect from previously permitted or allowed encroachments is known. The study reach should extend upstream, at a minimum, to the point where there are no remaining flood surcharge effects from the proposed floodway encroachment for the project in question.

The following equation, taken from USACE Hydrologic Engineering Center - Technical Paper No. 114, can be used to estimate the distance upstream or downstream the study reach should extend to adequately account for cumulative effects and to estimate a point to tie-in to an existing profile.

$$\mathbf{L=150\ HD^{0.8} / S}$$

Where,

L is the reach length in feet,

HD is the average hydraulic depth for the assumed 100-year frequency flood profile through the project reach in feet (cross sectional flow area in ft^2 divided by top width in feet), and

S is the average reach slope in percent (e.g., feet per 100 feet).

Revisions of both the downstream and upstream extents of the study reach may be necessary if additional flood profile information becomes available during preparation of a detailed flood study. IDNR staff should be contacted to consider allowing a shorter study reach if the applicant believes the required study reach is excessive in light of the fact that the surcharges are consistently decreasing upstream and that potential for

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Phone: (317) 895-2585
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E-mail: info@ucindy.com
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BY JNR DATE 2/24/14 SUBJECT Heavy Haul Road over Lentzier Cr. SHEET NO. ____ OF ____
CHKD BY NJK DATE 2/25/14 JOB NO. 14-402

Reach Length

Per DNR General Guidelines (3.5.1)

$$L = 150\, HD^{0.8} / S$$

HD: Use Permit FW-26753 (I-265 over Lentzier - Upstream)

Max. Hydraulic Depth ~ 5' / Avg. ~ 4' → Use Average

$$S = \frac{(450' - 440')}{6640'} = 0.0015 = 0.15$$

Check Slope with FW-26753 Hec-RAS File:

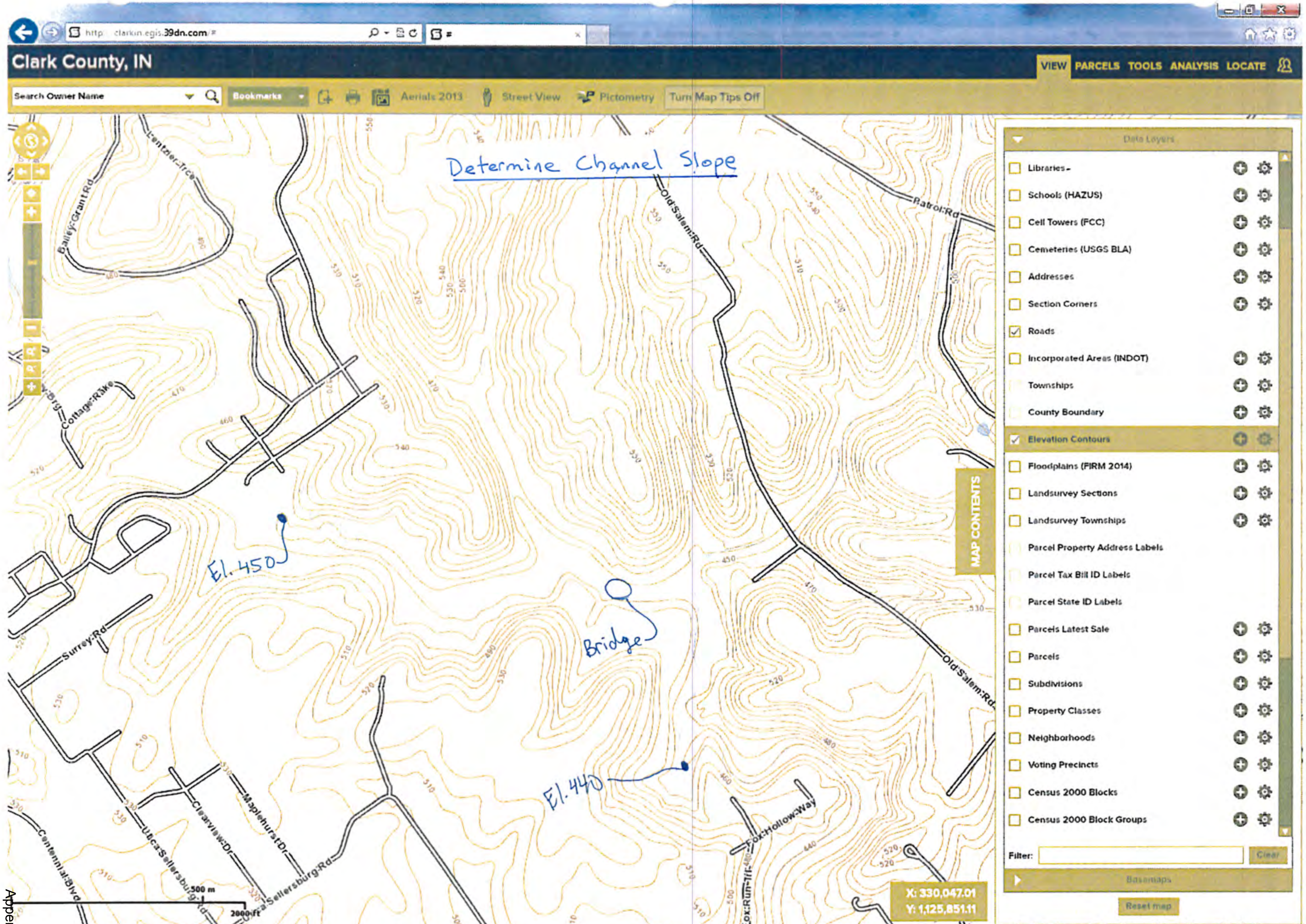
$$L = 1{,}660'$$

$$S = \frac{(452.3' - 449.8')}{1660'} = 0.0015$$

Checks

$$L = 150 \frac{HD^{0.8}}{S} = \frac{150\,(4')^{0.8}}{0.15} = 3{,}050'$$

Actual Used, L = 4,300'



Length between El. 450' & El. 440' = 6,640 feet

Permit Research

http://dnrmaps.dnr.in.gov/appsphp/model/index.php

Indiana Hydrology and Hydraulics Model Library

Indiana Department of Natural Resources DNR

Jump to a county

Select your county from below

Clark

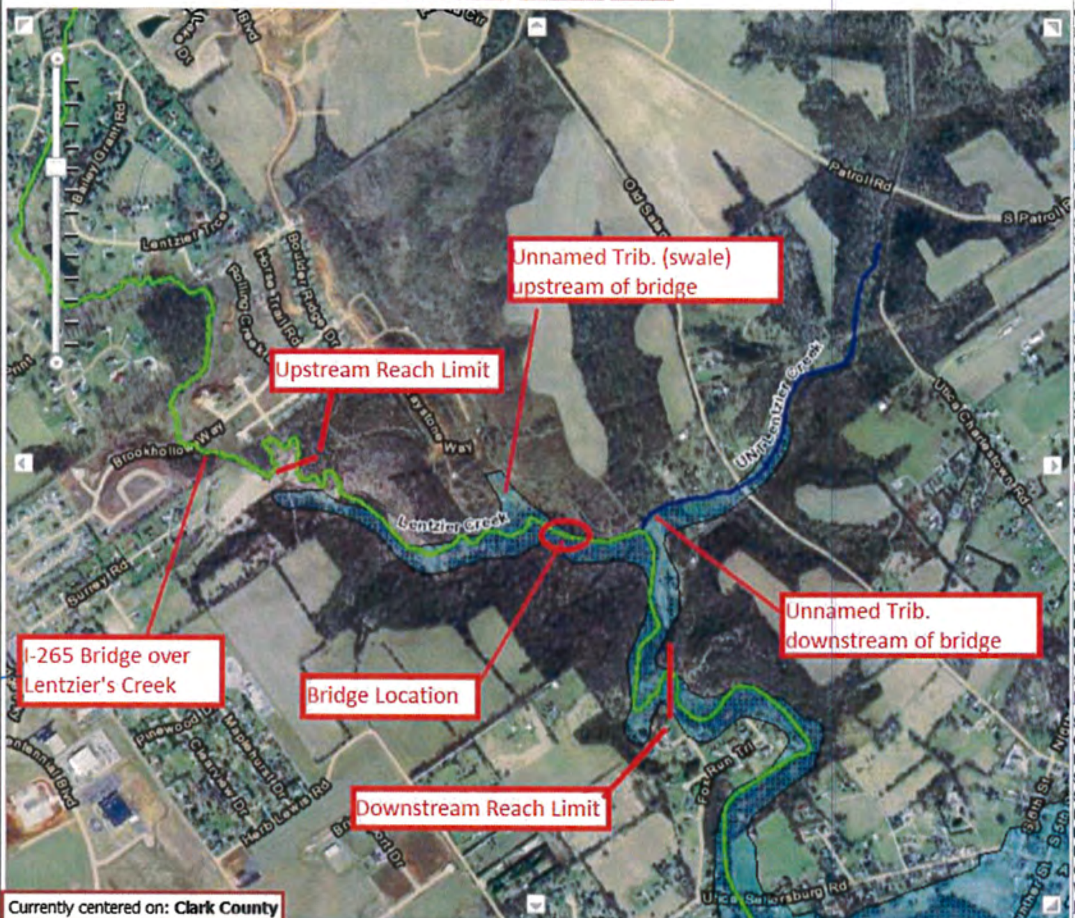
Have questions? Check out the Frequently Asked Questions tab.

Click and drag your mouse across the map to pan.

< Previous Tips | Next Tips >

Map | Frequently Asked Questions

Layers | Legend | Help



FW-26753

Stream Name: Lentzier Creek
County: Clark
Date : 05/11/1998
Study Type: FARA
Software: WSPRO
Model By:
Folder ID: GN-1764
Description: *No description available*
Download

Stream Name: Lentzier Creek
County: Clark
Date : 05/30/2002
Study Type: FARA
Software: HEC-RAS 3.0.1
Model By: Division of Water
Folder ID: GN-17090
Description: A proposed subdivision on a tract of land.
Download

Stream Name: Lentzier Creek
County: Clark
Date : 07/24/2002
Study Type: FARA
Software: HEC-RAS 3.0.1
Model By: Division of Water
Folder ID: GN-17590
Description: *No description available*
Download

Stream Name: Lentzier Creek
County: Clark
Date : 11/13/2001
Study Type: PERMIT
Software: HEC-RAS (version unknown)
Model By: null
Folder ID: FW-21357
Description: Three culverts will be constructed along the flow line of Lentzier Creek to provide access to a proposed residential subdivision located landward of the floodway.
Download

Stream Name: Lentzier Creek
County: Clark
Date : 02/07/2013
Study Type: PERMIT
Software: HEC-RAS 4.1.0
Model By: Parsons Transportation Group
Folder ID: FW-26753
Description: A total of three new bridges will be constructed over Lentzier Creek including I-265 Eastbound, I-265 Westbound, and the replacement of Brookhollow Way.
Download

W3C XHTML 1.0

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BY JNR DATE 2/24/14 SUBJECT Heavy Haul Road over Lentzier Cr. SHEET NO. ______ OF ______
CHKD BY NJK DATE 2/25/14 Permit Research JOB NO. 14-402

Permit FW-26753:

Proposed I-265 structures over Lentzier Creek (ORB project)

- Terminates upstream of Heavy Haul Crossing
  - Probably won't need to incorporate - verify w/ DNR

Permit FW-21357:

Structure to be replaced by ↑. Approved in 2001.

THIS IS NOT A PERMIT

Indiana Department of Natural Resources / Division of Water
Floodplain Analysis and Regulatory Assessment

File Number: BQ-29173-0
Request Date: 03/05/2014
County: Clark
Waterbody: Lentzier Creek

402 West Washington Street, Room W264
Indianapolis, IN 46204-2641
Telephone: (317) 232-4160 or (877) 928-3755
Fax: (317) 233-4579 Website: www.in.gov/dnr/water

Site Location: Approximately 5500' upstream (northwest) of the Utica-Sellersburg Road stream crossing, Utica Township, Grant: Clark Military Grant, 16

Discharge Recommendation: 1700 cfs (Q100)
Drainage Area: 5.3 square miles
Base Flood Elevation (BFE): Not Determined

Q500 = 1700 (1.4)
= 2380 cfs

1.4 Per IDM
Fig. 202-3C

Special Information
Division of Water Permitting

- Unless the bridge project meets the exemption criteria outlined below, approval of the DNR, Division of Water under the Flood Control Act (IC 14-28-1) is required for any construction in a floodway area including obstructing, filling, excavating, or building a structure. A provision which exempts certain bridge projects from permitting requirements under the Flood Control Act states: "A permit is not required for... a construction or reconstruction project on a state or county highway bridge in a rural area that crosses a stream having an upstream drainage area of ... 50 square miles or less ... "

  Therefore, in order for a bridge project to be exempt from the permit requirements, it must meet all of the following criteria:

  - be a state or county highway department project;
  - be a bridge (span structure, culverts, etc.);
  - be located in a rural area*; and
  - cross a stream having an upstream drainage area of less than 50 square miles

  * Rural area is defined as an area:
  1) where the lowest floor elevation, including a basement, of any residential, commercial, or industrial building impacted by the project is at least 2 feet above the base flood elevation with the project in place;
  2) located outside the corporate boundaries of a consolidated or an incorporated city or town; and
  3) located outside of the territorial authority for comprehensive planning (generally, a 2 mile planning buffer around a city or town)

  All construction associated with the rural bridge within the project right-of-way such as bank protection, spoil disposal, borrow pits, etc. are considered part of this exemption.

  This exemption has been grossly misunderstood and liberally applied in the past. As a result, the DNR, Division of Water is taking a firm stance on future violations. If challenged, it will be the responsibility of the person claiming the exemption to prove to the DNR, Division of Water that all 4 criteria have been satisfied. Failure to do so may result in the DNR, Division of Water initiating litigation with the potential for the imposition of fines.

  Note: This exemption only applies to the Flood Control Act (IC 14-28-1). If a bridge is to be constructed over a navigable waterway, or over or near a public freshwater lake, a permit may be required under the Navigable Waterways Act (IC 14-29-1), the Lowering of the Ten Acre Lake Act (IC 14-26-5) or the Lake Preservation Act (IC 14-26-2).

THIS IS NOT A PERMIT

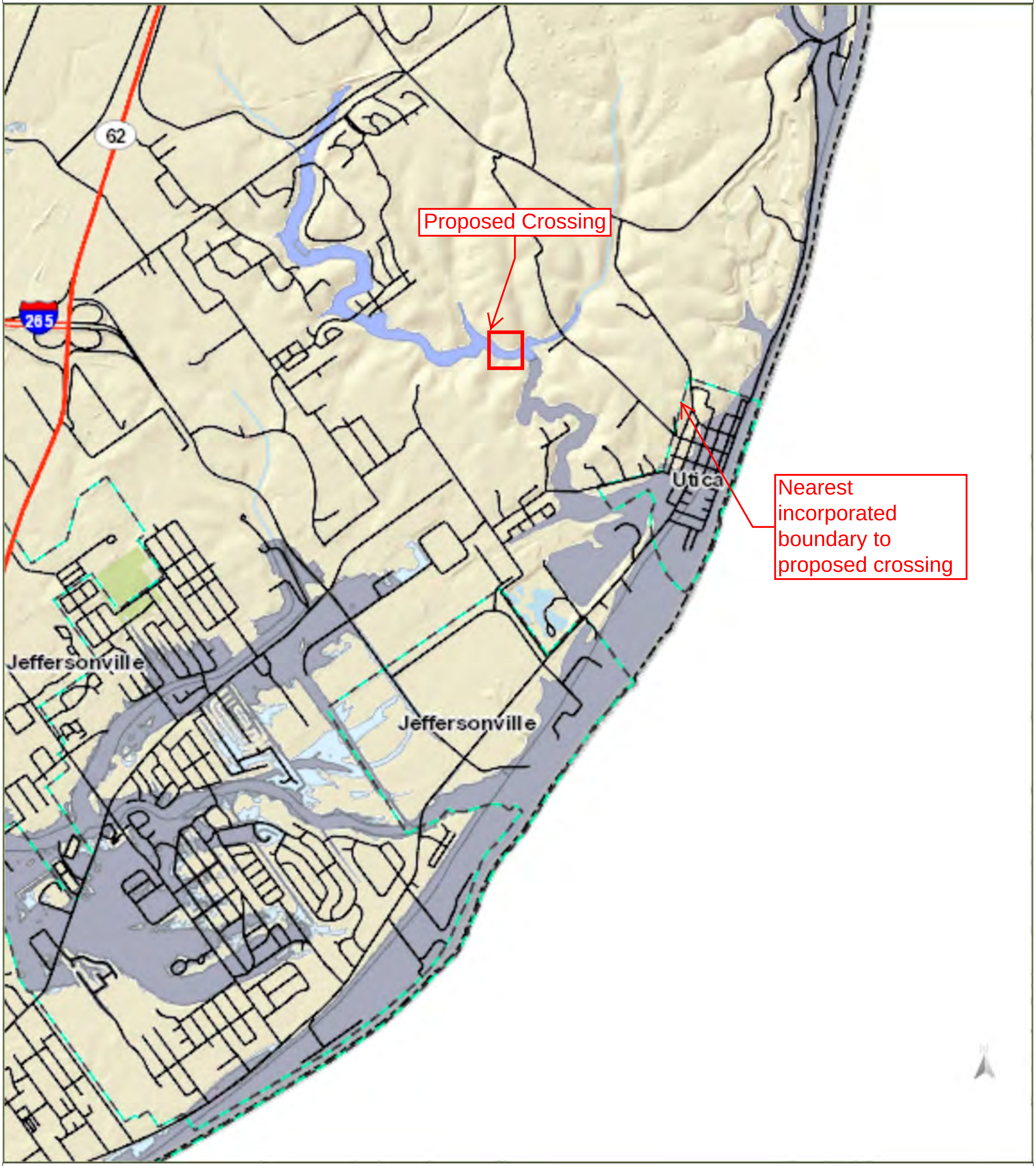
This Floodplain Analysis and Regulatory Assessment is not a building permit, approval of any project, or a waiver of provisions of local or zoning ordinances. Additionally, projects must comply with all other applicable federal, state, and local permit requirements.

If you have any questions concerning this letter, please contact Joseph D. Mapes, CFM at (317) 234-1049.

Joseph D. Mapes, CFM 03/05/2014

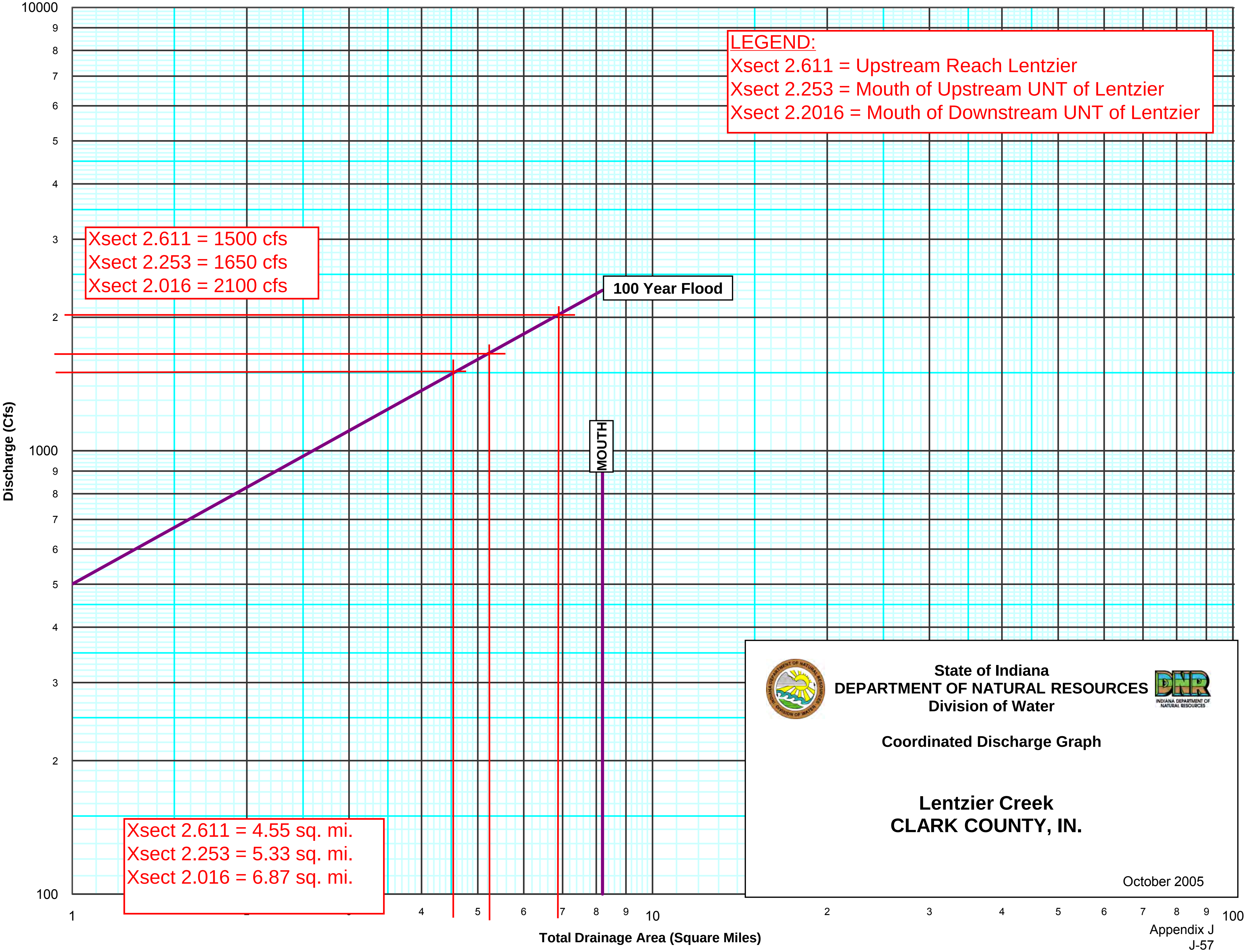
Copies Sent To: Jay N Ridens (Requestor)

Clark County, IN



Clark County GIS

Printed: 03/25/14



LEGEND:
Xsect 2.611 = Upstream Reach Lentzier
Xsect 2.253 = Mouth of Upstream UNT of Lentzier
Xsect 2.2016 = Mouth of Downstream UNT of Lentzier
Xsect 2.611 = 1500 cfs
Xsect 2.253 = 1650 cfs
Xsect 2.016 = 2100 cfs
100 Year Flood
MOUTH
Xsect 2.611 = 4.55 sq. mi.
Xsect 2.253 = 5.33 sq. mi.
Xsect 2.016 = 6.87 sq. mi.
Discharge (Cfs)
Total Drainage Area (Square Miles)
State of Indiana
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Coordinated Discharge Graph
Lentzier Creek
CLARK COUNTY, IN.
October 2005

Drainage Area of Lentzier Creek at the U/S Reach

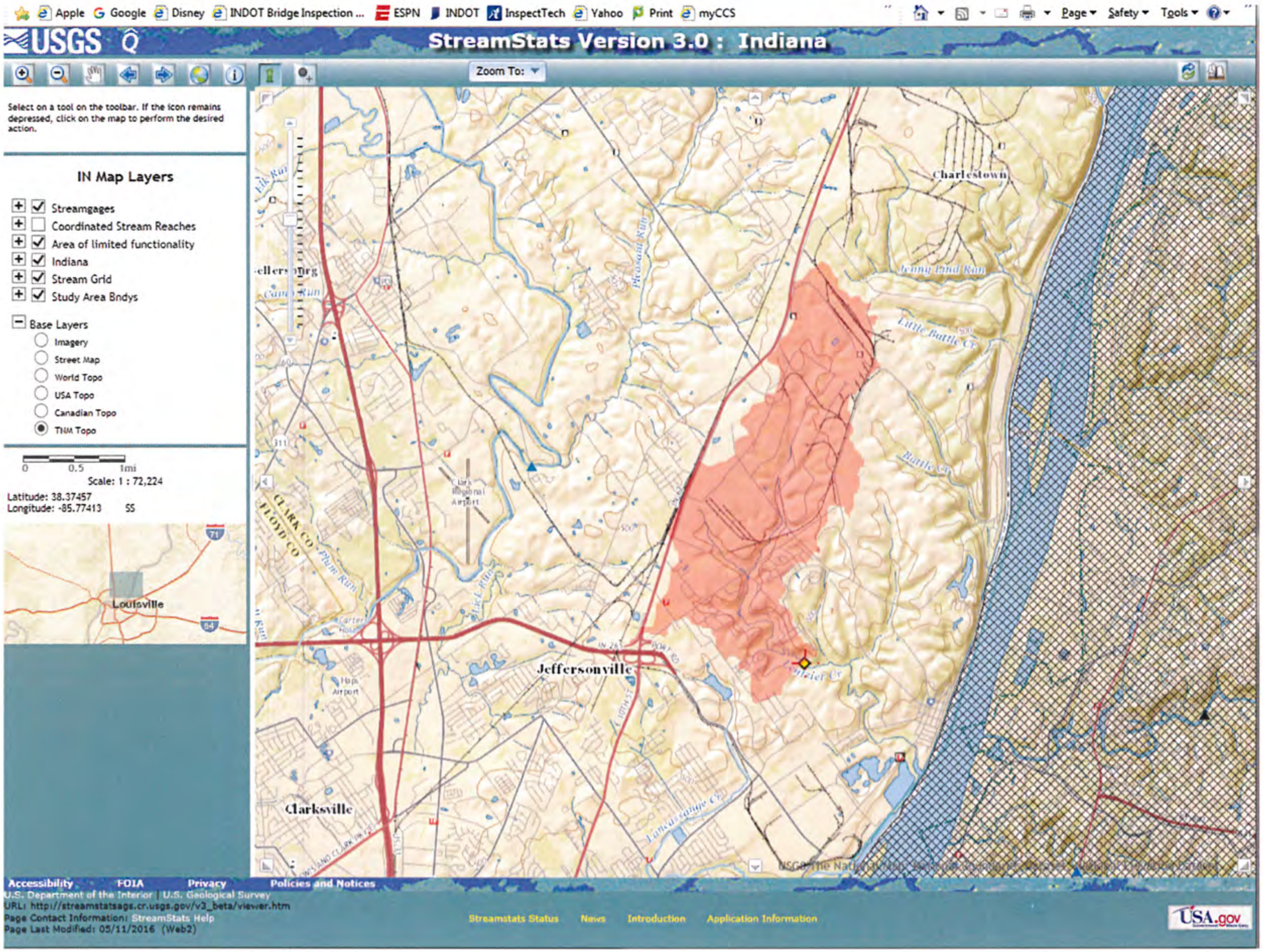
StreamStats Version 3.0

Basin Characteristics Ungaged Site Report

Date: Mon Nov 21, 2016 4:40:06 PM GMT-5
Study Area: Indiana
NAD 1983 Latitude: 38.3426 (38 20 33)
NAD 1983 Longitude: -85.676 (-85 40 34)

Label	Value	Units	Definition
DRNAREA	4.553	square miles	Area that drains to a point on a stream
CSL10_85	23.1	feet per mi	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known
HIGHREG	1007	dimensionless	High-Flow Hydrologic Region code
URBAN	9.15	percent	Percentage of basin with urban development
WETLAND	0.0382	percent	Percentage of Wetlands
CONTDA	4.553	square miles	Area that contributes flow to a point on a stream (total drainage area minus non-contributing areas within basin)
BFREGNO	1567		undefined
LC11IMP	8.15	percent	Average percentage of impervious area determined from NLCD 2011 impervious dataset
LC11DEV	32.7	percent	Percentage of developed (urban) land from NLCD 2011 classes 21-24

Drainage Area of Lentzier Creek at the U/S Reach



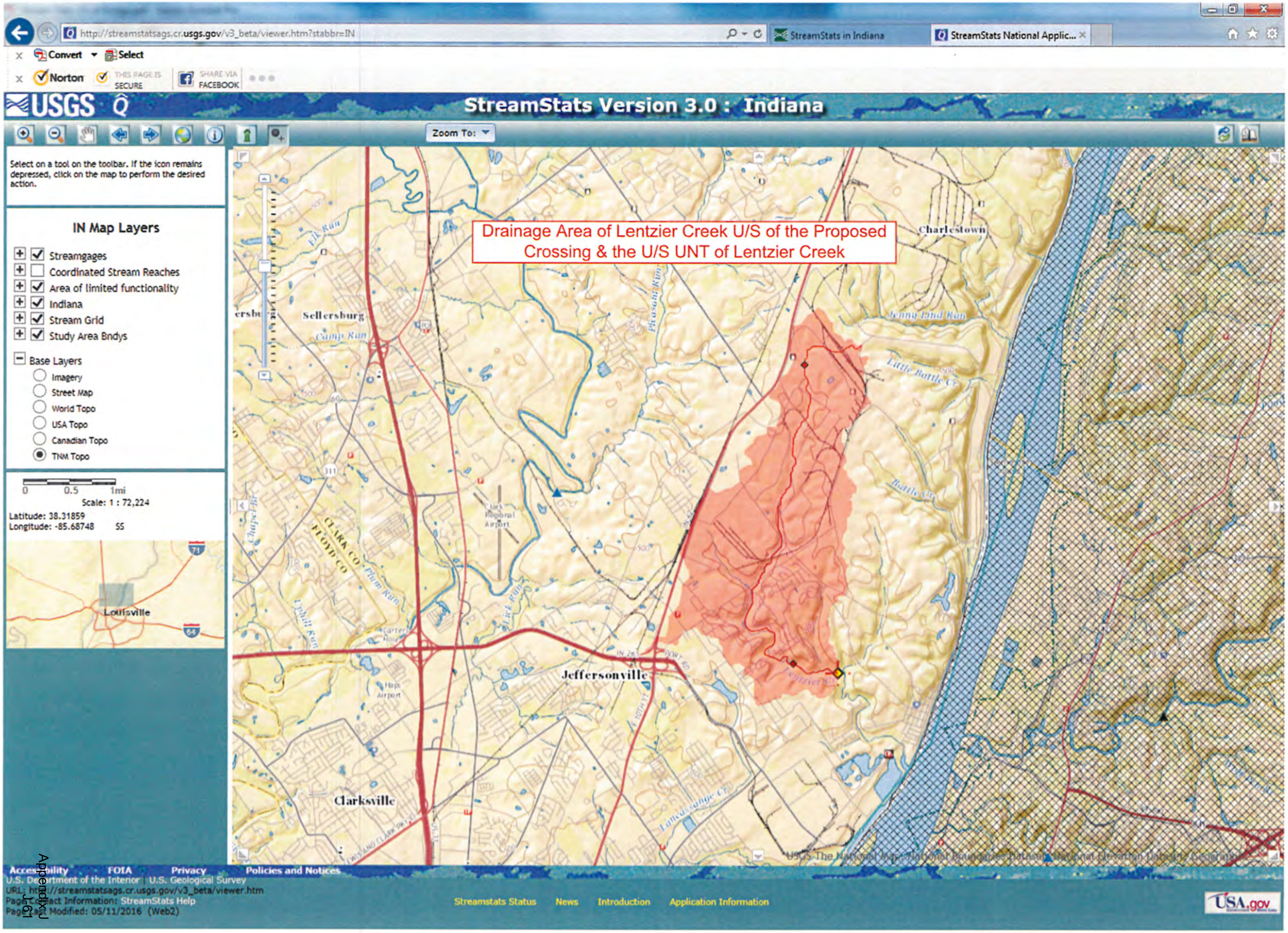
Drainage Area of Lentzier Creek U/S of the Proposed Crossing & the U/S UNT of Lentzier Creek

StreamStats Version 3.0

Basin Characteristics Ungaged Site Report

Date: Sat Nov 5, 2016 8:25:49 AM GMT-4
Study Area: Indiana
NAD 1983 Latitude: 38.342 (38 20 31)
NAD 1983 Longitude: -85.6688 (-85 40 08)

Label	Value	Units	Definition
DRNAREA	5.328	square miles	Area that drains to a point on a stream
CSL10_85	22.5	feet per mi	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known
HIGHREG	1007	dimensionless	High-Flow Hydrologic Region code
URBAN	7.87	percent	Percentage of basin with urban development
WETLAND	0.0326	percent	Percentage of Wetlands
CONTDA	5.328	square miles	Area that contributes flow to a point on a stream (total drainage area minus non-contributing areas within basin)
BFREGNO	1567		undefined
LC11IMP	7.26	percent	Average percentage of impervious area determined from NLCD 2011 impervious dataset
LC11DEV	30.6	percent	Percentage of developed (urban) land from NLCD 2011 classes 21-24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SHARE VIA FACEBOOK
USGS
StreamStats Version 3.0 : Indiana
Zoom To:
Select on a tool on the toolbar. If the icon remains depressed, click on the map to perform the desired action.
IN Map Layers
Streamgages
Coordinated Stream Reaches
Area of limited functionality
Indiana
Stream Grid
Study Area Bndys
Base Layers
Imagery
Street Map
World Topo
USA Topo
Canadian Topo
TNM Topo
0
0.5
1mi
Scale: 1 : 72,224
Latitude: 38.31859
Longitude: -85.68748
SS
Louisville
Drainage Area of Lentzier Creek U/S of the Proposed Crossing & the U/S UNT of Lentzier Creek
Charlestown
Sellersburg
Camp Run
Elk Run
Pleasant Run
Jenny Lind Run
Little Battle Cr
Battle Cr
Clark Regional Airport
CLARK CO
FLOYD CO
Plum Run
Lick Run
Uphill Run
Jeffersonville
Clarksville
Lancassange Cr
Accessibility
FOIA
Privacy
Policies and Notices
U.S. Department of the Interior | U.S. Geological Survey
URL: http://streamstatsags.cr.usgs.gov/v3_beta/viewer.htm
Page Contact Information: StreamStats Help
Page Last Modified: 05/11/2016 (Web2)
Streamstats Status
News
Introduction
Application Information
USA.gov

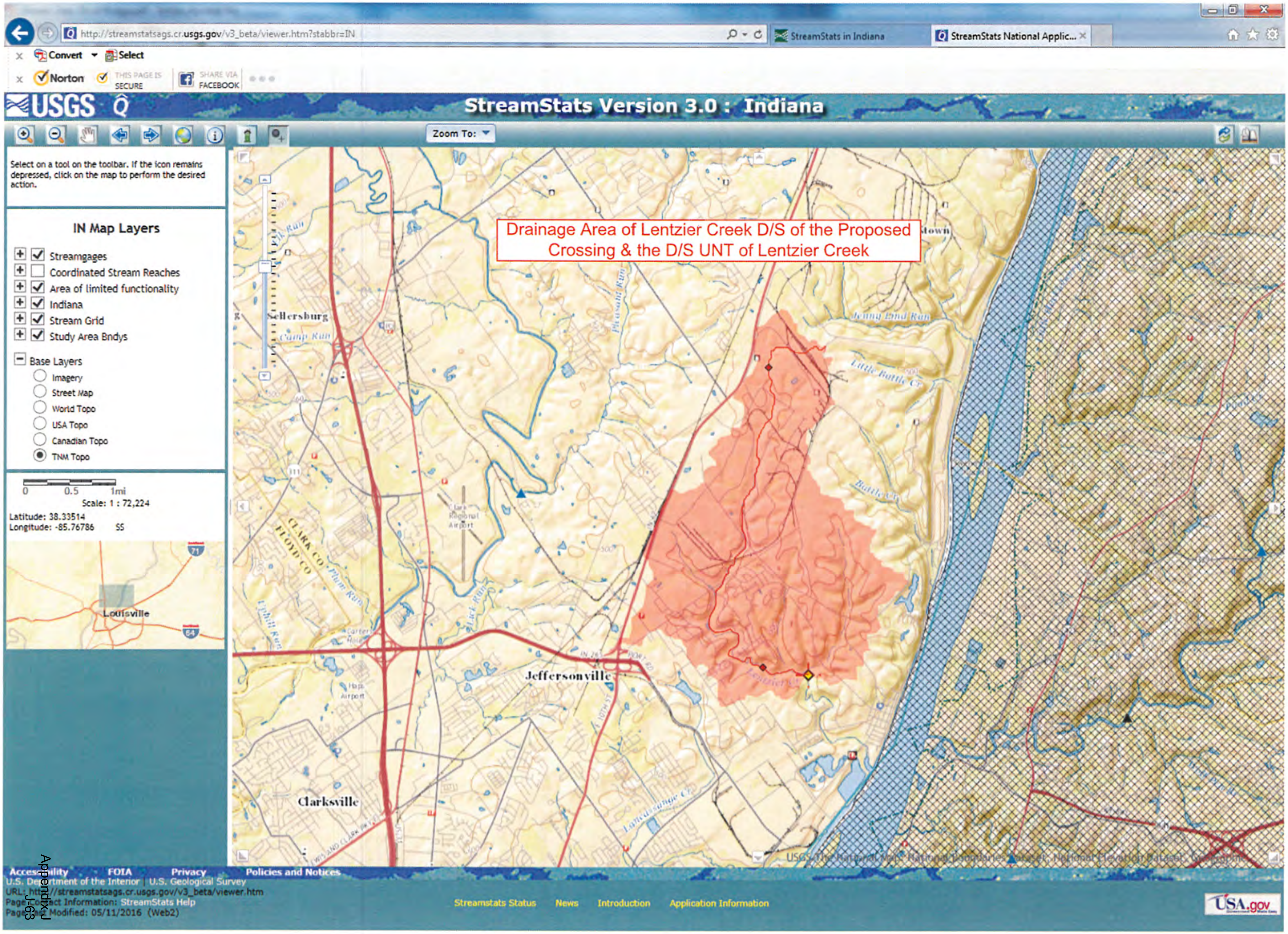
Drainage Area of Lentzier Creek D/S of the Proposed Crossing & the D/S UNT of Lentzier Creek

StreamStats Version 3.0

Basin Characteristics Ungaged Site Report

Date: Sat Nov 5, 2016 8:12:28 AM GMT-4
Study Area: Indiana
NAD 1983 Latitude: 38.3419 (38 20 31)
NAD 1983 Longitude: -85.6673 (-85 40 03)

Label	Value	Units	Definition
DRNAREA	6.874	square miles	Area that drains to a point on a stream
CSL10_85	22.4	feet per mi	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known
HIGHREG	1007	dimensionless	High-Flow Hydrologic Region code
URBAN	6.24	percent	Percentage of basin with urban development
WETLAND	0.0253	percent	Percentage of Wetlands
CONTDA	6.874	square miles	Area that contributes flow to a point on a stream (total drainage area minus non-contributing areas within basin)
BFREGNO	1567		undefined
LC11IMP	5.67	percent	Average percentage of impervious area determined from NLCD 2011 impervious dataset
LC11DEV	24.3	percent	Percentage of developed (urban) land from NLCD 2011 classes 21-24


http://streamstatsags.cr.usgs.gov/v3_beta/viewer.htm?stabbr=IN
StreamStats in Indiana
StreamStats National Applic...
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USGS
StreamStats Version 3.0 : Indiana
Zoom To:
Select on a tool on the toolbar. If the icon remains depressed, click on the map to perform the desired action.
IN Map Layers
Streamgages
Coordinated Stream Reaches
Area of limited functionality
Indiana
Stream Grid
Study Area Bndys
Base Layers
Imagery
Street Map
World Topo
USA Topo
Canadian Topo
TNM Topo
0
0.5
1mi
Scale: 1 : 72,224
Latitude: 38.33514
Longitude: -85.76786
Louisville
Drainage Area of Lentzier Creek D/S of the Proposed Crossing & the D/S UNT of Lentzier Creek
Sellersburg
Camp Run
Jenny Lind Run
Little Battle Cr
Battle Cr
CLARK CO
FLOYD CO
Plum Run
Lick Run
Jeffersonville
Clarksville
Accessibility
FOIA
Privacy
Policies and Notices
U.S. Department of the Interior | U.S. Geological Survey
URL: http://streamstatsags.cr.usgs.gov/v3_beta/viewer.htm
Page Contact Information: StreamStats Help
Page Last Modified: 05/11/2016 (Web2)
Streamstats Status
News
Introduction
Application Information
USA.gov

watershed storage, or a very large drainage basin. This method is also used for design of a detention/retention pond or storage facility.

3. HEC-HMS. This hydrograph method can be used under the same conditions shown above for TR-20.

4. IDNR Letter of Discharge. The IDNR Letter of Discharge must be requested for a structure that requires a Construction in a Floodway Permit.

5. IDNR Coordinated Discharge Curves. This is the preferred method for a stream for which the information is available. The reference is *Coordinated Discharges of Selected Streams in Indiana*. It also appears on the IDNR-Water website.

6 Streamstats. This method can be used in conjunction with other methods. This method is valuable for setting parameters or justification as to what the appropriate discharge can be.

7. Frequency Analysis of Stream-Gaging Records. This method is considered to have high confidence on a larger watershed for which data is available, since it involves real-time data. The USGS, and the IDNR Division of Water, maintain a database of discharges for various frequencies computed using methodologies included in Water Resources Council Bulletin 17B.

8. Purdue Regression Equations. This method can be used in a rural area for estimating if no other method is available.

9. FEMA. The 1% exceedance probability specified in the applicable FEMA flood-insurance study should be used to analyze impacts of a proposed crossing on a regulatory floodway. However, if the discharge is considered outdated, the discharge based on current methods can be used subject to receiving the necessary regulatory approvals.

202-3.03 Q_{500} Determination for Scour Calculations [Added Feb. 2014]

The following methods, listed by preference, should be used to determine the Q_{500} for scour calculations.

1. Discharge published in a FEMA Flood Insurance Study (FIS). If there is a 0.2% annual EP discharge published by FEMA in a FIS, this discharge should take precedence over any other methodology. No published FIS (3/24/14)

NJK 3/24/14

2. Discharge derived from a coordinated discharge curve. The 0.2% annual EP discharge can be estimated by extrapolation from the Coordinated Discharge curves, using the following technique:

   a. Find the drainage area of the stream at the site of interest, and then determine the 10, 25, 50, and 100 year peak values from the graph.
   b. Plot these values on a semi log graph, with the peak discharge on the normal(y) axis, and the inverse of the return interval on the log (x) axis.
   c. Fit a straight line between these points, and the use the equation to derive a value at 0.002 (0.2%).

   No Q10, Q25, Q50 coordinated discharge curves.

   See Figure 202-3B for an example.

3. Use a multiplier of the 1% annual EP discharge. If there are no discharges published in the FIS or in a coordinated discharge curve, then the 0.2% annual EP discharge can be derived from the 1% annual EP discharge by use of a multiplier, which varies by region. The different regions and the relevant multiplier are shown in Figure 202-3C. A GIS shape file is also available for download from the Department's Editable Documents page.

202-3.04 Selection of Discharge for Pump Station

The federal design criteria shown in HEC-24, *Highway Stormwater Pump Station Design*, should be followed for a pump station. The hydrological considerations shown in of HEC-24 Sections 5.3 through 5.5 should be utilized.

202-3.05 Selection of Methods Table

See Figure 202-3A for the typical methods choices based on facility.

202-4.0 DOCUMENTATION FOR HYDROLOGY

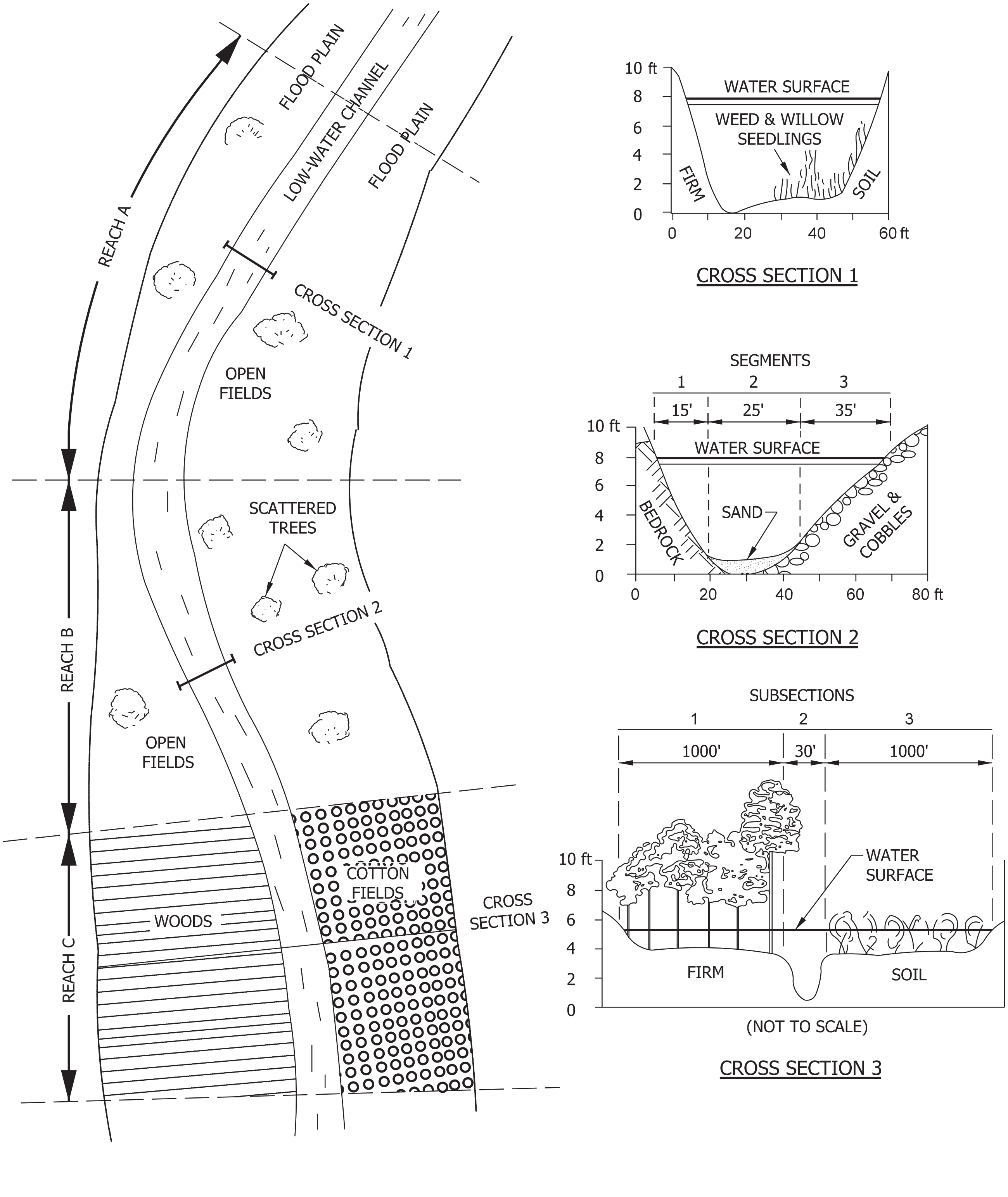
The following provides an explanation of the submittal requirements for a hydraulic report as it pertains to hydrology. See Chapter 203 for a list what should be included in the hydraulic report.

NJK 3/24/14

REGIONAL MULTIPLIERS FOR DETERMINATION OF 0.2% ANNUAL EP

Figure 202-3C

Back



HYPOTHETICAL CROSS SECTION SHOWING REACHES, SEGMENTS, AND SUBSECTIONS USED IN ASSIGNING n VALUES

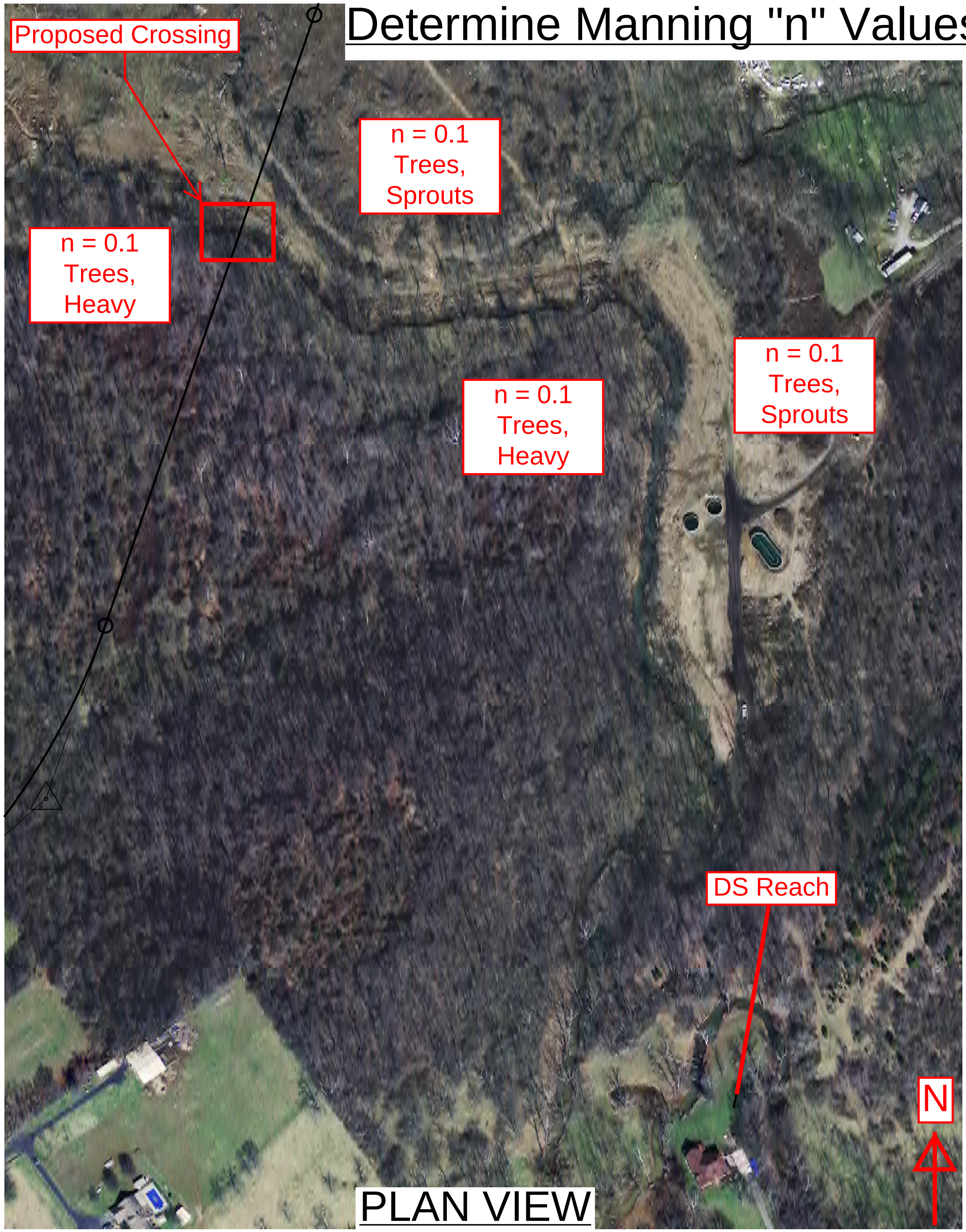
Figure 203-6B

Back

Determine Manning "n" Values

PLAN VIEW

Determine Manning "n" Values



PLAN VIEW

Type of Channel and Description	Minimum	Normal	Maximum
EXCAVATED OR DREDGED			
1. Earth, Straight and Uniform	0.016	0.018	0.020
a. Clean, recently completed	0.018	0.022	0.025
b. Clean, after weathering	0.022	0.025	0.030
c. Gravel, uniform section, clean	0.022	0.027	0.033
2. Earth, Winding and Sluggish			
a. No vegetation	0.023	0.025	0.030
b. Grass, some weeds	0.025	0.030	0.033
c. Dense weeds or aquatic plants in deep channel	0.030	0.035	0.040
d. Earth bottom and rubble sides	0.025	0.030	0.035
e. Stony bottom and weedy sides	0.025	0.035	0.045
f. Cobble bottom and clean sides	0.030	0.040	0.050
3. Dragline, Excavated or Dredged			
a. No vegetation	0.025	0.028	0.033
b. Light brush on banks	0.035	0.050	0.060
4. Rock Cut			
a. Smooth and uniform	0.025	0.035	0.040
b. Jagged and irregular	0.035	0.040	0.050
5. Channel Not Maintained, Weeds and Brush Uncut			
a. Dense weeds, high as flow depth	0.050	0.080	0.120
b. Clean bottom, brush on sides	0.040	0.050	0.080
c. Clean bottom, highest stage of flow	0.045	0.070	0.110
d. Dense brush, high stage	0.080	0.100	0.140
NATURAL STREAM			
1. Minor Stream (top width at flood stage < 100 ft)			
a. Stream on plain			
(1) Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
(2) Same as above, but more stones or weeds	0.030	0.035	0.040
(3) Clean, winding, some pools or shoals	0.033	0.040	0.045
(4) Same as above, but some weeds or stones	0.035	0.045	0.050
(5) Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
(6) Same as (4), but more stones	0.045	0.050	0.060
(7) Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
(8) Very weedy reaches, deep pools, or floodway with heavy stand of timber and underbrush	0.075	0.100	0.150

Back

Type of Channel and Description	Minimum	Normal	Maximum
NATURAL STREAM (contd.)			
1. Minor Stream (contd.)			
b. Mountain stream, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
(1) Bottom: gravel, cobbles, and few boulders	0.030	0.040	0.050
(2) Bottom: cobbles with large boulders	0.040	0.050	0.07
2. Floodplain			
a. Pasture, no brush			
(1) Short grass	0.025	0.030	0.035
(2) High grass	0.030	0.035	0.050
b. Cultivated area			
(1) No crop	0.020	0.030	0.040
(2) Mature row crops	0.025	0.035	0.045
(3) Mature field crops	0.030	0.040	0.050
c. Brush			
(1) Scattered brush, heavy weeds	0.035	0.050	0.070
(2) Light brush and trees, in winter	0.035	0.050	0.060
(3) Light brush and trees, in summer	0.040	0.060	0.080
(4) Medium to dense brush, in winter	0.045	0.070	0.110
(5) Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
(1) Dense willows, in summer, straight	0.110	0.150	0.200
(2) Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
(3) Same as above, but with heavy growth of sprouts	0.050	0.060	0.080
(4) Heavy stand of timber, a few downed trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
(5) Same as above, but with flood stage reaching branches	0.100	0.120	0.160
3. Major Stream (top width at flood stage > 100 ft). The *n* value is less than that for a minor stream of similar description, because banks offer less effective resistance.			
a. Regular section with no boulders or brush	0.025	n/a	0.060
b. Irregular and rough section	0.035	n/a	0.100

Source: Chow, V.T.

VALUES OF MANNING'S *n* FOR UNIFORM FLOW, Figure 203-3A

Back

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Supplemental Support Information

21. The proposed structure's span should be equal to or greater than the existing span unless prior approval is given from the Office of Hydraulics.

203-3.03 Design Procedure and Criteria

203-3.03(01) Bridge Sizing

The following criteria are required for hydraulic bridge sizing.

✓ 1. Design-Storm Frequency. Figure 203-2C should be used to determine the appropriate storm event for design. It shows the design-storm requirements for allowable backwater, outlet velocity, and road-serviceability freeboard. Use 1% (Q100) for 2 Lane AADT > 3,000

✓ 2. Allowable Backwater. This is the difference caused by a bridge between the upstream water-surface elevation and the natural condition with no bridge at the same location. The backwater is the maximum proposed bridge value that occurs at a given cross-section location. The design-storm requirements are shown in Figure 203-2C.

   If the existing bridge has a backwater of greater than 1 ft, the proposed bridge has an allowable backwater equal to or less than 1 ft. If the existing bridge has a backwater less than or equal to 1 ft., the proposed bridge has an allowable backwater equal to or less than the backwater of the existing bridge. If the proposed bridge is on new alignment, the allowable backwater is 0.14 ft. For exceptions, see item 10 below. Proposed is 0.12'

   FHWA does not require economic justification for a bridge that causes less than 1 ft. of backwater. Therefore, a formal risk assessment will not be required.

✓ 3. Outlet Velocity. The design-storm frequency shown in Figure 203-2C should be used to determine the appropriate storm event for design. Figure 203-2D should be used to determine the appropriate riprap size based on outlet velocity. < 6.5 fps ⇒ Revetment along abutments

✓ 4. Road-Serviceability Freeboard. The headwater elevation from the bridge should maintain a road-serviceability freeboard to the edge of pavement based on the facility level shown in Figure 203-2C. If the facility level allows, embankment overtopping may be incorporated into the design, but should be located away from the bridge abutments and superstructure. The required road serviceability should be maintained throughout the entire flood reach of the stream. A larger downstream waterway should be checked to determine if its floodwaters can backwater through the system and affect road serviceability. If this potential exists, a joint-stream probability analysis should be performed to check the correct storm events that should be analyzed for potential road overtopping. See Figure 203-2G. The joint-stream probability analysis is based on the peak discharges of both the design stream and the larger downstream waterway occurring at different times. The analysis compares the streams at different storm designs based on their difference in drainage area. OK, rdwy profile/alignment controls bridge

✓ 5. Structure Freeboard. Where practical, a minimum clearance of 2 ft should be provided between the Q_{100} elevation and the low chord of the bridge to allow for passage of ice and debris. Where this is not practical, the clearance should be established based on the type of stream and level of protection desired as approved by the Office of Hydraulics. For example, 1 ft should be adequate for a small stream that normally does not transport drift. An urban bridge with a grade limitation can provide no freeboard. A 3-ft freeboard is desirable for a major river which is known to carry large debris. The crest vertical-curve profile is the preferred highway crossing profile in allowing for embankment overtopping at a lower discharge. OK, rdwy profile/alignment controls bridge.

✓ 6. Span Lengths. Where possible, a single-span bridge is desired in lieu of a multi-span bridge, though this may sacrifice desired structure freeboard. The minimum span length for a bridge with more than three spans should be 100 ft for those spans over the main channel. A three-span bridge should have the center span length maximized at a site where debris can be a problem. For a two-span bridge, span lengths are subject to approval of the Office of Hydraulics. Needed 3 span bridge for hydraulic opening. Center span is > 100'

✓ 7. Channel Clearing. This consists of the removal of sediment to enlarge the waterway opening. Channel clearing should not occur within 1 ft of the Ordinary High Water elevation. Where the Ordinary High Water elevation is less than 1 ft above the flowline elevation, channel clearing should not occur within 2 ft of the flowline elevation. Did not consider due to unknown rock depth

N/A 8. Multiple-Opening Structure. A multiple-opening structure is used in a wide floodplain to pass a portion of the flow once the stream reaches a certain stage. The objectives in choosing the location of a multiple opening include the following:

a. maintenance of flow distribution and flow patterns;
b. accommodation of relatively large flow concentrations on the floodplain;
c. avoidance of floodplain flow along the roadway embankment for a long distance;
d. crossing of significant tributary channels; and
e. possible reduction of the size of the main bridge and the overall cost of the project.

The technological weakness in modeling a multiple opening is in the use of a one-dimensional model, such as HEC-RAS, to analyze two-dimensional flow. The development of a two-dimensional model, such as FESWMS, is a step toward more-adequate analysis of a complex stream-crossing system. The most complex factor in designing a multiple opening is determining the division of flow between two or more structures. If incorrectly proportioned, one or more of the structures can be overtaxed during a flood event. The design of a multiple opening should be generous to guard against that possibility.

N/A 9. Temporary-Runaround Structure. A temporary-runaround structure is typically operational for three months to two years. Therefore, the serviceability criteria are greatly reduced. At a minimum, such a structure should be serviceable during a 50% annual EP discharge.

Figure 203-2C should be checked to determine the road-serviceability design storm required. The edge of pavement should be above the headwater elevation of the required design storm.

The backwater should be determined for the 1% annual EP discharge event. For a structure requiring an IDNR permit, the backwater at 1% annual EP should not exceed 0.14 ft over existing conditions. IDNR should be contacted for further guidance. For a structure not requiring an IDNR permit, the backwater from the 1% annual EP event should not exceed 1 ft below the finished-floor elevations of nearby buildings or residences. Impacts to crops and yards should be allowed for only a short duration.

The most cost-efficient temporary-runaround structure is achieved by lowering the roadway profile as much as possible while still obtaining the required road serviceability.

✓ 10. New-Alignment Bridge. For a new bridge on a new alignment, the maximum backwater should not exceed 0.14 ft. The 0.14 ft maximum may be modified as follows:

Proposed backwater is ≤ 0.14'

a. the backwater dissipates to 0.14 ft or less at the right-of-way line;
b. the channel is sufficiently deep to contain the increased water height without overtopping the banks; the backwater is less than or equal to 1 ft; and the maximum velocity is not excessive; or
c. a flood easement can be purchased upstream of the bridge to allow for greater than 0.14 ft of backwater.

In a rural area where land costs are minimal, the cost savings may be substantial to purchase flood easements and reduce the bridge-structure size. The use of flood easements should be identified early in the design stage so that they can be included in any land purchasing. However, flood easements are still limited to the maximum 1-ft backwater requirement.

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An exception to the 0.14-ft backwater allowance for a new bridge on a new alignment is subject to approval of The Office of Hydraulics.

✓ 11. Bridge that Requires an IDNR CIF Permit. The water-surface elevation cannot be increased more than 0.14 ft from existing conditions outside the right of way. The IDNR *Floodplain Guidelines Manual* should be checked to determine if a CIF permit is required, and for the definition of what the existing or base conditions are.

Proposed W.S. elev. is < 0.14'

203-3.03(02) Bridge-Hydraulics Modeling

The regulatory agencies require the use of computer hydraulic-modeling software to support calculations used in flood modeling. The required modeling program is HEC-RAS. The HEC-RAS procedures are followed as stated in the IDNR manual, *General Guidelines for the Hydrologic-Hydraulic Assessment of Floodplains in Indiana*, or *Floodplain Guidelines*, and the USACE HEC-RAS manuals. The following should be considered in performing a HEC-RAS model.

Survey used for xsections at bridge (4, 3, Br. U, Br. D, 2, 1)

✓ 1. Survey Accuracy. A survey is performed for the purpose of bridge or road design. However, the survey does not always extend far enough up- and downstream to cover the entire reach used in hydraulic-modeling design. It may be necessary to propagate the last cross-section up- and downstream as necessary to extend to the full reach length desired. If available, some county, city, or USGS maps include contours that can be useful in determining the cross-section shape outside the general project survey area. These tend to be most useful in sizing the flood plain. Current aerial photography should be used where current land uses may have changed from the original survey, such as new levees, structures, etc. Other available types of mapping should be discussed with the Office of Hydraulics prior to use. The hydraulic model should have adjusted the survey to the NAVD 88 datum. The *Floodplain Guidelines* Chapters 4 and 5 provide information on survey and mapping requirements. Xsect. from DNR HEC-RAS Model, Assumed Xsect's created from LIDAR which gave top of water, therefore, flowline adjusted

✓ 2. Cross-Sections and Ineffective Flow. The cross-sections should extend far enough up- and downstream to include areas that can affect the water surface as it passes through the bridge of interest. This can include other downstream bridges or structures that can have potential backwater effects to the bridge of interest. The beginning cross-section should be the same for natural, existing, and proposed conditions for the same discharge. The ending cross-section should show a decline in backwater converging back towards the natural water-surface elevation. There are no structures U/S or D/S w/in reach.

The individual cross-sections should have data points that extend higher than the water-surface elevation at its extents. Extending the cross-sections beyond the water-surface ✓

elevation can affect the scale of the cross-section so that the channel itself is difficult to visualize in the model display. The cross-sections should be chosen at appropriate locations that are perpendicular to the channel. However, the overbank section may have to be manipulated so that two cross-sections do not overlap. If possible, scour holes and large sediment mounds near the bridge should be avoided as cross-section locations. If such a location is necessary, manipulation of the flowline may be necessary to avoid large rises and drops.

See *Floodplain Guidelines* Chapter 8 for more information on modeling. For the appropriate roughness *n* value, see Figure 203-3A.

DNR Model roughness values were compared to site photos and figure 203-3A

3. Bridge. In HEC-RAS, a bridge automatically uses the adjacent cross sections in the modeling. It may be necessary to investigate the internal cross-sections to make changes for channel clearing or lowering the channel's *n* value through the bridge. The bridge should be modeled such that is normal to the direction of flow. This can be done manually or by using the skew function. Xsections based on survey were used for the bridge's internal cross-sections. The bridge was modeled normal to the direction of flow.
4. Check-RAS. - Check-RAS is a separate program that can be used in conjunction with HEC-RAS to help determine if errors occurred during the modeling procedure.

203-3.03(03) Scour

Scour is the most common cause of bridge failure. Therefore, potential scour problems should be recognized. The appropriate countermeasures should be used as necessary to improve bridge safety. HEC-18 and HEC-20 are FHWA documents that provide information and appropriate analysis procedure for determining scour. The scour can be computed using hand calculations from HEC-18, or by using the bridge modeling from HEC-RAS.

The types of scour that are used in bridge-hydraulics calculations include contraction, pier or local, and abutment. Only contraction and pier scour should be computed. Abutment scour is accounted for, due to riprap protection required at each abutment. Abutment scour has been shown to be overestimated.

For a new or replacement bridge, the scour should be computed for both the 1% annual EP and 0.2% annual EP. The 0.2% annual EP discharge should not be computed using the traditional 1.7 multiplier of the 1% annual EP discharge method, as this has typically overestimated scour and increased foundation costs. The 0.2% annual EP discharge should be determined using the same methods described in Chapter 202 as used to determine other storm events. Scour countermeasures are not required, as all bridge pier piles will be driven below the low-scour elevation. However, the embankment should have appropriately-sized riprap placed on it in a cone shape around the

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203-3.03(05) Pressure-Flow Scour

With pressure flow, the local scour depth at a pier or abutment is larger than for free-surface flow with a similar depth and approach velocity. The increase in local scour at a pier subject to pressure flow results from the flow being directed downward toward the bed by the superstructure and by increasing the intensity of the horseshoe vortex. The vertical contraction of the flow is a more significant cause of the increase in scour depth. However, where a bridge becomes submerged, the average velocity under it is reduced due to a combination of additional backwater caused by the bridge superstructure impeding the flow, and a reduction of discharge which must pass under the bridge due to weir flow over the bridge and approach embankments. As a consequence, an increase in local scour due to pressure flow can be offset by a lesser velocity through the bridge opening due to increased backwater, and a reduction in discharge due to overtopping.

In using HEC-RAS in a pressure-flow scenario, the program usually will not determine some variables, such as the average flow depth at the bridge for contraction scour. They should be entered manually.

HEC-RAS can be used to determine the discharge through the bridge and the velocity of approach and depth upstream of the piers where flow impacts the bridge superstructure. These values should be used to calculate local pier scour. Engineering judgment should then be used to determine the appropriate multiplier times the calculated pier-scour depth for the pressure-flow scour depth. This multiplier ranges from 1.0 for a low-approach Froude number Fr = -0.1, to 1.6 for a high-approach Froude number, Fr = 0.6. If the bridge is overtopped, the depth to be used in the pier-scour equations and for computing the Froude number is the depth to the top of the bridge deck or guardrail obstructing the flow. Research sponsored by FHWA has a listed procedure for three separate pressure-flow situations. See FHWA-HRT-09-041 October 2009 for more information on this process.

203-3.04 Determination of Hydraulic- and Scour-Data Parameters

The method used to determine the hydraulic- and scour-data parameters using HEC-RAS is described below. The parameters should be shown for both existing and proposed conditions where applicable.

✓ 1. Hydraulic Data.

   ✓ a. Drainage Area. The drainage area is the delineated area that drains to the structure in question. See Chapter 202. DNR Discharge letter; verified w/ StreamStats.

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b. Q_{100}. The 1% annual EP discharge should be determined using the methods described in Chapter 202. Used coordinated discharge graph; verified w/ DNR letter

c. Q_{100} Elevation. This elevation is determined for natural conditions at the downstream face of the bridge. If using HEC-RAS, this can be determined by using interpolated sections between the adjacent bridge sections in natural conditions to the downstream bridge face. (See Appendix "C")

d. Q_{100} Headwater Elevation. This elevation is determined for the proposed conditions at the closest upstream cross section from the bridge. This information is used so that the reviewer can check road-serviceability requirements across the entire floodplain and watershed. at XSect. 2.204, El. = 453.26

e. Gross Waterway Area Opening Below Q_{100} Elevation. The required area is determined by using the Q_{100} natural water surface elevation at the downstream bridge face. Since this is to be the gross area, the flow-area output from HEC-RAS, which is net area, should include the piers and adjusted flow-area water-surface elevation to the Q_{100} elevation. The gross waterway area should be taken in a direction parallel to the flow. (See Appendix "C")

N/A f. Road-Overflow Area. This is the actual flow area that will go over the road. This is not based on the Q_{100} elevation. It should use the approach-crest elevation along with the road profile to determine the area.

g. Q_{100} Velocity. This is the outlet velocity at the downstream face of the bridge as it exits the structure. This is shown in the HEC-RAS Bridge Output as velocity for the downstream side of the bridge. No other adjustments should be made, and the continuity equation should not be used. The outlet velocity is the average velocity across the whole structure. (See Appendix "C")

h. Minimum Low-Structure Elevation. The low-structure elevation should be taken at the lowest elevation point along the bottom of a beam, slab, or concrete flat section under the bridge. If the structure is an arch, the low-structure elevation is at the top inside of the arch structure. Low-structure elev. is estimated, but well above Q100.

i. Skew. The bridge skew is offset from the perpendicular to the roadway centerline. $\theta = 45°$

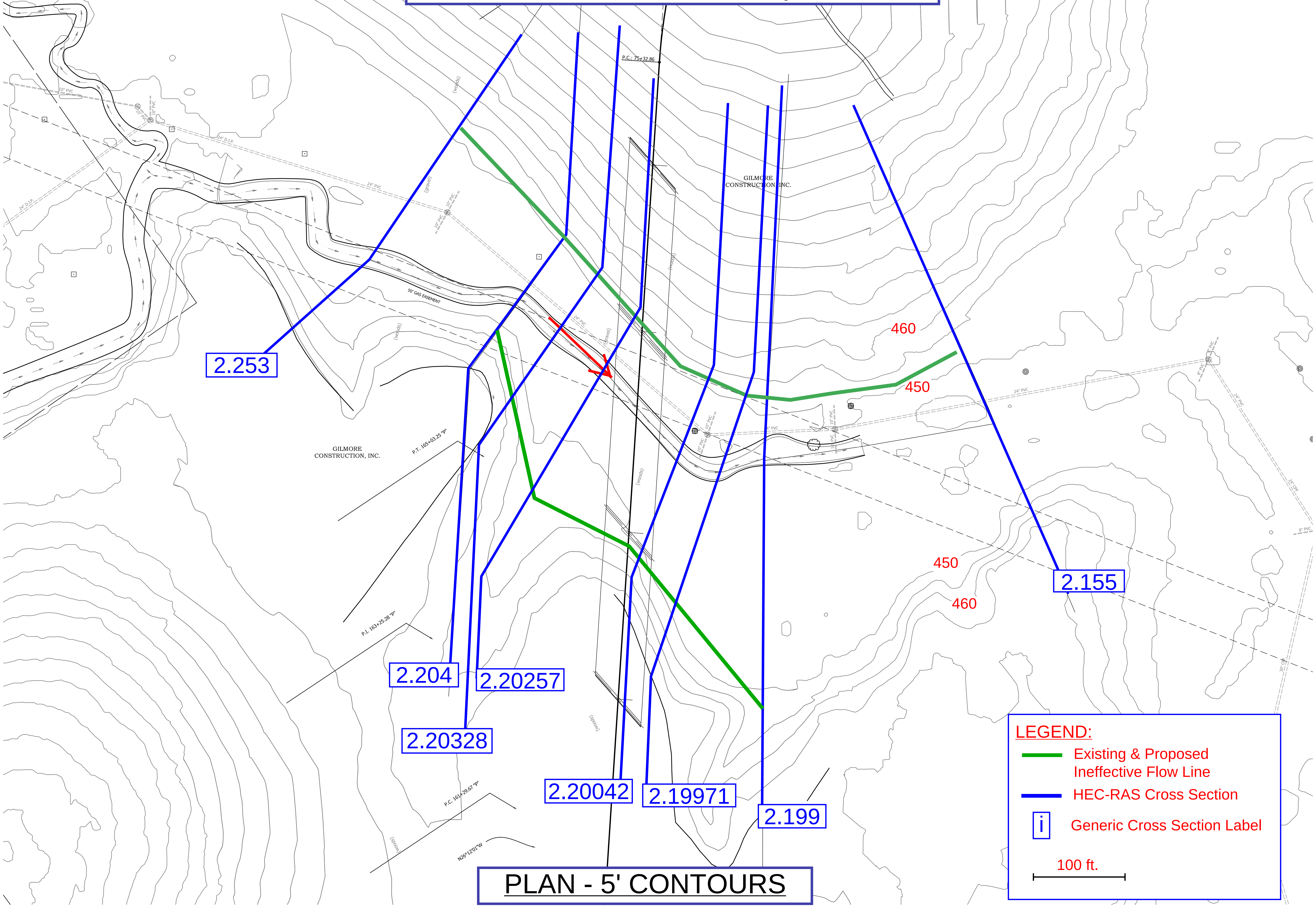
~~2. Scour Data. Q_{100} and Q_{100} elevation are as described above.~~

Appendix C

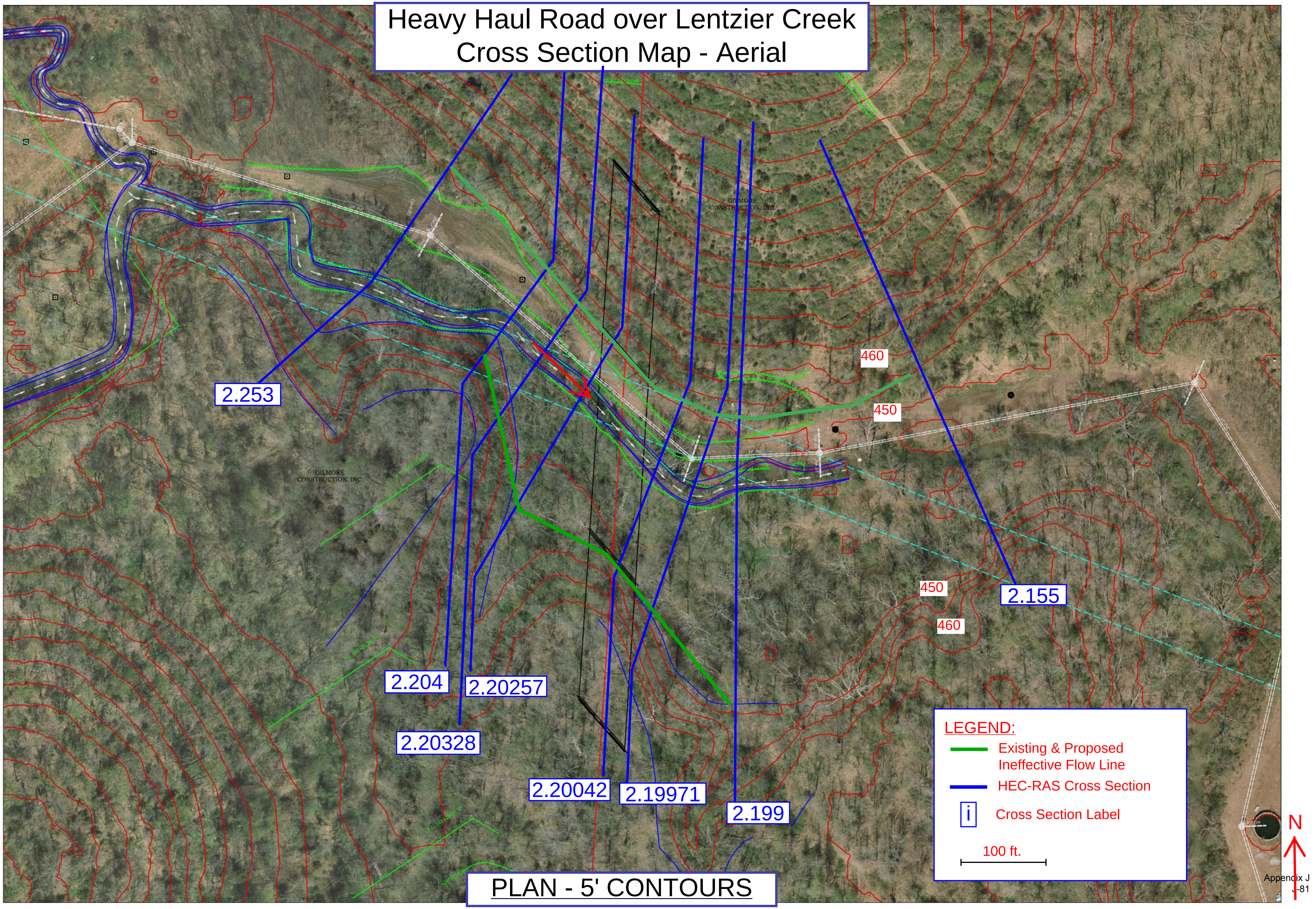
- □ Cross Section Map
- □ HEC-RAS File Name List
- □ Starting Water Surface Elevation
- □ HEC-RAS Cross Sections
- □ HEC-RAS Hydraulic Design Outputs & Calculations
- □ Scour Countermeasure Recommendations
- □ Check-RAS Output & Responses

UNITED Consulting

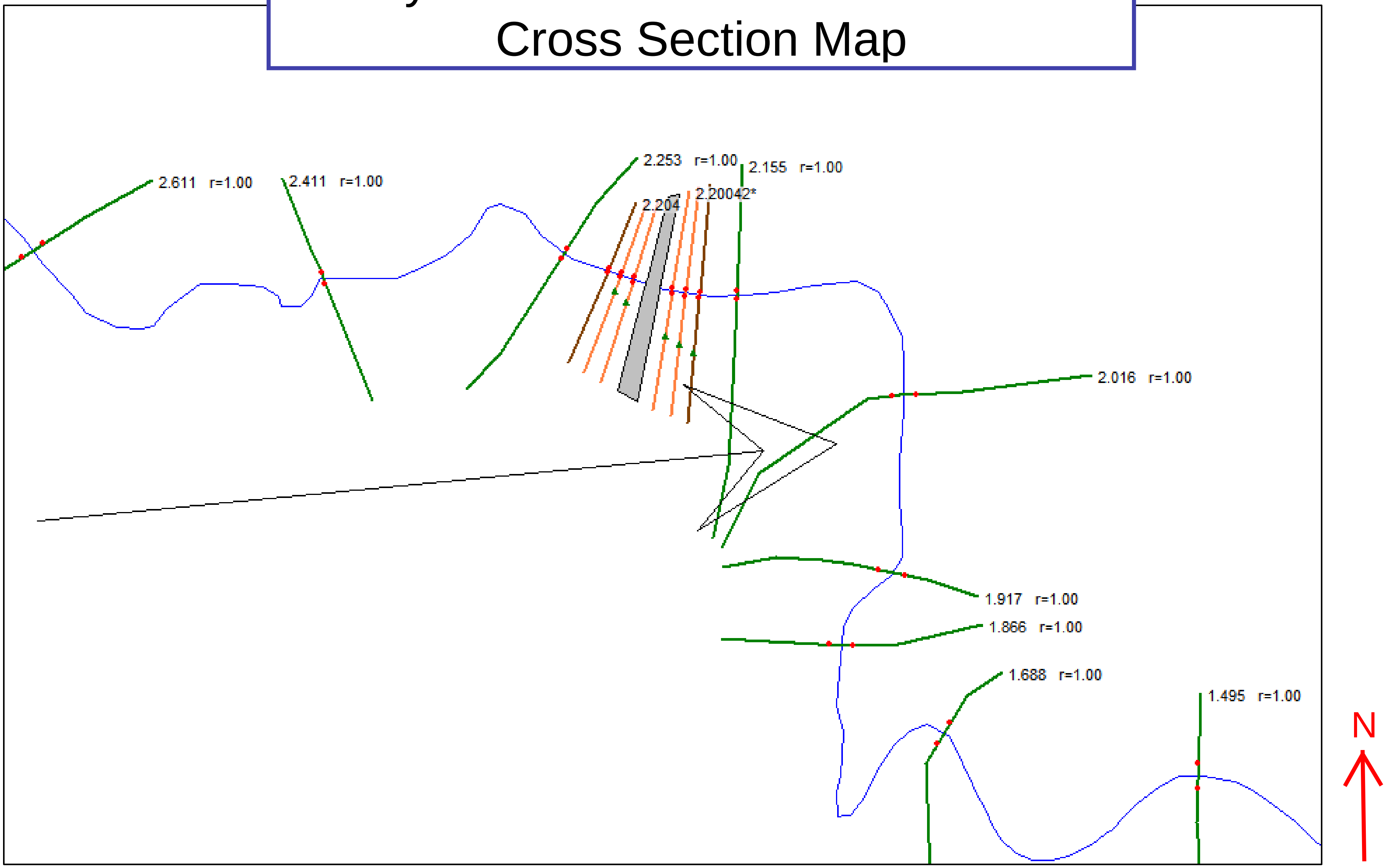
Heavy Haul Road over Lentzier Creek
Cross Section Map



PLAN - 5' CONTOURS


Heavy Haul Road over Lentzier Creek
Cross Section Map - Aerial
2.253
2.204
2.20257
2.20328
2.20042
2.19971
2.199
2.155
460
450
450
460
GILMORE CONSTRUCTION, INC.
GILMORE CONSTRUCTION, INC.
LEGEND:
Existing & Proposed Ineffective Flow Line
HEC-RAS Cross Section
i Cross Section Label
100 ft.
N
PLAN - 5' CONTOURS

Heavy Haul Road over Lentzier Creek
Cross Section Map



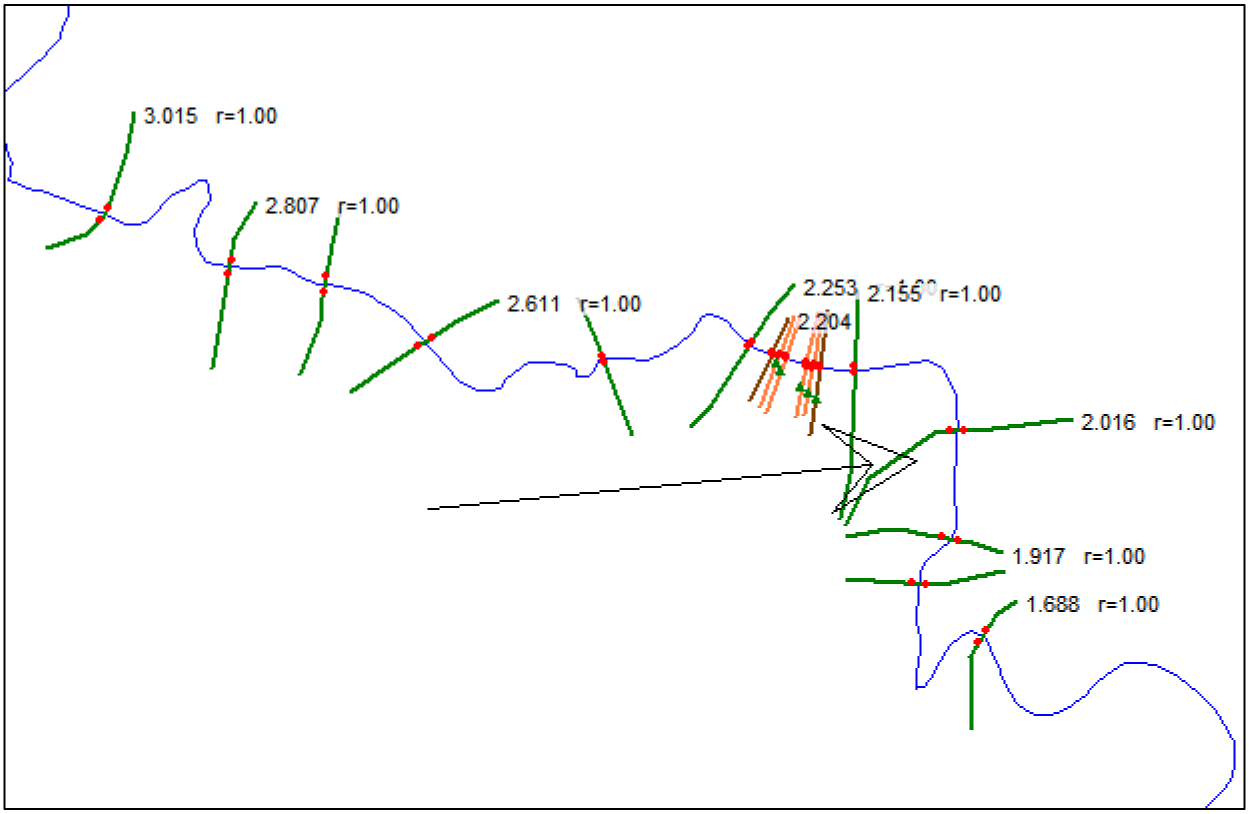
HEC-RAS Filenames:

RE: Hydraulics Computations
Heavy Haul Road over Lentzier Creek

Description	HEC-RAS Filename
Project File	LentzierHvyHaul.prj
Steady Flow File	LentzierHvyHaul.f01
Natural Geometry File	Same as existing
Existing Geometry File	LentzierHvyHaul.g01
Proposed Geometry File	LentzierHvyHaul.g02
Natural Plan File	Same as existing
Existing Plan File	LentzierHvyHaul.p01
Proposed Plan File	LentzierHvyHaul.p02
Hydraulic/Scour Design	LentzierHvyHaul..h01 & LentzierHvyHaul..O01

Heavy Haul Road over Lentzier Creek

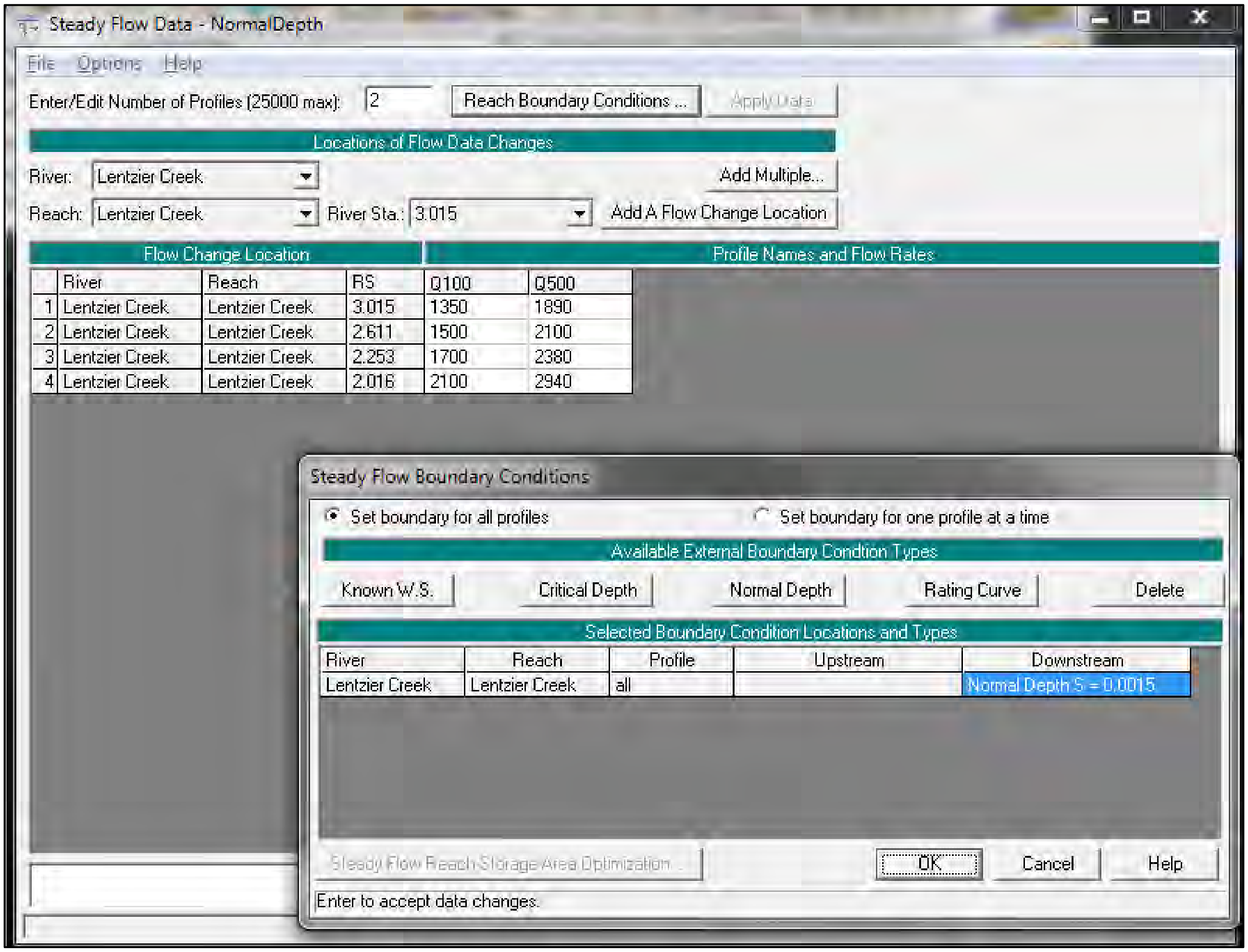
Starting Water Surface Elevations



(Existing HEC-RAS Geometry)

Heavy Haul Road over Lentzier Creek

Starting Water Surface Elevations



(Flow data with normal slope to determine starting water surface elevation)

Heavy Haul Road over Lentzier Creek

Starting Water Surface Elevations

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

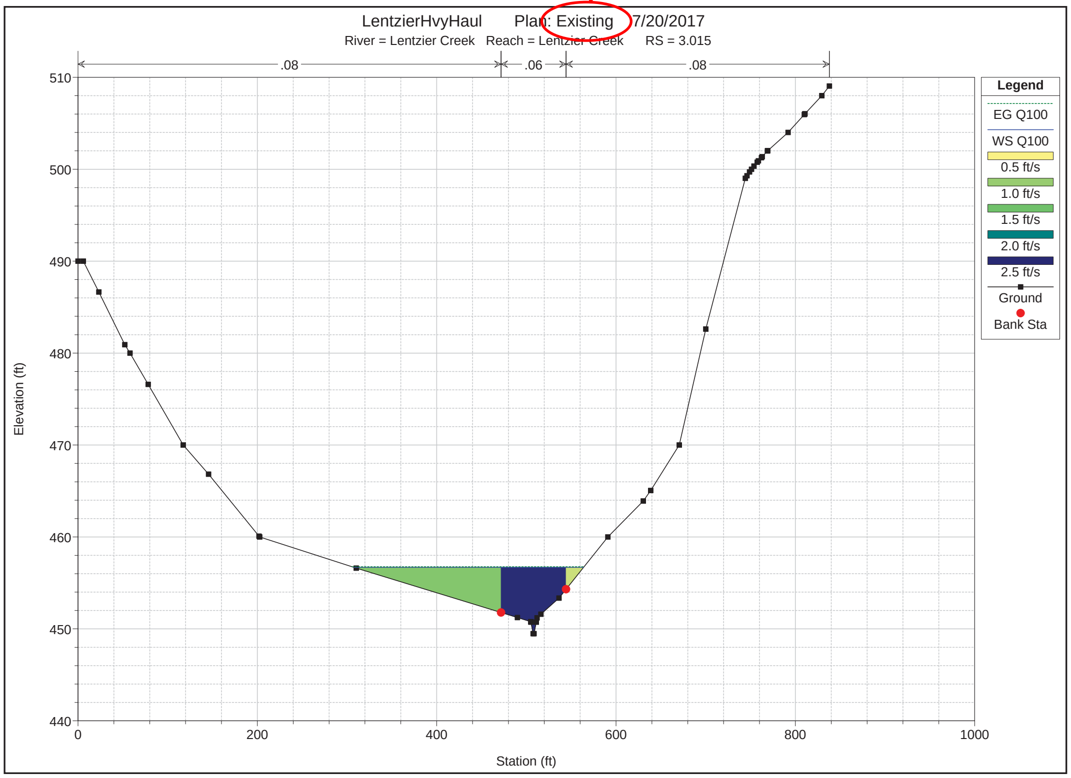
HEC-RAS Plan: Start WSE River: Lentzier Creek Reach: Lentzier Creek

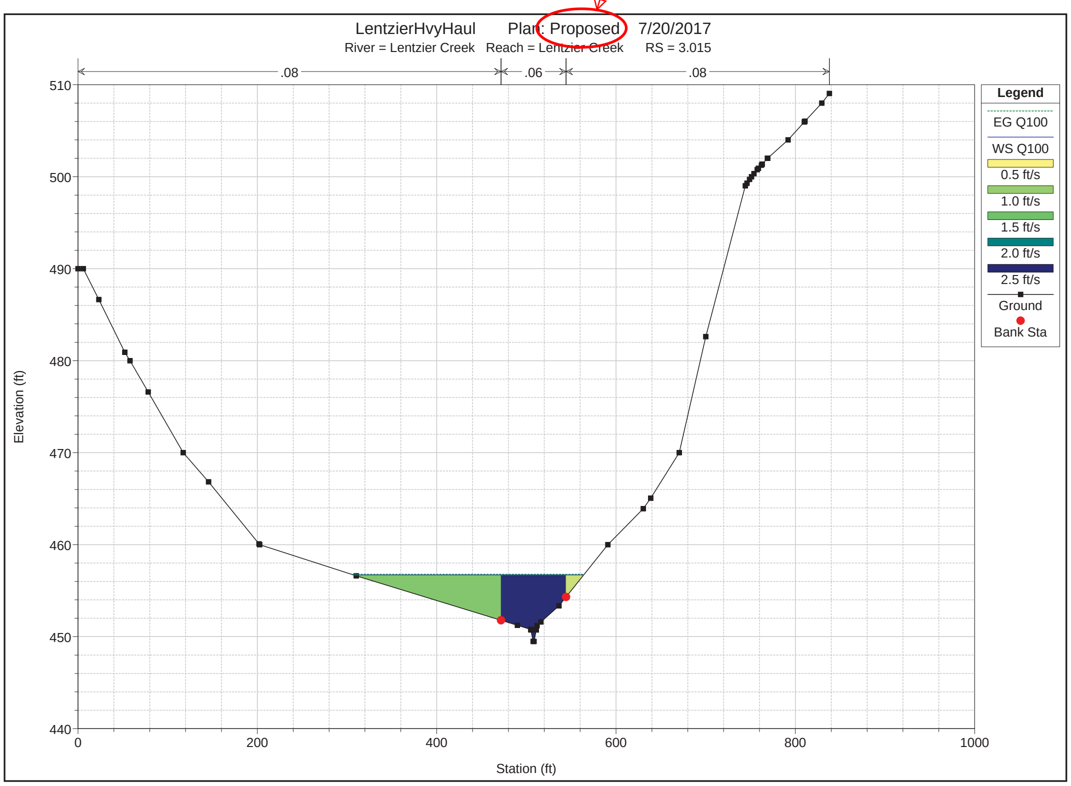
Reload Data

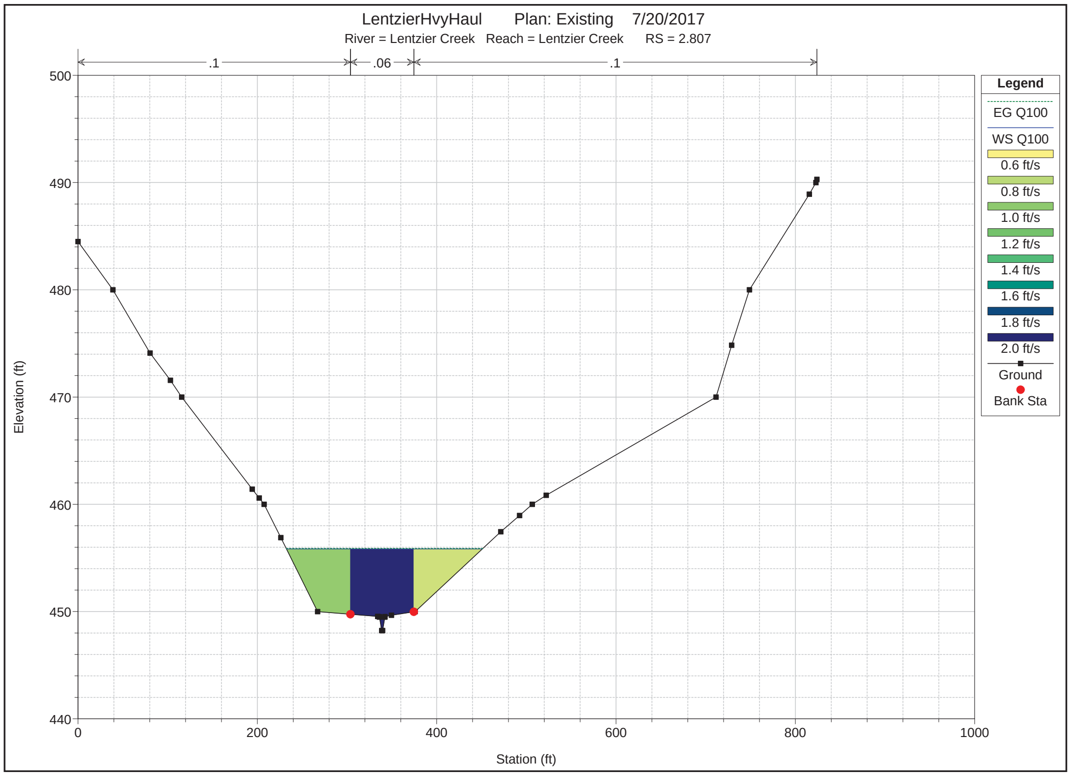
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Lentzier Creek	2.199	Q100	1700.00	441.89	452.71	449.87	452.76	0.001020	2.80	1186.99	350.73	0.17
Lentzier Creek	2.199	Q500	2380.00	441.89	453.94	450.35	454.00	0.000925	2.92	1532.74	370.08	0.16
Lentzier Creek	2.155	Q100	1700.00	441.76	452.08		452.34	0.002784	4.79	590.74	162.76	0.28
Lentzier Creek	2.155	Q500	2380.00	441.76	453.33		453.60	0.002688	5.13	802.19	176.60	0.28
Lentzier Creek	2.016	Q100	2100.00	441.01	450.84		450.95	0.001372	3.13	970.49	216.53	0.22
Lentzier Creek	2.016	Q500	2940.00	441.01	452.16		452.29	0.001261	3.40	1265.08	227.70	0.22
Lentzier Creek	1.917	Q100	2100.00	440.11	450.23		450.34	0.000988	2.92	995.21	216.03	0.19
Lentzier Creek	1.917	Q500	2940.00	440.11	451.58		451.71	0.000975	3.24	1297.76	232.28	0.19
Lentzier Creek	1.866	Q100	2100.00	439.65	449.34		449.79	0.005484	5.46	423.39	98.57	0.42
Lentzier Creek	1.866	Q500	2940.00	439.65	450.65		451.17	0.004920	5.96	564.23	116.82	0.41
Lentzier Creek	1.688	Q100	2100.00	437.99	447.08	442.[illegible]3	447.26	0.001502	3.59	735.47	145.20	0.23
Lentzier Creek	1.688	Q500	2940.00	437.99	448.51	443.56	448.72	0.001502	4.04	955.04	162.59	0.24

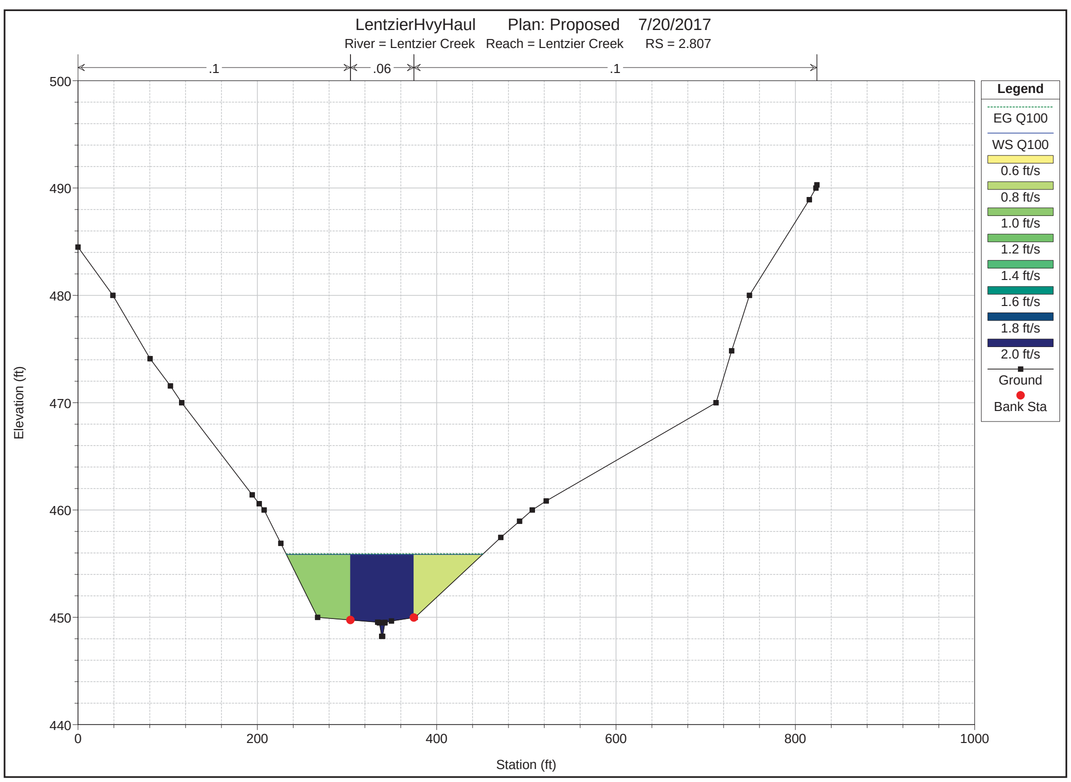
Starting Water Surface Elevations for the Existing and Proposed Conditions

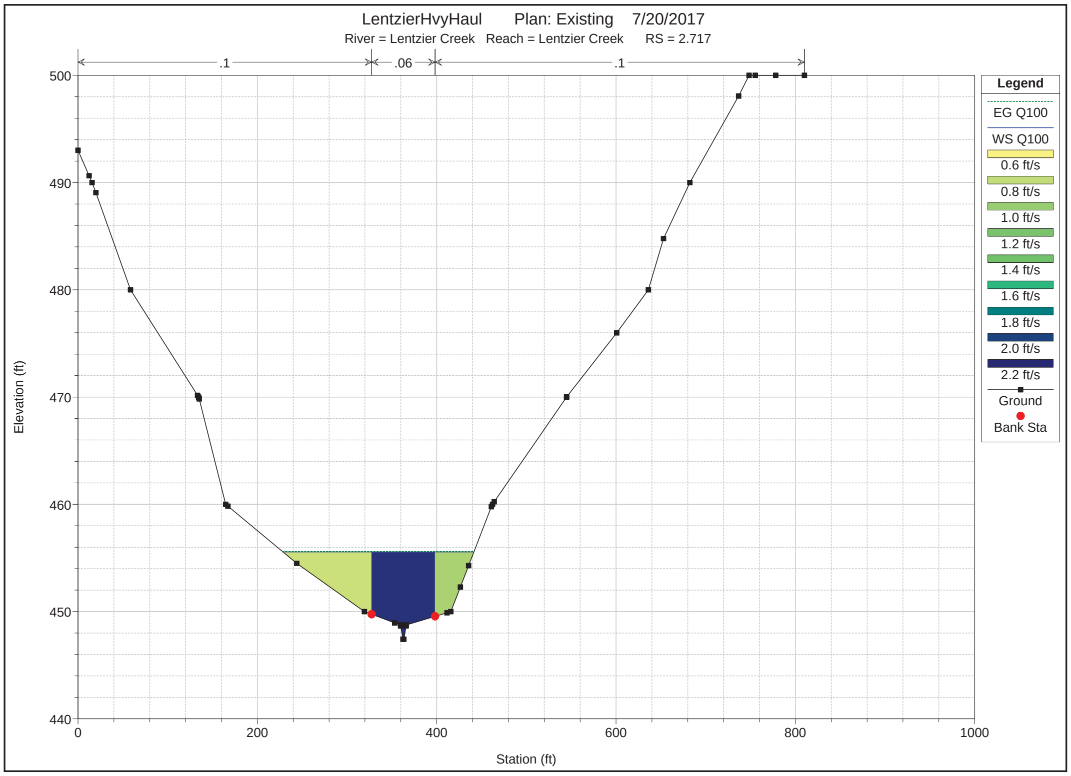
Existing & Proposed Cross Sections






LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.807
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
0.6 ft/s
0.8 ft/s
1.0 ft/s
1.2 ft/s
1.4 ft/s
1.6 ft/s
1.8 ft/s
2.0 ft/s
Ground
Bank Sta


LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.807
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
0.6 ft/s
0.8 ft/s
1.0 ft/s
1.2 ft/s
1.4 ft/s
1.6 ft/s
1.8 ft/s
2.0 ft/s
Ground
Bank Sta


LentzierHvyHaul Plan: Existing 7/20/2017
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.1
.06
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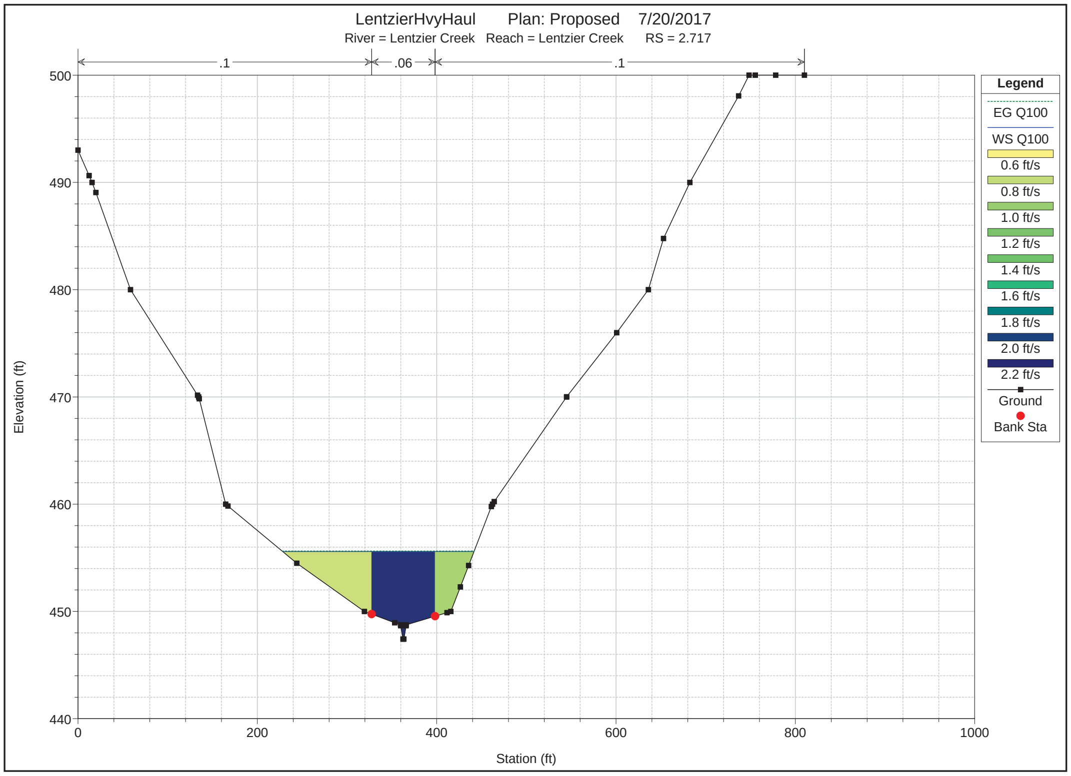
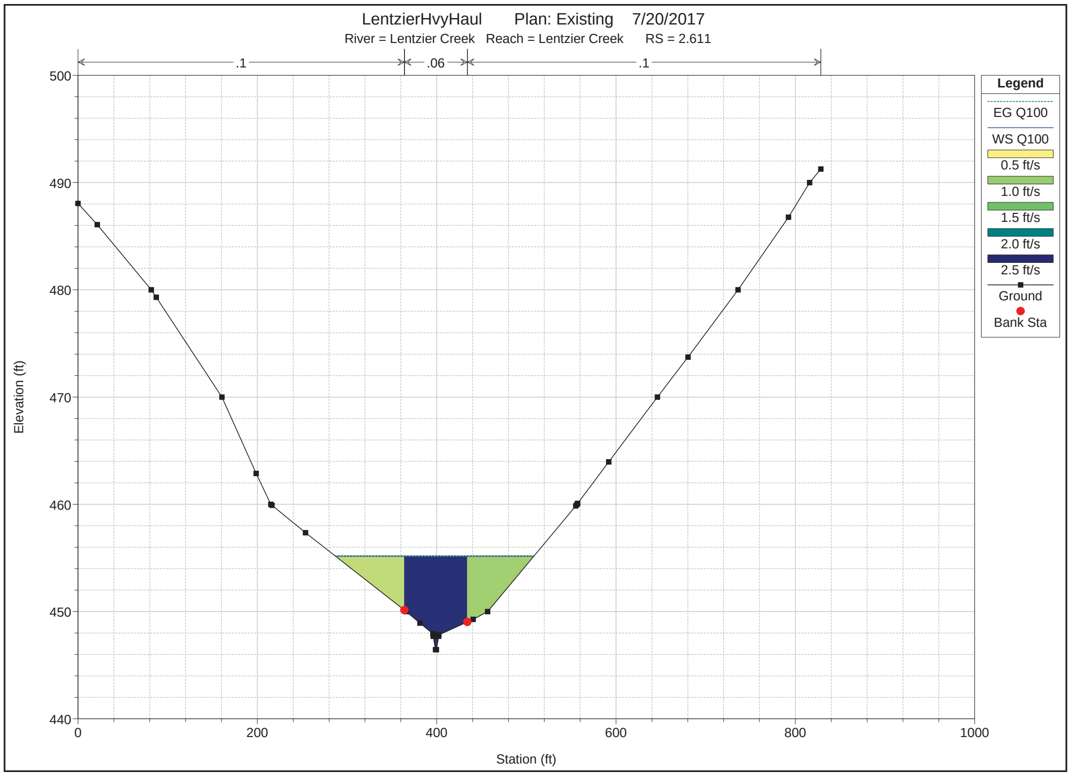
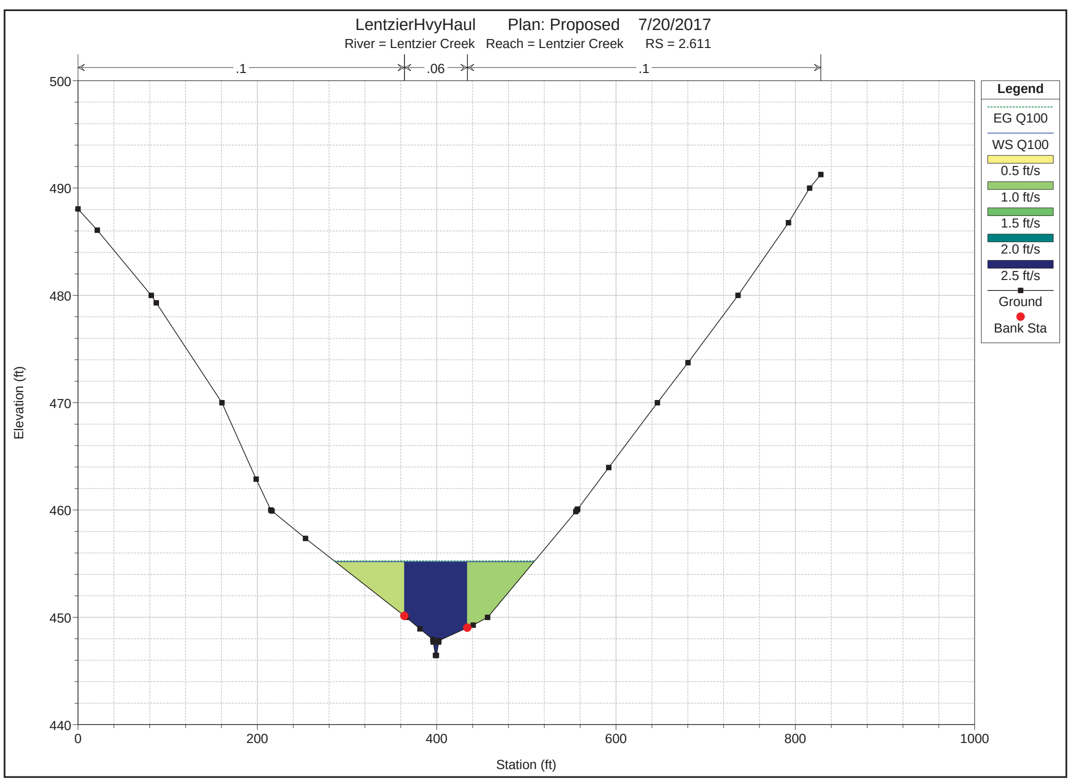
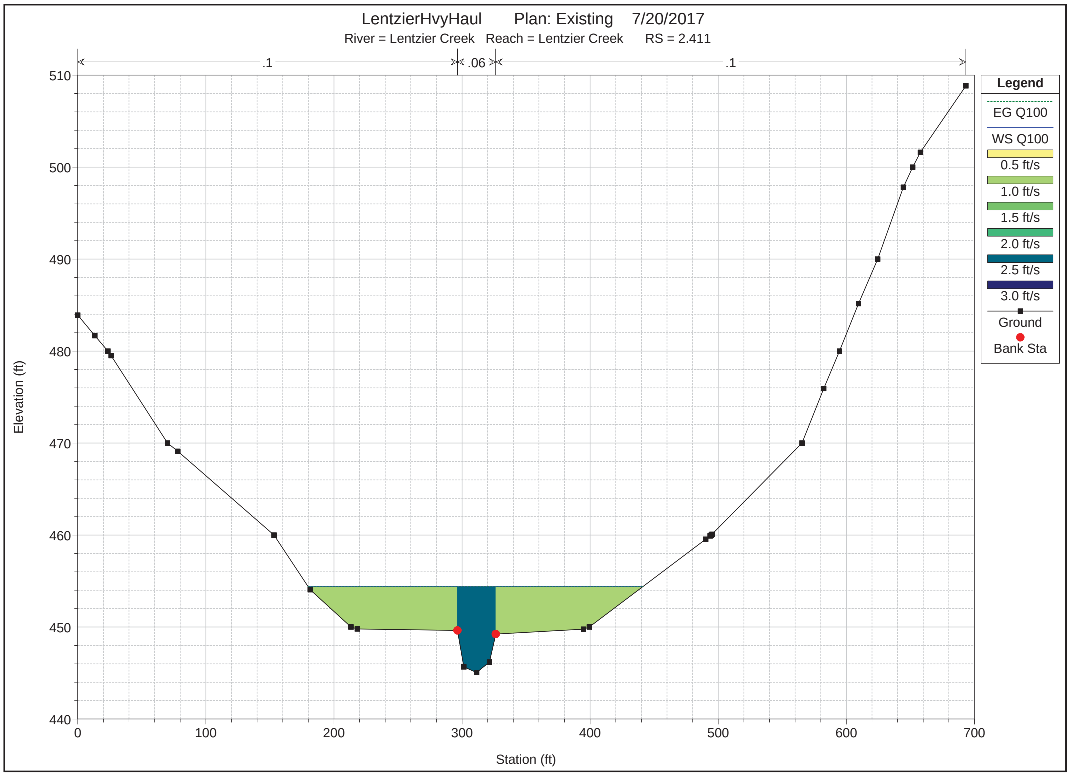
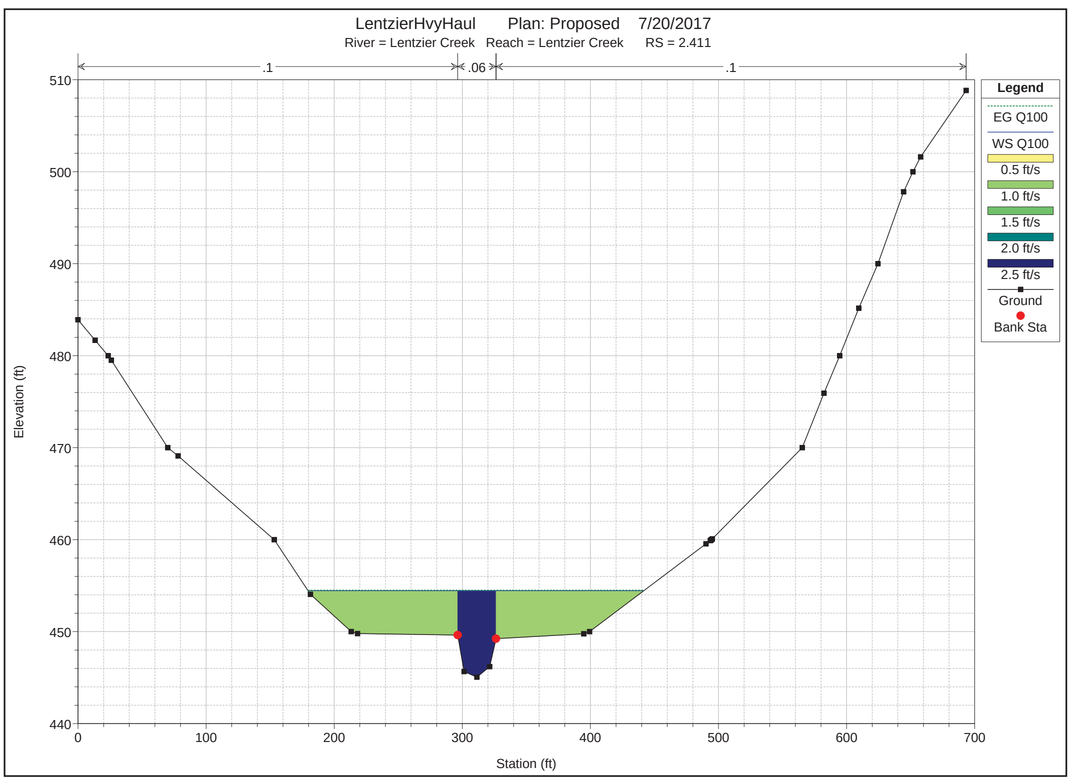
Legend
EG Q100
WS Q100
0.6 ft/s
0.8 ft/s
1.0 ft/s
1.2 ft/s
1.4 ft/s
1.6 ft/s
1.8 ft/s
2.0 ft/s
2.2 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

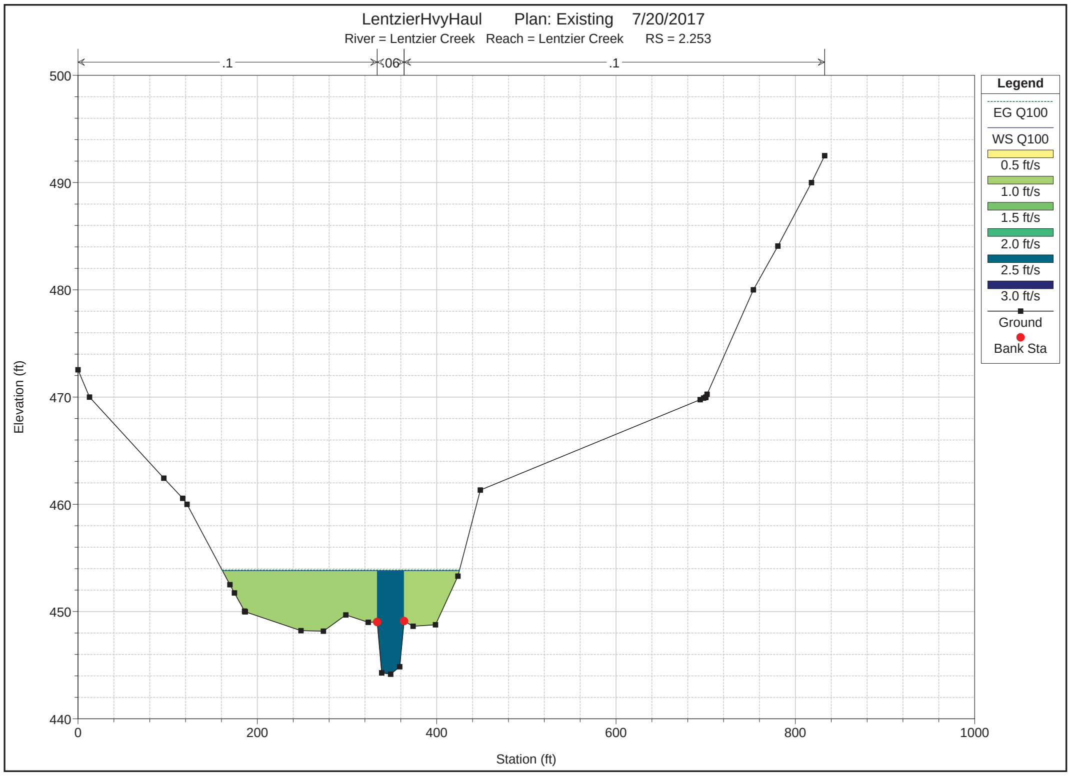

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.717
.1
.06
.1
Legend
EG Q100
WS Q100
0.6 ft/s
0.8 ft/s
1.0 ft/s
1.2 ft/s
1.4 ft/s
1.6 ft/s
1.8 ft/s
2.0 ft/s
2.2 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

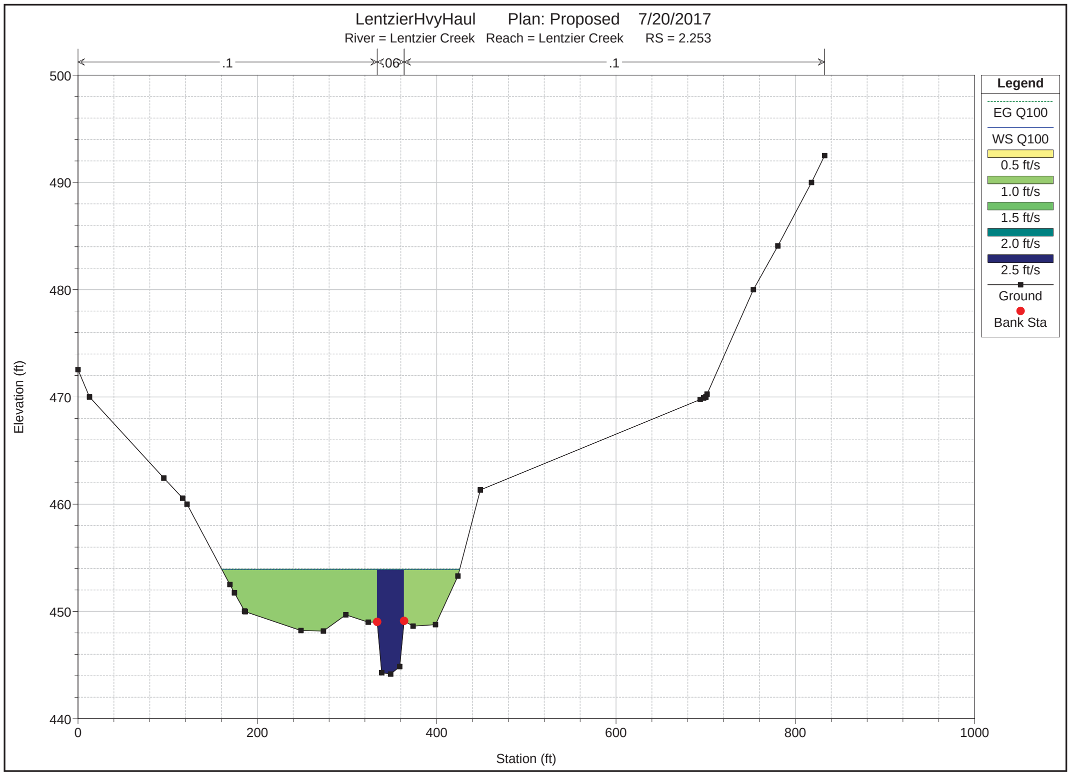

LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.611
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta

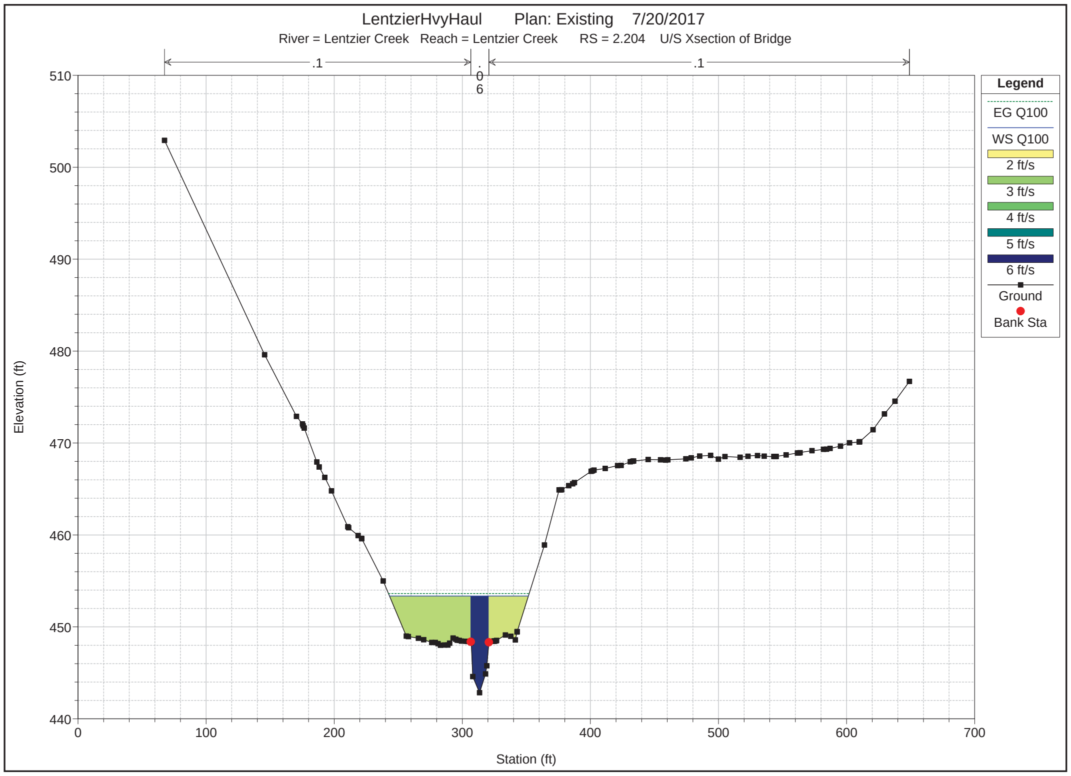

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.611
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta


LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.411
.1
.06
.1
Legend
EG Q100
WS Q100
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
510
500
490
480
470
460
450
440
0
100
200
300
400
500
600
700

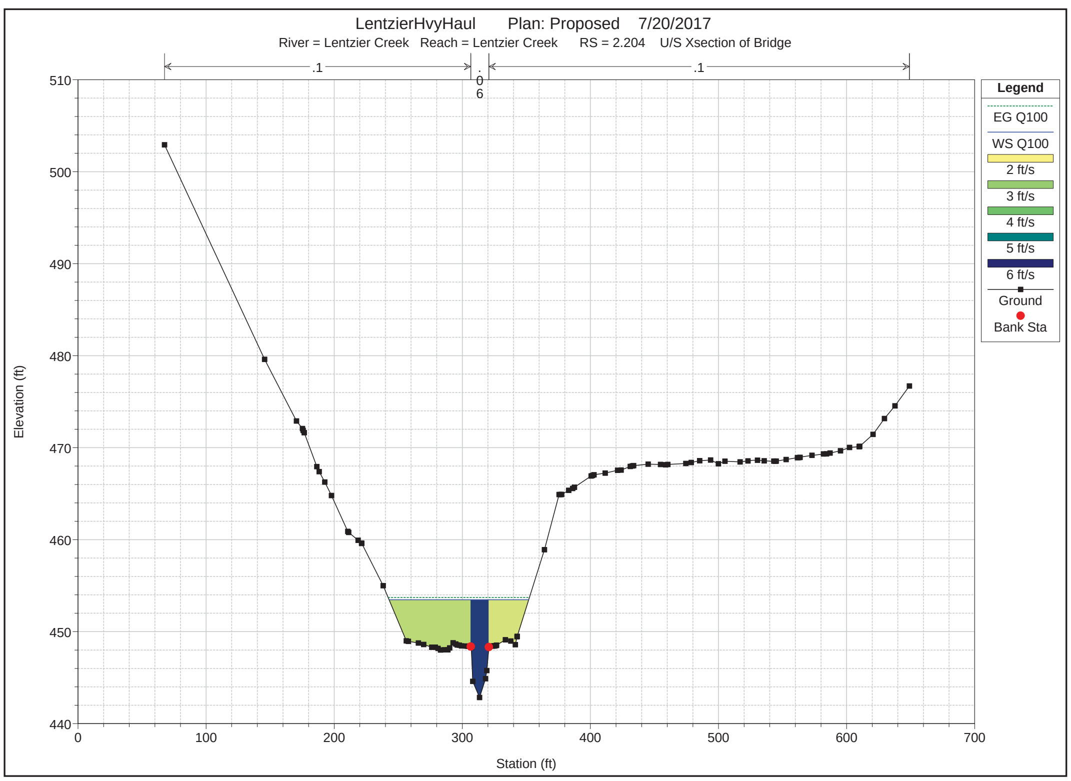

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.411
.1
.06
.1
Legend
EG Q100
WS Q100
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
510
500
490
480
470
460
450
440
0
100
200
300
400
500
600
700


LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.253
.1
.06
.1
Legend
EG Q100
WS Q100
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
500
490
480
470
460
450
440
0
200
400
600
800
1000

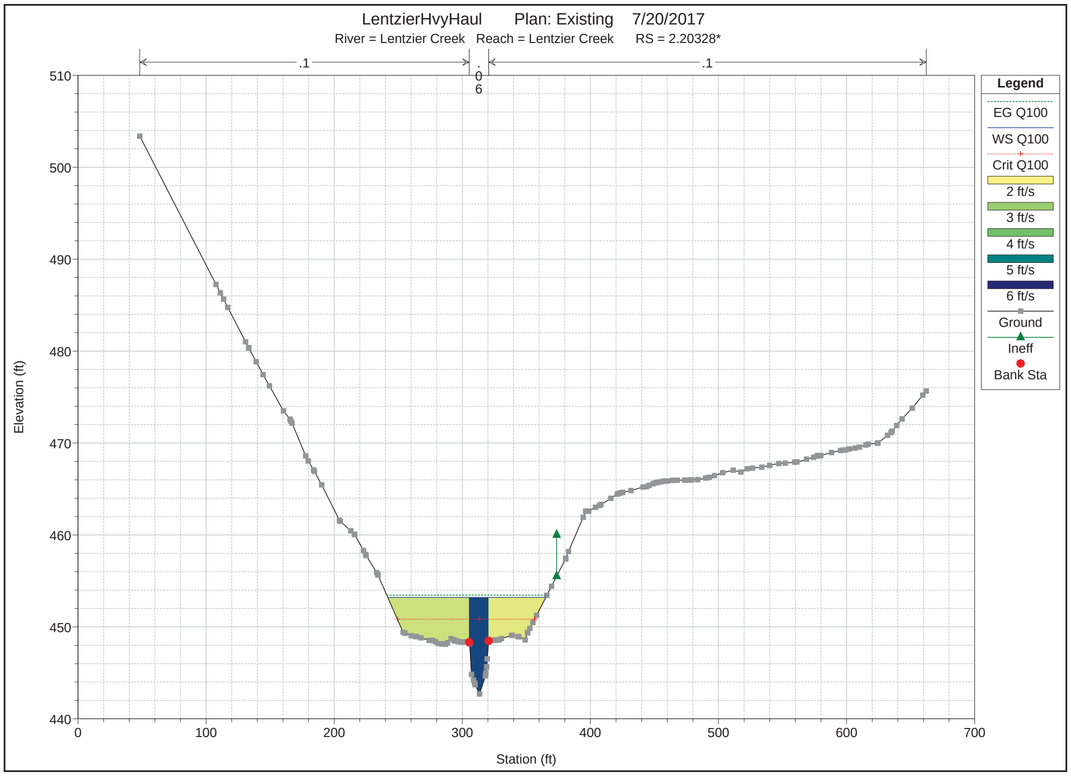

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.253
.1
.06
.1
Legend
EG Q100
WS Q100
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
500
490
480
470
460
450
440
0
200
400
600
800
1000

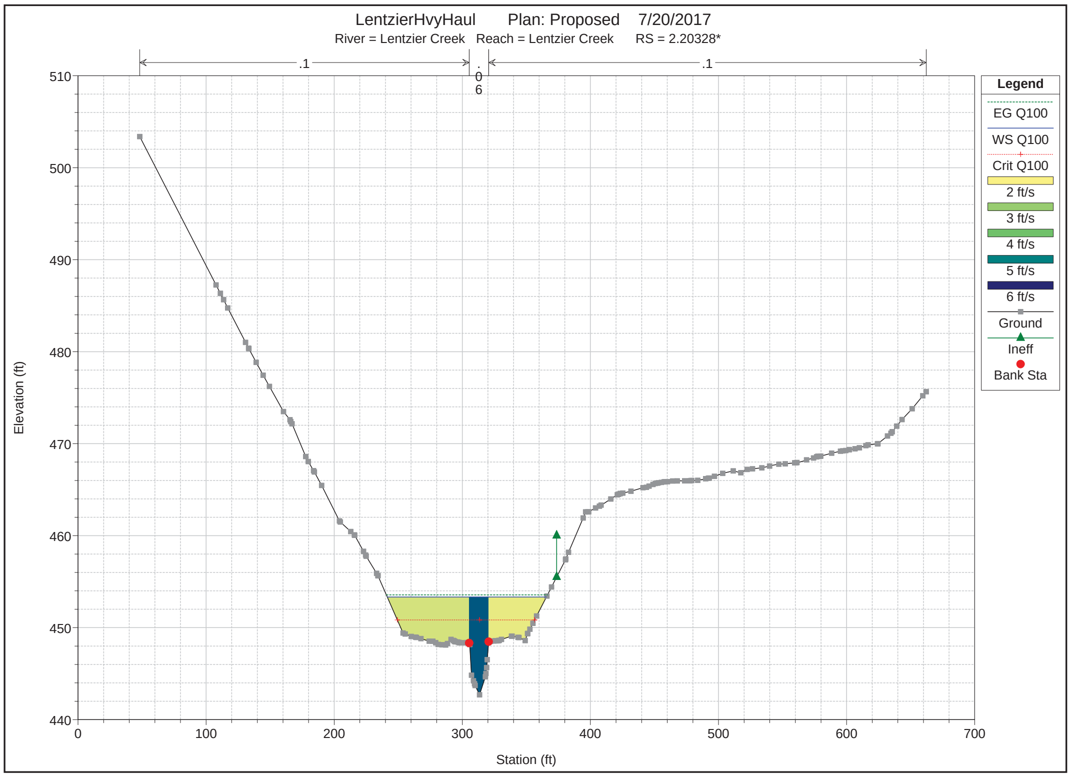


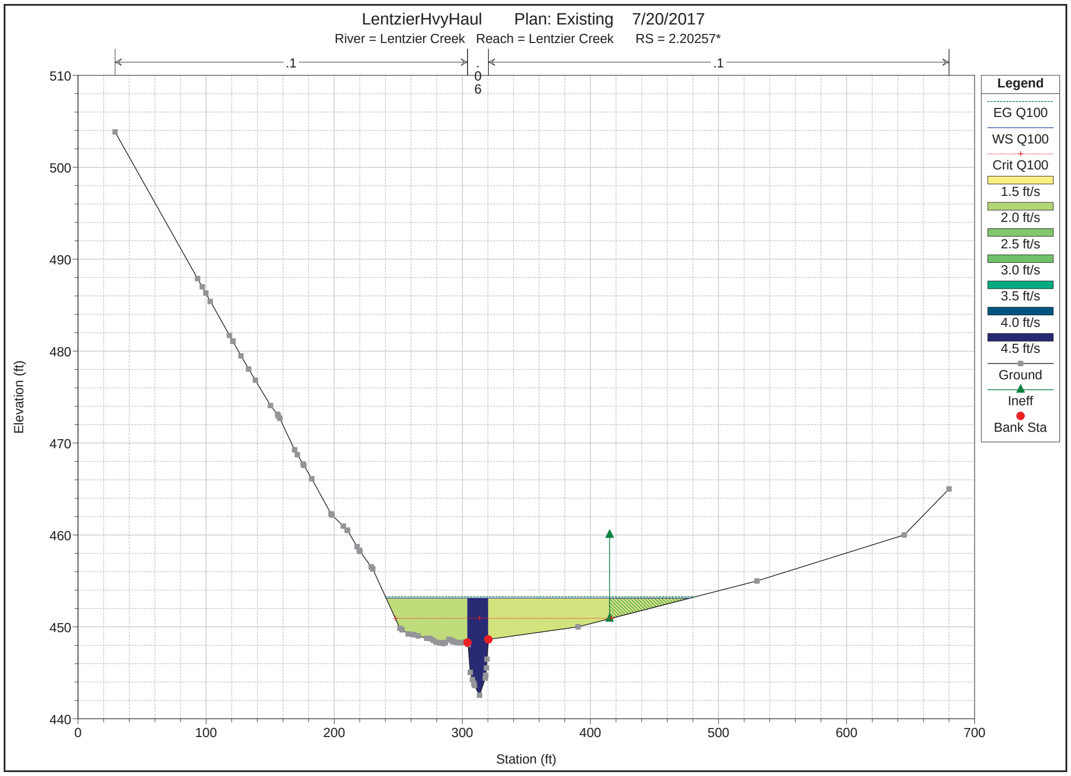
LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.204 U/S Xsection of Bridge
.1
.06
.1
Legend
EG Q100
WS Q100
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

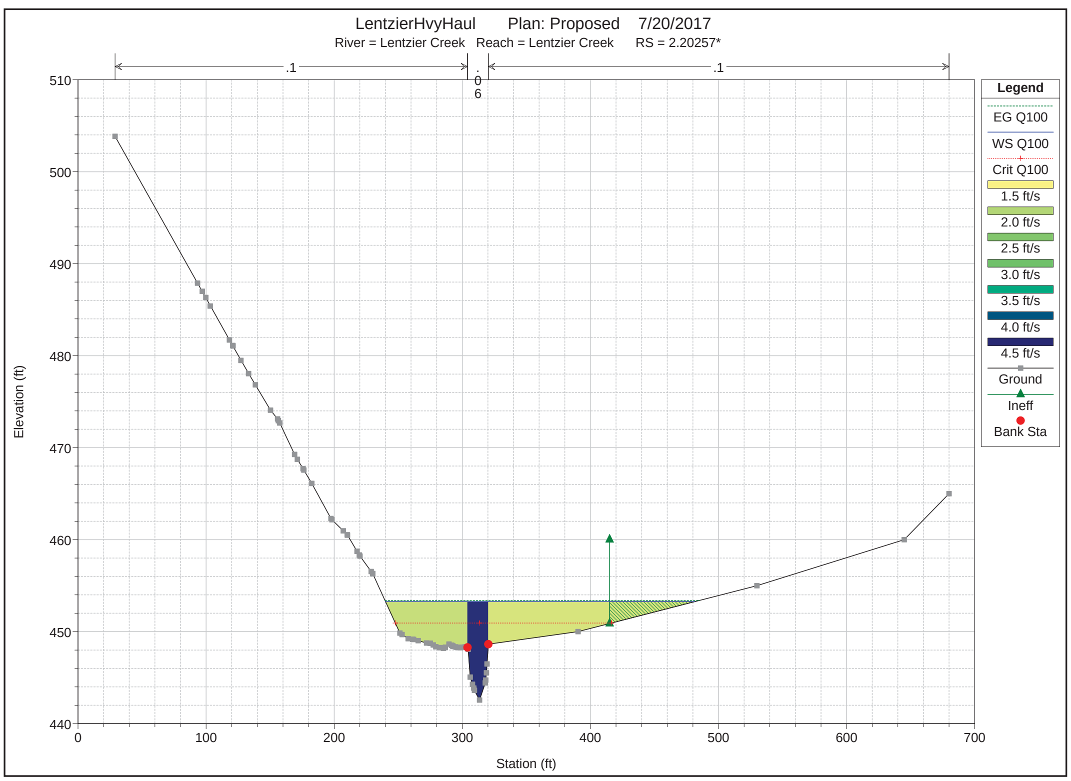


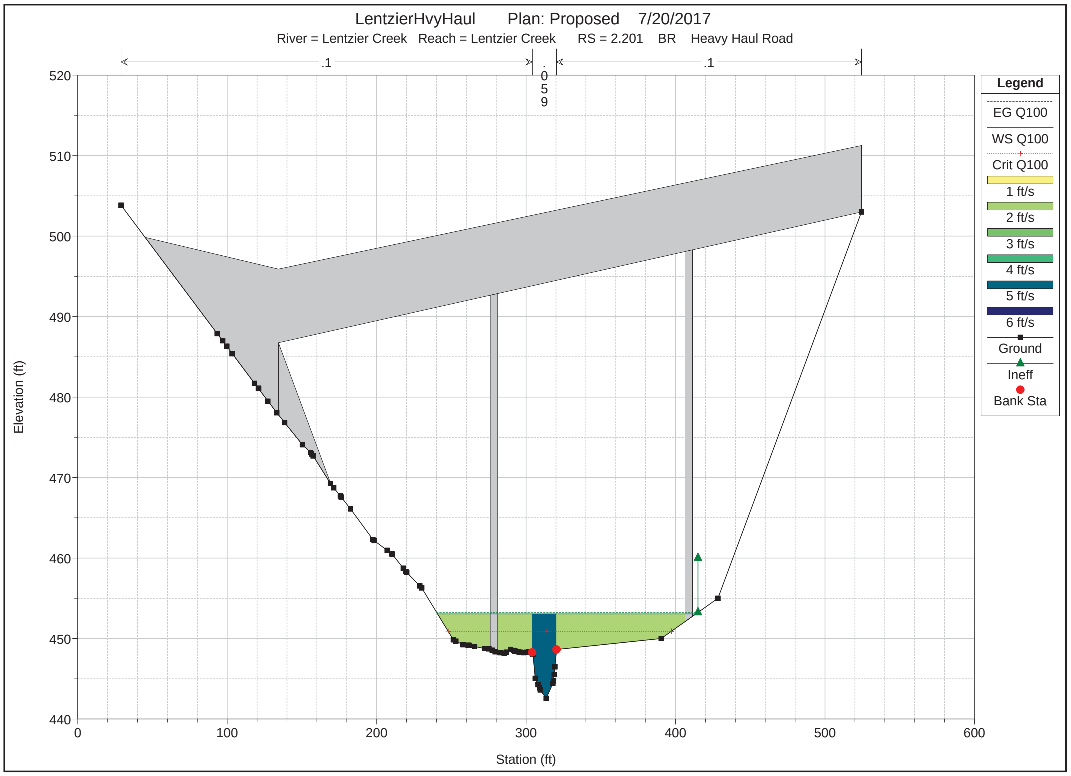
LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.204 U/S Xsection of Bridge
.1
.06
.1
Legend
EG Q100
WS Q100
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

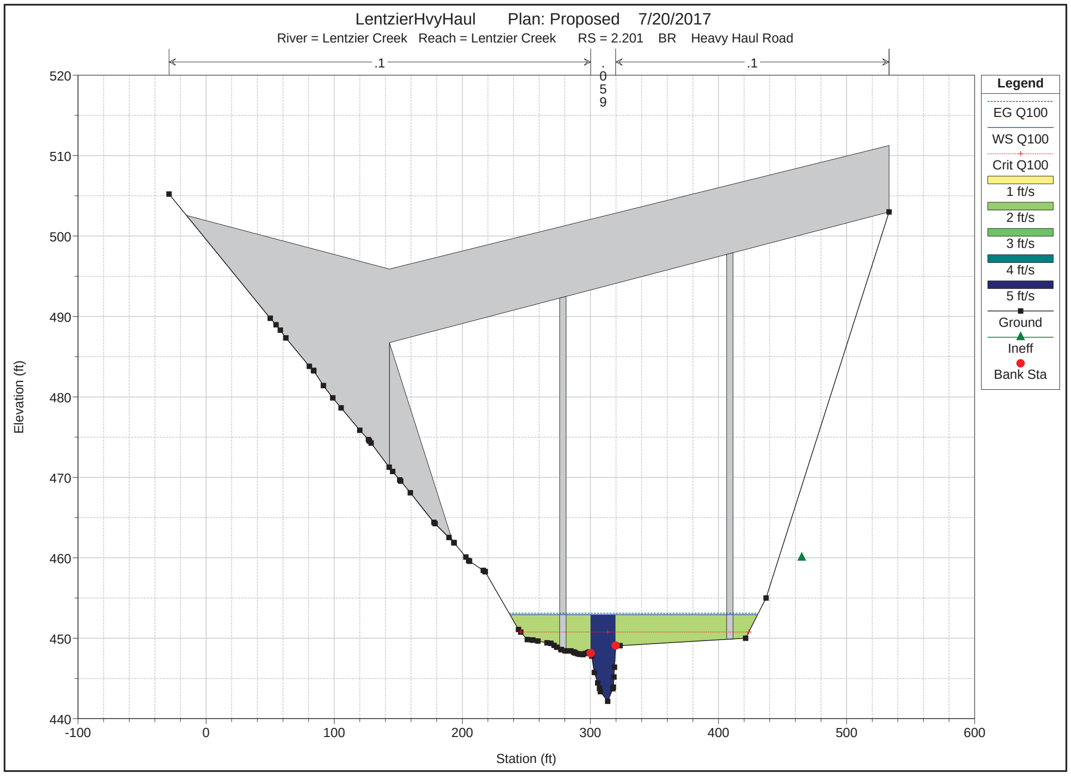

LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.20328*
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
Crit Q100
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Ineff
Bank Sta

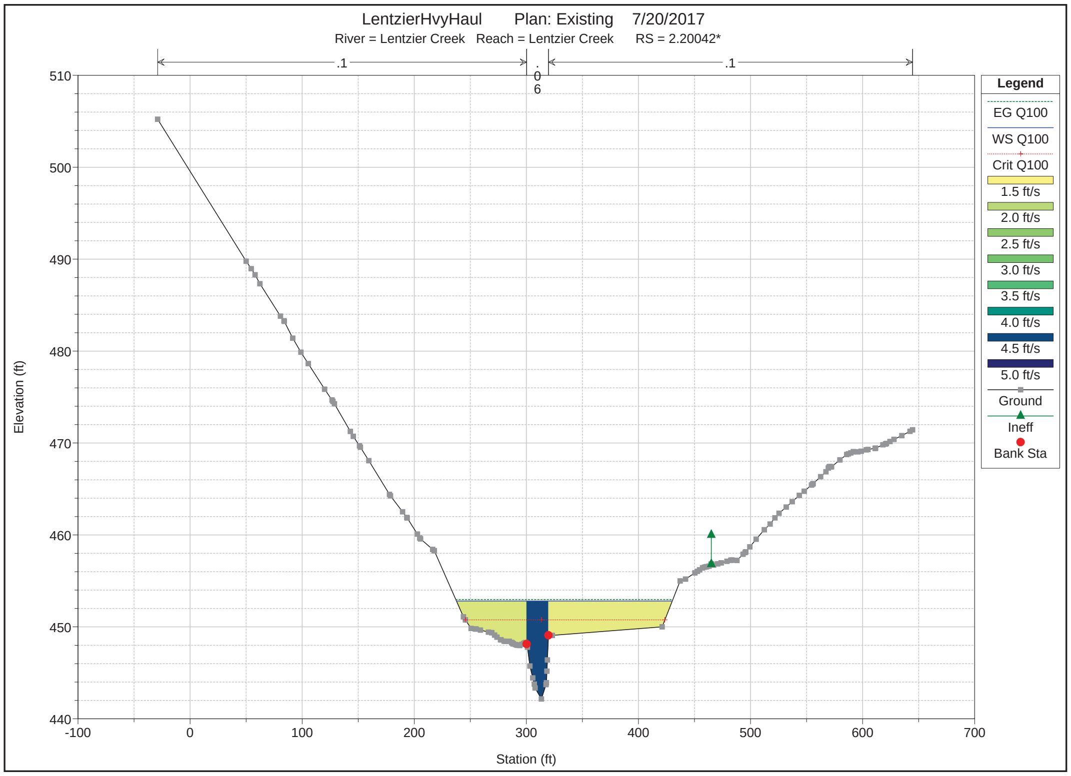

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.20328*
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
Crit Q100
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Ineff
Bank Sta


LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.20257*
.1
.06
.1
Legend
EG Q100
WS Q100
Crit Q100
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
4.0 ft/s
4.5 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
510
500
490
480
470
460
450
440
0
100
200
300
400
500
600
700

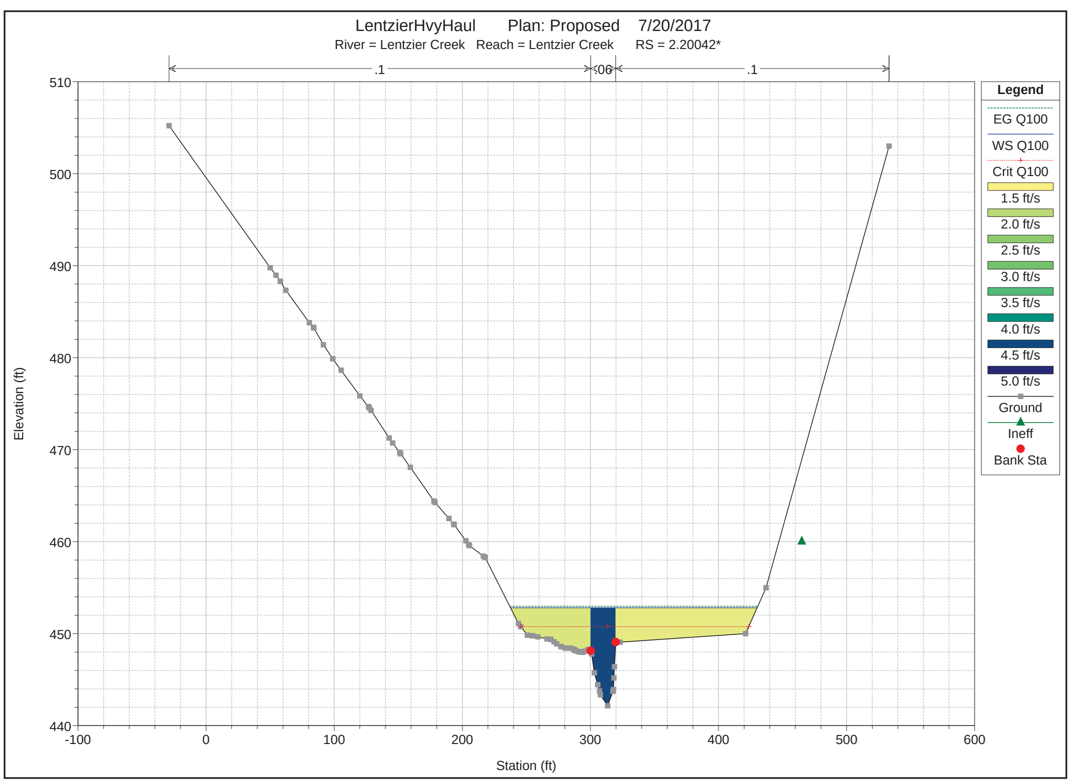

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.20257*
.1
.06
.1
Legend
EG Q100
WS Q100
Crit Q100
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
4.0 ft/s
4.5 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
510
500
490
480
470
460
450
440
0
100
200
300
400
500
600
700


LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.201 BR Heavy Haul Road
.1
.059
.1
Legend
EG Q100
WS Q100
Crit Q100
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
520
510
500
490
480
470
460
450
440
0
100
200
300
400
500
600

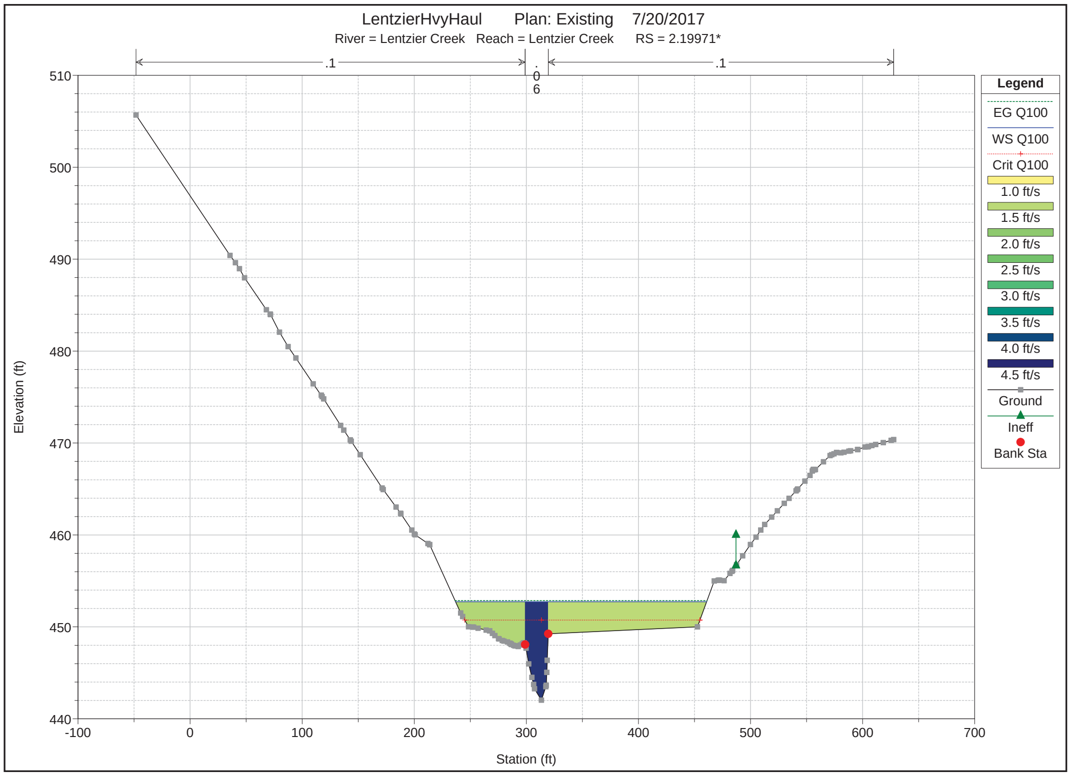

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.201 BR Heavy Haul Road
.1
.059
.1
Legend
EG Q100
WS Q100
Crit Q100
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
520
510
500
490
480
470
460
450
440
-100
0
100
200
300
400
500
600

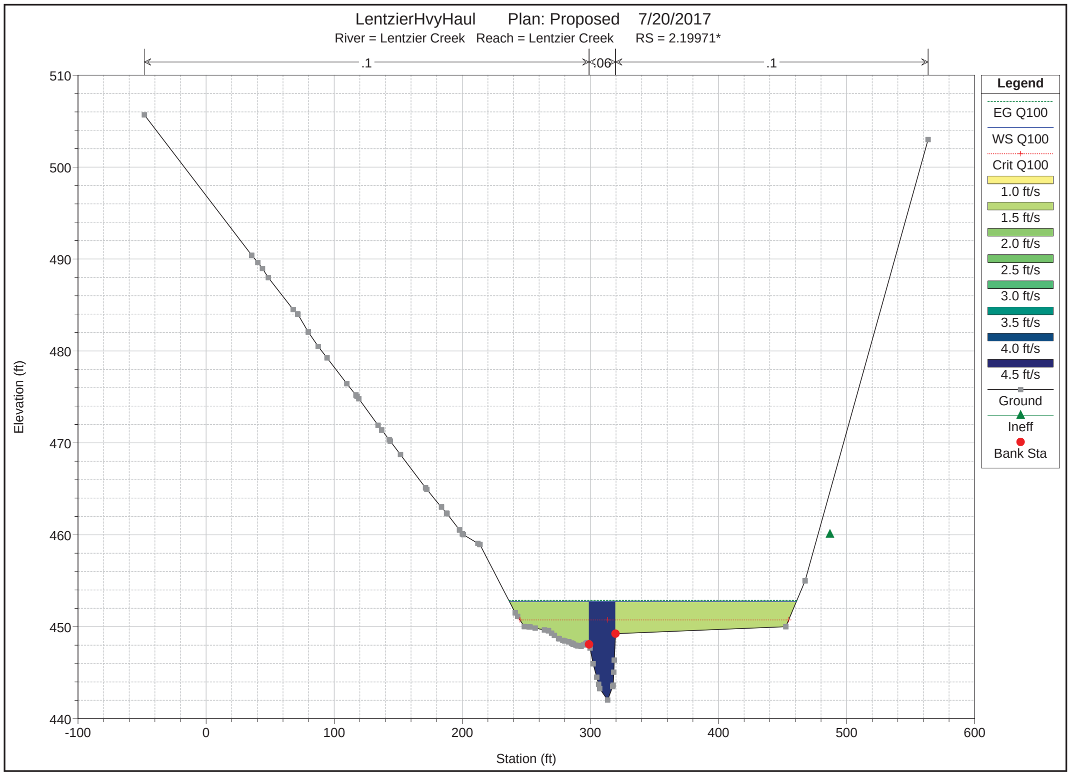


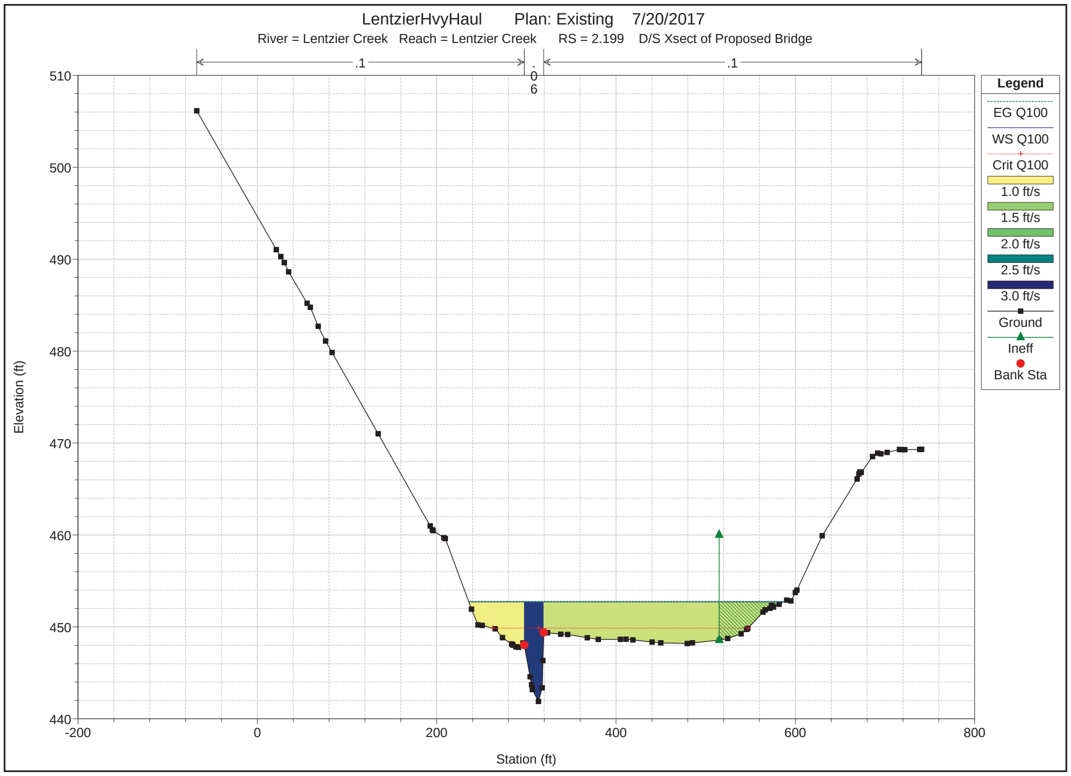
LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.20042*
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
Crit Q100
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
4.0 ft/s
4.5 ft/s
5.0 ft/s
Ground
Ineff
Bank Sta

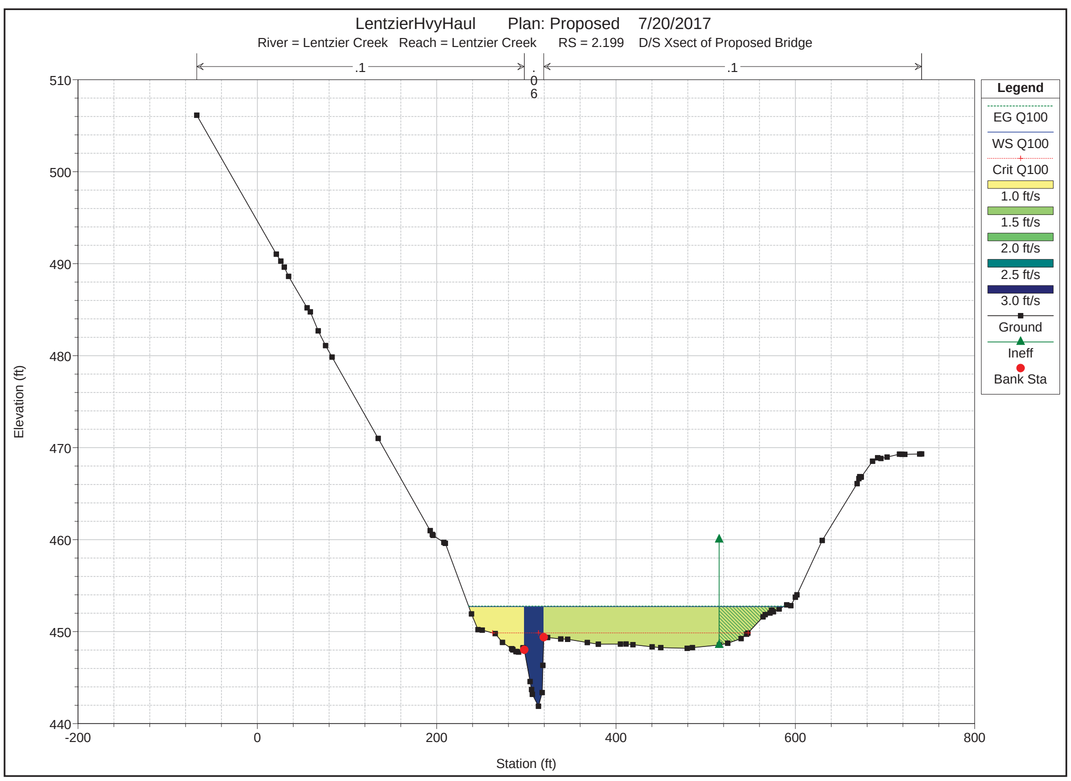


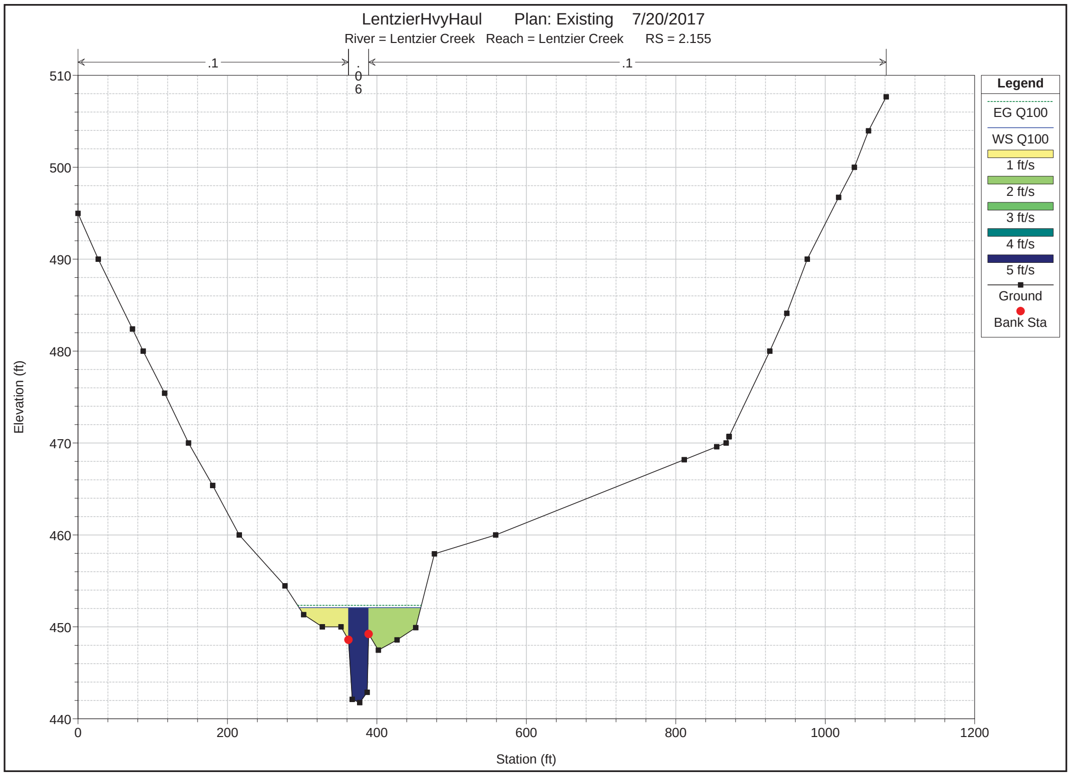
LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.20042*
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
Crit Q100
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
4.0 ft/s
4.5 ft/s
5.0 ft/s
Ground
Ineff
Bank Sta

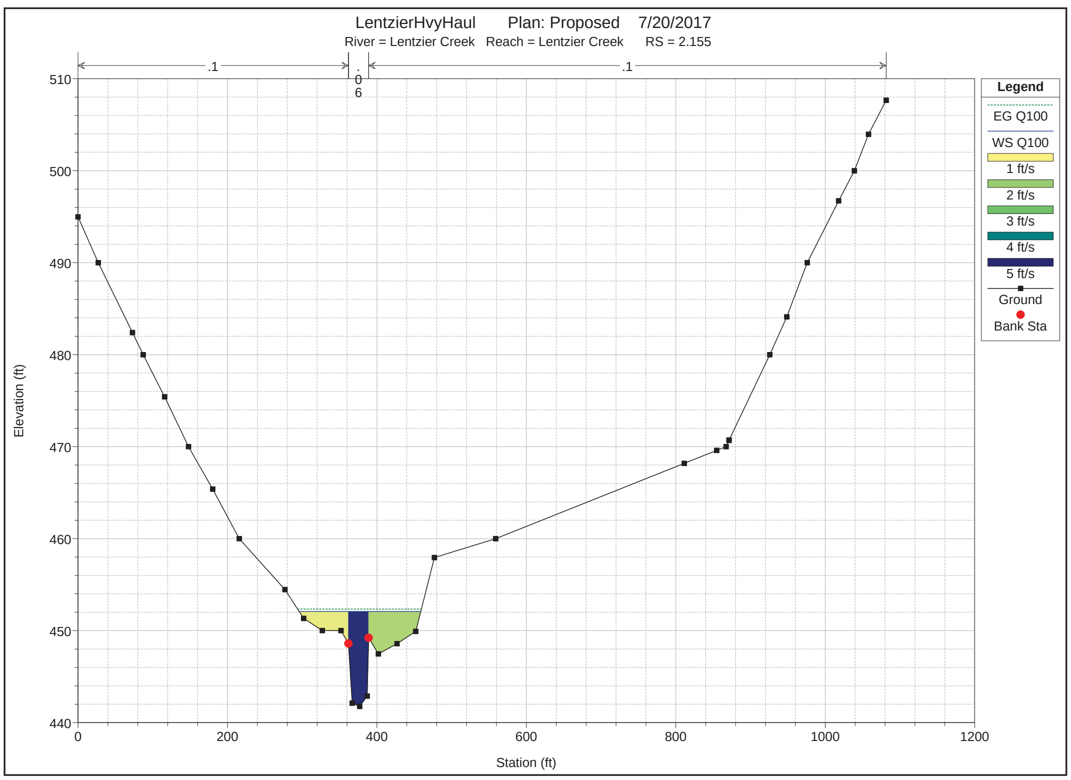

LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.19971*
.1
.06
.1
Legend
EG Q100
WS Q100
Crit Q100
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
4.0 ft/s
4.5 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
510
500
490
480
470
460
450
440
-100
0
100
200
300
400
500
600
700

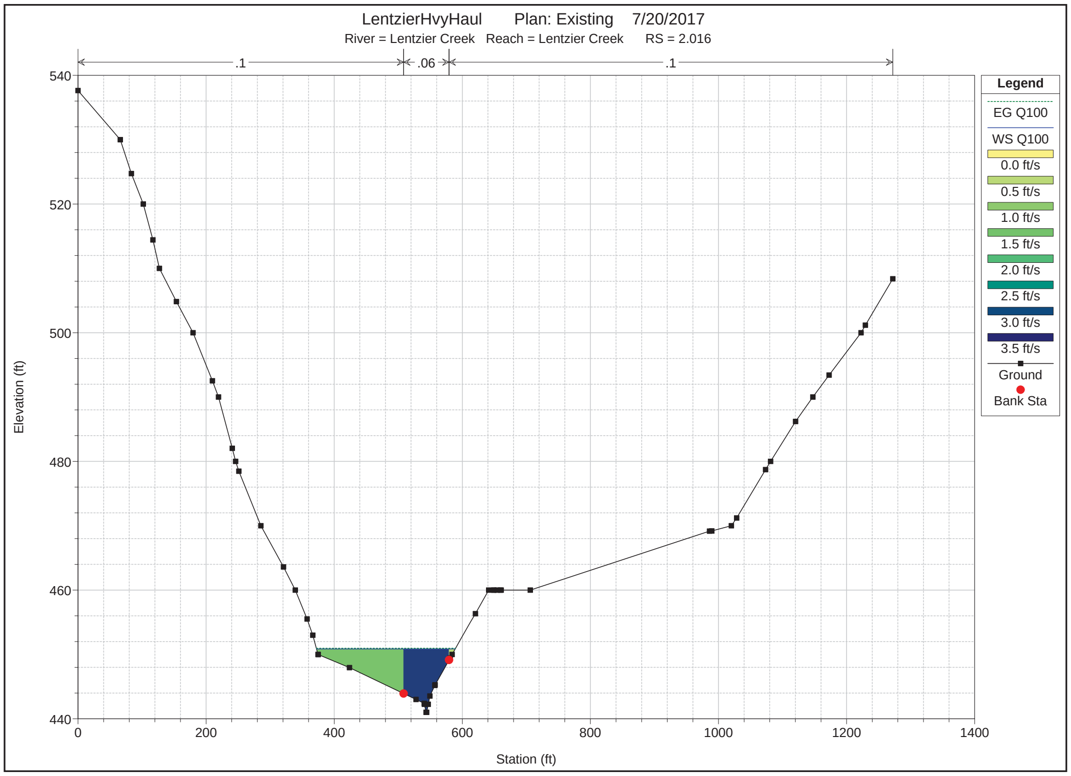

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.19971*
.1
.06
.1
Legend
EG Q100
WS Q100
Crit Q100
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
4.0 ft/s
4.5 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
510
500
490
480
470
460
450
440
-100
0
100
200
300
400
500
600


LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.199 D/S Xsect of Proposed Bridge
.1
.06
.1
Legend
EG Q100
WS Q100
Crit Q100
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
510
500
490
480
470
460
450
440
-200
0
200
400
600
800

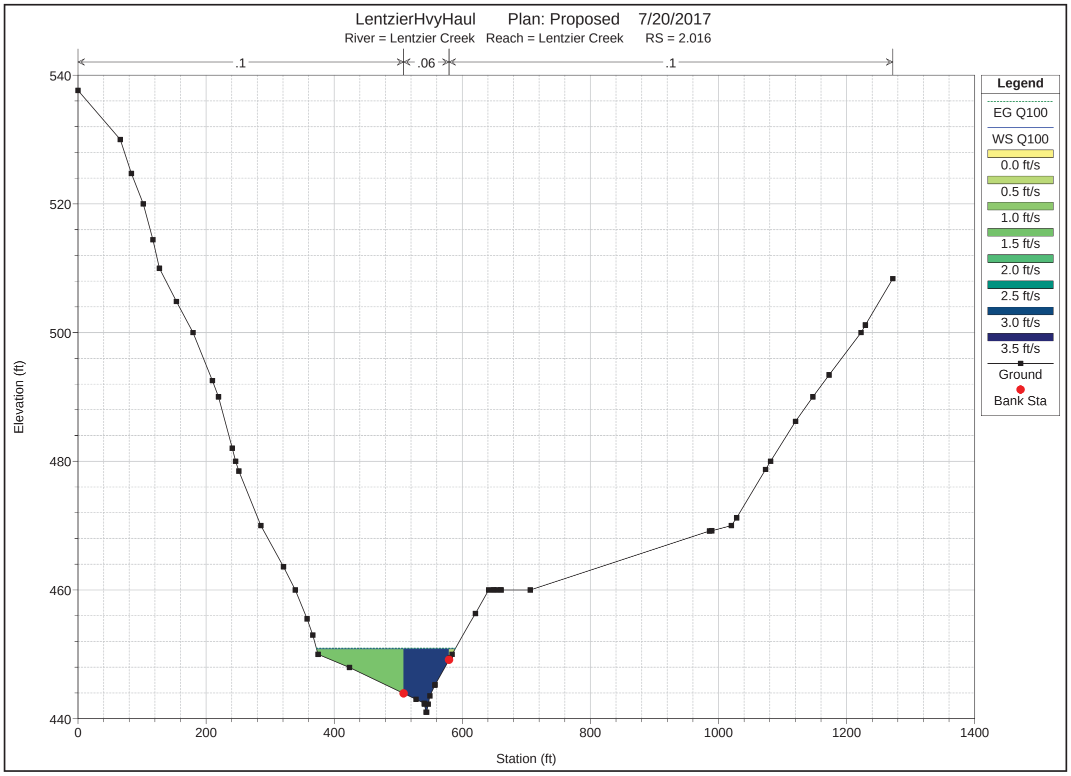

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.199 D/S Xsect of Proposed Bridge
.1
.06
.1
Legend
EG Q100
WS Q100
Crit Q100
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
510
500
490
480
470
460
450
440
-200
0
200
400
600
800


LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.155
.1
.06
.1
Legend
EG Q100
WS Q100
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
510
500
490
480
470
460
450
440
0
200
400
600
800
1000
1200

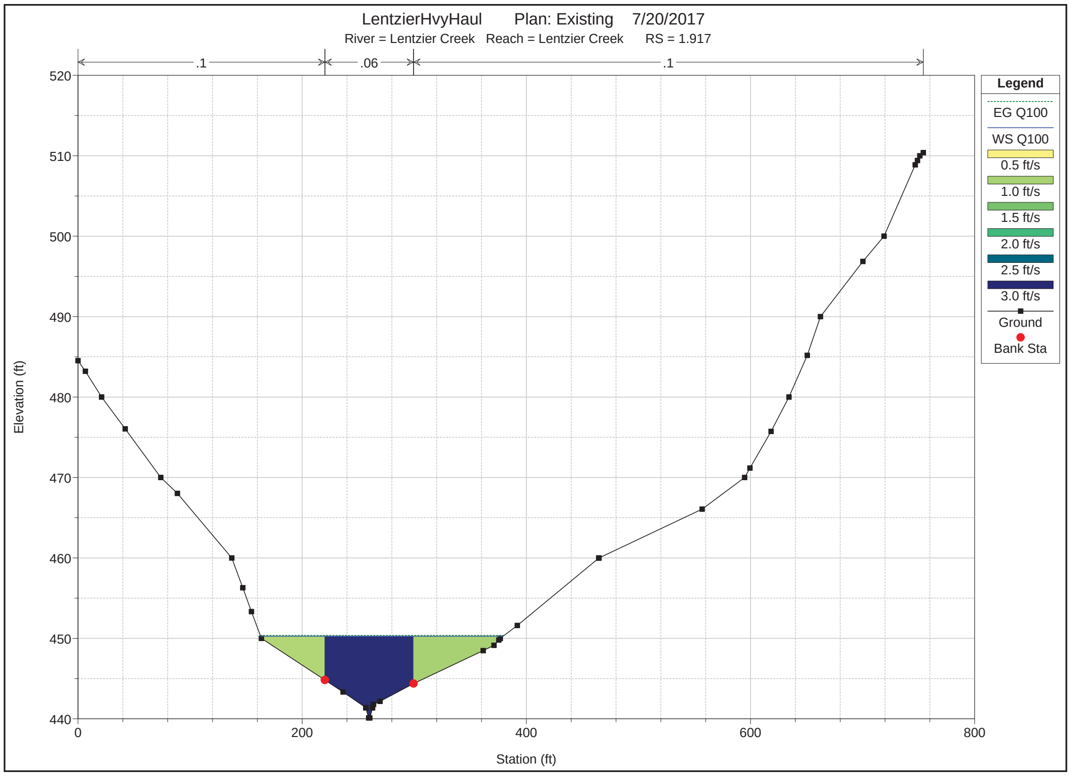

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.155
.1
.06
.1
Legend
EG Q100
WS Q100
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
510
500
490
480
470
460
450
440
0
200
400
600
800
1000
1200

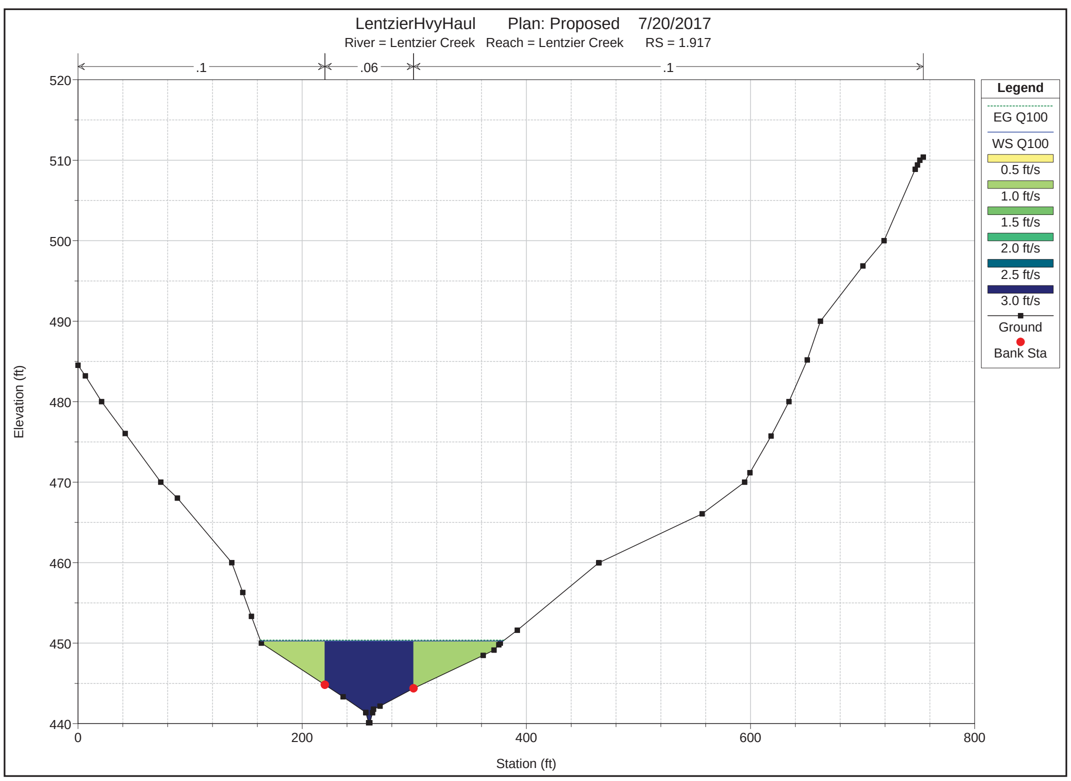


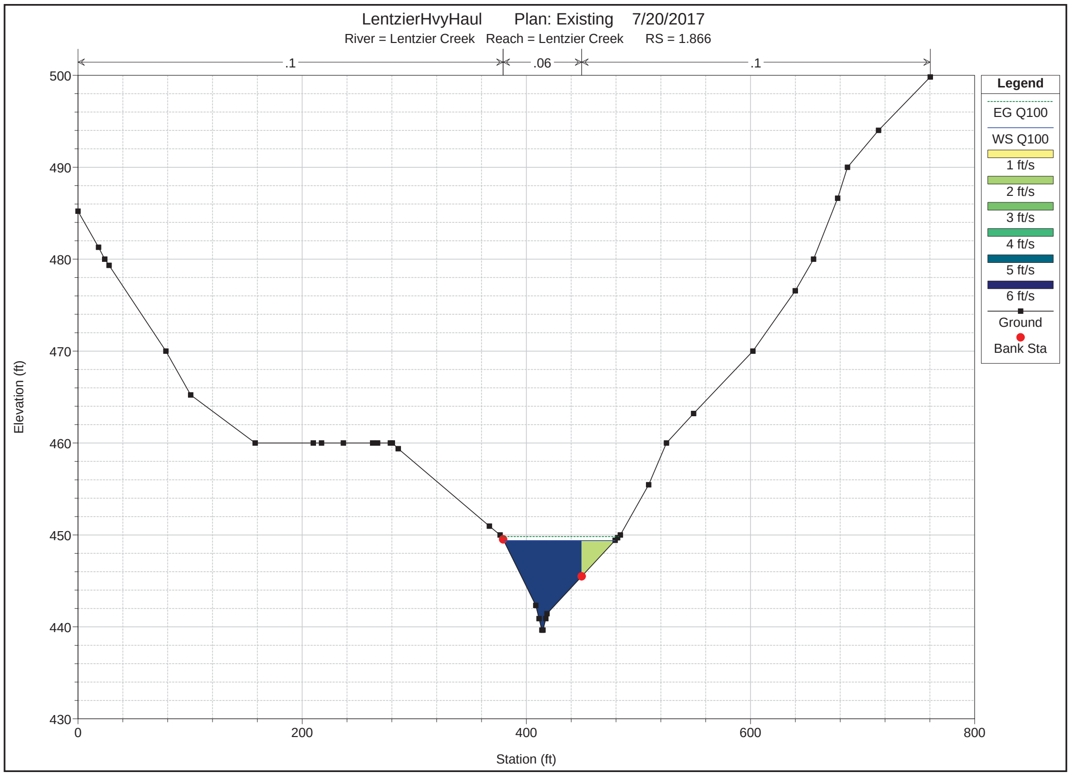
LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.016
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
Ground
Bank Sta

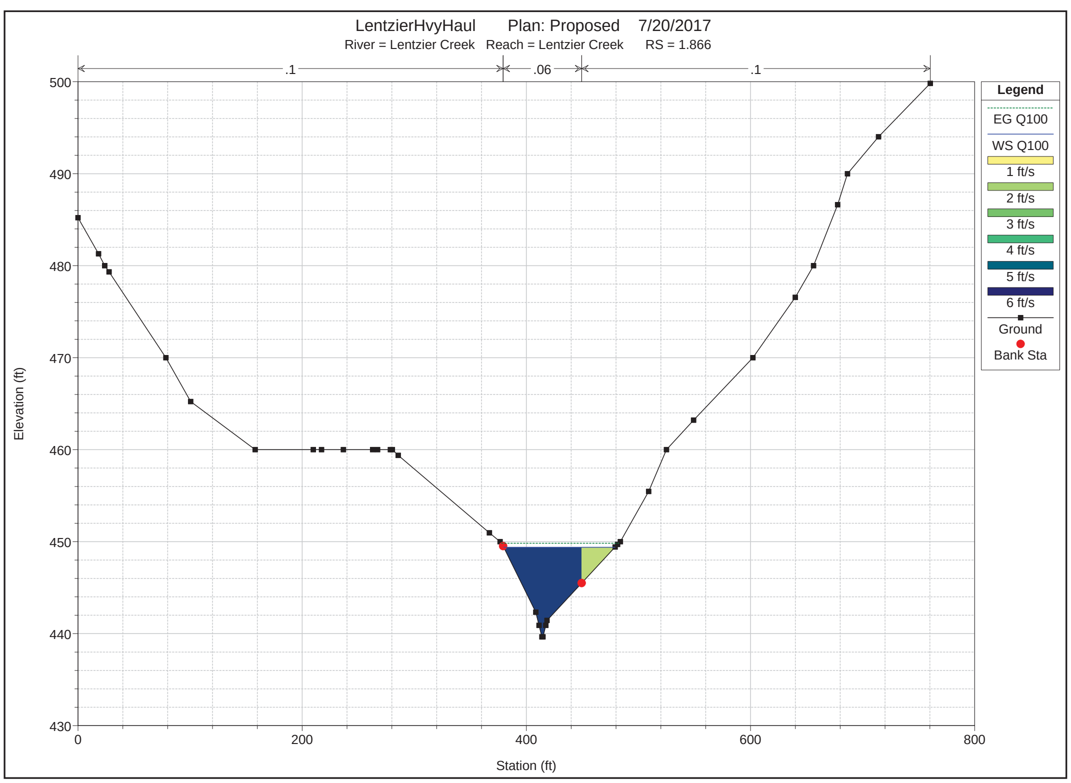


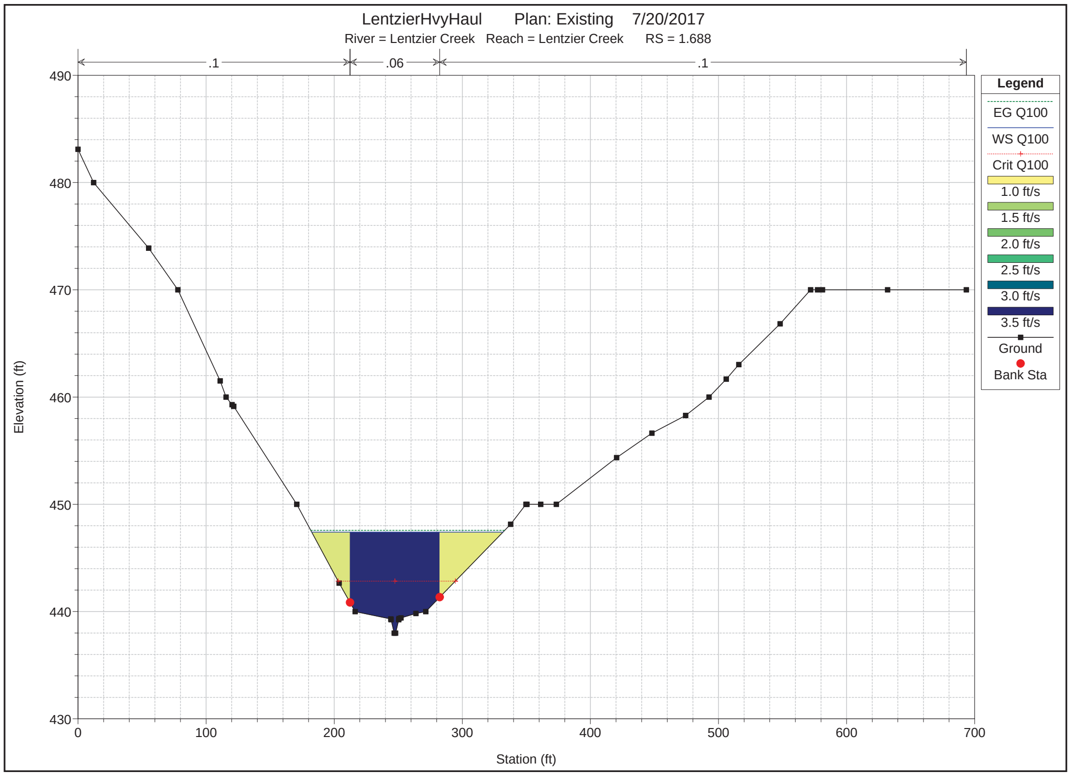
LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 2.016
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
Ground
Bank Sta

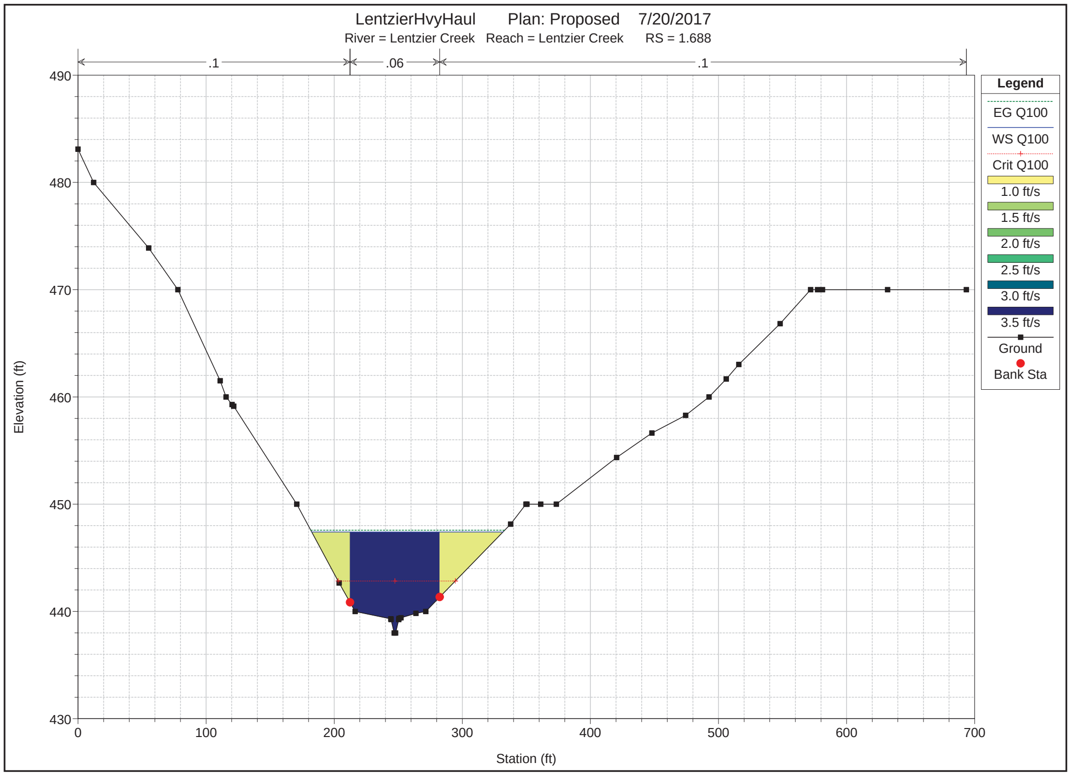

LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 1.917
.1
.06
.1
Legend
EG Q100
WS Q100
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
520
510
500
490
480
470
460
450
440
0
200
400
600
800

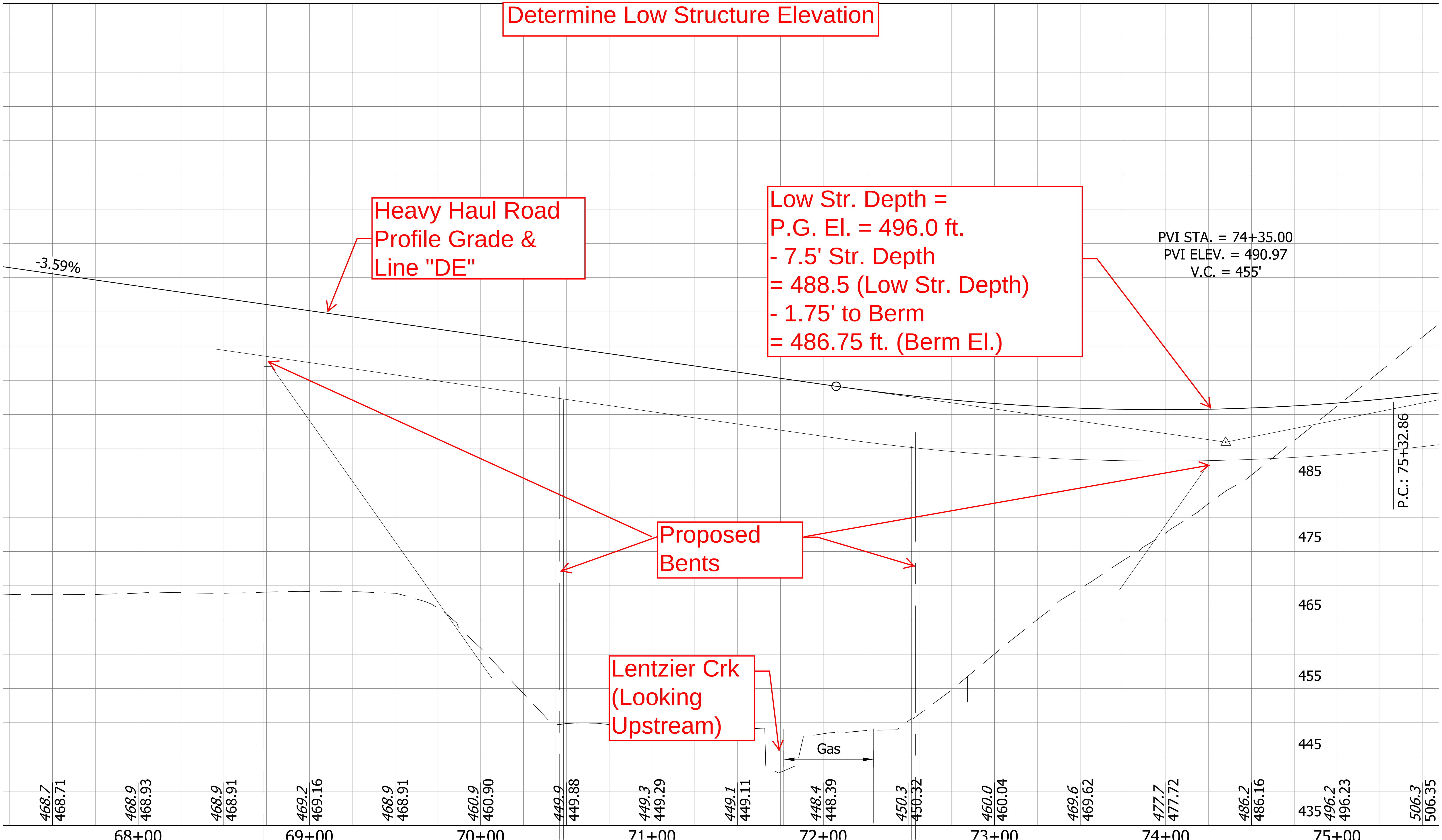

LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 1.917
.1
.06
.1
Legend
EG Q100
WS Q100
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
520
510
500
490
480
470
460
450
440
0
200
400
600
800


LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 1.866
.1
.06
.1
Elevation (ft)
500
490
480
470
460
450
440
430
0
200
400
600
800
Station (ft)
Legend
EG Q100
WS Q100
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta


LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 1.866
.1
.06
.1
Elevation (ft)
500
490
480
470
460
450
440
430
0
200
400
600
800
Station (ft)
Legend
EG Q100
WS Q100
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta

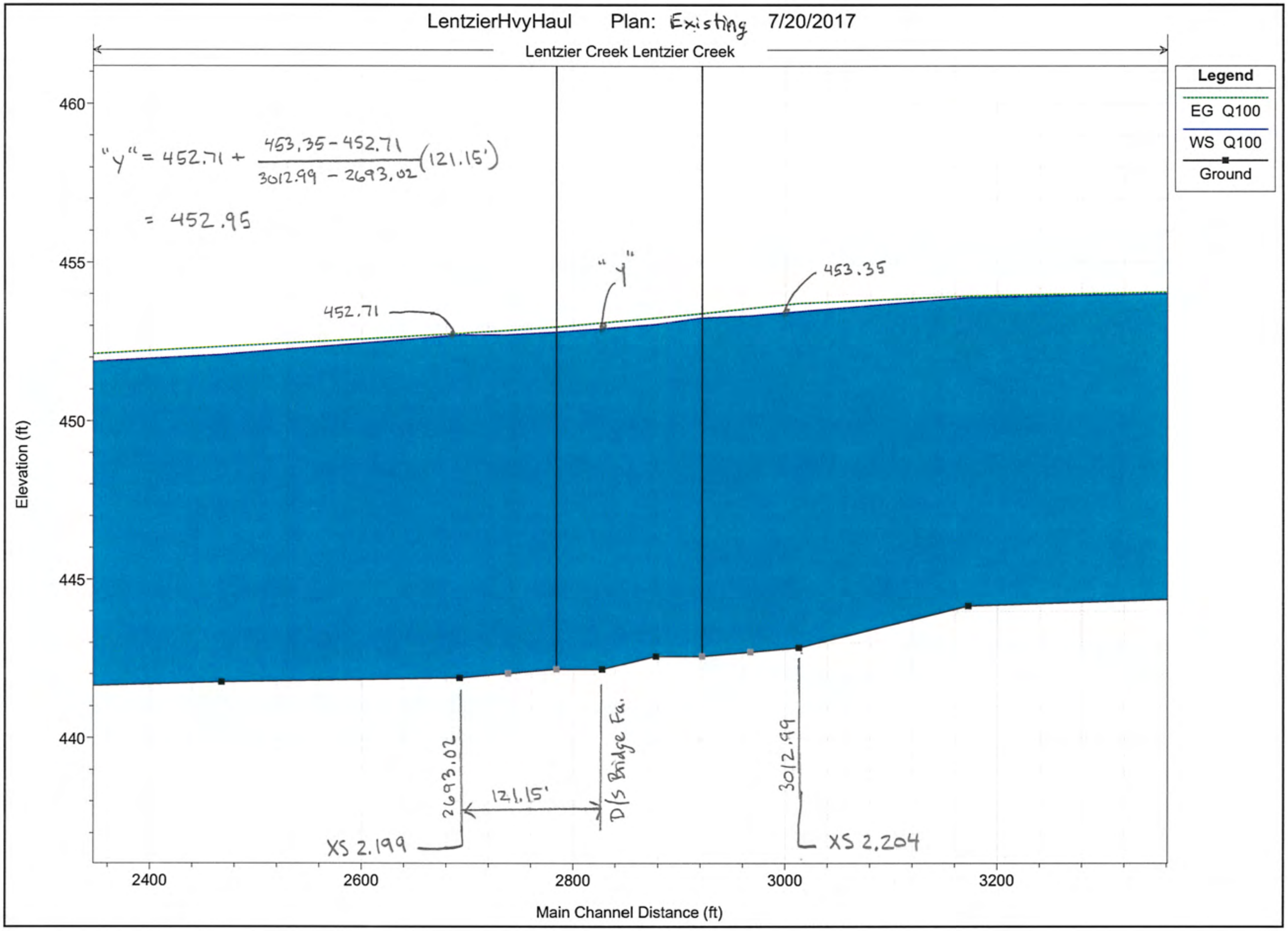

LentzierHvyHaul Plan: Existing 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 1.688
.1
.06
.1
Legend
EG Q100
WS Q100
Crit Q100
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


LentzierHvyHaul Plan: Proposed 7/20/2017
River = Lentzier Creek Reach = Lentzier Creek RS = 1.688
.1
.06
.1
Legend
EG Q100
WS Q100
Crit Q100
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

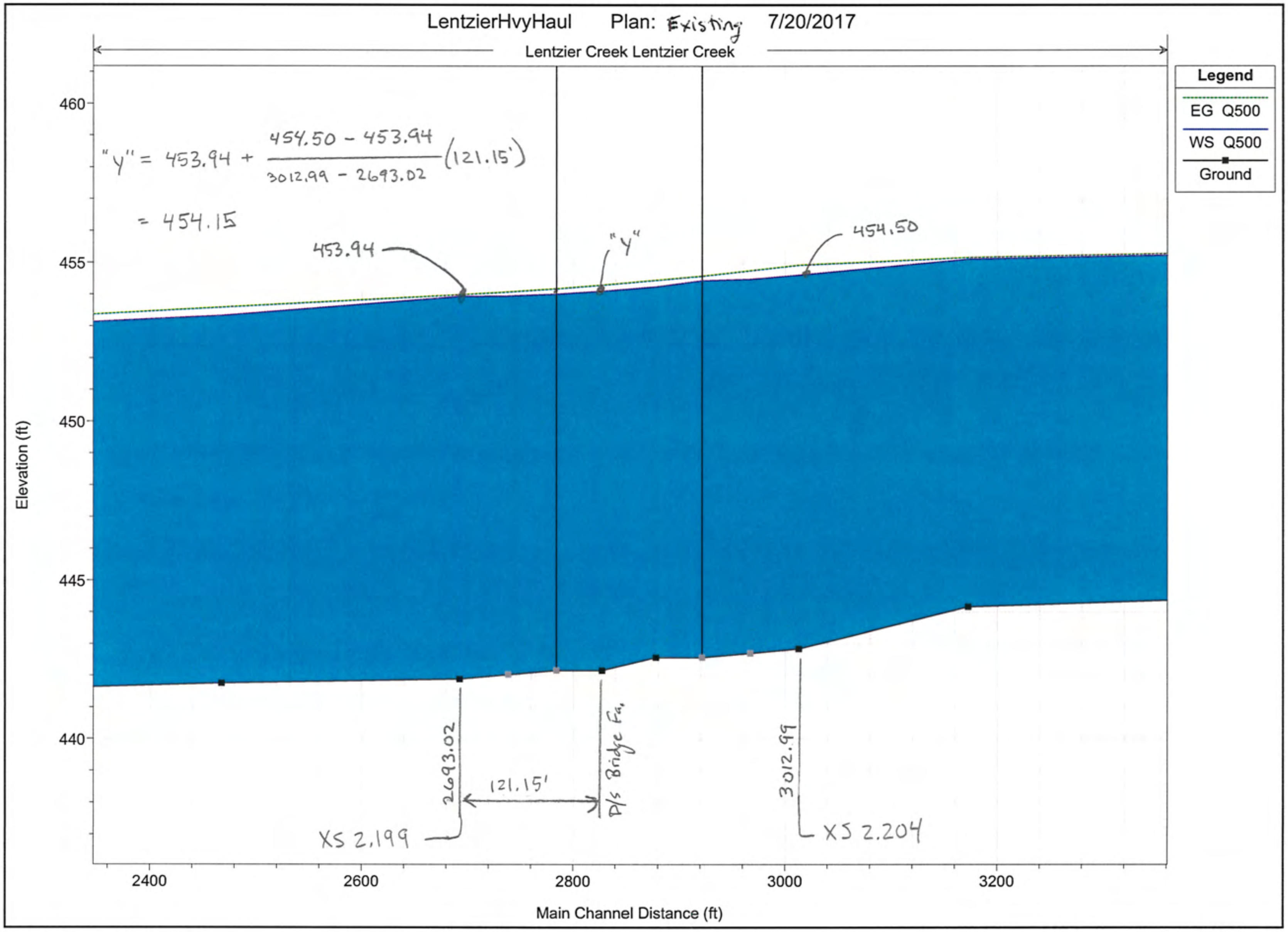


PROPOSED ELEVATION

Determine Q100 Elevation



Determine Q500 Elevation



HEC-RAS River: Lentzier Creek Reach: Lentzier Creek

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Lentzier Creek	2.253	Q100	Existing	1700.00	444.16	453.82		453.86	0.000684	2.53	1272.09	264.20	0.15
Lentzier Creek	2.253	Q100	Proposed	1700.00	444.16	453.90		453.95	0.000652	2.49	1293.93	264.99	0.15
Lentzier Creek	2.253	Q500	Existing	2380.00	444.16	455.02		455.07	0.000702	2.80	1596.33	275.62	0.16
Lentzier Creek	2.253	Q500	Proposed	2380.00	444.16	455.11		455.17	0.000669	2.75	1623.26	276.55	0.15
Lentzier Creek	2.204	Q100	Existing	1700.00	442.84	453.35		453.62	0.004461	5.70	515.74	108.41	0.34
Lentzier Creek	2.204	Q100	Proposed	1700.00	442.84	453.46		453.72	0.004197	5.58	527.23	108.97	0.33
Lentzier Creek	2.204	Q500	Existing	2380.00	442.84	454.50		454.82	0.004735	6.38	643.18	114.44	0.36
Lentzier Creek	2.204	Q500	Proposed	2380.00	442.84	454.62		454.93	0.004457	6.24	657.31	115.09	0.35
Lentzier Creek	2.20328*	Q100	Existing	1700.00	442.70	453.21	450.84	453.46	0.004000	5.46	554.56	123.36	0.33
Lentzier Creek	2.20328*	Q100	Proposed	1700.00	442.70	453.33	450.84	453.56	0.003730	5.32	569.00	124.15	0.32
Lentzier Creek	2.20328*	Q500	Existing	2380.00	442.70	454.36	451.48	454.64	0.004138	6.03	700.75	131.21	0.34
Lentzier Creek	2.20328*	Q500	Proposed	2380.00	442.70	454.49	451.48	454.76	0.003865	5.88	718.38	132.13	0.33
Lentzier Creek	2.20257*	Q100	Existing	1700.00	442.57	453.14	450.93	453.28	0.002636	4.48	726.40	237.46	0.27
Lentzier Creek	2.20257*	Q100	Proposed	1700.00	442.57	453.26	450.93	453.40	0.002422	4.34	748.13	241.34	0.26
Lentzier Creek	2.20257*	Q500	Existing	2380.00	442.57	454.30	451.44	454.46	0.002500	4.75	932.26	273.87	0.27
Lentzier Creek	2.20257*	Q500	Proposed	2380.00	442.57	454.44	451.44	454.59	0.002313	4.61	957.22	278.23	0.26
Lentzier Creek	2.20042*	Q100	Existing	1700.00	442.16	452.81	450.77	452.97	0.002662	4.53	729.10	192.51	0.27
Lentzier Creek	2.20042*	Q100	Proposed	1700.00	442.16	452.81	450.77	452.97	0.002662	4.53	729.10	192.51	0.27
Lentzier Creek	2.20042*	Q500	Existing	2380.00	442.16	454.02	451.31	454.18	0.002400	4.70	967.03	200.75	0.26
Lentzier Creek	2.20042*	Q500	Proposed	2380.00	442.16	454.02	451.31	454.18	0.002400	4.70	967.03	200.75	0.26

Q100 Backwater is 0.12 ft.
Q500 Backwater is 0.14 ft.

Q100

Flow Distribution Output

File Type Options Help

River: Lentzier Creek Profile: Q100

Reach: Lentzier Creek RS: 2.201 BR U Plan: Proposed

Plan: Proposed Lentzier Creek Lentzier Creek RS: 2.201 BR U Profile: Q100

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)	Shear (lb/sq ft)	Power (lb/ft s)
10	Chan	308.49	309.12	30.77	5.72	0.68	1.81	9.14	5.38	1.72	9.25
11	Chan	309.12	309.74	32.69	5.89	0.67	1.92	9.41	5.55	1.80	9.99
12	Chan	309.74	310.37	34.61	6.00	0.65	2.04	9.60	5.76	1.91	10.98
13	Chan	310.37	310.99	35.61	6.11	0.65	2.09	9.76	5.83	1.94	11.30
14	Chan	310.99	311.62	36.62	6.21	0.65	2.15	9.92	5.90	1.97	11.62
15	Chan	311.62	312.25	37.63	6.31	0.65	2.21	10.09	5.96	2.00	11.94
16	Chan	312.25	312.87	38.66	6.42	0.65	2.27	10.25	6.03	2.04	12.27
17	Chan	312.87	313.50	39.60	6.52	0.65	2.33	10.42	6.07	2.06	12.52
18	Chan	313.50	314.12	38.01	6.47	0.68	2.24	10.34	5.87	1.96	11.52
19	Chan	314.12	314.75	36.43	6.31	0.68	2.14	10.08	5.78	1.91	11.04
20	Chan	314.75	315.37	34.88	6.14	0.68	2.05	9.82	5.68	1.86	10.57
21	Chan	315.37	316.00	33.35	5.98	0.68	1.96	9.56	5.58	1.81	10.11
22	Chan	316.00	316.63	31.85	5.82	0.68	1.87	9.30	5.47	1.76	9.65
23	Chan	316.63	317.25	30.38	5.66	0.68	1.79	9.04	5.37	1.71	9.21
24	Chan	317.25	317.88	28.94	5.49	0.68	1.70	8.78	5.27	1.66	[illegible]

Max. Velocity

Flow Distribution Output

File Type Options Help

River: Lentzier Creek Profile: Q100

Reach: Lentzier Creek RS: 2.201 BR D Plan: Proposed

Plan: Proposed Lentzier Creek Lentzier Creek RS: 2.201 BR D Profile: Q100

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)	Shear (lb/sq ft)	Power (lb/ft s)
13	Chan	307.77	308.52	37.98	7.23	0.77	2.23	9.62	5.26	1.59	8.38
14	Chan	308.52	309.27	39.25	7.35	0.77	2.31	9.78	5.34	1.63	8.73
15	Chan	309.27	310.02	40.32	7.47	0.77	2.37	9.94	5.40	1.66	8.97
16	Chan	310.02	310.77	41.41	7.59	0.77	2.44	10.11	5.46	1.69	9.21
17	Chan	310.77	311.52	42.51	7.71	0.77	2.50	10.27	5.52	1.71	9.45
18	Chan	311.52	312.27	43.62	7.83	0.77	2.57	10.43	5.57	1.74	9.70
19	Chan	312.27	313.02	44.74	7.95	0.77	2.63	10.59	5.63	1.77	9.95
20	Chan	313.02	313.77	44.97	8.04	0.78	2.65	10.70	5.60	1.75	9.80
21	Chan	313.77	314.52	42.72	7.87	0.80	2.51	10.49	5.43	1.67	9.07
22	Chan	314.52	315.28	40.78	7.66	0.80	2.40	10.20	5.33	1.63	8.66
23	Chan	315.28	316.03	38.88	7.44	0.80	2.29	9.91	5.22	1.58	8.26
24	Chan	316.03	316.78	37.02	7.23	0.80	2.18	9.62	5.12	1.53	7.86
25	Chan	316.78	317.53	35.18	7.01	0.80	2.07	9.34	5.02	1.49	7.47
26	Chan	317.53	318.28	20.96	6.60	1.50	1.23	8.79	3.18	0.75	2.38
27	Chan	318.28	319.03	10.87	5.21	2.23	0.64	6.93	2.09	0.40	0.83

Q500

Flow Distribution Output

File Type Options Help

River: Lentzier Creek Profile: Q500

Reach: Lentzier Creek RS: 2.201 BR U Plan: Proposed

Plan: Proposed Lentzier Creek Lentzier Creek RS: 2.201 BR U Profile: Q500

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)	Shear (lb/sq ft)	Power (lb/ft s)
13	Chan	310.37	310.99	42.44	6.85	0.65	1.78	10.95	6.19	2.07	12.83
14	Chan	310.99	311.62	43.51	6.95	0.65	1.83	11.11	6.26	2.10	13.15
15	Chan	311.62	312.25	44.59	7.06	0.65	1.87	11.28	6.32	2.13	13.48
16	Chan	312.25	312.87	45.68	7.16	0.65	1.92	11.44	6.38	2.16	13.81
17	Chan	312.87	313.50	46.66	7.26	0.65	1.96	11.61	6.43	2.19	14.06
18	Chan	313.50	314.12	44.84	7.21	0.68	1.88	11.53	6.22	2.08	12.94
19	Chan	314.12	314.75	43.17	7.05	0.68	1.81	11.27	6.12	2.04	12.46
20	Chan	314.75	315.37	41.52	6.89	0.68	1.74	11.01	6.03	1.99	11.98
21	Chan	315.37	316.00	39.90	6.72	0.68	1.68	10.75	5.93	1.94	11.52
22	Chan	316.00	316.63	38.30	6.56	0.68	1.61	10.49	5.84	1.89	11.06
23	Chan	316.63	317.25	36.73	6.40	0.68	1.54	10.23	5.74	1.85	10.60
24	Chan	317.25	317.88	35.19	6.24	0.68	1.48	9.97	5.64	1.80	10.16
25	Chan	317.88	318.50	27.35	5.99	0.90	1.15	9.58	4.56	1.31	5.97
26	Chan	318.50	319.13	18.42	5.45	1.27	0.77	8.70	3.38	0.84	2.83
27	Chan	319.13	319.75	13.42	4.68	1.40	0.56	7.48	2.87	0.65	1.87

Errors, Warnings and Notes

Max. Velocity

Flow Distribution Output

File Type Options Help

River: Lentzier Creek Profile: Q500

Reach: Lentzier Creek RS: 2.201 BR D Plan: Proposed

Plan: Proposed Lentzier Creek Lentzier Creek RS: 2.201 BR D Profile: Q500

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)	Shear (lb/sq ft)	Power (lb/ft s)
14	Chan	308.52	309.27	46.71	8.25	0.77	1.96	10.98	5.66	1.74	9.84
15	Chan	309.27	310.02	47.85	8.37	0.77	2.01	11.14	5.72	1.76	10.08
16	Chan	310.02	310.77	49.00	8.49	0.77	2.06	11.30	5.77	1.79	10.32
17	Chan	310.77	311.52	50.16	8.61	0.77	2.11	11.46	5.83	1.81	10.57
18	Chan	311.52	312.27	51.33	8.73	0.77	2.16	11.62	5.88	1.84	10.82
19	Chan	312.27	313.02	52.52	8.85	0.77	2.21	11.78	5.94	1.86	11.07
20	Chan	313.02	313.77	52.68	8.93	0.78	2.21	11.90	5.90	1.84	10.88
21	Chan	313.77	314.52	50.22	8.77	0.80	2.11	11.69	5.72	1.76	10.10
22	Chan	314.52	315.28	48.18	8.56	0.80	2.02	11.40	5.63	1.72	9.69
23	Chan	315.28	316.03	46.17	8.34	0.80	1.94	11.11	5.54	1.68	9.29
24	Chan	316.03	316.78	44.19	8.12	0.80	1.86	10.82	5.44	1.63	8.89
25	Chan	316.78	317.53	42.23	7.91	0.80	1.77	10.53	5.34	1.59	8.49
26	Chan	317.53	318.28	25.46	7.50	1.50	1.07	9.99	3.40	0.81	2.74
27	Chan	318.28	319.03	13.92	6.10	2.23	0.58	8.13	2.28	0.44	1.01
28	Chan	319.03	319.78	8.60	4.54	2.19	0.36	6.05	1.89	0.34	0.63

Determine Q_{100} Waterway Area

Plan: Proposed Lentzier Creek Lentzier Creek RS: 2.201 Profile: Q100

E.G. US. (ft)	453.40	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	453.26	E.G. Elev (ft)	453.26	453.10
Q Total (cfs)	1700.00	W.S. Elev (ft)	453.06	452.92
Q Bridge (cfs)	1700.00	Crit W.S. (ft)	450.91	450.77
Q Weir (cfs)		Max Chl Dpth (ft)	10.49	10.76
Weir Sta Lft (ft)		Vel Total (ft/s)	2.58	2.38
Weir Sta Rgt (ft)		Flow Area (sq ft)	657.86	712.79
Weir Submerg		Froude # Chl	0.30	0.28
Weir Max Depth (ft)		Specif Force (cu ft)	1795.12	1896.84
Min El Weir Flow (ft)	495.91	Hydr Depth (ft)	4.04	3.89
Min El Prs (ft)	503.00	W.P. Total (ft)	179.18	204.46
Delta EG (ft)	0.42	Conv. Total (cfs)	29641.0	32510.3
Delta WS (ft)	0.45	Top Width (ft)	162.88	183.24
BR Open Area (sq ft)	12580.59	Frctn Loss (ft)	0.15	0.12
BR Open Vel (ft/s)	2.58	C & E Loss (ft)	0.01	0.01
Coef of Q		Shear Total (lb/sq ft)	0.75	0.60
Br Sel Method	Energy only	Power Total (lb/ft s)	28.93	-28.93

Average Velocity (2.58)

Net Area (712.79)

Add Area of Piers : (452.95 [Q_{100}] − 448.6 [Approx. Ground Line]) 2 Piers (5' width) = 43.5 SFT

Add Area above Q_{100} : (452.95 − 452.92) 183.24 [Top width] = 5.5 SFT

Total Q_{100} Waterway Area = 712.79 + 43.5 + 5.5

= 761.79

USE 762 SFT

Determine Q_{500} Waterway Area

Plan: Proposed   Lentzier Creek   Lentzier Creek RS: 2.201   Profile: Q500

E.G. US. (ft)	454.59	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	454.44	E.G. Elev (ft)	454.46	454.30
Q Total (cfs)	2380.00	W.S. Elev (ft)	454.25	454.11
Q Bridge (cfs)	2380.00	Crit W.S. (ft)	451.49	451.35
Q Weir (cfs)		Max Chl Dpth (ft)	11.68	11.95
Weir Sta Lft (ft)		Vel Total (ft/s)	2.78	2.54
Weir Sta Rgt (ft)		Flow Area (sq ft)	855.08	937.05
Weir Submerg		Froude # Chl	0.30	0.28
Weir Max Depth (ft)		Specif Force (cu ft)	2769.45	2953.53
Min El Weir Flow (ft)	495.91	Hydr Depth (ft)	5.09	4.90
Min El Prs (ft)	503.00	W.P. Total (ft)	189.39	217.75
Delta EG (ft)	0.41	Conv. Total (cfs)	42517.3	46758.8
Delta WS (ft)	0.42	Top Width (ft)	175.80	191.40
BR Open Area (sq ft)	12580.59	Frctn Loss (ft)	0.14	0.11
BR Open Vel (ft/s)	2.78	C & E Loss (ft)	0.01	0.01
Coef of Q		Shear Total (lb/sq ft)	0.88	0.70
Br Sel Method	Energy only	Power Total (lb/ft s)	28.93	-28.93

Average Velocity

Net Area

Add Area of Piers: (454.15 [Q_{500}] - 448.6) 2 (5' width) = 55.5 SFT

Add Area above Q_{500}: (454.15 - 454.11) 191.40 = 7.7 SFT

Total Q_{500} Waterway Area = 937.05 + 55.5 + 7.7

= 1000.25

USE 1,001 SFT

Q100

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	4.40	8.86	3.91
	Approach Velocity (ft/s):	2.56	5.58	2.33
	Br Average Depth (ft):	3.83	8.63	3.33
	BR Opening Flow (cfs):	425.79	710.88	563.32
	BR Top WD (ft):	58.36	16.27	88.25
	Grain Size D50 (mm):	0.01	0.01	0.01
	Approach Flow (cfs):	719.83	697.01	283.16
	Approach Top WD (ft):	63.81	14.10	31.06
	K1 Coefficient:	0.690	0.690	0.690
Results				
	Scour Depth Ys (ft):	0.00	0.00	0.10
	Critical Velocity (ft/s):			
	Equation:	Live	Live	Live

Pier Scour

All piers have the same scour depth

Input Data		
	Pier Shape:	Round nose
	Pier Width (ft):	5.00
	Grain Size D50 (mm):	0.01000
	Depth Upstream (ft):	8.83
	Velocity Upstream (ft/s):	4.34
	K1 Nose Shape:	1.00
	Pier Angle:	0.00
	Pier Length (ft):	50.33
	K2 Angle Coef:	1.00
	K3 Bed Cond Coef:	1.10
	Grain Size D90 (mm):	
	K4 Armouring Coef:	1.00
Results		
	Scour Depth Ys (ft):	7.49
	Froude #:	0.26
	Equation:	CSU equation

Combined Scour Depths

Pier Scour + Contraction Scour (ft):

Left Bank:	7.49
Right Bank:	7.59

Use 8 ft.

Q500

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	5.30	10.02	4.72
	Approach Velocity (ft/s):	2.99	6.24	2.72
	Br Average Depth (ft):	4.74	9.82	4.47
	BR Opening Flow (cfs):	620.94	860.07	898.99
	BR Top WD (ft):	62.26	16.27	89.62
	Grain Size D50 (mm):	0.01	0.01	0.01
	Approach Flow (cfs):	1066.16	881.81	432.03
	Approach Top WD (ft):	67.30	14.10	33.68
	K1 Coefficient:	0.69	0.69	0.69
Results				
	Scour Depth Ys (ft):	0.00	0.00	0.03
	Critical Velocity (ft/s):			
	Equation:	Live	Live	Live

Pier Scour

All piers have the same scour depth

Input Data		
	Pier Shape:	Round nose
	Pier Width (ft):	5.00
	Grain Size D50 (mm):	0.01000
	Depth Upstream (ft):	10.02
	Velocity Upstream (ft/s):	4.61
	K1 Nose Shape:	1.00
	Pier Angle:	0.00
	Pier Length (ft):	72.00
	K2 Angle Coef:	1.00
	K3 Bed Cond Coef:	1.10
	Grain Size D90 (mm):	
	K4 Armouring Coef:	1.00
Results		
	Scour Depth Ys (ft):	7.82
	Froude #:	0.26
	Equation:	CSU equation

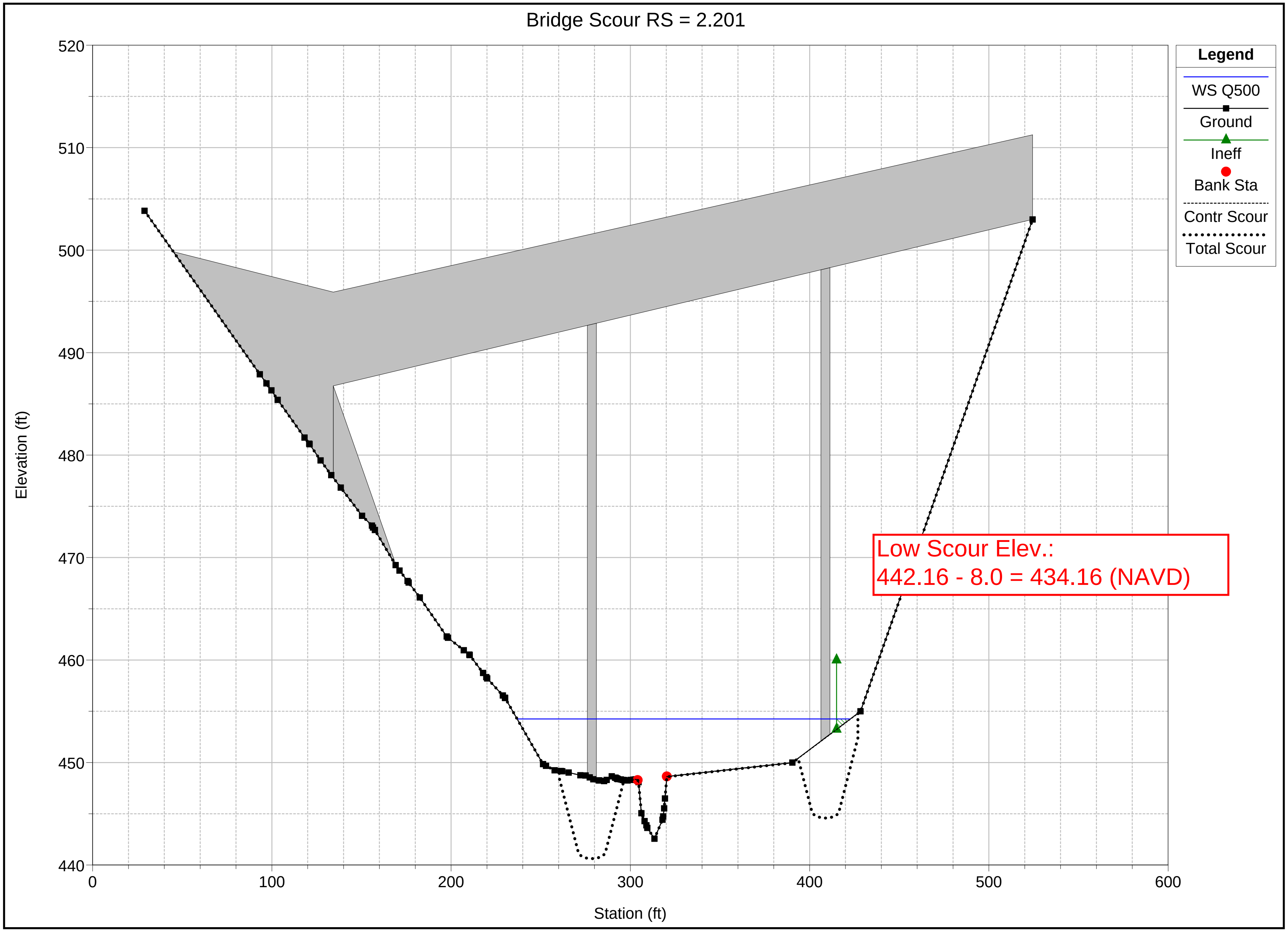
Combined Scour Depths

Pier Scour + Contraction Scour (ft):

Left Bank:	7.82
Right Bank:	7.85

Use 8 ft.

Q100 & Q500



Bridge Scour RS = 2.201
Legend
WS Q500
Ground
Ineff
Bank Sta
Contr Scour
Total Scour
Elevation (ft)
Station (ft)
520
510
500
490
480
470
460
450
440
0
100
200
300
400
500
600
Low Scour Elev.:
442.16 - 8.0 = 434.16 (NAVD)

Scour Countermeasures

Erosion-Protection Method	Velocity, *v* (ft/s)
Revetment Riprap	≤ 6.5
Class 1 Riprap	$6.5 < v < 10$
Class 2 Riprap	$10 \leq v \leq 13$
Energy Dissipator	> 13

Revetment required per max. stream velocity in channel

Note: If clear-zone or other issues prohibit the use of the required erosion-protection method, the Office of Hydraulics should be contacted for additional instructions.

STREAM VELOCITY FOR EROSION PROTECTION

Figure 203-2D

Back

Scour Countermeasure

Type	Minimum Thickness	
	Abutment	**Pier**
Revetment	1.5 ft	2.0 ft
Class 1	2.0 ft	3.0 ft
Class 2	2.5 ft	4.0 ft

2' thickness of Revetment around the piers

Riprap-Lay Thickness

Note: The thickness is measured such that the top is at the ground elevation.

Substructure Type	Lay Width
Sloping Abutment	The cone is covered top to toe, a square toe trench is placed below the riprap, based on lay thickness.
Vertical Abutment	2 times the water depth or a minimum of 10 ft
Pier	2 times the pier width or a minimum of 6 ft. The lay width is from the outside wall of the pier, all the way around.

2x5' = 10' > 6', USE 10'

Riprap-Lay Width

Note: For an oversized-box or three-sided structure, see the INDOT *Standard Drawings*.

RIPRAP SCOUR PROTECTION

Figure 203-3B

If scour countermeasures are provided then lay Revetment Riprap a minimum of 10 ft. wide from the face of the pier for the entire pier's perimeter. The Revetment Riprap minimum thickness shall be 2 ft.

Back

cHECk-RAS Report

Existing Model

HEC-RAS Project: *lentzierhvyhaul.prj*
Plan File: *lentzierhvyhaul.p01*
Geometry File: *lentzierhvyhaul.g01*
Flow File: *lentzierhvyhaul.f01*
Report Date: *7/20/2017*

Message ID	Message	Cross sections affected	Comments
MP SW 01DK	The name of the stream is ($streamname$). The flow regime is subcritical or mixed flow. Starting water-surface elevations are computed from Known WSELs as the downstream boundary condition. Provide backup information on Known water-surface elevations or use same energy slope for all the profiles as the starting boundary condition and rerun the plan.		
NT TL 02	Contraction and expansion loss coefficients are cc and ce, respectively. However, this cross section is not at a hydraulic structure. They should be equal to 0.1 and 0.3 according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	2.199; 2.19971; 2.20042; 2.20257; 2.20328	
XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The $assignedname$ WSEL of $wsel$ is higher than the ground elevation $grelv$ of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of $ineffelr$. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	2.199; 2.20257	

cHECk-RAS Report

Proposed Model

HEC-RAS Project:	*lentzierhvyhaul.prj*
Plan File:	*lentzierhvyhaul.p02*
Geometry File:	*lentzierhvyhaul.g02*
Flow File:	*lentzierhvyhaul.f01*
Report Date:	*7/20/2017*

Message ID	Message	Cross sections affected	Comments
BR LF 01	This is ($strucname$). The selected profile is $profilename$. Type of flow is low flow because, 1. EGEL 3 of $egel3$ is less than or equal to MinTopRd of $minelweirflow$. 2. EGEL 3 of $egel3$ is less than MxLoCdU of $mxlocdu$.	2.201(Bridge-UP)	
MP SW 01DK	The name of the stream is ($streamname$). The flow regime is subcritical or mixed flow. Starting water-surface elevations are computed from Known WSELs as the downstream boundary condition. Provide backup information on Known water-surface elevations or use same energy slope for all the profiles as the starting boundary condition and rerun the plan.		Taken from IDNR HEC-RAS model & verified with Indiana Floodplain Information Portal
NT TL 02	Contraction and expansion loss coefficients are cc and ce, respectively. However, this cross section is not at a hydraulic structure. They should be equal to 0.1 and 0.3 according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	2.199	The floodplain naturally contracts and expands at this cross section.
ST DT 01B	This is ($strucname$). 'Upstream Dist' of $distup$ in "Bridge Width Table" is less than the height of the bridge opening of $height$. This indicates that Section 3 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 3 should be relocated or provide a statement that it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 4, 3 and 2 and 'Upstream Dist' should be adjusted.	2.201(Bridge-UP)	The bridge height is approximately 50 ft. above the channel. Additional cross sections were added between the bridge and section 3 because the flood width varies significantly and it helps represent the natural valley.
ST DT 02B	This is ($strucname$). 'Downstream Dist' of $distdn$ in 'Bridge Width Table' is less than the height of the bridge opening of $height$. This indicates that Section 2 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 2 should be relocated or provide a statement that it represents the natural valley cross section. A HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 3 and 2 should be adjusted.	2.201(Bridge-DN)	The bridge height is approximately 50 ft. above the channel. Additional cross sections were added between the bridge and section 2 because the flood width varies significantly and it helps represent the natural valley.

ST GD 02BD	This is the Downstream Bridge Section. There is only one bridge. However, the low cord line crosses the ground line at more than two locations. The ground and deck/roadway data should be checked.	2.201(Bridge)	Geometry verified and additional low chord to ground line could not be identified.
ST GD 02BU	This is the Upstream Bridge Section. There is only one bridge. However, the low cord line crosses the ground line at more than two locations. The ground and deck/roadway data should be checked.	2.201(Bridge)	Geometry verified and additional low chord to ground line could not be identified.
ST IF 01S2L	This is Section 2 of a hydraulic structure. The highest flood frequency that has low or pressure flow is $profilename$. However, the Left Ineffective Flow station was not considered at Section 2. The ineffective flow station and elevation should be inserted. The left ineffective flow elevation should be equal to wsel2 of $wsel$. The placement of the left ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	2.201(Bridge)	The channel and structure is not typical. The flow does not contract at the structure because the structure completely spans the floodplain.
ST IF 01S3L	This is Section 3. The highest flood frequency that has low or pressure flow is $profilename$. However, the Left Ineffective Flow station was not considered at Section 3. The ineffective flow station and elevation should be inserted. The left ineffective flow elevation should be equal to lmntprdu of $lmntprdu$. The placement of the left ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	2.201(Bridge)	The channel and structure is not typical. The flow does not contract at the structure because the structure completely spans the floodplain.
ST IF 05S3R	This is Section 3 of a hydraulic structure. The right ineffective flow station is within the opening area of the structure. The right ineffective flow station of $ineffstar$ is less than the upstream right abutment station of $abutstar$ at ($strucname$). The Right ineffective flow station should be adjusted.	2.20257(Bridge)	The channel and structure is not typical. The flow does not contract at the structure because the structure completely spans the floodplain. The IF is due to natural conditions.
ST IF 06S2R	This is Section 2. The selected profile is $profilename$. Low or pressure flow occurs at ($strucname$). The Dn_Dist of $dndist$ at the structure is less than the opening height of $openheight$ of the structure. The cHECk-RAS computed right ineffective flow station of $compineffstar$ is greater than the input right ineffective flow station of $ineffstar$. The right ineffective flow station should be adjusted per the help instructions and the HEC-RAS manual.	2.20042(Bridge)	The channel and structure is not typical. The flow does not contract at the structure because the structure completely spans the floodplain. The IF is due to natural conditions.

ST IF 06S3R	This is Section 3. The selected profile is $profilename$. Low or pressure flow occurs at ($strucname$). The Up_Dist of $updist$ at the structure is less than the opening height of $openheight$ of the structure. The cHECk-RAS computed right ineffective flow station of $compineffstar$ is greater than the input right ineffective flow station of $ineffstar$. The right ineffective flow station should be adjusted per the help instructions and the HEC-RAS manual.	2.20257(Bridge)	The channel and structure is not typical. The flow does not contract at the structure because the structure completely spans the floodplain. The IF is due to natural conditions.
ST IF 07S1R	This is Section 1. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 3 of the downstream structure.	2.19971(Bridge)	The bridge height is approximately 50 ft. above the channel. Additional cross sections were added between the bridge and section 2 because the flood width varies significantly and it helps represent the natural valley.
ST IF 07S4R	This is Section 4. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	2.20328(Bridge)	The bridge height is approximately 50 ft. above the channel. Additional cross sections were added between the bridge and section 2 because the flood width varies significantly and it helps represent the natural valley.
ST IF 09S2L	This is Section 2. The highest flood frequency that is having low flow or pressure flow is $profilename$. The leftineffective flow elevation, Ineff_El_Left, should be equal to or higher than the WSEL at Section 2. However, the Ineff_El_Left of $ineffell$ at the left ineffective flow station $ineffstal$ is lower than the WSEL of $wsel2$ at Section 2. The Ineff_El_Left should be raised to or above the WSEL at Section 2.	2.20042(Bridge)	The channel and structure is not typical. The flow does not contract at the structure because the structure completely spans the floodplain.

ST IF 09S3L	This is Section 3. The highest flood frequency that is having low flow or pressure flow is $profilename$. The left ineffective flow elevation, Ineff_El_Left, should be equal to or higher than the WSEL at Section 3. However, the Ineff_El_Left of $ineffell$ at the left ineffective flow station $ineffstal$ is lower than the WSEL of $wsel3$ at Section 3. The computed Left Upstream Minimum Top Road elevation, LMnTpRdU of $lmntprdu$ is higher than the WSEL of $wsel3$ at Section 3. The Ineff_El_Left should be raised to the computed LMnTpRdU.	2.20257(Bridge)	The bridge height is approximately 50 ft. above the channel. Additional cross sections were added between the bridge and section 3 because the flood width varies significantly and it helps represent the natural valley.
XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The $assignedname$ WSEL of $wsel$ is higher than the ground elevation $grelv$ of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of $ineffelr$. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	2.199	The channel and structure is not typical. The flow does not contract at the structure because the structure completely spans the floodplain. The IF is due to natural conditions.