Hydraulic Modeling Methodology
USIBWC Directive SD.II.01031-M-1 Appendix F

Table of Contents

1. General. 1
2. Software 2
3. Data Collection 2
4. One-Dimensional (1D)/Two-Dimensional (2D) Model Development. 2
5. Inflow Hydrograph. 3
6. Roughness Coefficients. 4
7. Boundary Conditions. 4
8. Modeling Approach. 4
9. Numerical Stability Tolerance Values. 4
10. Existing Condition Model. 4
11. Model Calibration. 4
12. Proposed Condition Model. 6
13. Interim Condition Model. 7
14. Hydraulic Impact Calculations - Water Surface Elevation Increases 7
15. Hydraulic Impact Calculations - Percent Flow Deflections. 8
16. Hydraulic Modeling Report. 8
17. References. 9
18. USIBWC Resources and Information. 10
Example Spreadsheet - Calculation of Hydraulic Impacts. 12

The following methodology shall be adopted to develop georeferenced two-dimensional hydraulic models of the existing site condition and the proposed project condition, and to analyze the hydraulic impacts. Situations where hydraulic modeling is not required and where one-dimensional modeling is sufficient are also described.

1. General.

A. The Proponent is strongly encouraged to share preliminary drawings and project description, and meet with the USIBWC in advance to discuss site conditions, and their proposed project.

B. Depending upon the project, the modeling requirements may be less detailed than what is described in this section and advance discussions can help in saving significant costs and resources.

C. Minor projects such as towers or similar structures with a small footprint in a wide floodplain defined by the design flood are anticipated to have minor hydraulic impacts such as water surface elevations and flow deflections to the US or to Mexico. This may also be the case with small collapsible structures. For some projects such as aligned bridge piers, a one-dimensional (1D) hydraulic analysis may be sufficient to evaluate hydraulic impact.

D. For significant projects within the Rio Grande and Colorado River floodplains, Proponents shall demonstrate through detailed 1D/2D or 2D hydraulic modeling that the projects do not cause any adverse hydraulic impacts to either the United States or to Mexico, consistent with Article IV-B of the 1970 Boundary Treaty (*Treaty to Resolve Pending Boundary Difference and Maintain the Rio Grande and Colorado River as the International Boundary*).

E. Although not covered by this Treaty, Proponents shall demonstrate there are no adverse hydraulic impacts from projects at other locations such as Tijuana River, Nogales Wash and land boundary washes. See "*Appendix B-Land Boundary Project Requirements*" for guidance on determining the hydraulic impact on land projects.

2. **Software.** The latest version of the US Army Corps of Engineers (USACE) HEC-RAS software shall be used for the analysis. This is a free, public domain software and an industry standard.

3. **Data Collection.**

A. The model extent shall cover the project area and cover a reach sufficiently upstream and downstream from the project area. This ensures that the hydraulic results in the project area are not impacted by the boundary conditions. LiDAR data shall be collected to cover this extent. The LiDAR data shall also cover sufficient width to include the width of the floodplain due to the design flow in this reach. An estimate of the extent of the floodplain due to the design flow in the project reach may be obtained from existing one-dimensional HEC-RAS models, if they are available. In areas without levees, it is recommended that additional width be included, to be conservative.

B. Because the LiDAR data does not capture the geometry of the main channel below the water surface, cross-section surveys shall be conducted from bank to bank of the main channel. Cross-section surveys shall be conducted at a maximum spacing of 1,000 feet, with closer spacing at locations of curvature, urbanization and changes in geometry. Alternately, a bathymetric survey shall be conducted.

C. All data shall be referenced to the horizontal North American Datum (NAD) of 1983 and the North American Vertical Datum (NAVD) of 1988.

4. **One-Dimensional (1D)/Two-Dimensional (2D) Model Development.**

A. A 1D/2D hydraulic model shall be developed for the analysis. The 1D portion includes the main channel and the 2D portion include the floodplains. Alternatively, full 2D modeling can also be done, provided the main channel is represented with the proper grid size. The description below also applies for a full 2D modeling except for the main channel which would be represented by the smaller grid size. HEC-RAS supports multiple computational meshes of variable grid sizes within the two-dimensional modeling domain. A maximum 150-foot base grid size shall be used for the model. Break lines shall be added to locations where there is a barrier to the flow or controls to flow direction. They shall be placed inside a 2D flow area to align the mesh to geometric features such as road and levees, and along the main channel banks, among others.

B. A bathymetry surface shall be generated with the surveyed main channel cross sections. This surface shall be used to cut cross sections where necessary for the main channel for a 1D/2D model. Because the Rio Grande consists of many tight meanders, the 1D channel shall be simulated using cross-sections at a maximum 600-foot interval, and their width would represent the active main channel.

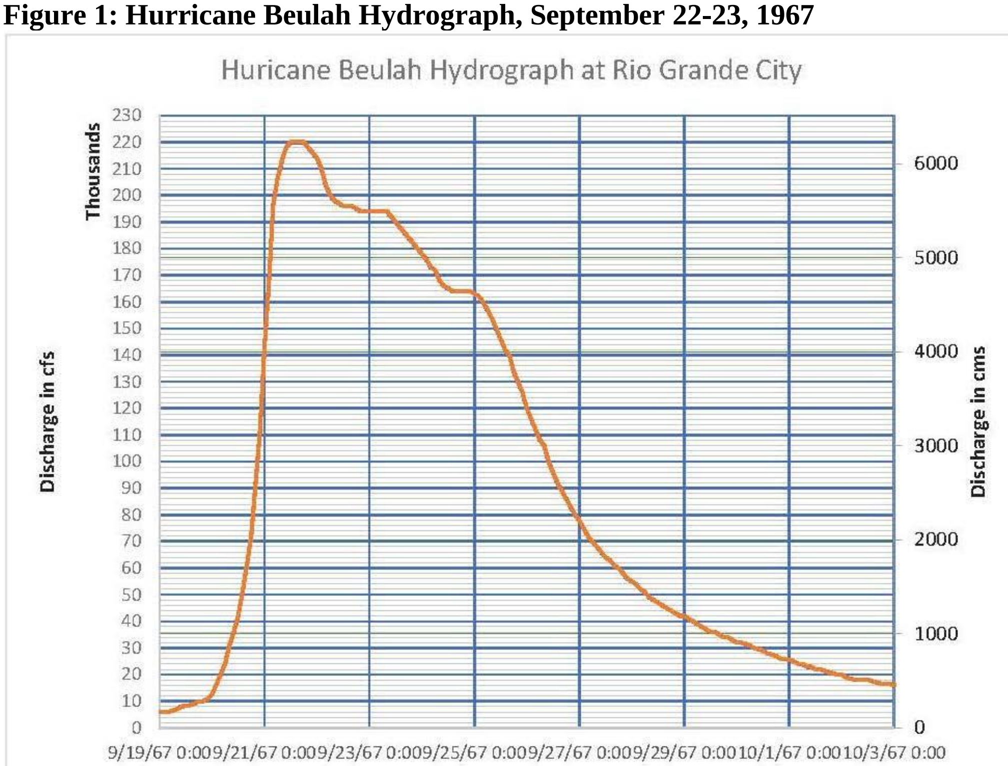
C. There shall be a mesh on each side of the river's floodplain. The connection between the 1D main channel and 2D flow area mesh shall be implemented according to the HEC-RAS guidelines using features such as the lateral weir.

D. Alternately, a full 2D hydraulic model may be developed. For the full 2D model, finer size grid cells shall be used for the main channel portion to adequately represent the geometry.

E. Break lines and finer grid elements shall be added around the proposed project alignment. The final geometry shall consist of two identical meshes for the "Existing Condition" and "Proposed Condition" models, allowing comparisons between them.

5. **Inflow Hydrograph.** A suitable inflow hydrograph based on the design flood shall be adopted in consultation with the USIBWC. For example, for the Lower Rio Grande during Hurricane Beulah, a peak discharge of 220,000 cfs was recorded at midnight of September 22–23, 1967 at Rio Grande City as shown in Figure 1. The IBWC design flow at Rio Grande City of 250,000 cfs is based on the peak flow from Hurricane Beulah. See "*Appendix H-Requirements for Projects On the Rio Grande and Colorado River Floodplains*" for the magnitude of the design flow at various locations along the Rio Grande and in the Colorado River.

Figure 1: Hurricane Beulah Hydrograph, September 22-23, 1967



6. **Roughness Coefficients.** Manning's roughness coefficients (n-values) for the main channel may be used similar to those in previous HEC-RAS models at the project reach if they exist. The floodplain roughness coefficients (2D areas) shall be developed using land use Geographic Information System (GIS) datasets from the US Geological Survey (USGS) and Instituto Nacional de Estadistica y Geografia (INEGI) data webservices. The land use types in the US and Mexican sides of the floodplain shall be noted for selecting the roughness coefficients. Example values for n-values include: main channel and open water = 0.05; developed open space = 0.03; developed low and medium intensity = 0.068; barren land (bare ground) = 0.03; deciduous forest = 0.08; evergreen forest = 0.10; mixed forest = 0.12; shrub/scrub = 0.10; herbaceous = 0.07; hay/pasture = 0.05; cultivated crops = 0.05; woody wetlands = 0.20; emergent wetlands = 0.20. Values from HEC-RAS manuals and the literature shall also be consulted. However, n-values may be suitably modified using engineering judgment and consistent with values in the engineering literature to address modeling issues such as numerical stability and volume conservation. ArcGIS shapefile of land use polygons may be created and associated with the corresponding roughness coefficients for use in the HEC-RAS model.

7. **Boundary Conditions.** The boundary conditions are applied upstream and downstream. As explained above, the modeling domain shall extend sufficiently upstream and downstream of the project extent to ensure that the boundary conditions do not impact the hydraulic variables at the project location.

8. **Modeling Approach.** The hydraulic modeling shall use the Full Momentum (Saint Venant) equations for the computations. These equations provide accurate solutions in situations such as highly dynamic flood waves, tight bends as seen in the meanders of the Rio Grande, and detailed water surface elevations and velocities at structures, among other situations as described in the HEC-RAS 2D Modeling Users Manual. Guidelines for grid size and timestep provided in the manual shall be followed to ensure that the model runs meet the Courant condition guidelines, exhibit good stability and excellent volume conservation.

9. **Numerical Stability Tolerance Values.** The following 1D and 2D settings (Figure 2, Figure 3, and Figure 4) are example recommendations for the computation of the models. Settings may be adjusted depending on the performance of the models to address issues such as model instability. The cross-section hydraulic table parameters shall be modified as necessary to improve model stability. The unsteady hydraulic models shall demonstrate excellent volume conservation results and have numerical instabilities eliminated or minimized.

10. **Existing Condition Model.** An existing condition 1D/2D or 2D HEC-RAS model shall be developed using the above elements.

11. **Model Calibration.** The existing condition HEC-RAS 1D/2D or 2D model shall be calibrated to match the water surface elevations from nearby gaging stations and historical highwater marks. The model needs to simulate the design flow elevation or higher by adjusting input parameters within a reasonable range. For example, the values of historical flood elevation values from Hurricane Beulah, Hurricane Alex, and similar events in the Lower Rio Grande or floods at the modeling reach may be used for the calibration. It should be recognized, however, that site conditions may have changed over time from features such as sediment and vegetation, limiting calibration efforts.

Figure 2: General 1D Unsteady Numerical Control Values

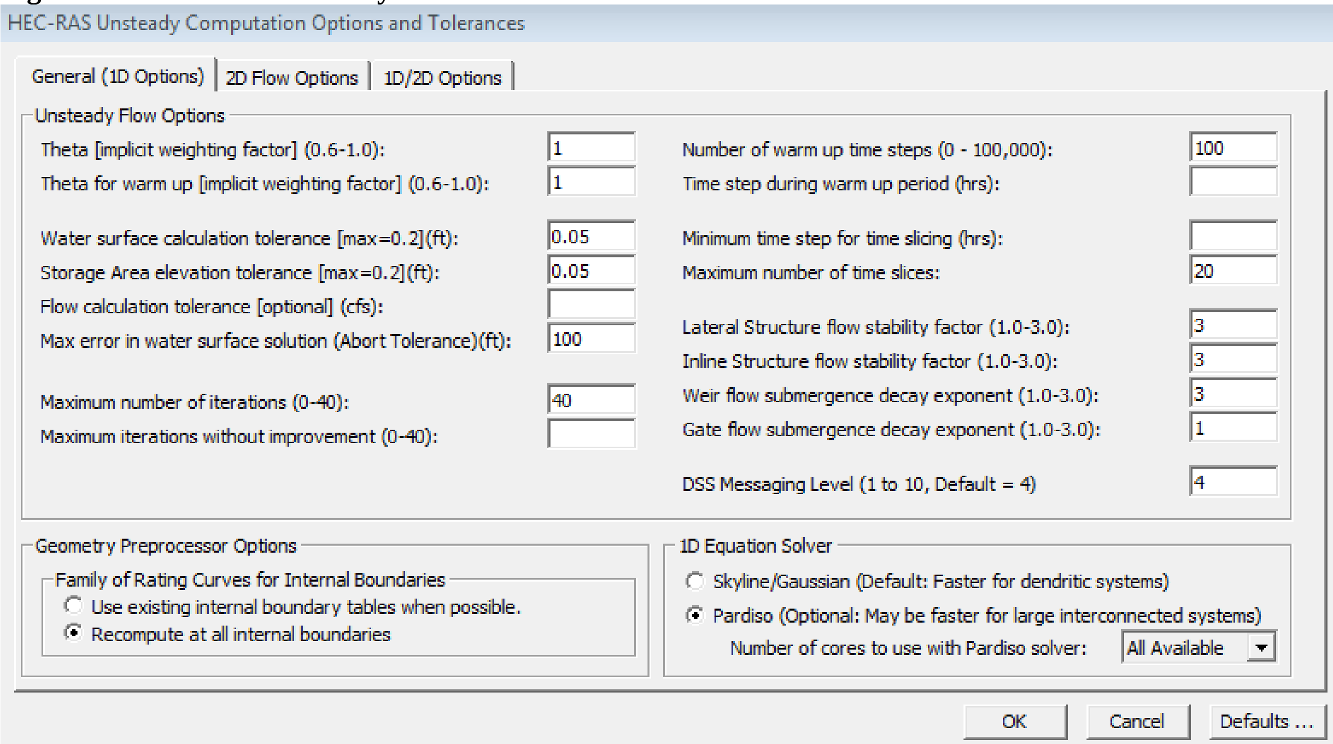
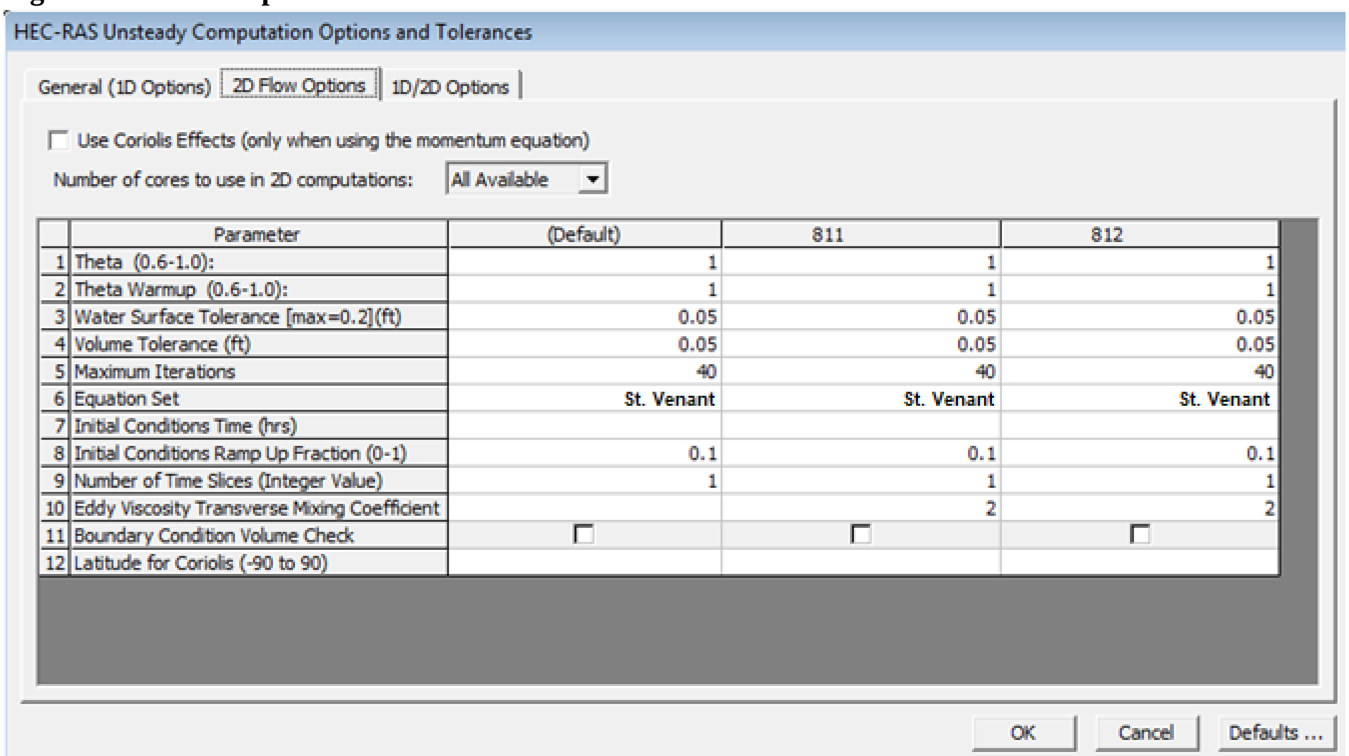
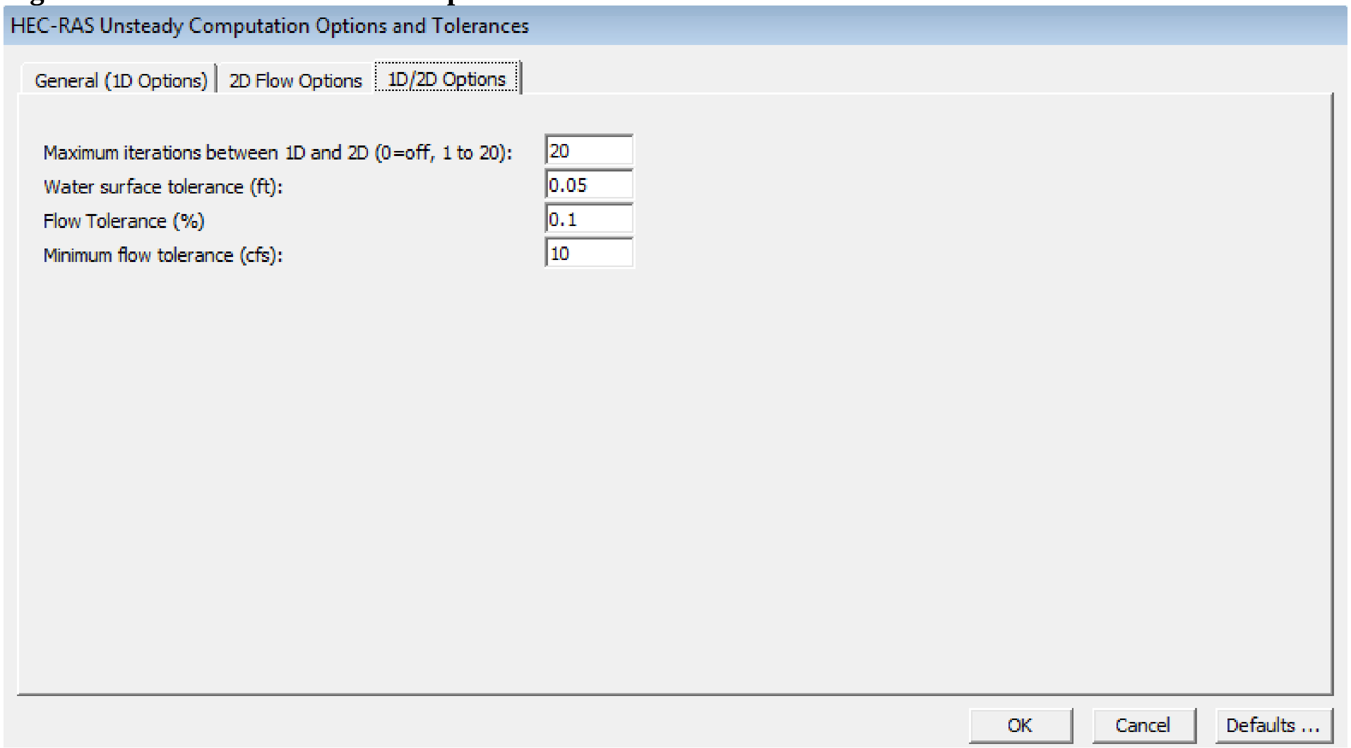


Figure 3: 2D Flow Options Tolerance Values



	Parameter	(Default)	811	812
1	Theta (0.6-1.0):	1	1	1
2	Theta Warmup (0.6-1.0):	1	1	1
3	Water Surface Tolerance [max=0.2](ft)	0.05	0.05	0.05
4	Volume Tolerance (ft)	0.05	0.05	0.05
5	Maximum Iterations	40	40	40
6	Equation Set	St. Venant	St. Venant	St. Venant
7	Initial Conditions Time (hrs)			
8	Initial Conditions Ramp Up Fraction (0-1)	0.1	0.1	0.1
9	Number of Time Slices (Integer Value)	1	1	1
10	Eddy Viscosity Transverse Mixing Coefficient		2	2
11	Boundary Condition Volume Check	☐	☐	☐
12	Latitude for Coriolis (-90 to 90)			

Figure 4: 1D/2D or 2D Tolerance Options



12. Proposed Condition Model.

A. Detailed examination of the impacts of the proposed project shall be facilitated using break lines within the 2D modeling domain. The project may be represented by a shapefile imported into HEC-RAS and break lines within the HEC-RAS break line module. Break lines force a finer computational grid within the 2D area.

B. In the existing condition, the break lines represent the existing terrain. In the proposed condition, the break lines are converted to interior 2D connections using the existing terrain stations and elevations. The stations and elevations shall be processed to generate the stations and elevations to the height of the project works at the existing ground.

C. For example, a proposed bollard fence shall be included in the existing condition model geometry by features such as a lateral weir using the HEC-RAS 2D Internal Hydraulic structures component. The lateral weir internal cross-section captures the terrain profile for the existing conditions, and for the proposed condition the bollard fence shall be represented by modifying the internal cross-sections. Software limitations shall be addressed as needed. The 2D Internal Hydraulic structure uses the “Normal 2D Equation” or the “Weir Equation” to compute the exchange of flows across a structure. Since each lateral weir segment can only accommodate a maximum of 500 stations, multipliers (example 8 to 10) may be used to combine the features of the proposed projects. It is preferable to represent the structures as they are and avoid using multipliers. To represent a long, linear feature such as a long length of a proposed bollard fence, multiple segments of lateral weirs may be required.

D. Flood flows generate debris, therefore, blockage due to debris shall be evaluated. For structures such as bollard fences, blockage at or above 30% along the length of the proposed bollard fence shall be evaluated. For other structures, the percentage of debris blockage shall be discussed with the USIBWC. The Proponent shall also discuss with the USIBWC in advance whether to model the blockage for individual element or for a group of elements together or other means.

13. **Interim Condition Model.** In case the project is constructed in multiple phases, interim condition hydraulic modeling is required for each phase. These models would be developed similar to the proposed condition model described above. The first interim condition model would use the existing condition model as a starting point and input the interim construction project. The next interim condition model would use the first interim condition model as the starting point and add the next phase of the project. The proposed condition model would represent the full build out condition of the project. Project segments that are not physically contiguous but are in close proximity to other segments may be considered as one project. Coordination with the USIBWC is recommended to determine if non-contiguous segments must be considered as one project. The succession of hydraulic models from the existing condition model to the proposed condition model shall show the cumulative infrastructure development within the floodplain.

14. **Hydraulic Impact Calculations - Water Surface Elevation Increases.**

    A. For 2D hydraulic models, water surface elevations (WSE) shall be compared by developing existing and proposed condition maximum WSE rasters using the HEC-RAS Mapper tools. The existing condition raster shall be subtracted from the proposed condition raster in ArcGIS tools to develop a third raster showing the difference. This new raster shows the increase in maximum WSE between the existing and proposed conditions. The raster can identify regions or clusters of changes in WSE. A map showing these WSE increases, with a legend on the magnitude of these increases, shall be prepared and included in the technical report. The map shall be of sufficient size to clearly identify the WSE differences and the legend indicating the values shall be legible. Spikes in WSE values attributable to localized numerical instability may exist in the raster files and these shall be documented and discussed with the USIBWC.

    B. For 1D hydraulic models, threshold limits for WSE increases are a maximum of 3 inches in urban areas and 6 inches in rural areas. WSE increase is the difference between the proposed and existing condition WSE. See page 12 for an example showing WSE increase calculations.

    C. These thresholds are valid, however, only in reaches of the Rio Grande without flood control levees. <u>In leveed areas, any increase in WSE represents a decrease in the levee freeboard and an increase in the flood risk to landside communities in the US and Mexico</u>. Therefore, there shall be no increase in the WSE values in the proposed condition in leveed areas.

    D. For WSE increases, spikes in WSE increases above threshold limits may not be considered as hydraulic impacts as they may be introduced by artifacts in numerical modeling such as a localized instability in some cell locations. Also, localized areas of WSE increases that are limited in extent and do not impact features such as levees or river banks may not be considered adverse hydraulic impacts. Where such increases occur, they shall be discussed with the USIBWC.

15. Hydraulic Impact Calculations - Percent Flow Deflections.

A. There are several ways to calculate percent deflections. However, the following procedures shall be used.

B. For 1D models, the hydraulic impacts due to increases in percent deflection of flows are calculated as follows. Looking downstream, the flow in the US portion is the flow in the left half of the main channel and the left floodplain. The flow in the Mexican portion is the flow in the right half of the main channel and the right floodplain.

C. These flows can be obtained for each cross section from the 1D HEC-RAS model output using the HEC-RAS variables 'Q Left,' 'Q Channel,' and 'Q Right' which represent the left overbank, main channel, and right overbank flows, respectively. For example, the proposed condition flow on the Mexican side, QMXproposed, is calculated as half the proposed condition flow in the main channel (because the centerline of the main channel is the boundary between US and Mexico) plus the total proposed condition flow in the right overbank (Mexico). This calculation is repeated for the existing condition flow in Mexico, QMXexisting. Similarly, the proposed condition US flow, QUSproposed, and existing condition US flow, QUSexisting, are calculated. To calculate the deflection of flows towards Mexico, QMXexisting is subtracted from the QMXproposed, and the difference is divided by QMXexisting. This is then expressed as a percentage. This process is repeated to calculate the percent deflection of flows towards the US

D. The flows in the 1D/2D model can be analyzed for deflection impacts in an equivalent manner using profile lines, or profile cross-sections, within HEC-RAS Mapper. The various flows are represented by the 2D mesh in the US (left overbank), the 1D channel component (the channel), and the 2D mesh in Mexico (right overbank). The profile cross-sections are drawn left to right across the 2D mesh as extensions of the 1D channel component cross-sections at intervals of 1,000 feet. The percent deflections of flow are calculated similar to the 1D models, using the maximum peak discharge, an optional output variable in HEC-RAS Mapper for the profile lines. For full 2D hydraulic models, the percent deflections are calculated similarly. Because of the flow direction variations throughout the reach, these profile lines are drawn perpendicular to the general flow direction in the floodplain at the prescribed locations. A figure of the cross-section locations for impact calculations shall be submitted in advance for review. The USIBWC may require impact calculations at additional cross sections at locations of interest.

E. At each cross section, the percent deflection of flow to either the US or to Mexico shall not exceed +5%. The results shall be presented in a spreadsheet showing the calculations explained above. See page 12 for an example of this spreadsheet showing percent deflection calculations.

16. Hydraulic Modeling Report.

A. The hydraulic modeling and results shall be documented in detail in a technical report.

B. The report is intended to be a stand-alone technical document that can be referred in future, for example, in case modifications to the Proponent's project are required based on observed adverse hydraulic impacts to flood events.

C. The report shall contain the following information:

(1) Contact Information. Include either a cover letter or section in the report that contains contact information (name, phone number, and/or email).

(2) Purpose of Study.

(3) Study Area.

(4) Modeling Methodology and Model Development.

(5) Results and Discussion. The results shall discuss the hydraulic impacts resulting from the proposed project.

(6) Conclusions.

(7) List of References.

D. Appendices Containing the Following:

(1) Figures.

(a) Relevant figures such as vicinity map, floodplain maps, and WSE difference rasters.

(b) Figures should be in color, legible, and convey technical information with prominent features labeled. Include multiple figures to convey information clearly if needed.

(c) Include relevant engineering drawings describing the proposed project.

(2) Model Outputs.

(a) WSE difference calculation tables.

(b) Deflection calculation tables.

(c) Hydraulic model outputs.

(d) HEC-RAS Standard Table 1, profile plots, cross-section plots, and HEC-RAS generated report.

(3) Reference Material. Include relevant documents such as portions from criteria manuals, FEMA FIRM, FEMA FIS table for discharges, geotechnical reports, and earlier hydraulic and hydrologic reports.

E. Electronic Files. Provide readme file describing all files provided, hydraulic models, spreadsheet calculations, GIS and CADD files, digital model files, impact calculations, reference studies, etc.

F. Final 100% Document. The final Hydraulic Modeling Report shall be signed and stamped by a professional engineer licensed to practice in the state where the work will be performed.

17. References.

A. The following list of references is intended to be a guide and should not be considered a comprehensive list of technical resources. References may be updated or revised after compilation of this list. Use of a newer version is not prohibited since it should offer better engineering and analysis data.

(1) S&B Infrastructure, Ltd., *Lower Rio Grande Flood Control Project, HEC-RAS Hydraulic Model Update and Validation (Peñitas to River Mile 28 and Off-River*

Floodways in Texas and Mexico), prepared for the International Boundary and Water Commission, July, 2008.

(2) S&B Infrastructure, Ltd., *Lower Rio Grande Flood Control Project, FLO-2D Simulation (Peñitas to River Mile 28 and Off-River Floodways in Texas and Mexico)*, prepared for the United States International Boundary and Water Commission (USIBWC), March 2009.

(3) U.S. Army Corps of Engineers (USACE), *Phase I Hydrology, Floodplain and Sediment Transport Report, Final. Tijuana River, United States-Mexico International Border to the Pacific Ocean, San Diego, California*, prepared for the City of San Diego. September 2018.

(4) U.S. Army Corps of Engineers, *Hydrologic Engineering Center - River Analysis System (HEC-RAS)*, Version 6.1, September 2021.

(5) U.S. Army Corps of Engineers, *Hydrologic Engineering Center - River Analysis System (HEC-RAS), 2D Modeling User's Manual*, Version 6.0, May 2021.

(6) U.S. Army Corps of Engineers, *Hydrologic Engineering Center - River Analysis System (HEC-RAS), HEC-RAS Mapper User's Manual*, Version 6.0, December 2020.

(7) U.S. Geological Survey, *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains*, Water-Supply Paper 2339.

(8) U.S. Section International Boundary and Water Commission, *Flood Frequency Study for the Rio Grande between El Paso, Texas/Juarez Chihuahua and Brownsville, Texas/Matamoros, Tamaulipas*, September 2003.

(9) U.S. Section International Boundary and Water Commission, *Hydraulic Model of the Rio Grande and Floodways Within the Lower Rio Grande Flood Control Project*, El Paso, Texas, June 2003.

18. USIBWC Resources and Information. Requirements for work, forms, and standard drawings are available on USIBWC's website at www.ibwc.gov/resources-info/.

A. The following documents are available for download on that site:

(1) Appendix A - Design and Construction Requirements for All Projects

(2) Appendix B - Land Boundary Project Requirements

(3) Appendix C - Requirements for Projects on or Affecting a USIBWC Flood Control Structure

(4) Appendix D - Minimum Levee Testing Requirements

(5) Appendix E - Design Report Requirements

(6) Appendix F - Hydraulic Modeling Methodology

(7) Appendix G - Reseeding USIBWC Property

(8) Appendix H - Floodplain Requirements

B. Please contact our Realty Office (realty@ibwc.gov) to discuss which requirements apply to your project. Do not wait until you are ready to construct your project. Contact them well in advance so they can discuss our requirements.

Approved:

RAMON MACIAS

Digitally signed by RAMON MACIAS
Date: 2024.01.30 17:14:22 -07'00'

January 30, 2024

Ramon Macias, III, P.E. Engineering
for
Dr. Maria-Elena Giner, P.E.
Commissioner

Date

Example Spreadsheet - Calculation of Hydraulic Impacts.

	Proposed Condition						Existing Condition					Diff	Diff	Proposed Condition		Existing Condition		Deflection		Percent Deflection	
RS	Qleft (cms)	Qch (cms)	Qright (cms)	WSEL (m)	Vel (m/s)	Q Total (cms)	Qleft (cms)	Qch (cms)	Qright (cms)	WSEL (m)	Vel (m/s)	WSEL (m)	Vel (m/s)	QUS (cms)	QMX (cms)	QUS (cms)	QMX (cms)	US (cms)	MX (cms)	US	MX
1000	245.14	2149.5	1565.36	118.42	1.98	3960	245.13	2149.53	1565.34	118.42	1.98	0.00	0.00	1319.89	2640.11	1319.90	2640.11	-0.0050	0.0050	0.00%	0.00%
999	133.65	2353.06	1473.29	118.42	1.84	3960	133.65	2353.09	1473.27	118.42	1.84	0.00	0.00	1310.18	2649.82	1310.20	2649.82	-0.0150	0.0050	0.00%	0.00%
998	199.12	2088.92	1671.96	118.42	1.85	3960	199.11	2088.95	1671.94	118.42	1.85	0.00	0.00	1243.58	2716.42	1243.59	2716.42	-0.0050	0.0050	0.00%	0.00%
997	200.64	2040.62	1718.74	118.42	1.79	3960	200.63	2040.65	1718.72	118.42	1.79	0.00	0.00	1220.95	2739.05	1220.96	2739.05	-0.0050	0.0050	0.00%	0.00%
996	167.88	2068.23	1723.89	118.41	1.78	3960	167.88	2068.26	1723.86	118.41	1.78	0.00	0.00	1202.00	2758.01	1202.01	2757.99	-0.0150	0.0150	0.00%	0.00%
995	306.58	1875.76	1777.67	118.4	1.88	3960	306.57	1875.79	1777.64	118.39	1.88	0.01	0.00	1244.46	2715.55	1244.47	2715.54	-0.0050	0.0150	0.00%	0.00%
994	331.06	1921.45	1707.49	118.39	1.85	3960	331.05	1921.48	1707.47	118.39	1.85	0.00	0.00	1291.79	2668.22	1291.79	2668.21	-0.0050	0.0050	0.00%	0.00%
993	364.35	1851.4	1744.25	118.38	1.86	3960	364.34	1851.43	1744.22	118.38	1.86	0.00	0.00	1290.05	2669.95	1290.06	2669.94	-0.0050	0.0150	0.00%	0.00%
992	359.39	1821.38	1779.23	118.38	1.86	3960	359.39	1821.42	1779.2	118.38	1.86	0.00	0.00	1270.08	2689.92	1270.10	2689.91	-0.0200	0.0100	0.00%	0.00%
991	329.73	1973.87	1656.41	118.37	1.83	3960	329.72	1973.91	1656.38	118.37	1.83	0.00	0.00	1316.67	2643.35	1316.68	2643.34	-0.0100	0.0100	0.00%	0.00%
990	278.07	2204.54	1477.4	118.36	1.77	3960	278.06	2204.58	1477.37	118.36	1.77	0.00	0.00	1380.34	2579.67	1380.35	2579.66	-0.0100	0.0100	0.00%	0.00%
989	317.77	1942.69	1699.54	118.35	1.85	3960	317.76	1942.73	1699.51	118.35	1.85	0.00	0.00	1289.12	2670.89	1289.13	2670.88	-0.0100	0.0100	0.00%	0.00%
988	346.82	2174.23	1438.95	118.35	1.75	3960	346.81	2174.27	1438.92	118.35	1.75	0.00	0.00	1433.94	2526.07	1433.95	2526.06	-0.0100	0.0100	0.00%	0.00%
987	360	2040.92	1559.08	118.33	1.85	3960	359.99	2040.96	1559.05	118.33	1.85	0.00	0.00	1380.46	2579.54	1380.47	2579.53	-0.0100	0.0100	0.00%	0.00%
986	343.31	2252.41	1364.27	118.32	1.83	3960	343.3	2252.46	1364.24	118.32	1.83	0.00	0.00	1469.52	2490.48	1469.53	2490.47	-0.0150	0.0050	0.00%	0.00%
985	248.02	2338.05	1373.92	118.32	1.78	3960	248.01	2338.1	1373.89	118.32	1.78	0.00	0.00	1417.05	2542.95	1417.06	2542.94	-0.0150	0.0050	0.00%	0.00%
984	333.28	2163.23	1463.5	118.31	1.82	3960	333.26	2163.28	1463.46	118.31	1.82	0.00	0.00	1414.90	2545.12	1414.90	2545.10	-0.0050	0.0150	0.00%	0.00%
983	350.94	2255.25	1353.81	118.31	1.69	3960	350.93	2255.3	1353.77	118.31	1.69	0.00	0.00	1478.57	2481.44	1478.58	2481.42	-0.0150	0.0150	0.00%	0.00%
982	367.47	2166.44	1426.09	118.29	1.83	3960	367.46	2166.49	1426.06	118.29	1.83	0.00	0.00	1450.69	2509.31	1450.71	2509.31	-0.0150	0.0050	0.00%	0.00%
981	432.04	2200.52	1327.44	118.28	1.84	3960	432.02	2200.58	1327.4	118.28	1.84	0.00	0.00	1532.30	2427.70	1532.31	2427.69	-0.0100	0.0100	0.00%	0.00%
980	456.73	2116.6	1386.67	118.26	1.83	3960	456.71	2116.65	1386.64	118.26	1.83	0.00	0.00	1515.03	2444.97	1515.04	2444.97	-0.0050	0.0050	0.00%	0.00%
979	357.45	2295.83	1306.72	118.25	1.8	3960	357.44	2295.88	1306.68	118.25	1.8	0.00	0.00	1505.37	2454.64	1505.38	2454.62	-0.0150	0.0150	0.00%	0.00%
978	282.18	2514.17	1163.65	118.24	1.77	3960	282.17	2514.23	1163.61	118.24	1.77	0.00	0.00	1539.27	2420.74	1539.29	2420.73	-0.0200	0.0100	0.00%	0.00%
977	370.56	2092.11	1497.33	118.24	1.83	3960	370.55	2092.17	1497.29	118.24	1.83	0.00	0.00	1416.62	2543.39	1416.64	2543.38	-0.0200	0.0100	0.00%	0.00%
976	251.33	2312.56	1396.11	118.23	1.78	3960	251.32	2312.62	1396.06	118.23	1.78	0.00	0.00	1407.61	2552.39	1407.63	2552.37	-0.0200	0.0200	0.00%	0.00%
975	202.19	2507.1	1250.71	118.23	1.71	3960	202.18	2507.16	1250.67	118.23	1.71	0.00	0.00	1455.74	2504.26	1455.76	2504.25	-0.0200	0.0100	0.00%	0.00%
974	392.13	2492.52	1075.35	118.23	1.61	3960	392.1	2492.59	1075.31	118.23	1.61	0.00	0.00	1638.39	2321.61	1638.40	2321.61	-0.0050	0.0050	0.00%	0.00%
973	787.96	2033.87	1138.17	118.24	1.43	3960	788.21	2034.62	1137.17	118.24	1.43	0.00	0.00	1804.90	2155.11	1805.52	2154.48	-0.6250	0.6250	-0.03%	0.03%
972	1228.84	1870.49	860.68	118.25	1.35	3960	1228.55	1870.12	861.33	118.25	1.35	0.00	0.00	2164.09	1795.93	2163.61	1796.39	0.4750	-0.4650	0.02%	-0.03%
971	1265.63	1873.14	821.23	118.24	1.34	3960	1266.18	1874.04	819.78	118.24	1.34	0.00	0.00	2202.20	1757.80	2203.20	1756.80	-1.0000	1.0000	-0.05%	0.06%
970	1269.03	1915.06	775.92	118.24	1.3	3960	1268.83	1914.86	776.32	118.24	1.3	0.00	0.00	2226.56	1733.45	2226.26	1733.75	0.3000	-0.3000	0.01%	-0.02%
969	1256.22	1688.94	1014.84	118.23	1.4	3960	1256.09	1688.85	1015.07	118.23	1.4	0.00	0.00	2100.69	1859.31	2100.52	1859.50	0.1750	-0.1850	0.01%	-0.01%
968	1150.49	1976.81	832.7	118.22	1.38	3960	1150.48	1976.89	832.63	118.22	1.38	0.00	0.00	2138.90	1821.11	2138.93	1821.08	-0.0300	0.0300	0.00%	0.00%
967	1066.34	2046.61	847.05	118.21	1.4	3960	1065.51	2045.1	849.39	118.21	1.4	0.00	0.00	2089.65	1870.36	2088.06	1871.94	1.5850	-1.5850	0.08%	-0.08%
966	1128.56	1638.97	1192.47	118.21	1.46	3960	1128.84	1639.48	1191.68	118.21	1.46	0.00	0.00	1948.05	2011.96	1948.58	2011.42	-0.5350	0.5350	-0.03%	0.03%
965	1061.49	2079.2	819.31	118.21	1.26	3960	1061.18	2078.67	820.15	118.2	1.26	0.01	0.00	2101.09	1858.91	2100.52	1859.49	0.5750	-0.5750	0.03%	-0.03%
964	1152.89	1527.05	1280.07	118.2	1.36	3960	1153.22	1527.56	1279.22	118.2	1.36	0.00	0.00	1916.42	2043.60	1917.00	2043.00	-0.5850	0.5950	-0.03%	0.03%
963	1202.51	1477.97	1279.52	118.19	1.45	3960	1197.18	1471.4	1291.42	118.19	1.44	0.00	0.01	1941.50	2018.51	1932.88	2027.12	8.6150	-8.6150	0.45%	-0.42%
962	1021.46	2276.62	661.92	118.18	1.35	3960	1017.28	2267.22	675.5	118.18	1.34	0.00	0.01	2159.77	1800.23	2150.89	1809.11	8.8800	-8.8800	0.41%	-0.49%
961	951.21	2285.44	723.35	118.17	1.42	3960	947.78	2277.08	735.14	118.17	1.42	0.00	0.00	2093.93	1866.07	2086.32	1873.68	7.6100	-7.6100	0.36%	-0.41%
960	880.03	2285.36	794.62	118.16	1.46	3960	878.2	2280.56	801.24	118.16	1.46	0.00	0.00	2022.71	1937.30	2018.48	1941.52	4.2300	-4.2200	0.21%	-0.22%
959	803.26	2345.57	811.18	118.15	1.51	3960	800.91	2338.6	820.49	118.15	1.51	0.00	0.00	1976.05	1983.97	1970.21	1989.79	5.8350	-5.8250	0.30%	-0.29%
958	621.9	2457.31	880.79	118.13	1.56	3960	620.77	2452.78	886.44	118.13	1.56	0.00	0.00	1850.56	2109.45	1847.16	2112.83	3.3950	-3.3850	0.18%	-0.16%
957	840.17	2172.22	947.61	118.12	1.67	3960	838.73	2168.42	952.85	118.12	1.66	0.00	0.01	1926.28	2033.72	1922.94	2037.06	3.3400	-3.3400	0.17%	-0.16%
956	865.06	2008.1	1086.85	118.1	1.75	3960	864.28	2006.26	1089.46	118.1	1.75	0.00	0.00	1869.11	2090.90	1867.41	2092.59	1.7000	-1.6900	0.09%	-0.08%
955	982.51	1869.19	1108.3	118.1	1.67	3960	982.51	1869.19	1108.3	118.1	1.67	0.00	0.00	1917.11	2042.90	1917.11	2042.90	0.0000	0.0000	0.00%	0.00%
954	652	2342.03	965.98	118.08	1.7	3960	652	2342.03	965.98	118.08	1.7	0.00	0.00	1823.02	2137.00	1823.02	2137.00	0.0000	0.0000	0.00%	0.00%
953	673.2	2178.89	1107.91	118.06	1.84	3960	673.2	2178.89	1107.91	118.06	1.84	0.00	0.00	1762.65	2197.36	1762.65	2197.36	0.0000	0.0000	0.00%	0.00%
952	695.54	2129.33	1135.13	118.05	1.91	3960	695.54	2129.33	1135.13	118.05	1.91	0.00	0.00	1760.21	2199.80	1760.21	2199.80	0.0000	0.0000	0.00%	0.00%
951	709.85	2139.47	1110.68	118.04	1.92	3960	709.85	2139.47	1110.68	118.04	1.92	0.00	0.00	1779.59	2180.42	1779.59	2180.42	0.0000	0.0000	0.00%	0.00%
950	746.34	2123.97	1089.69	118.02	1.99	3960	746.34	2123.97	1089.69	118.02	1.99	0.00	0.00	1808.33	2151.68	1808.33	2151.68	0.0000	0.0000	0.00%	0.00%
949	503.34	2465.6	991.07	118.01	1.88	3960	503.34	2465.6	991.07	118.01	1.88	0.00	0.00	1736.14	2223.87	1736.14	2223.87	0.0000	0.0000	0.00%	0.00%
948	473.87	2493.72	992.4	117.98	1.97	3960	473.87	2493.72	992.4	117.98	1.97	0.00	0.00	1720.73	2239.26	1720.73	2239.26	0.0000	0.0000	0.00%	0.00%
												0.01	0.01					8.88	1.00	0.45%	0.06%
												0.00	0.00					-1.00	-8.88	-0.05%	-0.49%