BOUNDARY DISTANCE INFLUENCE OF HYDRAULIC STRUCTURE

Uses MACRO function: BoundaryDistance(Q_RATIO,A_RATIO,SLOPE,SKEW,CURVE)

Enable Macros for the Spreadsheet to work

INPUT

VARIABLE	VALUE	DESCRIPTION
Q_REF	500	<= Reference discharge value (CFS) (Method A)
Q_TEST	1500	<= Test discharge value (CFS) (Method A)
A_OPENING	23	<= Structure opening area (SQ. FT.) (Method A)
A_FAR-FIELD	100	<= Cross sectional flow area away from structure (SQ.FT.) (Method A)
T_FAR-FIELD	100	<= Flow width away from structure (FT.) (Method A)
D_BANKFULL	1	<= Bankfull Depth (FT.) (Method D)
T_BANKFULL	100	<= Bankfull Width (FT.) (Method B)
SLOPE	0.02	<= Dimensionless slope in vicinity of structure (Method A and D)
ORIENTATION	SKEW	<= Structure orientation (Pull Down) (Method A)
CURVATURE	STRAIGHT	<= Channel curvature (Pull Down) (Method A)

FLOW AND AREA RATIOS (COMPUTED)

Q_RATIO	3	Q_TEST/Q_REF (Method A)
A_RATIO	0.23	A_TEST/A_REF (Method A)

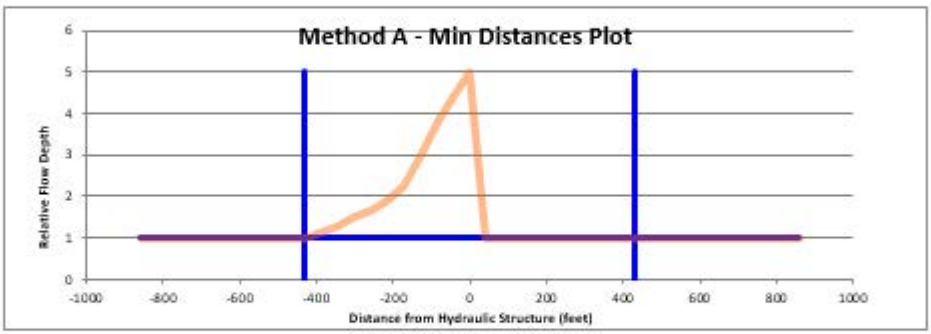
OUTPUT

DISTANCE ESTIMATE A	429	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - Low Value)
DISTANCE ESTIMATE A	857	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - High Value)
DISTANCE ESTIMATE B	2000	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - Low Value)
DISTANCE ESTIMATE B	3000	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - High Value)
DISTANCE ESTIMATE C	300	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - Low Value)
DISTANCE ESTIMATE C	1500	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - High Value)
DISTANCE ESTIMATE D	400	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - Low Value)
DISTANCE ESTIMATE D	798	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - High Value)

METHOD SELECT (Pull Down)	Method D: (Hybrid) Samuels, P. (1989). Backwater Lengths in Rivers. Proceedings of the Institution of Civil Engineers (p. 571582). Great Britian: Hydraulics Research. AND Castellarin, A., Baldassarre, G. D., Bates, P., and Brath, A. (2009). Optimal Cross- Sectional Spacing in Preissmann Scheme 1D Hydrodynamic Models. Journal of Hydraulic Engineering , 96-105.

SELECTED METHOD VALUES (FROM ABOVE)

MIN/MAX DISTANCE	MIN	MAX
FEET	400	798



Background

- The designer would like to avoid modeling an entire stream system (many structures) to study the change at single location (one structure)

- TxDOT Research 0-6841 examined existing literature and conducted a HEC-RAS study to develop Rules-Of-Thumb (ROT) for selecting boundary location distances

TxDOT

Basic Hydrology & Hydraulics: DES 601

Module XXX
TITLE

Module Outline

- Background
- Applicability
- Using the Tool

Acronyms

- HDM: TxDOT Hydraulic Design Manual 2015 Ed. (on-line)
- HDS2: FHWA-NHI-02-001 Highway Hydrology
- ROT: Rule-of-Thumb

Background

- Culverts, bridges, and other obstructions change the water surface profile in a channel
- The addition or removal of flow from a stream may affect the water surface downstream and possibly upstream
- The effect on the water surface near the structure is known by modeling the receiving stream

Background

- Boundary effects can propagate into region of interest
- Limited guidance on where to locate boundaries in HDM standard-step backwater method
- Want boundary effects small in region of interest

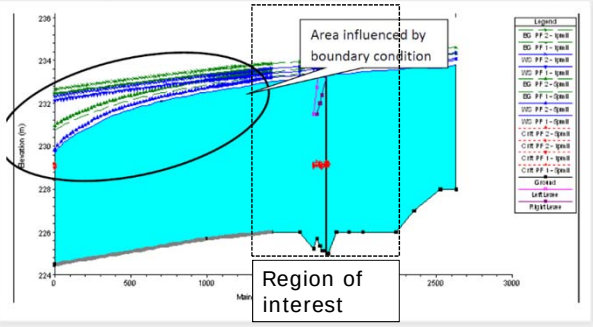


Image 1. Influence of boundary conditions

Source: AHYDRA

TxDOT

Background

- The designer would like to avoid modeling an entire stream system (many structures) to study the change at single location (one structure)
- TxDOT Research 0-6841 examined existing literature and conducted a HEC-RAS study to develop Rules-Of-Thumb (ROT) for selecting boundary location distances

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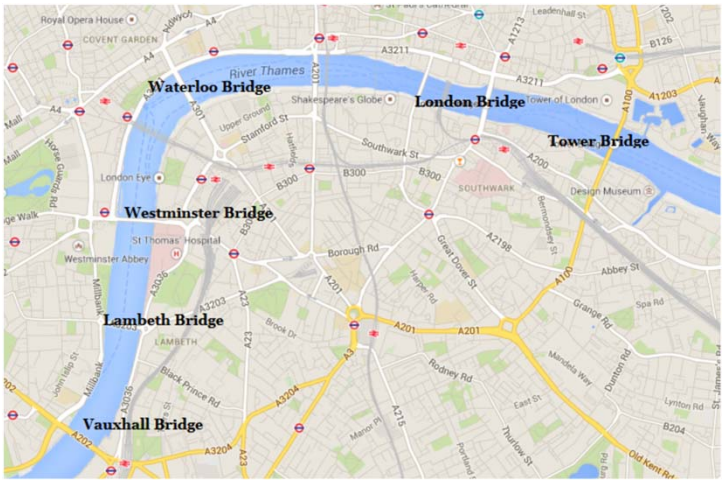
Background

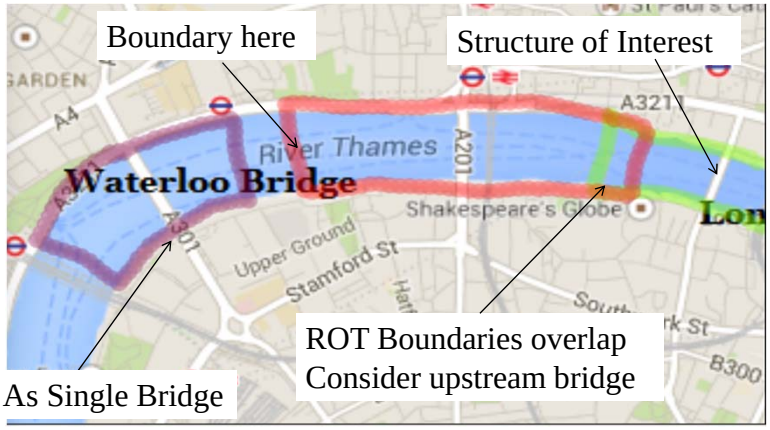
- How far do boundary effects extend?



TxDOT

Background

- How far do boundary effects extend?



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Applicability

- ROT are intended for examining a single location
- Also identifies if additional locations should be included
  - Locate boundary distances for structure of interest
  - If nearby structures boundaries have overlap, then include these in overall modeling effort

TxDOT

Rules-Of-Thumb

- Four rules emerged from the study:

1 Boundary distance is approximately

$$DIST = \alpha_0 + \alpha_1 DIST_{estimate} + \alpha_2 (DIST_{estimate})^2 \quad (5)$$

where the estimate is the result of Equation 4

$$LOG10(DIST) = \beta_0 + \beta_1 LOG10(S_0) + \beta_2 LOG10(Q_{RATIO}) + \beta_3 LOG10(A_{RATIO}) + \beta_4 SKEW + \beta_5 CRV \quad (4)$$

Modeling a Change in Flowrate through Detention or Additional Pavement on the Receiving Stream, FHWA/TX-15/0-6841-1

TxDOT

Rules-Of-Thumb

- Four rules emerged from the study:

2 Boundary distance is approximately 20 to 30 bank full channel widths

Wildland Hydrology, 2013. References in support of stream restoration, erosion control, and geomorphology. Accessed on July 7, 2013 at http://www.wildlandhydrology.com/html/references_.html

TxDOT

Rules-Of-Thumb

3 Boundary distance approximately 100 to 500 feet approaching (upstream) and 300 to 1,500 feet departing (downstream)

Nebraska Department of Roads. (2015). Hydraulic Analysis Guidelines. Bridge Division.

TxDOT

Rules-Of-Thumb

4 Boundary distance *L* approximately where *D* is bank full depth and S_0 is the channel slope.

$$L = 40 \cdot \left(0.2 \frac{D}{S_0} \right)$$

Samuels, P. (1989). Backwater Lengths in Rivers. Proceedings of the Institution of Civil Engineers (p. 571582). Great Britian: Hydraulics Research.

Castellarin, A., Baldassarre, G. D., Bates, P., and Brath, A. (2009). Optimal Cross-Sectional Spacing in Preissmann Scheme 1D Hydrodynamic Models. Journal of Hydraulic Engineering , 96-105.

TxDOT

Rules-Of-Thumb

- The four rules produce different results, but most are of similar magnitude
- Ultimate decision is designer's judgment
- To facilitate the calculations involved a spreadsheet-based tool was built that implements the four rules, then the designer chooses a preferred rule and can use that value to establish modeling boundaries

TxDOT

Using the Tool

- **BoundaryDistanceRuleOfThumb-2015.xlsm**
- Implements the various ROT distances; the designer must make the decision which guidance to follow, although the tool reports several different guidelines

TxDOT

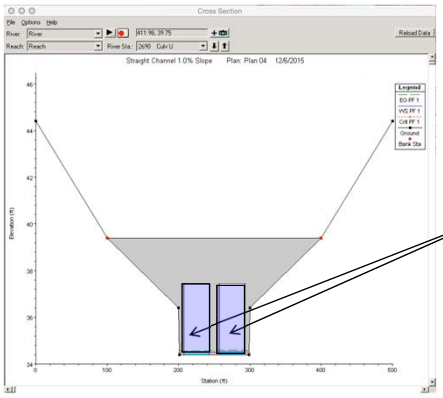
Using the Tool – Needed Values

- Reference Discharge – The original pre-change discharge at the location
- Test Discharge – The added or reduced discharge at the location
- Structure opening flow area
- Far field flow area
- Far field top width
- Bank full flow depth
- Bank full flow width
- Curved or Straight Channel
- Skewed or Aligned Hydraulic Structure

TxDOT

Structure Opening Flow Area

- Elevation view looking downstream

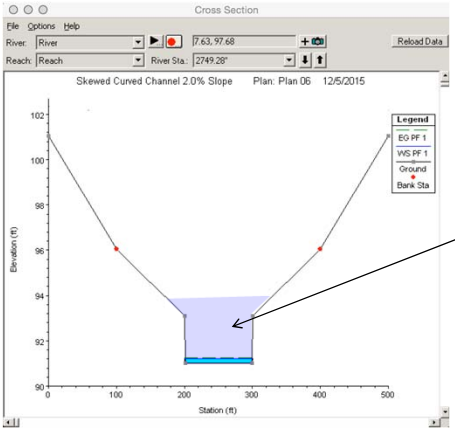


Flow area of the structure at Soffit flow depth

TxDOT

Far-field flow area

- Elevation view looking downstream

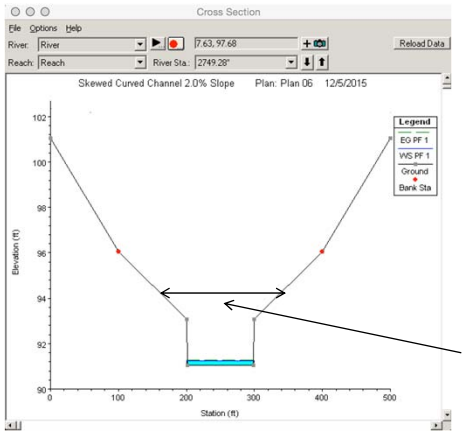


Flow area of the channel away from the structure at the Soffit flow depth

TxDOT

Far-field top width

- Elevation view looking downstream

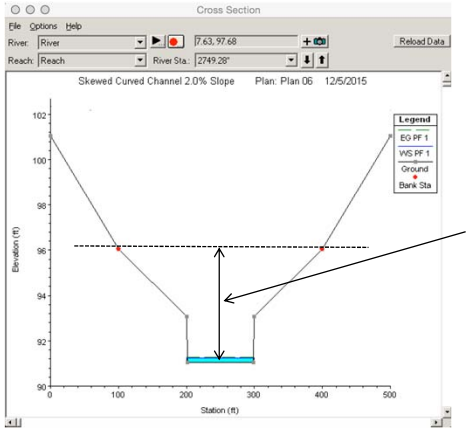


Top width at reference and test flow depths (used in several, but not all ROTs)

TxDOT

Bank full flow depth

- Elevation view looking downstream

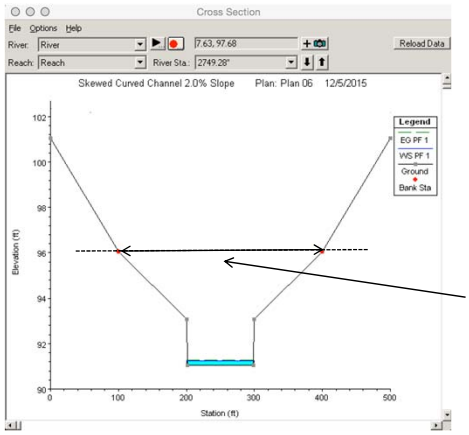


Bank full flow depth (used in several, but not all ROTs)

TxDOT

Bank full flow width

- Elevation view looking downstream

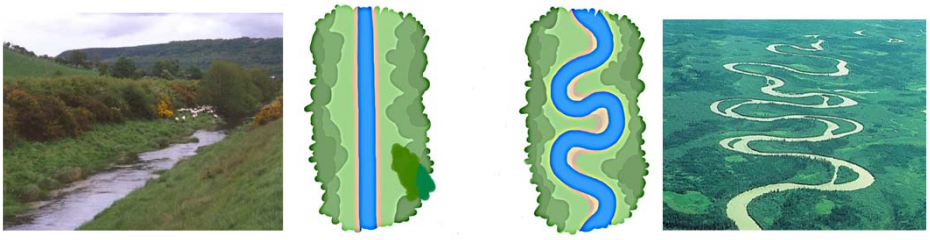


Bank full top width (used in several, but not all ROTs)

TxDOT

Straight or Curved Channel

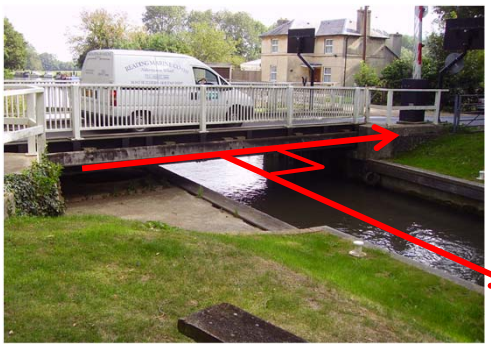
- Categorical Variable



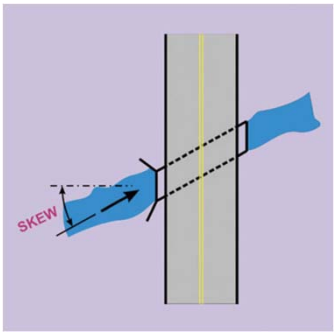
TxDOT

Aligned or Skew Structure

- Categorical Variable



No Skew (Skew Angle = 0)



Skew (Skew Angle > 10)

TxDOT

Using the Tool -- Interface

Home | Layout | Tables | Charts | SmartArt | Formulas | Data | Review | Developer

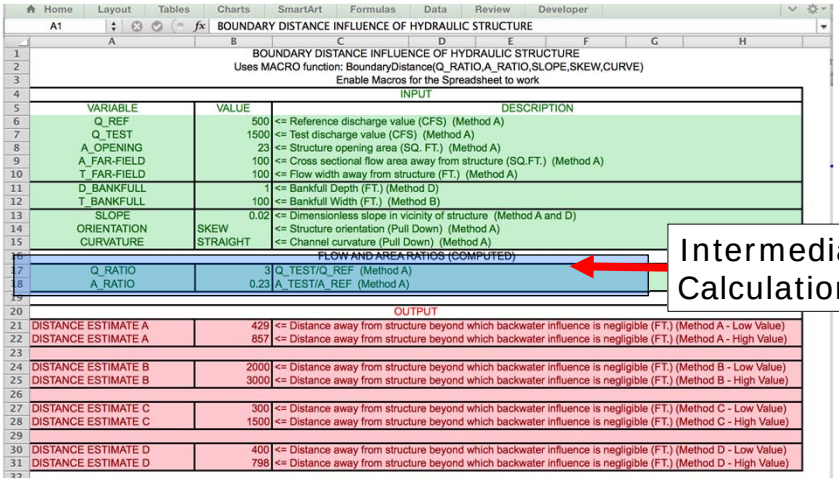
A1 | BOUNDARY DISTANCE INFLUENCE OF HYDRAULIC STRUCTURE

	A	B	C	D	E	F	G	H
1	BOUNDARY DISTANCE INFLUENCE OF HYDRAULIC STRUCTURE							
2	Uses MACRO function: BoundaryDistance(Q_RATIO,A_RATIO,SLOPE,SKEW,CURVE)							
3	Enable Macros for the Spreadsheet to work							
4	INPUT							
5	VARIABLE	VALUE	DESCRIPTION					
6	Q_REF	500	<= Reference discharge value (CFS) (Method A)					
7	Q_TEST	1500	<= Test discharge value (CFS) (Method A)					
8	A_OPENING	23	<= Structure opening area (SQ. FT.) (Method A)					
9	A_FAR-FIELD	100	<= Cross sectional flow area away from structure (SQ.FT.) (Method A)					
10	T_FAR-FIELD	100	<= Flow width away from structure (FT.) (Method A)					
11	D_BANKFULL	1	<= Bankfull Depth (FT.) (Method D)					
12	T_BANKFULL	100	<= Bankfull Width (FT.) (Method B)					
13	SLOPE	0.02	<= Dimensionless slope in vicinity of structure (Method A and D)					
14	ORIENTATION	SKEW	<= Structure orientation (Pull Down) (Method A)					
15	CURVATURE	STRAIGHT	<= Channel curvature (Pull Down) (Method A)					
16	FLOW AND AREA RATIOS (COMPUTED)							
17	Q_RATIO	3	Q_TEST/Q_REF (Method A)					
18	A_RATIO	0.23	A_TEST/A_REF (Method A)					
19								
20	OUTPUT							
21	DISTANCE ESTIMATE A	429	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - Low Value)					
22	DISTANCE ESTIMATE A	857	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - High Value)					
23								
24	DISTANCE ESTIMATE B	2000	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - Low Value)					
25	DISTANCE ESTIMATE B	3000	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - High Value)					
26								
27	DISTANCE ESTIMATE C	300	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - Low Value)					
28	DISTANCE ESTIMATE C	1500	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - High Value)					
29								
30	DISTANCE ESTIMATE D	400	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - Low Value)					
31	DISTANCE ESTIMATE D	798	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - High Value)					

Designer supplied input

TxDOT

Using the Tool -- Interface



BOUNDARY DISTANCE INFLUENCE OF HYDRAULIC STRUCTURE
Uses MACRO function: BoundaryDistance(Q_RATIO,A_RATIO,SLOPE,SKEW,CURVE)
Enable Macros for the Spreadsheet to work

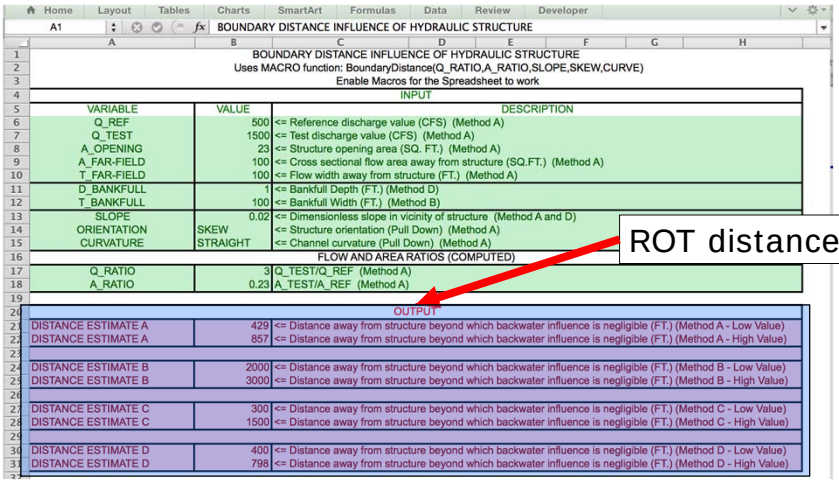
INPUT

VARIABLE	VALUE	DESCRIPTION
Q_REF	500	<= Reference discharge value (CFS) (Method A)
Q_TEST	1500	<= Test discharge value (CFS) (Method A)
A_OPENING	23	<= Structure opening area (SQ. FT.) (Method A)
A_FAR-FIELD	100	<= Cross sectional flow area away from structure (SQ.FT.) (Method A)
T_FAR-FIELD	100	<= Flow width away from structure (FT.) (Method A)
D_BANKFULL	1	<= Bankfull Depth (FT.) (Method D)
T_BANKFULL	100	<= Bankfull Width (FT.) (Method B)
SLOPE	0.02	<= Dimensionless slope in vicinity of structure (Method A and D)
ORIENTATION	SKEW	<= Structure orientation (Pull Down) (Method A)
CURVATURE	STRAIGHT	<= Channel curvature (Pull Down) (Method A)
FLOW AND AREA RATIOS (COMPUTED)		
Q_RATIO	3	Q_TEST/Q_REF (Method A)
A_RATIO	0.23	A_TEST/A_REF (Method A)
OUTPUT		
DISTANCE ESTIMATE A	429	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - Low Value)
DISTANCE ESTIMATE A	857	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - High Value)
DISTANCE ESTIMATE B	2000	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - Low Value)
DISTANCE ESTIMATE B	3000	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - High Value)
DISTANCE ESTIMATE C	300	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - Low Value)
DISTANCE ESTIMATE C	1500	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - High Value)
DISTANCE ESTIMATE D	400	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - Low Value)
DISTANCE ESTIMATE D	798	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - High Value)

Intermediate Calculations

TxDOT

Using the Tool -- Interface



BOUNDARY DISTANCE INFLUENCE OF HYDRAULIC STRUCTURE
Uses MACRO function: BoundaryDistance(Q_RATIO,A_RATIO,SLOPE,SKEW,CURVE)
Enable Macros for the Spreadsheet to work

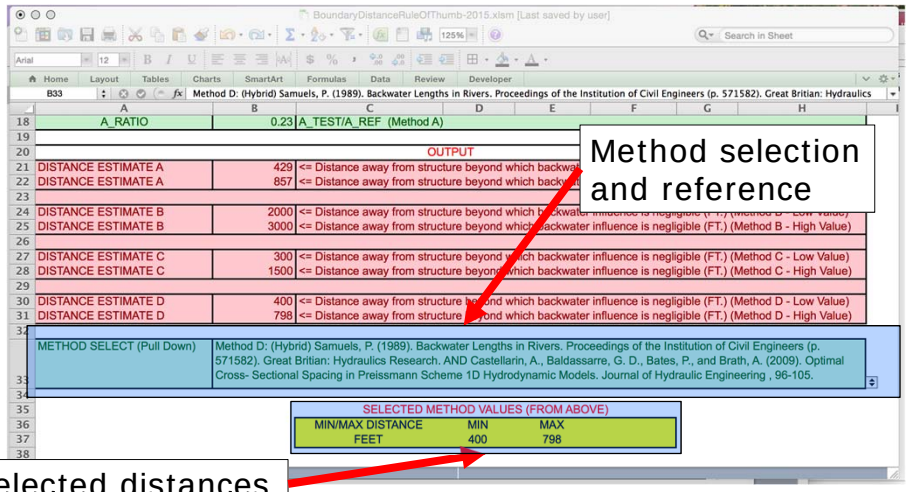
INPUT

VARIABLE	VALUE	DESCRIPTION
Q_REF	500	<= Reference discharge value (CFS) (Method A)
Q_TEST	1500	<= Test discharge value (CFS) (Method A)
A_OPENING	23	<= Structure opening area (SQ. FT.) (Method A)
A_FAR-FIELD	100	<= Cross sectional flow area away from structure (SQ.FT.) (Method A)
T_FAR-FIELD	100	<= Flow width away from structure (FT.) (Method A)
D_BANKFULL	1	<= Bankfull Depth (FT.) (Method D)
T_BANKFULL	100	<= Bankfull Width (FT.) (Method B)
SLOPE	0.02	<= Dimensionless slope in vicinity of structure (Method A and D)
ORIENTATION	SKEW	<= Structure orientation (Pull Down) (Method A)
CURVATURE	STRAIGHT	<= Channel curvature (Pull Down) (Method A)
FLOW AND AREA RATIOS (COMPUTED)		
Q_RATIO	3	Q_TEST/Q_REF (Method A)
A_RATIO	0.23	A_TEST/A_REF (Method A)
OUTPUT		
DISTANCE ESTIMATE A	429	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - Low Value)
DISTANCE ESTIMATE A	857	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - High Value)
DISTANCE ESTIMATE B	2000	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - Low Value)
DISTANCE ESTIMATE B	3000	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - High Value)
DISTANCE ESTIMATE C	300	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - Low Value)
DISTANCE ESTIMATE C	1500	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - High Value)
DISTANCE ESTIMATE D	400	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - Low Value)
DISTANCE ESTIMATE D	798	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - High Value)

ROT distances

TxDOT

Using the Tool -- Interface



TxDOT

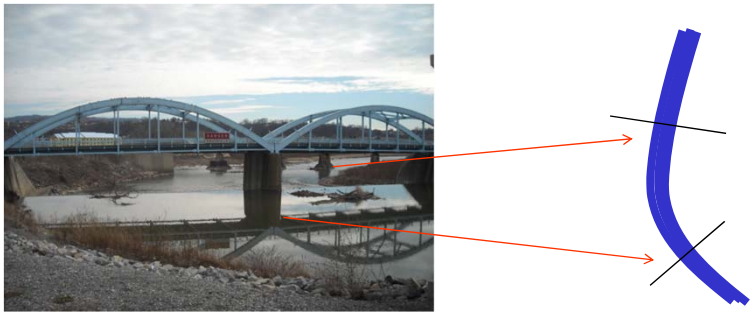
Using the Tool – Illustrative Example

- Consider the bridges pictured
  - Determine where model boundaries should be placed to evaluate hydraulic impact of the pier(s)

TxDOT

Using the Tool – Illustrative Example

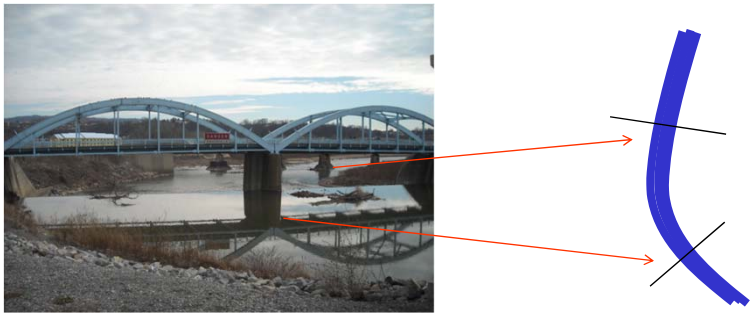
- Consider the bridges pictured
  - Determine where model boundaries should be placed to evaluate hydraulic impact of the pier(s)



TxDOT

Using the Tool – Illustrative Example

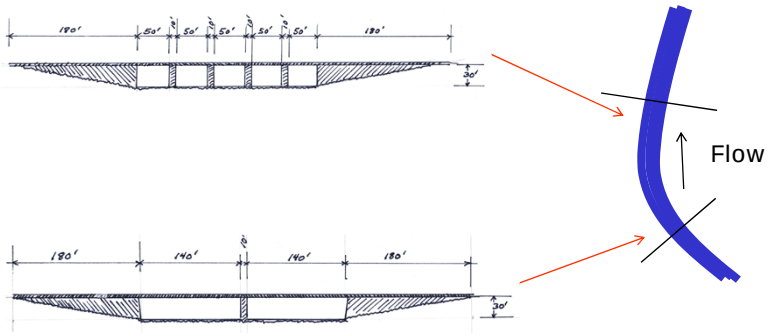
- Consider upstream (pictured) bridge first



TxDOT

Using the Tool – Illustrative Example

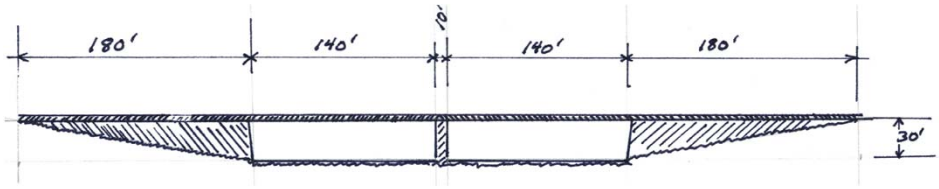
- Consider upstream (pictured) bridge first



TxDOT

Using the Tool – Illustrative Example

- Bridge #1 Cross Section



- Far-Field Cross Section

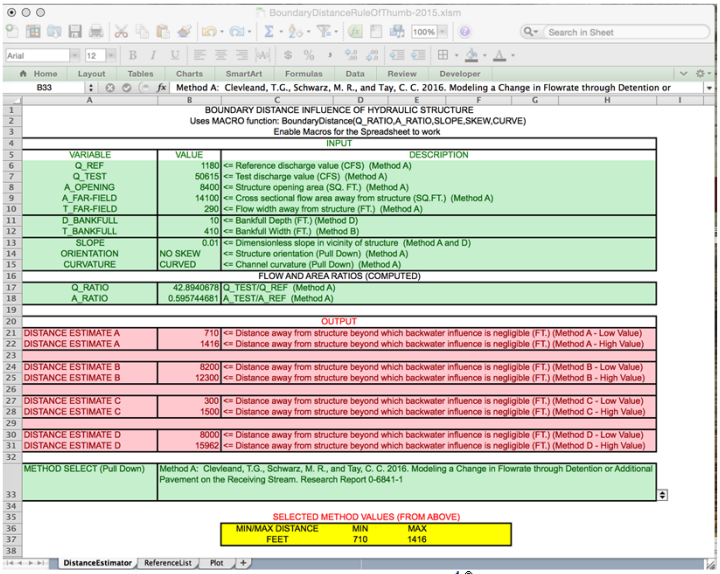
TxDOT

Using the Tool – Illustrative Example Bridge #1

- Reference Discharge : 1,180 cfs
- Test Discharge : 50,615 cfs
- Structure flow area: 8,400 sq. ft. (@ 30ft. deep)
- Far field flow area: 14,100 sq. ft. (@ 30ft. deep)
- Far field top width: 290 ft. (@ 30ft. deep)
- Bank full flow depth: 10 ft.
- Bank full flow width : 410 ft.
- Curved or Straight Channel : Curved
- Skewed or Aligned Hydraulic Structure : Aligned

TxDOT

Using the Tool – Illustrative Example



BoundaryDistanceRuleOfThumb-2015.xlsm

B33: Method A: Clevleand, T.G., Schwarz, M. R., and Tay, C. C. 2016. Modeling a Change in Flowrate through Detention or

BOUNDARY DISTANCE INFLUENCE OF HYDRAULIC STRUCTURE
Uses MACRO function: BoundaryDistance(Q_RATIO,A_RATIO,SLOPE,SKEW,CURVE)
Enable Macros for the Spreadsheet to work

INPUT

VARIABLE	VALUE	DESCRIPTION
Q_REF	1180	<= Reference discharge value (CFS) (Method A)
Q_TEST	50615	<= Test discharge value (CFS) (Method A)
A_OPENING	8400	<= Structure opening area (SQ. FT.) (Method A)
A_FAR-FIELD	14100	<= Cross sectional flow area away from structure (SQ.FT.) (Method A)
T_FAR-FIELD	290	<= Flow width away from structure (FT.) (Method A)
D_BANKFULL	10	<= Bankfull Depth (FT.) (Method D)
T_BANKFULL	410	<= Bankfull Width (FT.) (Method B)
SLOPE	0.01	<= Dimensionless slope in vicinity of structure (Method A and D)
ORIENTATION	NO SKEW	<= Structure orientation (Pull Down) (Method A)
CURVATURE	CURVED	<= Channel curvature (Pull Down) (Method A)

FLOW AND AREA RATIOS (COMPUTED)

Q_RATIO	42.8940678	Q_TEST/Q_REF (Method A)
A_RATIO	0.595744681	A_TEST/A_REF (Method A)

OUTPUT

DISTANCE ESTIMATE A	710	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - Low Value)
DISTANCE ESTIMATE A	1416	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - High Value)
DISTANCE ESTIMATE B	8200	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - Low Value)
DISTANCE ESTIMATE B	12300	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - High Value)
DISTANCE ESTIMATE C	300	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - Low Value)
DISTANCE ESTIMATE C	1500	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - High Value)
DISTANCE ESTIMATE D	8000	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - Low Value)
DISTANCE ESTIMATE D	15962	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - High Value)

METHOD SELECT (Pull Down): Method A: Clevleand, T.G., Schwarz, M. R., and Tay, C. C. 2016. Modeling a Change in Flowrate through Detention or Additional Pavement on the Receiving Stream. Research Report 0-6841-1

SELECTED METHOD VALUES (FROM ABOVE)

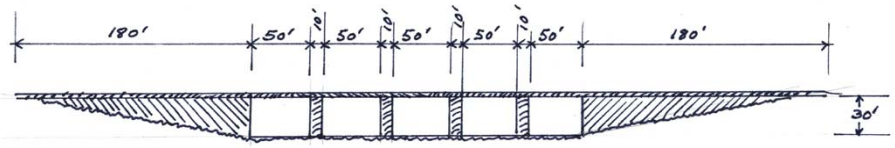
MIN/MAX DISTANCE	MIN	MAX
FEET	710	1416

DistanceEstimator | ReferenceList | Plot

TxDOT

Using the Tool – Illustrative Example

- Bridge #2 Cross Section



- Far-Field Cross Section

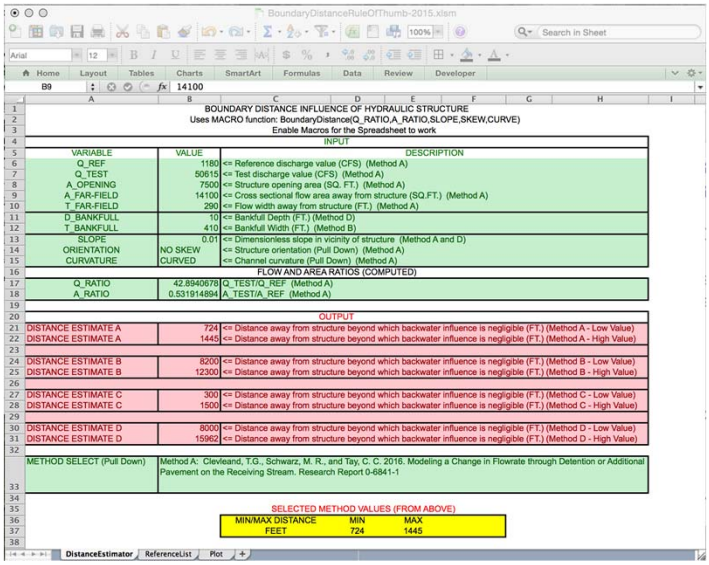
TxDOT

Using the Tool – Illustrative Example Bridge #2

- Reference Discharge : 1,180 cfs
- Test Discharge : 50,615 cfs
- Structure flow area: 7,500 sq. ft. (@ 30ft. deep)
- Far field flow area: 14,100 sq. ft. (@ 30ft. deep)
- Far field top width: 290 ft. (@ 30ft. deep)
- Bank full flow depth: 10 ft.
- Bank full flow width : 410 ft.
- Curved or Straight Channel : Curved
- Skewed or Aligned Hydraulic Structure : Aligned

TxDOT

Using the Tool – Illustrative Example



BoundaryDistanceRuleOfThumb-2015.xlsm

BOUNDARY DISTANCE INFLUENCE OF HYDRAULIC STRUCTURE
Uses MACRO function: BoundaryDistance(Q_RATIO,A_RATIO,SLOPE,SKEW,CURVE)
Enable Macros for the Spreadsheet to work

INPUT

VARIABLE	VALUE	DESCRIPTION
Q_REF	1180	<= Reference discharge value (CFS) (Method A)
Q_TEST	50615	<= Test discharge value (CFS) (Method A)
A_OPENING	7500	<= Structure opening area (SQ. FT.) (Method A)
A_FAR-FIELD	14100	<= Cross sectional flow area away from structure (SQ.FT.) (Method A)
T_FAR-FIELD	290	<= Flow width away from structure (FT.) (Method A)
D_BANKFULL	10	<= Bankfull Depth (FT.) (Method D)
T_BANKFULL	410	<= Bankfull Width (FT.) (Method B)
SLOPE	0.01	<= Dimensionless slope in vicinity of structure (Method A and D)
ORIENTATION	NO SKEW	<= Structure orientation (Pull Down) (Method A)
CURVATURE	CURVED	<= Channel curvature (Pull Down) (Method A)

FLOW AND AREA RATIOS (COMPUTED)

Q_RATIO	42.8940678	Q_TEST/Q_REF (Method A)
A_RATIO	0.531914894	A_TEST/A_REF (Method A)

OUTPUT

DISTANCE ESTIMATE A	724	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - Low Value)
DISTANCE ESTIMATE A	1445	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method A - High Value)
DISTANCE ESTIMATE B	8200	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - Low Value)
DISTANCE ESTIMATE B	12300	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method B - High Value)
DISTANCE ESTIMATE C	300	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - Low Value)
DISTANCE ESTIMATE C	1500	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method C - High Value)
DISTANCE ESTIMATE D	8000	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - Low Value)
DISTANCE ESTIMATE D	15962	<= Distance away from structure beyond which backwater influence is negligible (FT.) (Method D - High Value)
METHOD SELECT (Pull Down)	Method A: Clevleand, T.G., Schwarz, M. R., and Tay, C. C. 2016. Modeling a Change in Flowrate through Detention or Additional Pavement on the Receiving Stream. Research Report 0-6841-1	

SELECTED METHOD VALUES (FROM ABOVE)

MIN/MAX DISTANCE	MIN	MAX
FEET	724	1445

DistanceEstimator | ReferenceList | Plot

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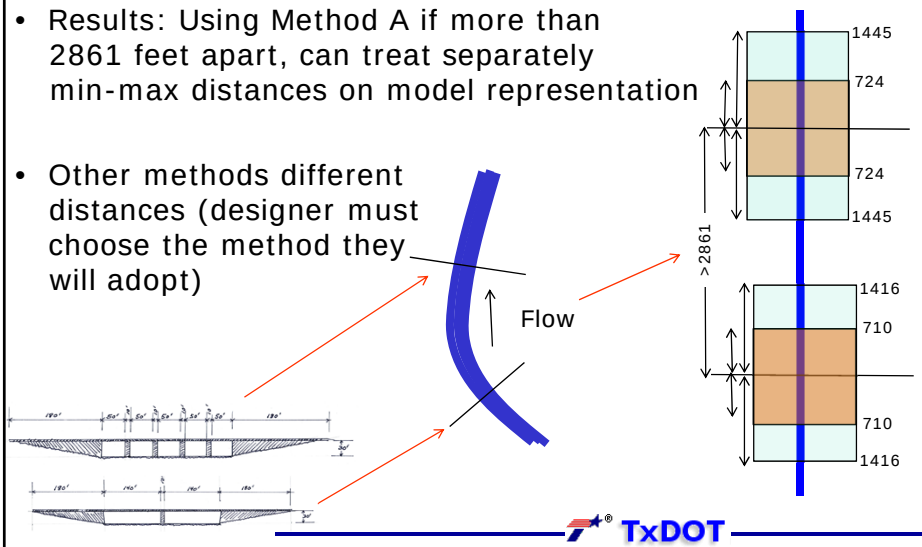
Using the Tool – Illustrative Example

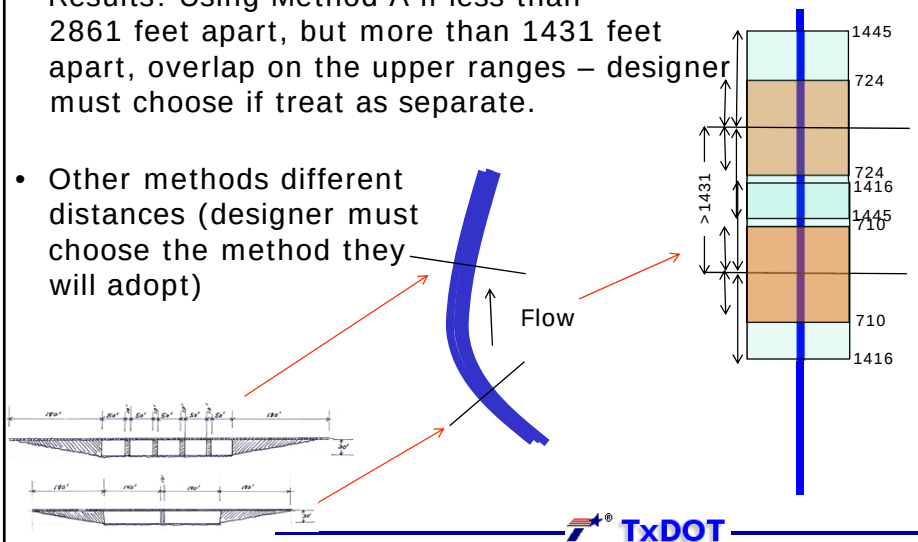
- Results: Using Method A if more than 2861 feet apart, can treat separately min-max distances on model representation
- Other methods different distances (designer must choose the method they will adopt)



TxDOT

Using the Tool – Illustrative Example

- Results: Using Method A if less than 2861 feet apart, but more than 1431 feet apart, overlap on the upper ranges – designer must choose if treat as separate.
- Other methods different distances (designer must choose the method they will adopt)



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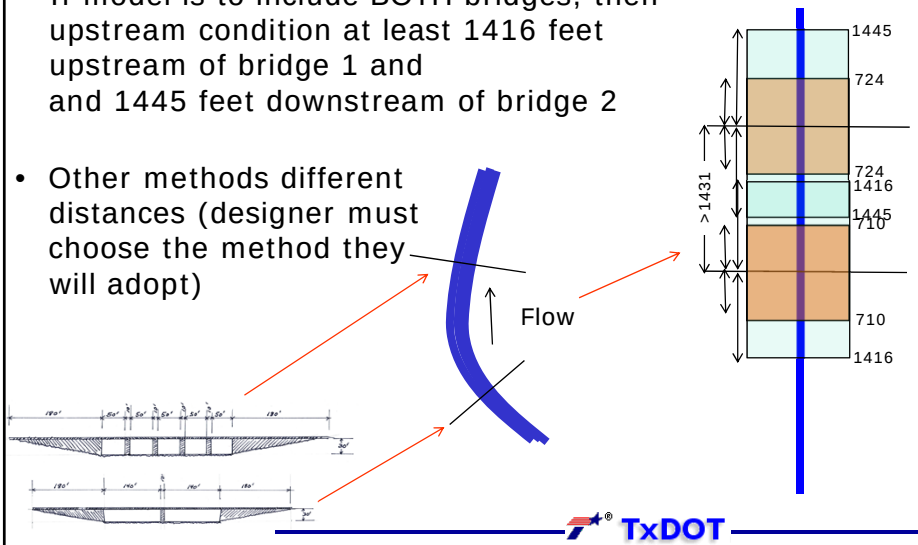
Using the Tool – Illustrative Example

- If model is to include BOTH bridges, then upstream condition at least 1416 feet upstream of bridge 1 and and 1445 feet downstream of bridge 2
- Other methods different distances (designer must choose the method they will adopt)



TxDOT

Summary

- Tool to estimate model boundary locations based on a minimal description of the structure hydraulics and stream geometry
- Helps avoid modeling an entire stream system for a change at one location, when a more localized model is appropriate (designer must decide)
- Multiple methods are available:
  - Methods A and C are relatively close in numerical output
  - Methods B and D are relatively close in numerical output (but tend to be larger than A or C)

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