HYDRAULIC 1D MODEL CHECKLIST

PROJECT:
PROJECT NO:
LOCATION:
DESIGNER:

STEADY FLOW DATA	Yes	No	N/A
Boundary Conditions Upstream Downstream			
☐ Normal Depth S= S=			
☐ Known WS WSE = WSE_{50} = Q_{50} = WSE = WSE_{100} = Q_{100} = WSE = WSE_{500} = Q_{500} =			
☐ Critical Depth			
☐ Rating Curve source = source =			
Sensitivity analysis of normal depth slopes all converge downstream of bridge?	☐	☐	☐
Known WS used from the FEMA Flood Insurance Study (NAVD)?	☐	☐	☐
Backwater Influence	☐	☐	☐
☐ Structure ☐ Reservoir ☐ River Drainage Area Ratio: Frequency for Coincidental Occurrences: Downstream distance: Known water surface:			
Flow Regime ☐ Subcritical (*Froude < 1.0 at all sections, DS boundary conditions*) ☐ Supercritical (*Froude > 1.0 at all sections, US boundary conditions*) ☐ Mixed (*Froude > 1.0 at some sections, US and DS boundary conditions*)			

Discharge
 ☐ Closed bottom pipes (*spans less than 12 feet*)
     25-year Design (*HW/D≤1.25*):   _____ cfs
     100-year Base/riprap/overtopping: _____ cfs
 ☐ Closed bottom rectangular culverts (*spans less than 12 feet*)
     50-year Design (*HW/D≤1.25*):   _____ cfs
     100-year Base/riprap/overtopping: _____ cfs
 ☐ All open bottom structures and culverts (*spans 12-20 feet*)
     50-year Design (*1' freeboard*):   _____ cfs
     100-year Base/riprap/overtopping: _____ cfs
 ☐ Bridges (*spans more than 20 feet*)
     50-year Design (*2' freeboard*):   _____ cfs
     100-year Base/riprap/girder: _____ cfs
     500-year Scour/overtopping: _____ cfs
 ☐ Bridges/Culverts over controlled-flow canals
     Average flow Design (*1' freeboard*):   _____ cfs
     Maximum flow Low chord,riprap/scour: _____ cfs
     (stormwater or infiltration added to max flow?)			

Comments:			

GEOMETRIC DATA Cross Sections	Yes	No	N/A
Background pictures (.jpg) on the Schematic?	☐	☐	☐
Stations increase from downstream to upstream?	☐	☐	☐
Data is entered from left to right looking downstream (*XS direction arrows*)?	☐	☐	☐
Extend across 100-year floodplain without "vertical walls"?	☐	☐	☐
Perpendicular to anticipated flow direction in channel and overbanks?	☐	☐	☐
Each cross section represents a single water surface elevation (*stage*)?	☐	☐	☐
Do any overlap?	☐	☐	☐
Are interpolated cross sections used?	☐	☐	☐
If Geo-referenced, cross sections are **green** (*GIS Tools > XS Cut Lines Table*)?	☐	☐	☐
If not Geo-referenced, cross sections are **brown**?	☐	☐	☐
If Geo-referenced, "Display Ratio of Cut Line Length to XS Length" are 1.0, except at optional skewed bridge and Bounding sections?	☐	☐	☐
If not Geo-referenced, the "Scale Cut Lines to Reach Lines" is checked?	☐	☐	☐
Schematic and river stations match downstream reach lengths table?	☐	☐	☐
Left and right bank stations are reasonable with consistent elevations?	☐	☐	☐
Contraction/Expansion Coefficients (Steady Flow) adjusted for bridge effects?	☐	☐	☐
Manning's n-values used were calibrated or a sensitivity analysis performed?	☐	☐	☐

Manning's Roughness Coefficients ('n' values)
    Left Overbank   Min.   Max.
    Channel   Min.   Max.
    Right Overbank Min. Max.			

Backwater influence downstream of bridge?
    Backwater length: $L = 0.7*D/S$ (*Paul Samuel equation*)
    Spacing distance: $dx = 0.15*D/S$ (*Paul Samuel equation*)
                  (*D is bank full depth, S is bed slope*)
	☐	☐	☐

Ineffective Flow areas (*no wetted perimeter, storage but no conveyance*) in overbanks are appropriate?	☐	☐	☐
Levees (*wetted perimeter, no storage until overtopped*) are appropriate?	☐	☐	☐
Obstructions (*wetted perimeter, no storage or conveyance*) are appropriate?	☐	☐	☐
FEMA lettered cross sections used in the model?	☐	☐	☐
No-Rise Certification measured from same cross section (Exist-vs-Proposed)?	☐	☐	☐
Error Warnings and Notes are reasonable for each Profile?	☐	☐	☐
Ineffective Flow Area			
Ineffective flow limits modeled within contraction/expansion reaches?	☐	☐	☐
Elevations for ineffective flow correspond to weir flow over bridge US & DS?	☐	☐	☐
(4) Approach XS: (*d= avg. length constriction from road abutment*)			
(3) Bounding XS: (*Ineffective Flow 1:1 from US bridge face*)			
(2) Bounding XS: (*Ineffective Flow 1:1 from DS bridge face*)			
(1) Exit XS:			
Bounding XS's are at or beyond the roadway embankment toe?	☐	☐	☐
Bounding XS's are parallel to each other?	☐	☐	☐
Length of contraction L_c =			
Length of expansion, L_e =			
Contraction Ratio, CR =			
Expansion Ratio, ER =			
Comments:			

Bridge Geometry	Yes	No	N/A
Bridge River Sta.:			
"Distance" between upstream XS and deck/roadway: _____ ft			
Deck/roadway "width" along the stream: _____ ft			
Deck/roadway "width" matches the report/drawings?	☐	☐	☐
High chord elevation (*top of road*): _____ ft			
Low chord elevation (*min. low*): _____ ft			
High/low chords match the report/drawings?	☐	☐	☐
Bridge span based on Deck/Roadway stations (*skew angle "0"*):			
Bridge span based on Bridge Data profiles (*skew angle "0"*):			
Bridge span matches the report/drawings?	☐	☐	☐
Embankment side slopes (*display purposes only Profile Plot*): _____ (H:V)			
Minimum weir flow elevation is blank? (*defaults to lowest high chord elevation on the US side of the bridge to start checking for weir flow*)	☐	☐	☐
Roadway profile grade modeled along the deck/roadway high chord?	☐	☐	☐
Abutments created with Sloping Abutment Editor or editing Bounding XS's?	☐	☐	☐
Abutment side slopes at BRU and BRD (w/skew angle): _____ (H:V)			
Abutment side slopes match the report/drawings?	☐	☐	☐
Deck roadway and abutments skewed?	☐	☐	☐
Skew angle based on angle of flow path as it goes through the bridge compared with a line perpendicular to the Bounding XS's?	☐	☐	☐
Number of spans:			
Number of piers:			
Pier centerline station distances match pier spans?	☐	☐	☐
Pier widths are correct?	☐	☐	☐
Pier elevations are correct (entered lowest to highest values)?	☐	☐	☐
Piers match the report/drawings?	☐	☐	☐
Pier skewed?	☐	☐	☐

Bridge Modeling Approach
Low Flow Methods (*flow below the maximum low chord*):
  ☐ Energy (Standard Step)
  ☐ Momentum   Pier drag coefficient, C_d:
  ☐ Yarnell (Class A only)   Pier shape coefficient, K:
  ☐ WSPRO Method (Class A only)
High Flow Methods (*flow contacts the maximum low chord*):
  ☐ Energy Only (Standard Step)
  ☐ Pressure and/or Weir			

Culvert Geometry	Yes	No	N/A
Culvert River Sta.:			
"Distance" between upstream XS and deck/roadway: _____ ft			
Deck/roadway "width" along the stream: _____ ft			
Deck/roadway matches the report/drawings?	☐	☐	☐
High chord elevation (*top of road*): _____ ft			
High chord matches the report/drawings?	☐	☐	☐
Embankment side slopes (*display purposes only Profile Plot*): _____ (H:V)			
Minimum weir flow elevation is blank (*defaults to lowest high chord elevation on the upstream side of the culvert)*?	☐	☐	☐
Shape: ☐ Circular ☐ Box ☐ Pipe Arch ☐ Ellipse ☐ Arch ☐ Semi-Circle ☐ Low Arch ☐ High Arch ☐ Conspan Arch			
Span: _____ ft			
Rise: _____ ft			
Length: _____ ft			
Span, rise, and length match the report/drawings?	☐	☐	☐
FHWA Chart # (*Table 6-6*):			
FHWA Scale # (*Table 6-6*):			
Chart and scale description matches the report/drawings?	☐	☐	☐
Distance to upstream XS: _____ ft			
Entrance Loss Coefficient (*Tables 6-3, 6-4, and 6-5*):			
Exit Loss Coefficient:			
Manning's n value for Top (*Tables 6-1 and 6-2*):			
Manning's n value for Bottom:			
Depth (*above invert*) to use bottom n value:			
Depth blocked (*from passing flow*):			
Upstream Invert Elevation:			
Downstream Invert Elevation:			
Inverts match the report/drawings?	☐	☐	☐

CONTRACTION SCOUR (Q_{500})	Yes	No	N/A
Streambed Particle Size D_{50}: _____ mm = _____ in. = _____ ft. Method used to determine D_{50}? ☐ Visual inspection ☐ Woman pebble count ☐ Sieve analysis ☐ Core boring			
Critical Velocity HEC-18, Equation 6.1 used? ☐ Clear-water contraction scour ☐ Live-bed contraction scour	☐	☐	☐
Live-Bed Scour HEC-18, Equations 6.2-6.3 used?	☐	☐	☐
HEC-RAS output tables included?	☐	☐	☐
Clear-Water Scour HEC-18, Equations 6.4-6.5 used?	☐	☐	☐
HEC-RAS output tables included?	☐	☐	☐
LOCAL PIER SCOUR (Q_{500}) **Local Pier Scour for Simple Pier Substructure**			
HEC-18, Equation 7.3 (CSU equation) used?	☐	☐	☐
L, length of pier:			
a, pier width:			
θ, angle of attack:			
K_1 correction factor for pier nose shape is correct? (HEC-18, Table 7.1)	☐	☐	☐
K_2 correction factor for angle of attack is correct? (HEC-18, Table 7.2)	☐	☐	☐
K_3 correction factor for bed condition is correct? (HEC-18, Table 7.3)	☐	☐	☐
K_4 correction factor set to 1.0 (*removed from HEC-18, Fifth edition, 2012*)?	☐	☐	☐

REFERENCES

1. Hydraulic Engineering Center. 2010. HEC-RAS, River Analysis System Hydraulic Reference Manual. U.S. Army Corps of Engineers, Davis, CA.
2. Hydraulic Engineering Center. 2010. HEC-RAS, River Analysis System Hydraulic Reference Manual. Appendix B – Flow Transitions in Bridge Backwater Analysis, U.S. Army Corps of Engineers, Davis, CA.
3. Federal Highway Administration. 2012. Hydraulic Engineering Circular No. 18, Evaluating Scour At Bridge (Fifth Edition).
4. Samuels, P.G., 1989. "Backwater lengths in rivers", Proceedings – Institution of Civil Engineers, Part 2, Research and Theory, 87, 571-582.
5. Hydraulic Engineering Center. 1995. RD-42 "Flow Transitions in Bridge Backwater Analysis".