

Common Hydraulics Submittal Errors

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Agenda

- **General report issues**
- **Common calculation errors**
- **Common design errors**
- **Other frequent omissions**



General Report Issues

- **QA Forms**
- **Signing & sealing**
- **ERMS file uploads**



QA Forms

- **Two types**
 - General QA form for all INDOT projects
 - Hydraulics specific form
- **Both required**



INDOT QA Form

QUALITY ASSURANCE FORM

CONSULTANT COMPLETES THIS SECTION

Consultant: I.R.N. Engineer, Inc

Des. No.: 9876543 Project No.: 1234567

Project Description: Small Structure Replacement on SR 72 over Some Ditch

Submittal: Stage 1

This submittal has been reviewed with regard to consistency, completeness, and overall content prior to submittal by Phred Kerfapple, Project Manager, on November 21, 2013, telephone number (317) 867-5309.

REVIEWER COMPLETES THIS SECTION

The submittal described above has been reviewed for quality in accordance with the Quality Assurance Procedures.

The consultant is responsible for checking all of its work as outlined in *Indiana Design Manual* Section 6-2.0, Quality Assurance Procedures. The table shown below indicates which of the reviewer's personnel has checked which items.

Item	Designer	Reviewer
Hydraulics Calculations	Ima Designer	Ronald Frobnitz

Remarks:



INDOT QA Form

- **Required for all INDOT projects.**
- **Available from IDM Ch 14 Plan Development.**



Hydraulics QA Form

Hydraulics QA Checklist

Route: Des No.
County: City or Town:
Description:
Designer: Reviewer:

MAPS

- USGS Quad. Scale Date
- ARC GIS Date
- Flood-Insurance Firm and FHBM
- Soils Map
- Aerial Photos Scale Date

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)
Gaging Data

BRIDGE INSPECTION REPORTS

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 _____

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



Hydraulics QA Form

- **Assists with reviews.**
- **Checklist to cover all hydraulics bases.**



Signing & Sealing

- **Per IDM Ch 14-2.04(01)**
- **Required for all hydraulics submittals.**



ERMS

- **Zipped files not allowed.**
- **All HEC-RAS & HY-8 files accepted.**
- **Working on adding TR-20 files.**
- **All Hydraulics files begin with HYD.**



Calculations

- **Hydrology**
 - Acceptable Sources
- **Hydraulics Parameters**
 - Waterway Area Below Q100
- **Hydraulics Parameters**
 - Hand Calculations



Hydrology

- **StreamStats not sufficient as a sole discharge determination.**
- **Per IDM Ch 202, use with TR-20, gaging stations, etc.**



Hydrology

■ Fig 202-3A

Facility Description	Methodology					
	Rational Method*	TR-20 or HEC-HMS	IDNR Coordinated Curves	USGS Gaging Information	Stream Stats	Purdue Regression Equations
Culvert	2	2	1	--	3	--
Bridge or Channel, < 5 sq mi drainage area	--	2	1	3	3	3
Bridge or Channel, ≥ 5 sq mi drainage area	--	3	1	2	3	3
Storm Drain and Inlets	1	4	--	--	--	--
Storage Facility	5	1	--	--	--	--
Pumping Station **	--	1	--	--	--	--

Hydrology

- **FIS flow rates should be used for CIF models.**
- **DNR discharge should match. If not, contact DNR.**



Hydrology

■ Joint probability analysis

AREA RATIO	FREQUENCY FOR COINCIDENTAL OCCURRENCE			
	10% EP		1% EP	
	MAIN STREAM	TRIBUTARY	MAIN STREAM	TRIBUTARY
10 000 to 1	1	10	2	100
	10	1	100	2
1000 to 1	2	10	10	100
	10	2	100	10
100 to 1	5	10	25	100
	10	5	100	25
10 to 1	10	10	50	100
	10	10	100	50
1 to 1	10	10	100	100
	10	10	100	100

Source: *HEC-22*, Table 7-3.

JOINT PROBABILITY ANALYSIS

Figure 203-2G



Hydrology

■ **Joint probability analysis**

- Use when receiving stream may backwater into project.
- Consider for road serviceability only.
- May not affect design, but show it was considered.



Hydraulics Parameters

- **Hand calculations**
 - Assist with review.
 - Provides benefit of doubt to designer.



Hydraulics Parameters

- **Gross waterway area below Q100:**
 - Three components:
 - Downstream bridge flow area
 - Piers
 - Difference between the proposed water surface elevation and the natural water surface elevation.



Gross Waterway Area

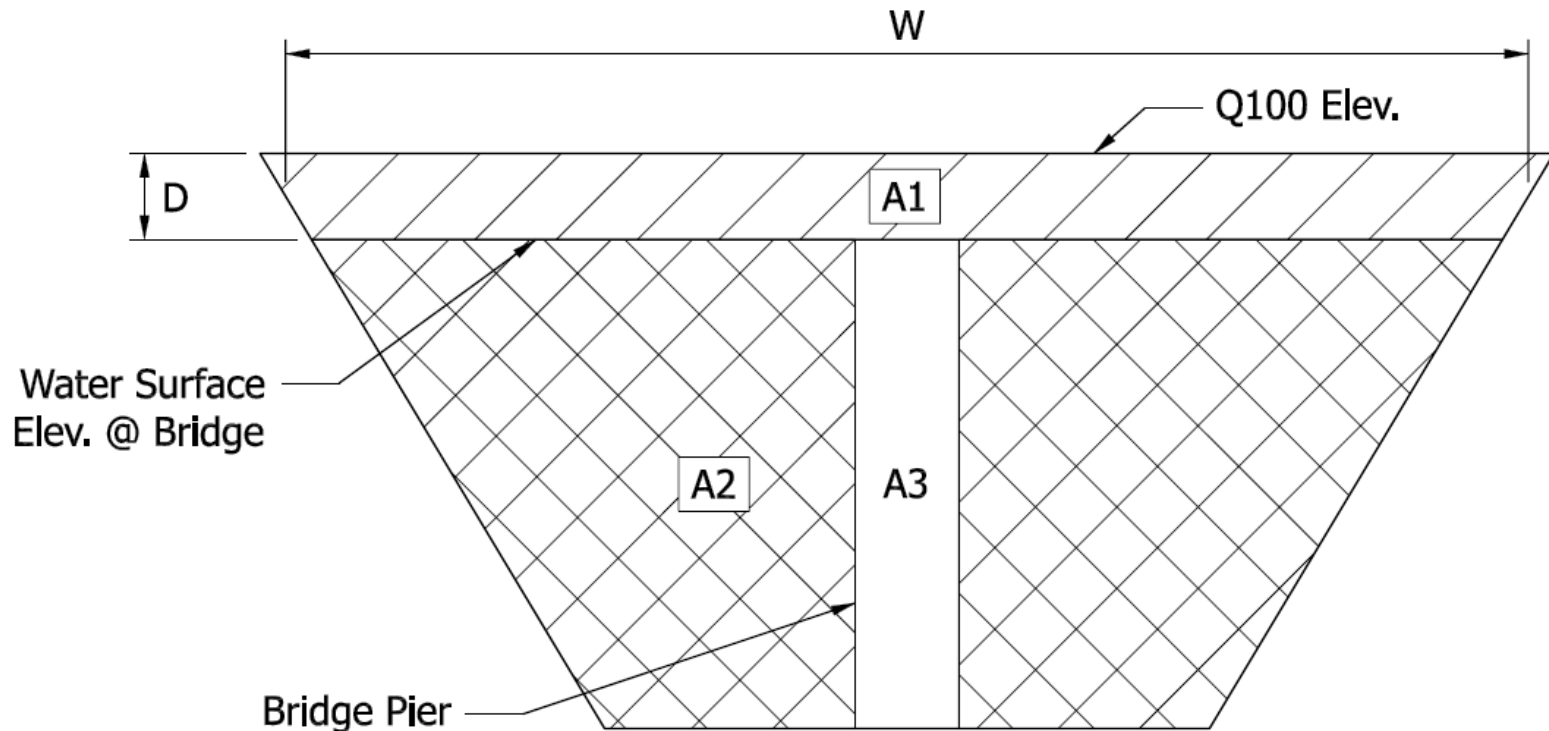
- **Bridge flow area – area below *proposed* water surface elevation.**

E.G. US. (ft)	808.97	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	808.67	E.G. Elev (ft)	808.86	808.72
Q Total (cfs)	1500.00	W.S. Elev (ft)	808.02	807.83
Q Bridge (cfs)	1500.00	Crit W.S. (ft)	806.65	806.57
Q Weir (cfs)		Max Chl Dpth (ft)	7.55	7.43
Weir Sta Lft (ft)		Vel Total (ft/s)	6.84	7.06
Weir Sta Rgt (ft)		Flow Area (sq ft)	219.42	212.45
Weir Submerg		Froude # Chl	0.64	0.68
Weir Max Depth (ft)		Specif Force (cu ft)	946.34	930.34
Min El Weir Flow (ft)	812.01	Hydr Depth (ft)	4.20	4.13
Min El Prs (ft)	810.00	W.P. Total (ft)	76.72	75.04
Delta EG (ft)	0.44	Conv. Total (cfs)	23170.1	22304.7
Delta WS (ft)	0.69	Top Width (ft)	52.19	51.44
BR Open Area (sq ft)	330.55	Frctn Loss (ft)	0.13	0.09
BR Open Vel (ft/s)	7.06	C & E Loss (ft)	0.01	0.11
Coef of Q		Shear Total (lb/sq ft)	0.75	0.80
Br Sel Method	Energy only	Power Total (lb/ft s)	5.12	5.64



Gross Waterway Area

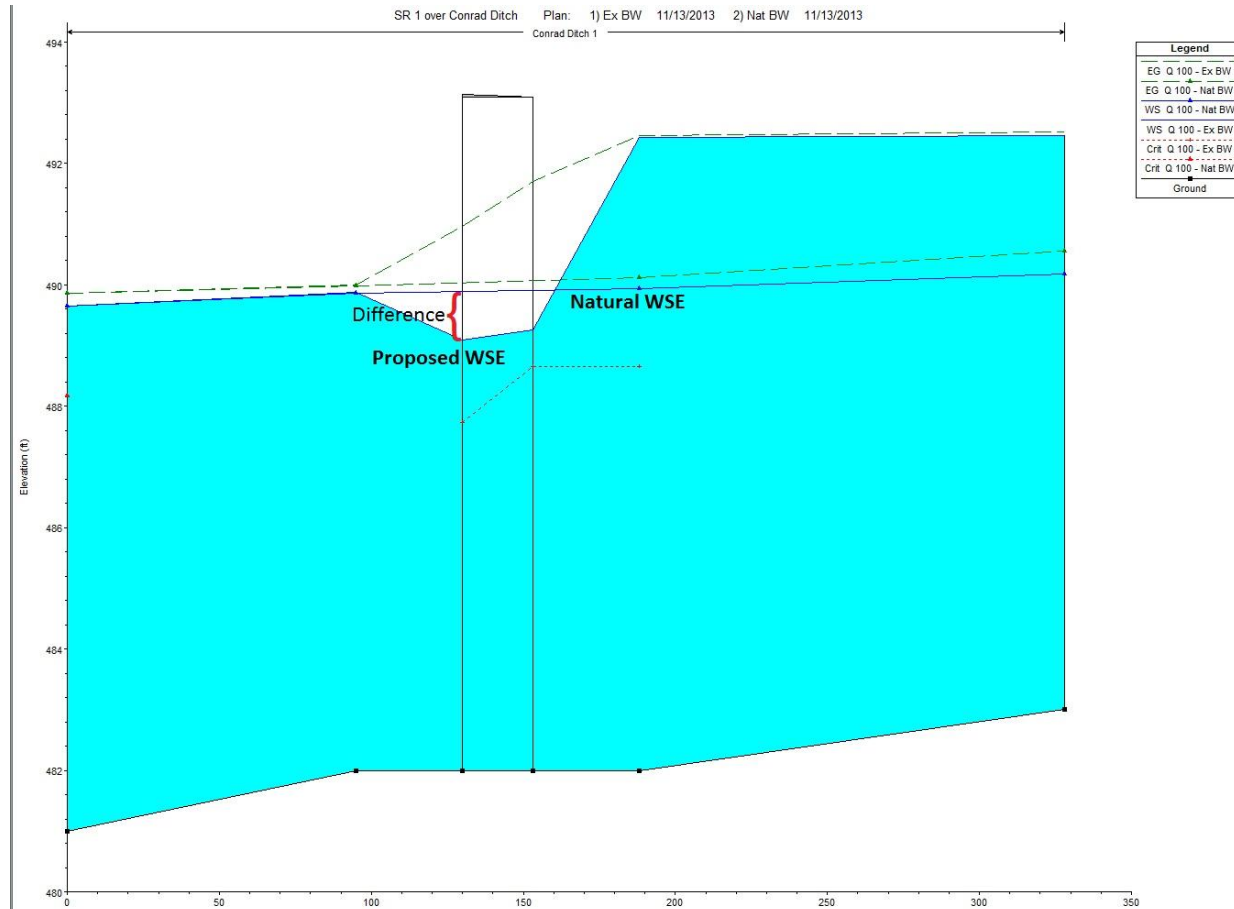
- **Pier:** Area of pier from flow line to *proposed* water surface elevation.



$$A1 + A2 + A3 = \text{Gross Waterway Area}$$

Gross Waterway Area

- **Difference between natural and proposed WSE.**



Design

- **Bridge overtopping & scour**
- **Scour countermeasures**
- **Storm drain issues**
- **Other common issues**



Bridge Overtopping & Scour

- **Maximum velocities may not always occur at Q100/Q500.**
- **If bridge overtops, maximum velocity can occur right before road overflow.**
- **Use maximum velocities for scour calculations.**



Scour Countermeasures

- **Provide scour countermeasure recommendations in Hydraulics Report.**
- **Scour critical bridges must have recommendations.**
- **Identify countermeasures for non-scour critical bridges, but “no further countermeasures required” is acceptable.**



Storm Drains

- **Consider storm drain outfall in relation to receiving stream.**
- **Too low an outlet may be submerged and won't drain.**
- **Joint probability should be considered.**



Storm Drains

- **Structure numbers in report should match plans.**
- **At the very least, provide a chart to compare the two.**



Other Problems

- **Contact the County Surveyor.**
- **Indiana Code is written in their support.**
- **County Surveyor has final say on all legal drains and tiles.**



Other Problems

- **Show right-of-way on plans.**
- **Can't confirm backwater dissipates by the right-of-way without knowing where it is.**



Recap

- **Sign and seal the Hydraulics Report.**
- **StreamStats is a reasonable check, but not sufficient for final hydrology.**
- **Provide hand calculations.**



Recap

- **Provide scour recommendations in addition to calculations.**
- **Contact the County Surveyor early in the design process.**
- **Mark the right-of-way on the plans.**



Questions?

