

Appendix C

HEC-RAS Output Variables

Variable Name	Units	Description
# Barrels	#	Number of barrels in a culvert.
Alpha	-	Alpha - energy weighting coefficient.
Area	sq ft	Flow area of the entire cross section including ineffective flow.
Area Channel	sq ft	Flow area of the main channel including ineffective flow.
Area Left	sq ft	Flow area of the left overbank including ineffective flow.
Area Right	sq ft	Flow area of the right overbank including ineffective flow.
Base WS	ft	Water surface for first profile (used in comparison to encroachment profiles).
Beta	-	Beta - momentum weighting coefficient.
BR Open Area	sq ft	Total area of the entire bridge opening.
BR Open Vel	ft/s	Average velocity inside the bridge opening (Maximum of BU and BD).
Br Sel Mthd	-	Selected bridge hydraulic modeling method.
Breach CL	ft	Center line of weir breach.
Breach WD	ft	Bottom width of weir breach.
Breach Bottom El	ft	Bottom Elevation of weir breach.
Breach Top El	ft	Top Elevation of weir breach.
Breach SSL	ft	Left side slope of weir breach.
Breach SSR	ft	Right side slope of weir breach.
C & E Loss	ft	Contraction or expansion loss between two cross sections.
Center Station	ft	Stationing of the center of the main channel.
Ch Sta L	ft	Left station of main channel.
Ch Sta R	ft	Right station of main channel.
Clv EG No Wr	ft	Energy grade elevation at the culvert when calculated without the weir.
Coef of Q	-	WSPRO bridge method coefficient of discharge.
Conv. Chnl	cfs	Conveyance of main channel.
Conv. Left	cfs	Conveyance of left overbank.
Conv. Ratio	-	Ratio of the conveyance of the current cross section to the conveyance of the downstream cross section.
Conv. Right	cfs	Conveyance of right overbank.
Conv. Total	cfs	Conveyance of total cross section.
Crit Depth	ft	Critical depth. Corresponds to critical water surface.
Crit E.G.	ft	Critical energy elevation. Minimum energy on the energy versus depth curve.
Crit Enrgy 1	ft	Energy associated with first critical depth.
Crit Enrgy 2	ft	Energy associated with second critical depth.
Crit Enrgy 3	ft	Energy associated with third critical depth.
Crit Num	#	Number of critical depths found.
Crit W.S.	ft	Critical water surface elevation. Water surface corresponding to the minimum energy on the energy versus depth curve.

Crit W.S. 1	ft	Water surface elevation of first critical depth.
Crit W.S. 2	ft	Water surface elevation of second critical depth.
Crit W.S. 3	ft	Water surface elevation of third critical depth.
Culv Crt Depth	ft	Critical depth inside the culvert.
Culv Depth Blocked	ft	Depth of fill in a culvert.
Culv EG In	ft	Energy gradeline inside the culvert at the inlet.
Culv EG Out	ft	Energy gradeline inside the culvert at the outlet.
Culv Ent Lss	ft	Culvert entrance loss (energy loss due only to entrance).
Culv Ext Lss	ft	Culvert exit loss (energy loss due to exit).
Culv Frctn Ls	ft	Friction loss through the culvert barrel.
Culv Ful Lng	ft	The length that the culvert flows full.
Culv Inlet Mann n		The composite n value at the culvert inlet.
Culv Inv El Dn	ft	Culvert inside invert elevation downstream.
Culv Inv El Up	ft	Culvert inside invert elevation upstream.
Culv Length	ft	Length of the culvert barrel.
Culv Nml Depth	ft	Normal depth for this culvert (and flow).
Culv Outlet Mann n		The composite n value at the culvert outlet.
Culv Q	cfs	Flow through all barrels in a culvert group.
Culv Vel DS	ft/s	Velocity inside of culvert at inlet.
Culv Vel US	ft/s	Velocity inside of culvert at outlet.
Culv WS In	ft	Water surface elevation inside the culvert at the inlet.
Culv WS Out	ft	Water surface elevation inside the culvert at the outlet.
Cum Ch Len	ft	Cumulative Channel Length.
Deck Width	ft	Width of bridge/culvert Deck (top of embankment), in direction of flow.
Delta EG	ft	Change in energy grade line through culvert(s) and bridge(s).
Delta WS	ft	Change in water surface through culvert(s) and bridge(s).
Dist Center L	ft	Distance from center of channel to left encroachment.
Dist Center R	ft	Distance from center of channel to right encroachment.
E.G. DS	ft	Energy grade elevation at downstream end of bridge or culvert.
E.G. Elev	ft	Energy gradeline for calculated WS Elev.
E.G. IC	ft	Upstream energy gradeline at culvert based on inlet control.
E.G. OC	ft	Upstream energy gradeline at culvert based on outlet control.
E.G. Slope	ft/ft	Slope of the energy grade line.
E.G. US.	ft	Energy grade elevation at upstream end of bridge or culvert (final answer).
Enc Method	-	Encroachment method used at this cross section.
Enc Sta L	ft	Left station of encroachment.
Enc Sta R	ft	Right station of encroachment.
Enc Val 1	ft	Target for encroachment analysis.
Enc Val 2	ft	Second target for encroachment analysis.
Encr WD	ft	Top width between encroachments.
Energy EG	ft	Energy grade elevation upstream of bridge for energy only method.
Energy WS	ft	Water surface elevation upstream of bridge for energy only method.
Energy/Wr EG	ft	Energy grade elevation upstream of bridge for low energy and weir method.
Energy/Wr WS	ft	Water surface elevation upstream of bridge for low flow energy method and weir flow.

Flow Area	sq ft	Total area of cross section active flow.
Flow Area Ch	sq ft	Area of main channel active flow.
Flow Area L	sq ft	Area of left overbank active flow.
Flow Area R	sq ft	Area of right overbank active flow.
Frctn Loss	ft	Friction loss between two cross sections.
Frctn Slope	ft/ft	Representative friction slope between two cross sections.
Frctn Slp Md	-	Friction slope averaging method used.
Froude # Chl	-	Froude number for the main channel.
Froude # XS	-	Froude number for the entire cross section.
Gate #Open	#	The number of gates opened in the current group.
Gate Area	sq ft	The flow area in an opened gate.
Gate Group Q	cfs	Flow through all gate openings in a gate group.
Gate Invert	ft	Gate spillway invert elevation.
Gate Open Ht	ft	Height of gate opening.
Gate Submerg	-	Degree of gate submergence. The ratio of the downstream depth above the gate to the upstream depth above the gate.
Headloss	ft	Total energy loss between two cross sections.
Hydr Depth	ft	Hydraulic depth for cross section (Area/Topwidth of active flow).
Hydr Depth C	ft	Hydraulic depth in channel (channel flow area/topwidth of channel flow).
Hydr Depth L	ft	Hydraulic depth in left overbank (left overbank flow area/topwidth of left overbank flow).
Hydr Depth R	ft	Hydraulic depth for right over bank (right overbank flow area/topwidth of right overbank flow).
Ice Btm Chan	ft	The bottom elevation of ice in the main channel.
Ice Btm LOB	ft	The bottom elevation of ice in the left overbank.
Ice Btm ROB	ft	The bottom elevation of ice in the right overbank.
Ice Err	ft	Convergence error in ice thickness for dynamic ice jam.
Ice Thick Chan	ft	Ice thickness in the main channel.
Ice Thick LOB	ft	Ice thickness in the left overbank.
Ice Thick ROB	ft	Ice thickness in the right overbank.
Ice Top Chan	ft	The top elevation of ice in the main channel.
Ice Top LOB	ft	The top elevation of ice in the left overbank.
Ice Top ROB	ft	The top elevation of ice in the right overbank.
Ice Vol Total	cu ft	Cumulative volume of ice in an ice jam.
Ice Vol. Chan	cu ft	Cumulative volume of ice in the main channel for an ice jam.
Ice Vol. LOB	cu ft	Cumulative volume of ice in the left overbank for an ice jam.
Ice Vol. ROB	cu ft	Cumulative volume of ice in the right overbank for an ice jam.
Ice WS Err	ft	Convergence error in water surface for dynamic ice jam.
Ineff El Left	ft	The elevation of the left ineffective area.
Ineff El Right	ft	The elevation of the right ineffective area.
Inflow	cfs	Net inflow into a storage area.
Invert Slope	ft/ft	The slope from the invert of this cross section to the next cross section downstream.
IW Gate Flow	cfs	Total flow through all of the gate groups of an inline weir/spillway.
K Perc L	ft	Conveyance reduction from left encroachment.
K Perc R	ft	Conveyance reduction from right encroachment.

L. Freeboard	ft	The freeboard in the main channel at the left bank (left bank elevation minus water surface elevation).
L. Levee Frbrd	ft	The freeboard before the left levee is over-topped.
Left Sta Eff	ft	Furthest left station where there is effective flow.
Length Chnl	ft	Downstream reach length of the main channel.
Length Left	ft	Downstream reach length of the left overbank.
Length Rght	ft	Downstream reach length of the right overbank.
Length Wtd.	ft	Weighted cross section reach length, based on flow distribution, in left bank, channel, and right bank.
Levee El Left	ft	The elevation of the left levee.
Levee El Right	ft	The elevation of the right levee.
LOB Elev	ft	The ground elevation at the left bank of the main channel.
Mann Comp	-	Composite Manning's n value for main channel.
Mann Wtd Chnl		Conveyance weighted Manning's n for the main channel.
Mann Wtd Chnl		Conveyance weighted Manning's n for the left overbank.
Mann Wtd Rght		Conveyance weighted Manning's n for the right overbank.
Mann Wtd Total		Manning's n value for the total main cross section.
Max Chl Dpth	ft	Maximum main channel depth.
Min Ch El	ft	Minimum main channel elevation.
Min El	ft	Minimum overall section elevation.
Min El Prs	ft	Elevation at the bridge when pressure flow begins.
Min Error	ft	The minimum error, between the calculated and assumed water surfaces when balancing the energy equation.
Min El Weir Flow	ft	Elevation where weir flow begins.
Min Weir El	ft	Minimum elevation of a weir.
Momen. EG	ft	Energy grade elevation upstream of bridge for momentum method.
Momen. WS	ft	Water surface elevation upstream of bridge for momentum method.
Net Flux	cfs	Net inflow - outflow for a storage area.
Num Trials	#	Current number (or final number) of trials attempted before the energy equation is balanced.
Obs WS	ft	Observed water surface elevation.
Outflow	cfs	Net outflow into a storage area.
Perc Q Leaving		Percentage of flow leaving through a lateral weir.
Piping Flow	ft	Flow from piping weir failure.
Power Chan	lb/ft s	Total stream power in main channel (main channel shear stress times main channel average velocity). Used in Yang's and other sediment transport equations.
Power LOB	lb/ft s	Total stream power in left overbank (left overbank shear stress times left overbank average velocity). Used in Yang's and other sediment transport equations.
Power ROB	lb/ft s	Total stream power in right overbank (right overbank shear stress times right overbank average velocity). Used in Yang's and other sediment transport equations.
Power Total	lb/ft s	Total stream power (total cross section shear stress times total cross section average velocity). Used in Yang's and other sediment transport equations.
Prof Delta EG	ft	Difference in EG between current profile and EG for first profile.

Prof Delta WS	ft	Difference in WS between current profile and WS for first profile.
Profile	#	Profile number.
Prs O EG	ft	Energy grade elevation upstream of bridge for pressure only method.
Prs O WS	ft	Water surface elevation upstream of bridge for pressure only method.
Prs/Wr EG	ft	Energy grade elevation upstream of bridge for pressure and/or weir method.
Prs/Wr WS	ft	Water surface elevation upstream of bridge for pressure and/or weir method.
Pumping Head	ft	Pumping head for the pump station.
Q Barrel	cfs	Flow through one barrel in a culvert group.
Q Bridge	cfs	Flow through the bridge opening.
Q Channel	cfs	Flow in main channel.
Q Culv	cfs	Total flow in all culvert groups.
Q DS	cfs	Flow in cross section downstream of lateral weir.
Q Lat RC	cfs	Lateral rating curve flow.
Q Leaving Total	cfs	Total flow leaving in a lateral weir including all gates.
Q Left	cfs	Flow in left overbank.
Q Perc Chan	ft	Percent of flow in main overbank.
Q Perc L	ft	Percent of flow in left overbank.
Q Perc R	ft	Percent of flow in right overbank.
Q Pump Group	cfs	Pump group flow.
Q Pump Station	cfs	Total flow in all pump groups in a pump station.
Q Right	cfs	Flow in right overbank.
Q Total	cfs	Total flow in cross section.
Q US	cfs	Flow in cross section upstream of a lateral weir.
Q Weir	cfs	Flow over the weir.
R. Freeboard	ft	The freeboard in the main channel at the right bank (right bank elevation minus water surface elevation).
R. Levee Frbrd	ft	The freeboard before the right levee is over-topped.
Rght Sta Eff	ft	Furthest right station that still has effective flow.
ROB Elev	ft	The ground elevation at the right bank of the main channel.
SA Area	acres	Surface area of a storage area.
SA Chan	acres	Cumulative surface area for main channel from the bottom of the reach.
SA Left	acres	Cumulative surface area for left overbank from the bottom of the reach.
SA Min El	ft	Minimum elevation of a storage area.
SA Right	acres	Cumulative surface area for right overbank from the bottom of the reach.
SA Total	acres	Cumulative surface area for entire cross section from the bottom of the reach.
SA Volume	acre-ft	Storage volume of a storage area.
Shear Chan	lb/sq ft	Shear stress in main channel ($\gamma R_{CH} S_f$).
Shear LOB	lb/sq ft	Shear stress in left overbank ($\gamma R_{LOB} S_f$).
Shear ROB	lb/sq ft	Shear stress in right overbank ($\gamma R_{ROB} S_f$).
Shear Total	lb/sq ft	Shear stress in total section ($\gamma R_T S_f$).

Spc Force PR	cu ft	Specific force prime. For mixed flow, the specific force at this cross section for the flow regime that does not control.
Specif Force	cu ft	The specific force for this cross section at the computed water surface elevation. $SF = A_T Y_{cent} + (Q^2)/(gA_{act})$
Sta W.S. Lft	ft	Left station where water intersects the ground.
Sta W.S. Rgt	ft	Right station where water intersects the ground.
Std Stp Case	#	Standard step method used to determine WSEL (1 = successful convergence, 2 = minimum error, 3 = resorted to critical depth).
Top W Act Chan	ft	Top width of the wetted channel, not including ineffective flow.
Top W Act Left	ft	Top width of the wetted left bank, not including ineffective flow.
Top W Act Right	ft	Top width of the wetted right bank, not including ineffective flow.
Top W Chnl	ft	Top width of the main channel. Does not include 'islands', but it does include ineffective flow.
Top W Left	ft	Top width of the left overbank. Does not include 'islands', but it does include ineffective flow.
Top W Right	ft	Top width of the right overbank. Does not include 'islands', but it does include ineffective flow.
Top Wdth Act	ft	Top width of the wetted cross section, not including ineffective flow.
Top Width	ft	Top width of the wetted cross section.
Total Gate Flow	cfs	Total flow through all of the gate groups of an inline/lateral weir.
Trvl Tme Avg	hrs	Cumulative travel time based on the average velocity of the entire cross section, per reach.
Trvl Tme Chl	hrs	Cumulative travel time based on the average velocity of the main channel, per reach.
Vel Chnl	ft/s	Average velocity of flow in main channel.
Vel Head	ft	Velocity head.
Vel Left	ft/s	Average velocity of flow in left overbank.
Vel Right	ft/s	Average velocity of flow in right overbank.
Vel Total	ft/s	Average velocity of flow in total cross section.
Vol Chan	acre-ft	Cumulative volume of water in the channel (including ineffective flow).
Vol Left	acre-ft	Cumulative volume of water in the left overbank (including ineffective flow).
Vol Right	acre-ft	Cumulative volume of water in the right overbank (including ineffective flow).
Volume	acre-ft	Cumulative volume of water in the direction of computations (including ineffective flow).
W.P. Channel	ft	Wetted perimeter of main channel.
W.P. Left	ft	Wetted perimeter of left overbank.
W.P. Right	ft	Wetted perimeter of right overbank.
W.P. Total	ft	Wetted perimeter of total cross section.
W.S. DS	ft	Water surface downstream of a bridge, culvert, or weir.
W.S. Elev	ft	Calculated water surface from energy equation.
WS Inlet	ft	WS at the inlet of a pump station.

WS Outlet	ft	WS at the outlet of a pump station.
W.S. Prime	ft	Water surface prime. For mixed flow, the water surface of the flow regime that does not control.
W.S. US.	ft	Water surface elevation upstream of bridge or culvert.
Weir Avg Depth	ft	The average depth of flow over the weir.
Weir Max Depth	ft	The maximum depth of flow over the weir.
Weir Sta DS	ft	Downstream station where weir flow ends.
Weir Sta Lft	ft	Station where flow starts on the left side of weir.
Weir Sta Rgt	ft	Station where flow ends on the right side of weir.
Weir Sta US	ft	Upstream station for weir flow starts.
Weir Submerg	-	The ratio of the downstream depth above the weir to the upstream depth above the weir.
Wr Flw Area	sq ft	Area of the flow going over the weir.
Wr Top Wdth	ft	Top width of water over the weir.
WS Air Entr.	ft	Water surface elevation accounting for air entrainment.
WSPRO EG	ft	Energy grade elevation upstream of bridge for the WSPRO method.
WSPRO WS	ft	Water surface elevation upstream of bridge for the WSPRO method.
Wtd. n Chnl	-	Conveyance weighted Manning's n for the main channel.
Wtd. n Left	-	Conveyance weighted Manning's n for the left overbank.
Wtd. n Right	-	Conveyance weighted Manning's n for the right overbank.
XS Delta EG	ft	Change in energy gradeline between current section and next one downstream.
XS Delta WS	ft	Change in water surface between current section and next one downstream.
Yarnell EG	ft	Energy grade elevation upstream of bridge for Yarnell method.
Yarnell WS	ft	Water surface elevation upstream of bridge for Yarnell method.