

Modified Level II Streambed-Scour Analysis for I-65-124-4285 Crossing Bush's Run in Marion County, Indiana

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CONVERSION FACTORS AND ABBREVIATIONS

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
square foot (ft ²)	929.0	square centimeter
feet per second (ft/s)	0.3048	meters per second
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second
mile (mi)	1.609	kilometer
square mile (mi ²)	2.590	square kilometer

Abbreviations used in this report:

D ₅₀	median diameter of bed material
Q100	100-year discharge
FEMA	Federal Emergency Management Agency
HEC	Hydraulic Engineering Circular
IDNR	Indiana Department of Natural Resources
INDOT	Indiana Department of Transportation
USGS	U. S. Geological Survey
WSPRO	Water Surface PROfile model

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By Robert L. Miller, Bret A. Robinson, *and* David C. Voelker

ABSTRACT

Level II scour evaluations follow a process in which hydrologic, hydraulic, and sediment-transport data are evaluated to calculate the depth of scour that may result when a given discharge is routed through a bridge opening. The results of the modified Level II analysis for I-65-124-4285 (interstate, north-bound ramp, and south-bound ramp bridges) where Interstate 65 crosses Bush's Run in Marion County, Indiana, are presented. The site is in the city of Indianapolis and in the northwestern part of Marion County. Scour depths were computed with the Water Surface PROfile model, version V050196, which incorporates the scour-calculation procedures outlined in Hydraulic Engineering Circular No. 18. For the interstate bridge, total scour depths at the piers were approximately 7.2 feet for the modeled discharge of 1,900 cubic feet per second and approximately 8.5 feet for the modeled discharge of 3,230 cubic feet per second. For the ramp bridges, contraction scour values ranged from 26.0 feet to 51.7 feet for the discharges modeled.

INTRODUCTION

The U.S. Geological Survey (USGS), in cooperation with the Indiana Department of Transportation (INDOT), is conducting Level II scour analyses at a number of bridges throughout Indiana. This report describes the methods applied and the modeling results for three bridges where interstate I-65 crosses Bush's Run.

Background and Scope

Level I scour assessment is a process where a large number of bridges are studied as a group. Assessments usually are made by evaluating a combination of geomorphic, hydrologic, and bridge-characteristic data. The results help investigators determine which bridges appear to be most likely to experience streambed-scour problems and which bridges appear to be relatively immune to problems brought on by streambed scour (for example, bridges built on bedrock).

When applied correctly, Level I scour assessments provide an investigator with information to identify those bridges that appear to be relatively safe and those bridges that fall into higher risk categories.

Level II scour evaluations describe the process for an investigator to apply a model to a bridge site and calculate the potential depth of scour that may result from a given flood event. Level II analyses involve the application of basic hydrologic, hydraulic, and sediment-transport engineering concepts and may include an evaluation of flood history, channel hydraulic conditions (for example, water-surface profile analysis), and basic sediment-transport analyses such as scour calculations (Lagasse and others, 1995).

The methods and model outlined in Hydraulic Engineering Circular (HEC) No. 18 (Richardson and Davis, 1995) formulate the basis for Level II scour evaluations. Methods used in this study for Level II scour evaluations are a modification of the HEC-18 standards. These modifications were made to comply with the methodology requested by INDOT (Merril Dougherty, Indiana Department of Transportation, oral commun., 1996). Descriptions of the specific modifications are given in the "Evaluation Methods" section of this report.

This report presents the methods followed for modeling, special considerations for this study site, and the input for and the output from the Water Surface PROfile (WSPRO) model.

Site Description

The study site is located in the city of Indianapolis and in the northwestern part of Marion County. The drainage area for the site is approximately 2.3 mi² (estimated using Hoggatt, 1975, and USGS 7.5-minute topographic data). The predominant land use in the basin is suburban; in the immediate vicinity of the bridges, the land is predominantly suburban.

Within the immediate vicinity of the bridges, Bush's Run has a channel-bed slope of approximately 0.005 ft/ft. The channel-bed material is sandy silt-clay, and the channel banks consist of gravelly sandy silt-clay. At the time of the Level I site visit on March 14, 1995, the banks were observed to have 0 to 25 percent woody vegetative cover; the field report noted that the banks were experiencing fluvial erosion.

The Interstate 65 crossing of Bush's Run is a 217-ft-long, multi-lane bridge consisting of four spans supported by concrete and steel piers and sloping concrete spill-through abutments. The ramp bridges crossing Bush's Run are 28-ft-long single-lane bridges consisting of single spans supported by vertical concrete abutments. Additional details describing conditions at the site are included in the Level I data base (Hopkins and Robinson, unpub. data, 1997). Photographs of the site, taken at the time of the Level I site visit, are archived at the USGS office in Indianapolis.

EVALUATION METHODS

The methods described in this section apply to a number of bridge sites in Indiana being evaluated for scour and outline the procedures requested by INDOT for these modified Level II scour analyses. The principal modification requested by INDOT was that the input data to the model come from or be estimated from existing data sources; no additional field data were collected. Actual methods used in the scour evaluation at this particular site use the most applicable method possible, given the data available.

To determine drainage area, either published values found in Hoggatt (1975) or 7.5-minute topographic maps with Hoggatt's original drainage-area delineations were used. Where there are no published data, drainage-area segments measured from the maps produced by Hoggatt were either subtracted from downstream sites or added to upstream sites published by Hoggatt (1975).

In Indiana, flood discharges are coordinated by agreement among State and Federal agencies. At sites where flood discharges officially are coordinated among State and Federal agencies in Indiana, the coordinated 100-year discharge (Q100) was modeled. INDOT also provided an additional flood discharge for these coordinated sites in excess of the Q100 to be modeled.

If a flood discharge was not coordinated, the USGS examined Federal Emergency Management Agency (FEMA) studies for Q100 determinations. Where FEMA studies did not produce a Q100, the USGS contacted IDNR for an estimated Q100 in the vicinity of the site being studied. If IDNR did not have a Q100, data from nearby USGS streamflow-gaging stations were analyzed with nearby and similar drainage basins that have been coordinated. At sites having no coordinated discharge data, the two discharges used in the model were 1) the approximated Q100 and 2) a discharge equal to 1.7 times the approximated Q100.

Most of the cross-section and bridge-opening geometry data were taken from the bridge plans (Indiana State Highway Commission, 1959) provided by INDOT. Bridge plans are presumed to be representative of current conditions at the site. To determine the cross-section geometry, a line was drawn on the bridge plans parallel to the bridge stationing and approximately one bridge width from the bridge. For sites where the bridge plans did not extend far enough laterally for collection of all cross-section data required for WSPRO model analysis, additional data were collected from 7.5-minute topographic maps.

The roadway and embankment profile was taken from the bridge and highway plans for those sites where roadway overtopping was expected. The INDOT bridge plans and 7.5-minute topographic maps were used as a guide, based on the water-surface elevations calculated by the WSPRO model, to determine if roadway overtopping might occur.

Roughness values (*n*-values) for the main channel were estimated by viewing photographs archived from the Level I scour assessments. The *n*-values for the overbanks were assigned on the basis of the surface-cover data summarized in the Level I data base (Hopkins and Robinson, unpub. data, 1997). From those data, the following roughness values were assigned to the surface-cover categories: urban—0.050, suburban—0.035, row crop—0.045, pasture—0.035, brush—0.120, forest—0.100, and wetland (any area covered by standing water)—0.100. The *n*-values for the overbanks were adjusted if the Level I photographs provided sufficient detail to warrant an adjustment.

WSPRO version V050196 was used to model flow through the study site. Starting water-surface elevation was obtained with a slope-conveyance computation. The channel-bed slope in the immediate vicinity of the bridge was estimated from the 7.5-minute topographic map and was used as the slope of the energy grade line for this computation.

WSPRO version V050196 includes a field that allows the input of up to four scour-adjustment factors (K1 to K4). For this modeling, the default value for K4 (bed armoring) was chosen. For scour-adjustment factors K1 and K2 (pier-nose shape and angle of attack, respectively), input values were determined by evaluating the data archived in the Level I data base (Hopkins and Robinson, unpub. data, 1997). For the K3 factor (bed forms), a value of 1.1 was applied in all cases.

In some cases, piers set on the overbanks are constructed with footings that are higher in elevation than pier footings in the main channel. In these situations, if the channel position changes, the piers that were initially constructed on the overbank may become part of the main channel. Therefore, to evaluate total potential scour, the model results obtained for contraction scour and deepest local scour in the main channel were added and applied to all piers in the bridge opening. This methodology allowed for an evaluation of potential undermining of pier supports in the event that future channel movement placed overbank piers in the main channel.

Where bridge pairs have a continuous abutment or fill between the bridges that does not allow expansion of flow, the bridge pair was modeled as one bridge. Sites with discontinuous abutments, allowing expansion between the bridges, were modeled as two separate bridges. In those cases, a valley cross section was measured between the bridges and used as the approach section for the downstream bridge and as the exit section for the upstream bridge.

At sites with no embankment to function as a weir or at sites where the tailwater drowns out the embankment, a composite bridge and road section was used to compute flow. Those sites were computed with friction-loss equations rather than with a bridge routine.

Total scour is taken as the sum of local scour plus contraction scour. If the model predicted negative contraction scour (aggradation), the contraction-scour value was assumed to be zero in determining the total scour depth (table 1). This assumption was made so that a negative contraction scour would not mask the potentially detrimental effects of local scour at a pier. No abutment scour evaluations were made in this study.

Table 1. Cumulative scour depths for the modeled discharges at structure I-65-124-4285 crossing Bush's Run in Marion County, Indiana
[--, no value]

Pier number ¹	Arbitrary ² Stationing	Initial bed-elevation (feet)	Main-channel contraction scour depth (feet)	Local scour depth (feet)	Worst-case total-scour depth ³ (feet)	Bottom elevation of pier (feet)	Worst-case bed elevation after scour ⁴ (feet)
Modeled discharge⁵ is 1,900 cubic feet per second; Interstate bridge							
2	-4	811	3.2	4.0	7.2	801.3	797.4
Modeled discharge is 3,230 cubic feet per second; Interstate bridge							
2	-4	811	4.4	4.1	8.5	801.3	796.1
3	60	816	4.4	4.1	8.5	800.8	796.1
Modeled discharge is 1,900 cubic feet per second; North-bound ramp bridge							
--	--	805.5	26.0	--	26.0	--	779.5
Modeled discharge is 3,230 cubic feet per second; North-bound ramp bridge							
--	--	805.0	51.7	--	51.7	--	753.8
Modeled discharge is 1,900 cubic feet per second; South-bound ramp bridge							
--	--	803.2	26.3	--	26.3	--	776.9
Modeled discharge is 3,230 cubic feet per second; South-bound ramp bridge							
--	--	803.2	44.7	--	44.7	--	758.5

¹Pier numbers were assigned from left to right as shown on the bridge plans.

²Cross sections were drawn on the bridge plans at selected locations with the zero (0) station set at an arbitrary location on the left bank.

³Worst-case total-scour depths are generated by summing the calculated contraction-scour depth with the worst case of local scour.

⁴Worst-case bed elevation is computed by subtracting the worst-case total-scour depth from the lowest initial bed elevation in the bridge opening (804.6 feet for the interstate bridge).

⁵Not a coordinated discharge.

SPECIAL CONSIDERATIONS

Model runs indicate the water-surface elevation at the bridge is lower than the low-steel elevation for the modeled discharges. Therefore, there should be no pressure flow through the bridge opening for the discharges modeled.

RESULTS

Scour depths were computed with a version of WSPRO (Larry Arneson, Federal Highway Administration, written commun., 1996) modified from Shearman (1990). This version of WSPRO includes scour calculations in the model output. Scour depths were calculated assuming an infinite depth of material that could erode and a homogeneous particle-size distribution. The results of the scour analysis are presented in table 1; a complete input file and output results are presented in the appendix.

REFERENCES

- Hoggatt, R.E., 1975, Drainage areas of Indiana streams: U.S. Geological Survey, Water Resources Division, 231 p.
- Indiana State Highway Commission, 1959, Bridge plans Interstate Route 65: Bridge File I-65-124-4285.
- Lagasse, P.F.; Schall, J.D.; Johnson, F.; Richardson, E.V.; and Chang, F., 1995, Stream stability at highway structures (2d ed.): Federal Highway Administration, Hydraulic Engineering Circular No. 20, Publication FHWA-IP-90-014, 144 p.
- Richardson, E.V., and Davis, S.R., 1995, Evaluating scour at bridges (3d ed.): Federal Highway Administration, Hydraulic Engineering Circular No. 18, Publication FHWA-IP-90-017, 204 p.
- Shearman, J.O., 1990, User's manual for WSPRO, a computer model for water-surface profile computations: Federal Highway Administration Publication FHWA-IP-89-027, 177 p.

APPENDIX

WSPRO INPUT FILE

```

T1      I-65 OVER BUSH'S RUN (3 BRIDGES)      I-65-124-4285
T2      COUNTY: MARION                        QUAD: ZIONSVILLE 110B
T3      07-25-97                             R L MILLER
SI      0
SK      .005      .005
Q      1900      3230
XS      EXSB -30
GR      -28 820  0 806  50 806  65 805.60  70 803.10  80 803.10
GR      85 805.60 125 807 126 820
N      .060 .060 .060
SA      65      85
XS      FULSB 0
GR      -28 820  1 806  50 806  65 805.75  70 803.25  80 803.25
GR      85 805.75 125 807 126 820
N      .060 .060 .060
SA      65      85
BR      BRSB 0 817.64 15
GR      0 817.64 1 806 4 806 9 803.25 19 803.25 24 806 27 806
GR      28 817.64 0 817.64
N      .040
CD      1 100 2 * 30
DC 0 BRSB 4 27 3 23
XS      APPSB 130
GR      -78 822 -50 808 -8 808 -2 805.25 3 805.25 8 803.75 18 803.75
GR      23 805.25 28 805.25 30 806 90 806 108 822
N      .060 .060 .060
SA      3      23
XS      EXIN 170
GR      -28 822  0 808  25 806.6  30 804.1  40 804.1  45 806.6  50 806.6
GR      53 808  55 808 83 822
N      .060 .060 .060
SA      25      45
XS      FULIN 220
GR      -28 822  0 808  7 808 10 806.85 15 806.85 20 804.35 30 804.35
GR      35 806.85 40 806.85 43 808 71 822
N      .060 .060 .060
SA      15      35
BR      BRIN 220 825.6
GR      -34 825.6 0 808.6 10 808.6 20 804.35 30 804.35 40 808.6
GR      45 808.6 62 825.6 -34 825.6
N      .040
PD      810.6 1.5 1
PD      816.1 1.5 2
PD      816.1 3 3
CD      3 125 2 825.6
DC 0 BRIN 10 40 15 35
DP      BRIN -34 62 1.5 * * 1 1 1.1
XS      APPIN 390
GR      -34 825  0 808 15 807.7 20 805.2 30 805.2 35 807.7 59 808
GR      60 825
N      .060 .060 .060
SA      15      35
XS      EXNB 420
GR      -26 825  0 812  7 812 15 807.85 20 807.85 25 805.35

```

WSPRO INPUT FILE

```

GR      35  805.35  40 807.85  45 807.85  51 811  54 811  55  825
N      .060  .060  .060
SA      20   40
XS  FVNB 450
GR     -26 825   0 812   7 812  15 808  20 808  25 805.5
GR     35  805.5  40 808  45 808  51 811  54 811  55  825
N      .060  .060  .060
SA      20   40
BR  BRNB 450  817.24
GR     0 817.24  1 808.5  2 808   6 808  11 805.5  21 805.5
GR    27 809  28 817.24  0 817.24
N      .040
CD     1 80  *  *  30
DC  BRNB 6 27 3 23
XS  APPNB 545
GR    -70 827  -40 812  -28 812  -10 811   3 808.45   8 805.95
GR   18 805.95  23 808.45  120 809  121 827
N     .045  .040  .045
SA      3    23
EX
ER

```

WSPRO OUTPUT

***** W S P R O *****

Federal Highway Administration - U. S. Geological Survey

Model for Water-Surface Profile Computations.

Run Date & Time: 8/14/97 3:38 pm Version V050196

Input File: 4285.dat Output File: 4285.LST

T1 I-65 OVER BUSH'S RUN (3 BRIDGES) I-65-124-4285
T2 COUNTY: MARION QUAD: ZIONSVILLE 110B
T3 07-25-97 R L MILLER
SI 0
SK .005 .005
Q 1900 3230

*** Processing Flow Data; Placing Information into Sequence 1 ***

***** W S P R O *****

Federal Highway Administration - U. S. Geological Survey

Model for Water-Surface Profile Computations.

Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES) I-65-124-4285
COUNTY: MARION QUAD: ZIONSVILLE 110B
07-25-97 R L MILLER

* Starting To Process Header Record EXSB *

XS EXSB -30
GR -28 820 0 806 50 806 65 805.60 70 803.10 80 803.10
GR 85 805.60 125 807 126 820
N .060 .060 .060
SA 65 85

*** Completed Reading Data Associated With Header Record EXSB ***
*** Storing X-Section Data In Temporary File As Record Number 1 ***

*** Data Summary For Header Record EXSB ***
SRD Location: -30. Cross-Section Skew: .0 Error Code 0
Valley Slope: .00000 Averaging Conveyance By Geometric Mean.
Energy Loss Coefficients -> Expansion: .50 Contraction: .00

X,Y-coordinates (9 pairs)

X	Y	X	Y	X	Y
-28.000	820.000	.000	806.000	50.000	806.000
65.000	805.600	70.000	803.100	80.000	803.100
85.000	805.600	125.000	807.000	126.000	820.000

Minimum and Maximum X,Y-coordinates

Minimum X-Station: -28.000 (associated Y-Elevation: 820.000)
Maximum X-Station: 126.000 (associated Y-Elevation: 820.000)

WSPRO OUTPUT

Minimum Y-Elevation: 803.100 (associated X-Station: 80.000)
 Maximum Y-Elevation: 820.000 (associated X-Station: -28.000)

Roughness Data (3 SubAreas)		
SubArea	Roughness Coefficient	Horizontal Breakpoint
1	.060	---
	---	65.000
2	.060	---
	---	85.000
3	.060	---

* Finished Processing Header Record EXSB *

***** W S P R O *****

Federal Highway Administration - U. S. Geological Survey
 Model for Water-Surface Profile Computations.
 Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES)	I-65-124-4285
COUNTY: MARION	QUAD: ZIONSVILLE 110B
07-25-97	R L MILLER

* Starting To Process Header Record FULSB *

XS FULSB 0

GR	-28	820	1	806	50	806	65	805.75	70	803.25	80	803.25
GR	85	805.75	125	807	126	820						
N	.060	.060	.060									
SA	65		85									

*** Completed Reading Data Associated With Header Record FULSB ***

*** Storing X-Section Data In Temporary File As Record Number 2 ***

*** Data Summary For Header Record FULSB ***

SRD Location: 0. Cross-Section Skew: .0 Error Code 0

Valley Slope: .00000 Averaging Conveyance By Geometric Mean.

Energy Loss Coefficients -> Expansion: .50 Contraction: .00

X,Y-coordinates (9 pairs)					
X	Y	X	Y	X	Y
-28.000	820.000	1.000	806.000	50.000	806.000
65.000	805.750	70.000	803.250	80.000	803.250
85.000	805.750	125.000	807.000	126.000	820.000

Minimum and Maximum X,Y-coordinates

WSPRO OUTPUT

Minimum X-Station: -28.000 (associated Y-Elevation: 820.000)
 Maximum X-Station: 126.000 (associated Y-Elevation: 820.000)
 Minimum Y-Elevation: 803.250 (associated X-Station: 80.000)
 Maximum Y-Elevation: 820.000 (associated X-Station: -28.000)

Roughness Data (3 SubAreas)		
SubArea	Roughness Coefficient	Horizontal Breakpoint
1	.060	---
	---	65.000
2	.060	---
	---	85.000
3	.060	---

* Finished Processing Header Record FULSB *

***** W S P R O *****

Federal Highway Administration - U. S. Geological Survey
 Model for Water-Surface Profile Computations.
 Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES) I-65-124-4285
 COUNTY: MARION QUAD: ZIONSVILLE 110B
 07-25-97 R L MILLER

* Starting To Process Header Record BR SB *

BR BR SB 0 817.64 15
 GR 0 817.64 1 806 4 806 9 803.25 19 803.25 24 806 27 806
 GR 28 817.64 0 817.64
 N .040
 CD 1 100 2 * 30

*** Completed Reading Data Associated With Header Record BR SB ***
 *** Storing Bridge Data In Temporary File As Record Number 3 ***

*** Data Summary For Bridge Record BR SB ***

SRD Location: 0. Cross-Section Skew: 15.0 Error Code 0
 Valley Slope: ***** Averaging Conveyance By Geometric Mean.
 Energy Loss Coefficients -> Expansion: .50 Contraction: .00

X,Y-coordinates (9 pairs)					
X	Y	X	Y	X	Y
.000	817.640	1.000	806.000	4.000	806.000
9.000	803.250	19.000	803.250	24.000	806.000
27.000	806.000	28.000	817.640	.000	817.640

WSPRO OUTPUT

Minimum and Maximum X,Y-coordinates

Minimum X-Station: .000 (associated Y-Elevation: 817.640)
 Maximum X-Station: 28.000 (associated Y-Elevation: 817.640)
 Minimum Y-Elevation: 803.250 (associated X-Station: 19.000)
 Maximum Y-Elevation: 817.640 (associated X-Station: .000)

X-coordinates & Horizontal Breakpoints Translated by Skew Angle

X Input	X Skewed	X Input	X Skewed	X Input	X Skewed
.000	.647	1.000	1.613	4.000	4.511
9.000	9.341	19.000	19.000	24.000	23.830
27.000	26.727	28.000	27.693	.000	.647

Roughness Data (1 SubAreas)

SubArea	Roughness Coefficient	Horizontal Breakpoint
1	.040	---

Discharge coefficient parameters

BRType	BRWdth	WWAngl	WWWdth	EntRnd	UserCD
1	100.000	30.00	*****	*****	*****

Pressure flow elevations

AVBCEL	PFElev
*****	817.640

Abutment Parameters

ABSLPL	ABSLPR	XTOELT	YTOELT	XTOERT	YTOERT
*****	*****	*****	*****	*****	*****

** No Pier/Pile Data Encountered **

* Finished Processing Header Record BR SB *

***** W S P R O *****

Federal Highway Administration - U. S. Geological Survey

Model for Water-Surface Profile Computations.

Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES)

I-65-124-4285

COUNTY: MARION

QUAD: ZIONSVILLE 110B

07-25-97

R L MILLER

DC 0 BR SB 4 27 3 23

* Starting To Process Header Record APP SB *

WSPRO OUTPUT

```
XS  APPSB 130
GR      -78 822 -50 808  -8 808  -2 805.25  3 805.25  8 803.75 18 803.75
GR      23 805.25 28 805.25  30 806 90 806 108 822
N        .060  .060  .060
SA        3      23
```

```
*** Completed Reading Data Associated With Header Record APPSB ***
*** Storing X-Section Data In Temporary File As Record Number 4 ***
```

```
*** Data Summary For Header Record APPSB ***
SRD Location:      130. Cross-Section Skew:  .0 Error Code  0
Valley Slope:     .00000 Averaging Conveyance By Geometric Mean.
Energy Loss Coefficients -> Expansion:  .50 Contraction:  .00
```

X,Y-coordinates (12 pairs)					
X	Y	X	Y	X	Y
-78.000	822.000	-50.000	808.000	-8.000	808.000
-2.000	805.250	3.000	805.250	8.000	803.750
18.000	803.750	23.000	805.250	28.000	805.250
30.000	806.000	90.000	806.000	108.000	822.000

```
Minimum and Maximum X,Y-coordinates
Minimum X-Station:  -78.000 ( associated Y-Elevation: 822.000 )
Maximum X-Station:  108.000 ( associated Y-Elevation: 822.000 )
Minimum Y-Elevation: 803.750 ( associated X-Station: 18.000 )
Maximum Y-Elevation: 822.000 ( associated X-Station: -78.000 )
```

Roughness Data (3 SubAreas)		
SubArea	Roughness Coefficient	Horizontal Breakpoint
1	.060	---
	---	3.000
2	.060	---
	---	23.000
3	.060	---

```
Bridge datum projection(s): XREFLT XREFRT FDSTLT FDSTRT
*****
```

```
*-----*
* Finished Processing Header Record APPSB *
*-----*
```

```
***** W S P R O *****
Federal Highway Administration - U. S. Geological Survey
Model for Water-Surface Profile Computations.
Input Units: English / Output Units: English
```

```
*-----*
I-65 OVER BUSH'S RUN (3 BRIDGES) I-65-124-4285
```

WSPRO OUTPUT

COUNTY: MARION
07-25-97

QUAD: ZIONSVILLE 110B
R L MILLER

```
*-----*
*      Starting To Process Header Record EXIN      *
*-----*
```

```
XS  EXIN  170
GR      -28 822  0 808  25 806.6  30 804.1  40 804.1  45 806.6  50 806.6
GR      53 808  55 808 83 822
N        .060   .060   .060
SA        25      45
```

```
*** Completed Reading Data Associated With Header Record EXIN ***
*** Storing X-Section Data In Temporary File As Record Number 5 ***
```

```
*** Data Summary For Header Record EXIN ***
SRD Location:      170. Cross-Section Skew:      .0 Error Code  0
Valley Slope:      .00000 Averaging Conveyance By Geometric Mean.
Energy Loss Coefficients -> Expansion:      .50 Contraction:      .00
```

X,Y-coordinates (10 pairs)					
X	Y	X	Y	X	Y
-28.000	822.000	.000	808.000	25.000	806.600
30.000	804.100	40.000	804.100	45.000	806.600
50.000	806.600	53.000	808.000	55.000	808.000
83.000	822.000				

```
Minimum and Maximum X,Y-coordinates
Minimum X-Station:      -28.000 ( associated Y-Elevation:  822.000 )
Maximum X-Station:      83.000 ( associated Y-Elevation:  822.000 )
Minimum Y-Elevation:      804.100 ( associated X-Station:      40.000 )
Maximum Y-Elevation:      822.000 ( associated X-Station:      -28.000 )
```

Roughness Data (3 SubAreas)		
SubArea	Roughness Coefficient	Horizontal Breakpoint
1	.060	---
	---	25.000
2	.060	---
	---	45.000
3	.060	---

```
*-----*
*      Finished Processing Header Record EXIN      *
*-----*
```

```
***** W S P R O *****
Federal Highway Administration - U. S. Geological Survey
Model for Water-Surface Profile Computations.
```

WSPRO OUTPUT

Input Units: English / Output Units: English

```
*-----*
I-65 OVER BUSH'S RUN (3 BRIDGES)          I-65-124-4285
COUNTY: MARION                          QUAD: ZIONSVILLE 110B
07-25-97                                R L MILLER
```

```
*-----*
*           Starting To Process Header Record FULIN           *
*-----*
```

```
XS    FULIN    220
GR      -28 822  0 808  7 808  10 806.85  15 806.85  20 804.35  30 804.35
GR      35 806.85 40 806.85 43 808  71 822
N       .060   .060   .060
SA      15      35
```

```
***    Completed Reading Data Associated With Header Record FULIN    ***
***    Storing X-Section Data In Temporary File As Record Number  6    ***
```

```
***                               Data Summary For Header Record FULIN                               ***
SRD Location:      220.    Cross-Section Skew:      .0    Error Code    0
Valley Slope:     .00000    Averaging Conveyance By Geometric Mean.
Energy Loss Coefficients -> Expansion:      .50    Contraction:      .00
```

X,Y-coordinates (11 pairs)					
X	Y	X	Y	X	Y
-28.000	822.000	.000	808.000	7.000	808.000
10.000	806.850	15.000	806.850	20.000	804.350
30.000	804.350	35.000	806.850	40.000	806.850
43.000	808.000	71.000	822.000		

```

Minimum and Maximum X,Y-coordinates
Minimum X-Station:      -28.000 ( associated Y-Elevation: 822.000 )
Maximum X-Station:      71.000 ( associated Y-Elevation: 822.000 )
Minimum Y-Elevation:     804.350 ( associated X-Station:  30.000 )
Maximum Y-Elevation:     822.000 ( associated X-Station: -28.000 )
```

Roughness Data (3 SubAreas)		
SubArea	Roughness Coefficient	Horizontal Breakpoint
1	.060	---
	---	15.000
2	.060	---
	---	35.000
3	.060	---

```
*-----*
*           Finished Processing Header Record FULIN           *
*-----*
```

WSPRO OUTPUT

***** W S P R O *****
 Federal Highway Administration - U. S. Geological Survey
 Model for Water-Surface Profile Computations.
 Input Units: English / Output Units: English

-----*
 I-65 OVER BUSH'S RUN (3 BRIDGES) I-65-124-4285
 COUNTY: MARION QUAD: ZIONSVILLE 110B
 07-25-97 R L MILLER

 * Starting To Process Header Record BRIN *

BR BRIN 220 825.6
 GR -34 825.6 0 808.6 10 808.6 20 804.35 30 804.35 40 808.6
 GR 45 808.6 62 825.6 -34 825.6
 N .040
 PD 810.6 1.5 1
 PD 816.1 1.5 2
 PD 816.1 3 3
 CD 3 125 2 825.6 -

*** Completed Reading Data Associated With Header Record BRIN ***
 *** Storing Bridge Data In Temporary File As Record Number 7 ***

*** Data Summary For Bridge Record BRIN ***
 SRD Location: 220. Cross-Section Skew: .0 Error Code 0
 Valley Slope: ***** Averaging Conveyance By Geometric Mean.
 Energy Loss Coefficients -> Expansion: .50 Contraction: .00

X,Y-coordinates (9 pairs)					
X	Y	X	Y	X	Y
-34.000	825.600	.000	808.600	10.000	808.600
20.000	804.350	30.000	804.350	40.000	808.600
45.000	808.600	62.000	825.600	-34.000	825.600

Minimum and Maximum X,Y-coordinates
 Minimum X-Station: -34.000 (associated Y-Elevation: 825.600)
 Maximum X-Station: 62.000 (associated Y-Elevation: 825.600)
 Minimum Y-Elevation: 804.350 (associated X-Station: 30.000)
 Maximum Y-Elevation: 825.600 (associated X-Station: -34.000)

Roughness Data (1 SubAreas)
 Roughness Horizontal
 SubArea Coefficient Breakpoint

 1 .040 ---

Discharge coefficient parameters
 BRType BRWidth EMBSS EMBElv UserCD
 3 125.000 2.00 825.600 *****

WSPRO OUTPUT

Pressure flow elevations

AVBCEL PFElev
***** 825.600

Abutment Parameters

ABSLPL ABSLPR XTOELT YTOELT XTOERT YTOERT

Pier/Pile Data (3 Group(s))

Code Indicates Bridge Uses Piers

Group	Elevation	Gross Width	Number
1	810.600	1.500	1
2	816.100	1.500	2
3	816.100	3.000	3

* Finished Processing Header Record BRIN *

***** W S P R O *****

Federal Highway Administration - U. S. Geological Survey

Model for Water-Surface Profile Computations.

Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES)

I-65-124-4285

COUNTY: MARION

QUAD: ZIONSVILLE 110B

07-25-97

R L MILLER

DC 0 BRIN 10 40 15 35

DP BRIN -34 62 1.5 * * 1 1 1.1

* Starting To Process Header Record APPIN *

XS APPIN 390

GR -34 825 0 808 15 807.7 20 805.2 30 805.2 35 807.7 59 808

GR 60 825

N .060 .060 .060

SA 15 35

*** Completed Reading Data Associated With Header Record APPIN ***
*** Storing X-Section Data In Temporary File As Record Number 8 ***

*** Data Summary For Header Record APPIN ***

SRD Location: 390. Cross-Section Skew: .0 Error Code 0

Valley Slope: .00000 Averaging Conveyance By Geometric Mean.

Energy Loss Coefficients -> Expansion: .50 Contraction: .00

X,Y-coordinates (8 pairs)

X Y X Y X Y

WSPRO OUTPUT

-34.000	825.000	.000	808.000	15.000	807.700
20.000	805.200	30.000	805.200	35.000	807.700
59.000	808.000	60.000	825.000		

Minimum and Maximum X,Y-coordinates

Minimum X-Station: -34.000 (associated Y-Elevation: 825.000)
 Maximum X-Station: 60.000 (associated Y-Elevation: 825.000)
 Minimum Y-Elevation: 805.200 (associated X-Station: 30.000)
 Maximum Y-Elevation: 825.000 (associated X-Station: -34.000)

Roughness Data (3 SubAreas)

SubArea	Roughness Coefficient	Horizontal Breakpoint
1	.060	---
	---	15.000
2	.060	---
	---	35.000
3	.060	---

Bridge datum projection(s): XREFLT XREFRT FDSTLT FDSTRT

 * Finished Processing Header Record APPIN *

***** W S P R O *****

Federal Highway Administration - U. S. Geological Survey

Model for Water-Surface Profile Computations.

Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES) I-65-124-4285
 COUNTY: MARION QUAD: ZIONSVILLE 110B
 07-25-97 R L MILLER

 * Starting To Process Header Record EXNB *

XS EXNB 420
 GR -26 825 0 812 7 812 15 807.85 20 807.85 25 805.35
 GR 35 805.35 40 807.85 45 807.85 51 811 54 811 55 825
 N .060 .060 .060
 SA 20 40

*** Completed Reading Data Associated With Header Record EXNB ***
 *** Storing X-Section Data In Temporary File As Record Number 9 ***

*** Data Summary For Header Record EXNB ***
 SRD Location: 420. Cross-Section Skew: .0 Error Code 0

WSPRO OUTPUT

Valley Slope: .00000 Averaging Conveyance By Geometric Mean.
 Energy Loss Coefficients -> Expansion: .50 Contraction: .00

X,Y-coordinates (12 pairs)					
X	Y	X	Y	X	Y
-26.000	825.000	.000	812.000	7.000	812.000
15.000	807.850	20.000	807.850	25.000	805.350
35.000	805.350	40.000	807.850	45.000	807.850
51.000	811.000	54.000	811.000	55.000	825.000

Minimum and Maximum X,Y-coordinates
 Minimum X-Station: -26.000 (associated Y-Elevation: 825.000)
 Maximum X-Station: 55.000 (associated Y-Elevation: 825.000)
 Minimum Y-Elevation: 805.350 (associated X-Station: 35.000)
 Maximum Y-Elevation: 825.000 (associated X-Station: -26.000)

Roughness Data (3 SubAreas)		
SubArea	Roughness Coefficient	Horizontal Breakpoint
1	.060	---
	---	20.000
2	.060	---
	---	40.000
3	.060	---

 * Finished Processing Header Record EXNB *

***** W S P R O *****
 Federal Highway Administration - U. S. Geological Survey
 Model for Water-Surface Profile Computations.
 Input Units: English / Output Units: English

 I-65 OVER BUSH'S RUN (3 BRIDGES) I-65-124-4285
 COUNTY: MARION QUAD: ZIONSVILLE 110B
 07-25-97 R L MILLER

 * Starting To Process Header Record FVNB *

XS FVNB 450
 GR -26 825 0 812 7 812 15 808 20 808 25 805.5
 GR 35 805.5 40 808 45 808 51 811 54 811 55 825
 N .060 .060 .060
 SA 20 40

*** Completed Reading Data Associated With Header Record FVNB ***
 *** Storing X-Section Data In Temporary File As Record Number 10 ***

WSPRO OUTPUT

```

***              Data Summary For Header Record FVNB              ***
SRD Location:      450.   Cross-Section Skew:   .0   Error Code   0
Valley Slope:     .00000   Averaging Conveyance By Geometric Mean.
Energy Loss Coefficients ->   Expansion:   .50   Contraction:   .00
  
```

```

              X,Y-coordinates (12 pairs)
              X          Y          X          Y          X          Y
-----
-26.000      825.000      .000      812.000      7.000      812.000
 15.000      808.000     20.000      808.000     25.000      805.500
 35.000      805.500     40.000      808.000     45.000      808.000
 51.000      811.000     54.000      811.000     55.000      825.000
-----
  
```

```

              Minimum and Maximum X,Y-coordinates
Minimum X-Station:  -26.000 ( associated Y-Elevation:  825.000 )
Maximum X-Station:   55.000 ( associated Y-Elevation:  825.000 )
Minimum Y-Elevation: 805.500 ( associated X-Station:   35.000 )
Maximum Y-Elevation: 825.000 ( associated X-Station:  -26.000 )
  
```

```

              Roughness Data ( 3 SubAreas )
              Roughness   Horizontal
SubArea   Coefficient   Breakpoint
-----
      1      .060      ---
      1      .060      20.000
      2      .060      ---
      2      .060      40.000
      3      .060      ---
-----
  
```

```

*-----*
*       Finished Processing Header Record FVNB       *
*-----*
  
```

```

***** W S P R O *****
Federal Highway Administration - U. S. Geological Survey
Model for Water-Surface Profile Computations.
Input Units: English / Output Units: English
  
```

```

*-----*
I-65 OVER BUSH'S RUN (3 BRIDGES)      I-65-124-4285
COUNTY: MARION                      QUAD: ZIONSVILLE 110B
07-25-97                             R L MILLER
  
```

```

*-----*
*       Starting To Process Header Record BRNB       *
*-----*
  
```

```

BR   BRNB  450  817.24
GR      0 817.24  1 808.5  2 808  6 808  11 805.5  21 805.5
GR     27 809  28 817.24  0 817.24
N              .040
CD      1 80  *  *  30
  
```

WSPRO OUTPUT

*** Completed Reading Data Associated With Header Record BRNB ***
 *** Storing Bridge Data In Temporary File As Record Number 11 ***

*** Data Summary For Bridge Record BRNB ***

SRD Location: 450. Cross-Section Skew: .0 Error Code 0
 Valley Slope: ***** Averaging Conveyance By Geometric Mean.
 Energy Loss Coefficients -> Expansion: .50 Contraction: .00

X,Y-coordinates (9 pairs)					
X	Y	X	Y	X	Y
.000	817.240	1.000	808.500	2.000	808.000
6.000	808.000	11.000	805.500	21.000	805.500
27.000	809.000	28.000	817.240	.000	817.240

Minimum and Maximum X,Y-coordinates
 Minimum X-Station: .000 (associated Y-Elevation: 817.240)
 Maximum X-Station: 28.000 (associated Y-Elevation: 817.240)
 Minimum Y-Elevation: 805.500 (associated X-Station: 21.000)
 Maximum Y-Elevation: 817.240 (associated X-Station: .000)

Roughness Data (1 SubAreas)		
SubArea	Roughness Coefficient	Horizontal Breakpoint
1	.040	---

Discharge coefficient parameters					
BRTYPE	BRWidth	WWAngl	WWWidth	EntRnd	UserCD
1	80.000	30.00	*****	*****	*****

Pressure flow elevations	
AVBCEL	PFElev
*****	817.240

Abutment Parameters					
ABSLPL	ABSLPR	XTOELT	YTOELT	XTOERT	YTOERT
*****	*****	*****	*****	*****	*****

** No Pier/Pile Data Encountered **

 * Finished Processing Header Record BRNB *

***** W S P R O *****
 Federal Highway Administration - U. S. Geological Survey
 Model for Water-Surface Profile Computations.
 Input Units: English / Output Units: English

WSPRO OUTPUT

I-65 OVER BUSH'S RUN (3 BRIDGES)
COUNTY: MARION
07-25-97
DC BRNB 6 27 3 23

I-65-124-4285
QUAD: ZIONSVILLE 110B
R L MILLER

* Starting To Process Header Record APPNB *

XS APPNB 545
GR -70 827 -40 812 -28 812 -10 811 3 808.45 8 805.95
GR 18 805.95 23 808.45 120 809 121 827
N .045 .040 .045
SA 3 23

*** Completed Reading Data Associated With Header Record APPNB ***
*** Storing X-Section Data In Temporary File As Record Number 12 ***

*** Data Summary For Header Record APPNB ***
SRD Location: 545. Cross-Section Skew: .0 Error Code 0
Valley Slope: .00000 Averaging Conveyance By Geometric Mean.
Energy Loss Coefficients -> Expansion: .50 Contraction: .00

X,Y-coordinates (10 pairs)					
X	Y	X	Y	X	Y
-70.000	827.000	-40.000	812.000	-28.000	812.000
-10.000	811.000	3.000	808.450	8.000	805.950
18.000	805.950	23.000	808.450	120.000	809.000
121.000	827.000				

Minimum and Maximum X,Y-coordinates
Minimum X-Station: -70.000 (associated Y-Elevation: 827.000)
Maximum X-Station: 121.000 (associated Y-Elevation: 827.000)
Minimum Y-Elevation: 805.950 (associated X-Station: 18.000)
Maximum Y-Elevation: 827.000 (associated X-Station: -70.000)

Roughness Data (3 SubAreas)		
SubArea	Roughness Coefficient	Horizontal Breakpoint
1	.045	---
	---	3.000
2	.040	---
	---	23.000
3	.045	---

Bridge datum projection(s): XREFLT XREFRT FDSTLT FDSTRT

* Finished Processing Header Record APPNB *

WSPRO OUTPUT

***** W S P R O *****
 Federal Highway Administration - U. S. Geological Survey
 Model for Water-Surface Profile Computations.
 Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES) I-65-124-4285
 COUNTY: MARION QUAD: ZIONSVILLE 110B
 07-25-97 R L MILLER

EX

 * Summary of Boundary Condition Information *

#	Reach Discharge	Water Surface Elevation	Friction Slope	Flow Regime
1	1900.00	*****	.0050	Sub-Critical
2	3230.00	*****	.0050	Sub-Critical

 * Beginning 2 Profile Calculation(s) *

***** W S P R O *****
 Federal Highway Administration - U. S. Geological Survey
 Model for Water-Surface Profile Computations.
 Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES) I-65-124-4285
 COUNTY: MARION QUAD: ZIONSVILLE 110B
 07-25-97 R L MILLER

	WSEL EGEL CRWS	VHD HF HO	Q V FR #	AREA K SF	SRDL FLEN ALPHA	LEW REW ERR
Section: EXSB	809.330	.285	1900.000	464.091	*****	-6.661
Header Type: XS	809.615	*****	4.094	26854.96	*****	125.179
SRD: -30.000	807.889	*****	.402	*****	1.094	*****
Section: FULSB	809.501	.268	1900.000	476.375	30.000	-6.251
Header Type: FV	809.768	.144	3.988	27986.75	30.000	125.192
SRD: .000	807.932	.000	.384	.0048	1.082	.009

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

Section: APPSB	810.061	.217	1900.000	540.079	130.000	-54.122
Header Type: AS	810.278	.509	3.518	32944.63	130.000	94.569
SRD: 130.000	807.993	.000	.345	.0039	1.127	.001

WSPRO OUTPUT

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

<<< The Following Data Reflect The "Constricted" Profile >>>

<<< Beginning Bridge/Culvert Hydraulic Computations >>>

===210 QUESTIONABLE CRITICAL-FLOW SOLUTION AT SECID "BRSB ".

Q, CRWS: 1900.00 809.90

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: BRSB	809.901	2.709	1900.000	143.973	30.000	.665
Header Type: BR	812.609	*****	13.197	13668.32	30.000	27.335
SRD: .000	809.901	*****	1.001	*****	1.000	*****

Specific Bridge Information	C	P/A	PFELEV	BLFN	XLAB	XRAB
Bridge Type 1 Flow Type 1	-----	-----	-----	-----	-----	-----
Pier/Pile Code **	1.0000	.000	817.640	*****	*****	*****

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: APPSB	814.591	.038	1900.000	1245.667	30.000	-63.182
Header Type: AS	814.629	.087	1.525	118984.70	39.247	99.665
SRD: 130.000	807.993	1.932	.099	.0039	1.045	.002

Approach Section APPSB Flow Contraction Information						
M(G)	M(K)	KQ	XLKQ	XRKQ	OTEL	
.821	.766	27862.7	12.842	39.512	814.591	

<<< End of Bridge Hydraulics Computations >>>

===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS AT SECID "EXIN ".

KRATIO: .40

Section: EXIN	814.526	.217	1900.000	536.175	40.000	-13.051
Header Type: XS	814.743	.026	3.544	47022.04	40.000	68.051
SRD: 170.000	809.944	.090	.256	.0006	1.111	-.001

Section: FULIN	814.571	.324	1900.000	444.366	50.000	-13.142
Header Type: FV	814.895	.100	4.276	38425.77	50.000	56.142
SRD: 220.000	810.438	.054	.318	.0020	1.140	-.001

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

Section: APPIN	815.026	.229	1900.000	514.719	170.000	-14.052
Header Type: AS	815.255	.360	3.691	44359.73	170.000	59.413

WSPRO OUTPUT

SRD: 390.000 810.535 .000 .256 .0021 1.080 .000

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

<<< The Following Data Reflect The "Constricted" Profile >>>

<<< Beginning Bridge/Culvert Hydraulic Computations >>>

	WSEL EGEL CRWS	VHD HF HO	Q V FR #	AREA K SF	SRDL FLEN ALPHA	LEW REW ERR
Section: BRIN	814.500	.346	1900.000	402.727	50.000	-11.800
Header Type: BR	814.846	.090	4.718	48846.36	50.000	50.900
SRD: 220.000	810.551	.014	.328	*****	1.000	-.003

Specific Bridge Information	C	P/A	PFELEV	BLEN	XLAB	XRAB
Bridge Type 3 Flow Type 1	-----	-----	-----	-----	-----	-----
Pier/Pile Code 0	1.0000	.015	825.600	*****	*****	*****

	WSEL EGEL CRWS	VHD HF HO	Q V FR #	AREA K SF	SRDL FLEN ALPHA	LEW REW ERR
Section: APPIN	814.929	.235	1900.000	507.560	45.000	-13.857
Header Type: AS	815.164	.091	3.743	43449.17	46.803	59.408
SRD: 390.000	810.535	.228	.261	.0021	1.081	.008

Approach Section APPIN Flow Contraction Information					
M(G)	M(K)	KQ	XLKQ	XRKQ	OTEL
.144	.013	42794.0	-9.375	53.335	814.929

<<< End of Bridge Hydraulics Computations >>>

===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS AT SECID "EXNB ".
KRATIO: .68

Section: EXNB	814.874	.509	1900.000	361.070	30.000	-5.749
Header Type: XS	815.383	.084	5.262	29618.98	30.000	54.277
SRD: 420.000	811.733	.137	.411	.0028	1.181	-.002
Section: FVNB	815.011	.500	1900.000	363.719	30.000	-6.021
Header Type: FV	815.510	.123	5.224	29823.00	30.000	54.286
SRD: 450.000	811.834	.000	.407	.0041	1.177	.005

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS AT SECID "APPNB".
KRATIO: 4.03

Section: APPNB	815.549	.057	1900.000	1046.391	95.000	-47.098
----------------	---------	------	----------	----------	--------	---------

WSPRO OUTPUT

Header Type: AS 815.606 .096 1.816 120123.10 95.000 120.364
 SRD: 545.000 810.633 .000 .135 .0010 1.109 .000

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

<<< The Following Data Reflect The "Constricted" Profile >>>
 <<< Beginning Bridge/Culvert Hydraulic Computations >>>

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: BRNB	814.404	1.381	1900.000	205.760	30.000	.325
Header Type: BR	815.784	.158	9.234	23150.31	30.000	27.656
SRD: 450.000	812.129	.243	.593	*****	1.041	-.001

Specific Bridge Information	C	P/A	PFELEV	BLN	XLAB	XRAB
Bridge Type 1 Flow Type 1						
Pier/Pile Code **	.9800	.000	817.240	*****	*****	*****

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: APPNB	816.306	.045	1900.000	1173.680	15.000	-48.611
Header Type: AS	816.350	.028	1.619	143347.00	25.531	120.406
SRD: 545.000	810.633	.539	.114	.0010	1.099	.003

Approach Section APPNB Flow Contraction Information					
M(G)	M(K)	KQ	XLKQ	XRKQ	OTEL
.836	.809	27414.8	26.763	54.095	816.306

<<< End of Bridge Hydraulics Computations >>>

***** W S P R O *****
 Federal Highway Administration - U. S. Geological Survey
 Model for Water-Surface Profile Computations.
 Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES) I-65-124-4285
 COUNTY: MARION QUAD: ZIONSVILLE 110B
 07-25-97 R L MILLER

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: EXSB	810.737	.403	3230.000	651.562	*****	-9.473
Header Type: XS	811.139	*****	4.957	45676.01	*****	125.287

WSPRO OUTPUT

```
SRD:      -30.000    808.657  *****      .408      *****      1.054      *****

Section: FULSB      810.900    .388    3230.000    662.479    30.000    -9.151
Header Type: FV      811.288    .146      4.876    46922.03    30.000    125.300
SRD:         .000    808.699    .000      .397      .0049    1.049    .003
```

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

```
Section: APPSB      811.505    .305    3230.000    758.059    130.000    -57.010
Header Type: AS      811.810    .522      4.261    55348.42    130.000    96.193
SRD:     130.000    809.076    .000      .351      .0040    1.080    .000
```

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

<<< The Following Data Reflect The "Constricted" Profile >>>

<<< Beginning Bridge/Culvert Hydraulic Computations >>>

```
===220 FLOW CLASS 1 ( 4 ) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
      WS3, WSIU, WS1, PFELV:    812.22    817.97    818.05    817.64
```

```
===245 ATTEMPTING FLOW CLASS 2 ( 5 ) SOLUTION.
```

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: BRSB	817.640	1.263	3203.558	355.529	30.000	.000
Header Type: BR	818.903	*****	9.011	36070.16	*****	28.000
SRD:	.000	812.196	*****	.631	*****	1.000
Specific Bridge Information						
	C	P/A	PFELEV	BLN	XLAB	XRAB
Bridge Type 1	Flow Type 2					
Pier/Pile Code **	.3978	.000	817.640	*****	*****	*****

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: APPSB	819.275	.040	3230.000	2042.747	30.000	-72.550
Header Type: AS	819.315	.045	1.581	252660.30	39.245	104.934
SRD: 130.000	809.076	1.984	.083	.0040	1.032	-.008

```
Approach Section APPSB Flow Contraction Information
M( G )    M( K )      KQ      XLKQ      XRKQ      OTEL
-----
***** ***** ***** ***** ***** 819.275
-----
```

<<< End of Bridge Hydraulics Computations >>>

```
===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS AT SECID "EXIN ".
      KRATIO:    .42
```


WSPRO OUTPUT

Section: EXIN	819.213	.195	3230.000	960.259	40.000	-22.426
Header Type: XS	819.408	.015	3.364	106912.60	40.000	77.426
SRD: 170.000	811.336	.077	.201	.0004	1.106	.000

Section: FULIN	819.224	.282	3230.000	810.027	50.000	-22.448
Header Type: FV	819.506	.055	3.988	88187.98	50.000	65.448
SRD: 220.000	812.034	.044	.247	.0011	1.141	.000

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

Section: APPIN	819.481	.237	3230.000	862.450	170.000	-22.963
Header Type: AS	819.719	.213	3.745	94315.19	170.000	59.675
SRD: 390.000	811.827	.000	.213	.0013	1.088	-.001

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

<<< The Following Data Reflect The "Constricted" Profile >>>
<<< Beginning Bridge/Culvert Hydraulic Computations >>>

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: BRIN	819.161	.307	3230.000	727.525	50.000	-21.121
Header Type: BR	819.467	.048	4.440	112842.70	50.000	55.561
SRD: 220.000	812.128	.011	.254	*****	1.000	-.002

Specific Bridge Information	C	P/A	PFELEV	BLEN	XLAB	XRAB
Bridge Type 3 Flow Type 1	-----	-----	-----	-----	-----	-----
Pier/Pile Code 0	1.0000	.024	825.600	*****	*****	*****

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: APPIN	819.396	.241	3230.000	855.428	45.000	-22.793
Header Type: AS	819.637	.052	3.776	93209.77	47.175	59.670
SRD: 390.000	811.827	.118	.216	.0013	1.088	.001

Approach Section APPIN Flow Contraction Information					
M(G)	M(K)	KQ	XLKQ	XRKQ	OTEL
-----	-----	-----	-----	-----	-----
.070	.000	100895.8	-18.650	58.039	819.396
-----	-----	-----	-----	-----	-----

<<< End of Bridge Hydraulics Computations >>>

Section: EXNB	819.341	.448	3230.000	649.819	30.000	-14.681
Header Type: XS	819.789	.049	4.971	68257.88	30.000	54.596
SRD: 420.000	813.582	.104	.309	.0016	1.167	-.001

WSPRO OUTPUT

Section: FVNB	819.417	.447	3230.000	649.540	30.000	-14.833
Header Type: FV	819.864	.067	4.973	68058.20	30.000	54.601
SRD: 450.000	813.690	.000	.309	.0022	1.164	.008

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS AT SECID "APPNB".
KRATIO: 4.02

Section: APPNB	819.863	.054	3230.000	1787.872	95.000	-55.725
Header Type: AS	819.917	.053	1.807	273916.60	95.000	120.603
SRD: 545.000	811.466	.000	.104	.0006	1.073	.000

<<< The Preceding Data Reflect The "Unconstricted" Profile >>>

<<< The Following Data Reflect The "Constricted" Profile >>>

<<< Beginning Bridge/Culvert Hydraulic Computations >>>

===255 ATTEMPTING FLOW CLASS 3 OR 6 SOLUTION.
WS3N, PFelv: 819.42 817.24

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: BRNB	817.240	1.980	3206.900	284.230	30.000	.000
Header Type: BR	819.220	*****	11.283	26192.77	*****	28.000
SRD: 450.000	814.414	*****	.883	*****	1.000	*****

Specific Bridge Information	C	P/A	PFELEV	BLEN	XLAB	XRAB
Bridge Type 1 Flow Type 3						
Pier/Pile Code **	.8000	.000	817.240	*****	*****	*****

	WSEL	VHD	Q	AREA	SRDL	LEW
	EGEL	HF	V	K	FLEN	REW
	CRWS	HO	FR #	SF	ALPHA	ERR
Section: APPNB	822.497	.034	3230.000	2259.600	15.000	-60.995
Header Type: AS	822.531	.026	1.429	391589.70	25.595	120.750
SRD: 545.000	811.466	.118	.074	.0006	1.067	-.007

Approach Section APPNB Flow Contraction Information					
M(G)	M(K)	KQ	XLKQ	XRKQ	OTEL
.070	.000	100895.8	-18.650	58.039	822.497

<<< End of Bridge Hydraulics Computations >>>

***** W S P R O *****
Federal Highway Administration - U. S. Geological Survey

WSPRO OUTPUT

Model for Water-Surface Profile Computations.
Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES)	I-65-124-4285
COUNTY: MARION	QUAD: ZIONSVILLE 110B
07-25-97	R L MILLER

*** Live-Bed Contraction Scour Calculations for Header Record BRSB ***

Constants and Input Variables

Bed Material Transport Mode Factor (k1):	.64
Total Pier Width Value (Pw):	.000

#	Scour Depth	-- Flow --		-- Width --		--- X-Limits ---	
		Contract	Approach	Contract	Approach	Side	Contract Approach
1	26.336	1900.000	390.374	23.000	20.000	Left: 4.000	3.000
	.....	Approach Channel Depth: 10.466		.....		Right: 27.000	23.000
2	44.689	3203.558	574.178	23.000	20.000	Left: 4.000	3.000
	.....	Approach Channel Depth: 15.150		.....		Right: 27.000	23.000

***** W S P R O *****

Federal Highway Administration - U. S. Geological Survey

Model for Water-Surface Profile Computations.
Input Units: English / Output Units: English

I-65 OVER BUSH'S RUN (3 BRIDGES)	I-65-124-4285
COUNTY: MARION	QUAD: ZIONSVILLE 110B
07-25-97	R L MILLER

*** Live-Bed Contraction Scour Calculations for Header Record BRIN ***

Constants and Input Variables

Bed Material Transport Mode Factor (k1):	.64
Total Pier Width Value (Pw):	1.500

#	Scour Depth	-- Flow --		-- Width --		--- X-Limits ---	
		Contract	Approach	Contract	Approach	Side	Contract Approach
1	3.255	1546.714	827.493	28.500	20.000	Left: 10.000	15.000
	.....	Approach Channel Depth: 9.104		.....		Right: 40.000	35.000
2	4.437	2321.415	1275.681	28.500	20.000	Left: 10.000	15.000
	.....	Approach Channel Depth: 13.571		.....		Right: 40.000	35.000

***** W S P R O *****

Federal Highway Administration - U. S. Geological Survey

WSPRO OUTPUT

Model for Water-Surface Profile Computations.
Input Units: English / Output Units: English

```

*-----*
I-65 OVER BUSH'S RUN (3 BRIDGES)          I-65-124-4285
COUNTY: MARION                          QUAD: ZIONSVILLE 110B
07-25-97                                R L MILLER
  
```

*** Pier Scour Calculations for Header Record BRIN ***

Constants and Input Variables

Pier Width: 1.500

```

*-----*
Pier Shape Factor          (K1):  1.00
Flow Angle of Attack Factor (K2):  1.00
Bed Condition Factor       (K3):  1.10
Bed Material Factor        (K4):  1.00
Velocity Multiplier        (VM):  1.00
Depth Multiplier           (YM):  1.00
*-----*
  
```

#	Scour Depth	---- Localized Hydraulic Properties ----					-- X-Stations --	
		Flow	WSE	Depth	Velocity	Froude #	Left	Right
1	3.97	1900.000	814.728	10.378	5.836	.319	-34.000	62.000
2	4.10	3230.000	819.279	14.929	5.610	.256	-34.000	62.000

***** W S P R O *****

Federal Highway Administration - U. S. Geological Survey
Model for Water-Surface Profile Computations.
Input Units: English / Output Units: English

```

*-----*
I-65 OVER BUSH'S RUN (3 BRIDGES)          I-65-124-4285
COUNTY: MARION                          QUAD: ZIONSVILLE 110B
07-25-97                                R L MILLER
  
```

*** Live-Bed Contraction Scour Calculations for Header Record BRNB ***

Constants and Input Variables

```

*-----*
Bed Material Transport Mode Factor (k1): .64
Total Pier Width Value             (Pw): 1.500
*-----*
  
```

#	Scour Depth	-- Flow --		-- Width --		--- X-Limits ---		
		Contract	Approach	Contract	Approach	Side	Contract	Approach
1	25.974	1900.000	420.396	19.500	20.000	Left:	6.000	3.000
	..... Approach Channel Depth:		9.731	.....		Right:	27.000	23.000
2	51.721	3168.443	590.195	19.500	20.000	Left:	6.000	3.000
	..... Approach Channel Depth:		15.922	.....		Right:	27.000	23.000

WSPRO OUTPUT

ER

***** Normal end of WSPRO execution. *****
***** Elapsed Time: 0 Minutes 7 Seconds *****