International Boundary and Water Commission

United States and Mexico

United States Section

4191 N. Mesa, El Paso, TX 79902

Land Boundary Project Requirements

USIBWC Directive SD.II.01031-M-1 Appendix B

Table of Contents

This document outlines the hydrologic and hydraulic modeling, erosion protection and additional documents to be submitted to the United States Section of the International Boundary and Water Commission (USIBWC) in advance of projects along the land boundary between the United States and Mexico. Additional requirements related to boundary delineation and demarcation are also described. Examples of these projects include the U.S. Customs and Border Protection (CBP) border fence projects constructed within the Roosevelt Easement (within 60 feet of the border), access roads, the U.S. General Services Administration (GSA) Port of Entry facilities, and related projects.

The purpose of these requirements is to avoid adverse hydraulic and erosional impacts to either the United States or Mexico and to maintain the structural integrity of the boundary monuments and visibility between the adjacent monuments, as well as maintaining access to these monuments per 22 USC §277a and §277d-34. The requirements are also intended to maintain the integrity of any existing intermediate markers between the boundary demarcation. The procedures outlined below are intended to prevent inadvertent encroachment or construction in the territory of Mexico.

1. Drainage Analysis.

A. The extent of the analysis required shall depend upon the complexity of the project. The methods used for the analysis shall be consistent with established engineering practice. In many cases, local municipalities have detailed criteria especially suited for local conditions, and these shall also be used.

B. Hydrology.

(1) For projects along the land boundary where rivers or washes flow from either the United States to Mexico or vice versa, the 100-year 24-hour discharges for the washes shall be determined from the upstream contributing watershed.

(2) Depending upon the nature of the project, discharges of additional return periods such as the 25-year or the 50-year may also need to be analyzed as determined by the USIBWC or for meeting local municipal drainage or other agency requirements. Analysis of lower return-period discharges may be necessary if there are clear adverse hydraulic impacts or erosional impacts anticipated from site conditions such as existing scour holes.

(3) The discharges are estimated using various methods such as the rational method, the Natural Resources Conservation Service (NRCS) TR-55 method and the U.S. Geological Survey (USGS) regression equations. The discharges may also be obtained by developing detailed hydrologic models using, for example, the U.S. Army Corps of Engineers (USACE) HEC-1 and HEC-HMS (version 4.8 or latest) software. For sites with flat terrain where clearly defined washes are not identifiable, two-dimensional software such as USACE HEC-RAS (version 6.1 or latest) or FLO-2D may also be used to generate hydrographs. Suitable design rainfall values may be obtained from sources such as the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Precipitation Frequency Data Server. The design rainfall depths are combined with hydrograph transform methods (for example, Snyder, Clark, Soil Conservation Service [SCS], User Specified hydrograph), loss parameters (for example, Green-Ampt, SCS, initial and uniform), and reservoir and channel routing procedures (for example Modified Puls, Muskingum-Cunge) to develop the hydrologic model. For large watersheds, estimates of discharges obtained for tributary washes shall be checked for reasonableness by comparison with regional envelope curves, historical storms, and discharge per unit area values reported in the literature.

(4) Drainage areas less than 1 square mile may be analyzed using the rational method or TR-55. For drainage areas greater than 1 square mile up to 10 square miles, the TR-55 method may be used. For drainage areas larger than 10 square miles, discharges may be calculated using the HEC-1 or HEC-HMS software or the USGS regression equations.

C. Hydraulics.

(1) Washes along the land boundary flow either south into Mexico or north into the United States. The hydraulic analysis and impact calculations are intended to assure that there are no adverse hydraulic impacts or adverse erosional impacts to either country resulting from a proposed project.

(2) Hydraulic analysis shall be conducted for sizing drainage structures such as low water crossings, roadside ditches, culverts, bridges, and gates and for generating water surface profiles.

(3) For smaller projects across tributary washes such as a minor culvert, nomographs and/or simpler models may be used for the analysis. For most projects, a steady state hydraulic analysis using the latest version of the public domain USACE HEC-RAS software shall be used for the analysis. It is preferable to develop georeferenced hydraulic models which permit display of cross-sections on aerial images and GIS-based floodplain mapping.

(4) For border fence projects or similar types of projects obstructing transboundary flows, existing (natural, without fence) and proposed (with fence) condition one-dimensional (1D) steady state hydraulic models shall be developed for existing and proposed conditions to evaluate the hydraulic impacts along the modeled reach. The latest version of the USACE HEC-RAS software shall be used for the analysis. Flood flows generate debris. Therefore, blockage due to debris at or above 20% shall be included by reducing the opening size between the bollards representing the fence in the proposed condition model. As part of the hydraulic calculations such as normal depth calculations and sizing of culverts, software such as the U.S. Federal Highway Administration (FHWA) HY-8 and similar public domain and proprietary software may be used.

(5) In particular situations, 1D unsteady flow analysis or two-dimension (2D) modeling may also be required. One-dimensional unsteady flow analysis can be useful in describing the passage of a flood through a structure and can be used in situations where it is important to know how long high water surface elevations would last. The unsteady analysis also helps in optimizing the sizing of hydraulic structures such as detention basins and channels, resulting in cost savings. Two-dimensional modeling may be required in locations where there are no distinct washes and flow is predominantly sheet flow. Two-dimensional modeling may be conducted using software such as HEC-RAS or FLO-2D. The project Proponent is strongly encouraged to meet with the USIBWC in advance of projects to discuss site conditions and other issues which may necessitate specific modeling requirements.

(6) Additional guidance on hydraulic modeling is available in "*Appendix F-Hydraulic Modeling Methodology*."

D. Data Collection.

(1) The hydraulic 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. This also ensures that the water surface elevations for the existing and proposed conditions are the same at the upstream and downstream ends of the model. 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. Because the LiDAR data does not capture the geometry of the main channel below the water, cross-section surveys shall be conducted. For smaller projects, cross section surveys may be sufficient to define the geometry.

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

E. Hydraulic Impact Calculations - Water Surface Elevation Increases.

(1) The hydraulic impact calculations are intended to assure that there are no adverse flooding impacts to the United States or to Mexico due to the proposed project. Water surface elevations (WSE) along the modeled reach typically increase due to the proposed project near the location of the project. At locations further upstream and downstream, the WSE values from the proposed condition gradually approach those of the existing condition values until there are no differences in the WSE values between the existing and proposed conditions.

WSE values shall be evaluated all at cross sections/locations along the modeled reach and the differences tabulated.

(2) For 1D hydraulic models, threshold limits for water surface elevation 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. Both existing and proposed condition hydraulic models shall have similar cross sections. WSE increases shall be calculated at each cross section of the hydraulic model. Tabulated hydraulic impact calculations shall also be provided in Excel spreadsheet to facilitate easier review. Threshold value of WSE rise shall not be exceeded along the entire modeled reach. If WSE increases are above the threshold limits, gates shall be included in the proposed structure and represented as openings in the hydraulic model to mitigate the impacts and lower them to below threshold levels. For project location within USIBWC levee, WSE increase shall be zero to have no impacts on the available freeboard.

(3) For hydraulic impact calculations for 2D modeling, "*Appendix F-Hydraulic Modeling Methodology*" shall be consulted.

(4) An example of how data should be presented in an Excel spreadsheet is provided on the last page of "*Appendix F-Hydraulic Modeling Methodology.*" Calculation of percent deflects are only required for the Rio Grande and Colorado River. They are not required for land boundary washes and the Tijuana River.

F. Additional Analysis for Projects Seeking Waiver from Meeting Hydraulic Impact Thresholds.

(1) Meeting the hydraulic impact thresholds noted in these requirements sometimes requires a large number of gates or culverts which may not be practical from a project operations standpoint or from severely elevated construction costs. An example of a large number would be 40 gates or culverts where it is not practical to open all these gates in the event of a flood.

(2) The following procedures shall be used if the Proponent wishes to seek a waiver for cases where a large number of gates or drainage structures are required to meet the threshold limits in rural areas and in cases for gates or culverts in remote locations which are difficult to access and open in a timely manner during a flood. The threshold limits for urban areas remain unchanged.

(3) Waiver from the 6-inch WSE requirement in rural areas may be sought in the following cases:

(a) In cases where a large number of gates or culverts are required to meet the hydraulic impact thresholds for rural areas.

(b) In cases where the gates or culverts are in a remote location and the remote location creates operational challenges with regard to opening the gates during flood events and/or regular maintenance of the gates.

(4) In cases where a waiver from the 6-inch WSE requirement is sought in rural areas, the following 3 hydraulic models shall be developed by the Proponent at its sole expense and effort:

(a) An existing condition (no-structure/project) HEC-RAS hydraulic model shall be developed.

(b) A proposed (with structure/project) condition model shall be developed with gates or culverts included to reduce WSE increases to below threshold limits. This would be the model with the large number of gates or culverts.

(c) A second 'cost or operationally effective' proposed condition model shall be developed with a minimum of 3 plans. The plans shall show successively reduced numbers of gates or culverts. Each plan will therefore result in WSE elevations which are higher than the threshold limit by a certain amount. The maximum WSE increase shall be 1 foot, similar to the concept of the U.S. Federal Emergency Management Agency (FEMA) floodway mapping.

(5) The 3 plans in the second 'cost or operationally effective' model shall not result in WSE increases that result in upstream flooding of properties in the U.S. or in Mexico. They shall also not result in adverse erosional impacts. Any erosional impacts shall be mitigated by including erosion protection in the proposed condition models above.

(6) The results of the above analysis shall be documented in a technical report. Hydraulic impact calculations shall be tabulated. The floodplain widths and lengths upstream for the conditions for which WSE differences are seen from the existing condition model shall be tabulated. "Upstream" can be located in either Mexico or the United States depending upon the flow direction. The name of the owners whose land is being impacted by WSE changes and/or erosion upstream shall be documented. The report and the digital hydraulic models shall be submitted for USIBWC review.

G. Erosion Protection. Suitable erosion protection shall be provided for the proposed structures to prevent the development of scour holes and erosion. Such protection shall be based on guidelines provided in technical engineering manuals and include surface treatments such as loose riprap, grouted riprap, concrete, and energy dissipaters, among others based on soil types, flow velocities and other factors. Components of scour in bridge structures can be determined using the HEC-RAS software.

H. Sediment Transport. The potential of projects to change the sediment transport characteristics may need to be evaluated in some cases. An example would be a project causing a change in the flow regime resulting in sediment deposition or removal. This requires sediment transport modeling using software such as HEC-RAS. The modeling will provide an insight into the changes in sediment deposition and aggradation patterns between existing and proposed conditions. Where impacts are considered to be excessive, suitable measures must be adopted to minimize changes to sediment transport behavior along a wash or river. For sediment-laden flows, the discharge for each basin shall be increased appropriately using sediment bulking factors.

I. Drainage Report.

(1) The report is intended to be a stand-alone technical document that can be referred to in the future, for example, to mitigate adverse impacts. The Drainage Report shall address items 1.A. through 1.H.

(2) The report shall contain the following information:

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

(b) Purpose of Study.

(c) Location.

(d) Site Description. Include offsite and onsite drainage conditions, prominent drainage features such as levees, FEMA floodplains, etc.

(e) Proposed Conditions.

(f) Methodology. Include hydrologic and hydraulic analysis for existing and proposed conditions with list of software used with version numbers.

(g) Results and Discussion. Discuss hydraulic impacts, compliance with criteria from relevant agencies, etc.

(h) Conclusions.

(i) List of References.

(3) Appendices Containing the Following:

(a) Figures.

1. Relevant figures such as vicinity map, soils maps, land use maps, drainage basin maps, floodplain maps, or FEMA FIRM.
2. Figures should be in color, legible, and convey technical information with prominent features labeled. Include multiple figures to convey information clearly if needed.
3. Include relevant engineering drawings describing the proposed project.

(b) Model Outputs.

1. Calculation tables including WSE difference, hydrologic model outputs, and hydraulic model outputs.
2. HEC-RAS Standard Table 1, profile plots, cross-section plots, and HEC-RAS generated report.
3. Storm drain calculations along with scour and sediment calculations.

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

(4) Electronic Files. Provide readme file describing all files provided, hydrologic models, hydraulic models, spreadsheet calculations, effective FEMA models, GIS and CADD files (AutoCAD preferred), reference studies, etc.

(5) Final 100% Document. The final Drainage Report shall be signed and stamped by a professional engineer licensed to practice in the state where the work will be performed.

2. Boundary Monuments.

A. In order to ensure U.S. Government's compliance with Minute No. 244 entitled "*Maintenance of the International Land Boundary Monuments (Minute 244)*" dated December 4, 1973, both sections of the IBWC are required to perform maintenance of the monuments that mark the international boundary to assure their permanence and visibility. Both the United States and Mexican Sections of the IBWC maintain 276 international monuments, 259 principal monuments and 18 intermediaries. To assure compliance to Minute 244, and to maintain the integrity of the International Boundary Line, all projects relating to the area in and around the monuments must be coordinated with the USIBWC.

B. The proposed project shall not impact the structural integrity of the boundary monuments and the visibility between adjacent monuments. The United States and Mexico have agreed that the international boundary on the western boundary (the land boundary) will be demarcated with monuments and that a line of sight between monuments must be maintained. The countries have agreed that maintenance of the monuments includes ensuring that the monuments are not damaged and that there is visibility of and between the monuments. The countries share the obligation of maintaining the monuments.

C. It shall be ensured that all portions of work, including footings and subgrade structures, are set at a minimum of 3 feet away from the footing of all existing monuments. There shall be no physical alteration or dislocation of a boundary monument without prior consultation with the USIBWC.

D. Any intermediate boundary markers placed by the IBWC between adjacent monuments shall also not be impacted by the proposed project. Some intermediate boundary monuments have been placed that are 30 feet tall. The top of these monuments shall not be blocked from view. No structure higher than 25 feet shall be placed within 50 feet of these monuments.

E. At no point will any work begin that will affect the International Boundary Line, monuments and/or the characteristics of the landscape. The Proponent shall perform no work on the monuments. Access to the monuments and intermediate boundary markers must not be adversely impacted.

F. Any damage to a monument shall be promptly reported to the IBWC.

3. Boundary Delineation and Demarcation.

A. The proposed project shall not impact the boundary delineation markers. These markers are set in accordance with Minute 302 entitled "*Enhanced Demarcation and Monumentation of the International Boundary at International Boundary River Bridges and Land Boundary Ports of Entry*."

B. The project Proponent shall reach out to the USIBWC in advance of the project construction for the international boundary delineation at the location of the project. The USIBWC survey team together with representatives from the Mexican Section of the IBWC shall perform the international boundary delineation along the reach of the project. The survey team shall also verify the construction stake outs of the proposed project. In situations where the USIBWC survey team is not able to be physically present to perform the border delineation and verification of construction stake outs, the project Proponent shall contact the USIBWC surveyor on how to proceed.

C. It shall be ensured that all portions of the proposed project structure, including footings and subgrade structures, are set at a minimum of 3 feet away from the border on the U.S. side. Specific situations may require an offset greater than 3 feet. These procedures shall ensure that there are no encroachments of the proposed construction into the country of Mexico and ensure that IBWC can access the International Boundary Line to survey and ensure concurrence with the Treaties of 1848, 1853, and 1882.

(1) For Ports of Entry, in cases where the 3 foot offset cannot be met due to the proponents responsibilities and project requirements, the 3 foot offset may be modified, as determined on a case-by-case basis. Proponent shall provide a

construction plan that reflects how construction can and shall be implemented without encroaching into Mexico. All construction and operations requirements regarding avoiding encroachments into the territory of Mexico shall be observed.

D. Proponent shall address all comments generated during USIBWC's review and shall resubmit project documents incorporating required revisions.

E. The USIBWC shall share details of any boundary plaques to be placed and the style of the demarcation markers along the international boundary. The Proponent shall include these details in their project drawings. The Proponent shall purchase the boundary plaques for the project.

F. In Port of Entry projects, the boundary delineation shall also help determine the alignment of the boundary markers and location of the boundary plaques to be installed upon the completion of the project. The project Proponent is responsible for the maintenance of the boundary plaques and boundary demarcation markers over the life of the project.

4. Construction Considerations. The project Proponent shall assure that they take construction means and methods and site conditions, such as subsurface soil conditions, into account in determining the alignment/location of a project. During construction of the proposed project, no equipment, personnel, or material shall cross the International Boundary Line. All construction shall occur on the U.S. side of the International Boundary Line. After construction, operations such as repairs and debris removal shall not result in personnel, equipment and construction material encroaching into the territory of Mexico.

5. Maintenance Considerations. IBWC may routinely maintain areas near or on the international boundary. The proposed project shall not impact IBWC operations unless previously agreed to between the cooperating agencies and/or as provide herein. IBWC will not be liable for any damage that may occur to the proponent’s project as result of these operations or agreements.

6. Summary. The Proponent is strongly encouraged to consult with the USIBWC sufficiently in advance, recommended at least 4 months, of a proposed project construction start date to discuss site conditions and other issues which may require specific modeling requirements. The requirements described in this document shall be followed in preparing submittals for review and in site work. The documents shall be submitted at least 2 months in advance of any proposed construction start date. Any significant review comments shall be addressed before the start of construction. For detailed 2D modeling, waivers, and complex projects, a complete package shall be submitted at least 3 months before the proposed construction start date.

7. 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) Arizona Department of Transportation, *Highway Drainage Design Manual, Hydraulics, Final Report*, Phoenix, Arizona, January 2007.

(2) Asquith, W. H., and Roussel, M. C., *Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas*, U.S. Geological Survey Scientific Investigations Report 2004-5041, 2004.

(3) Asquith, W. H., *Depth-Duration Frequency of Precipitation for Texas*, U.S. Geological Survey Water Resources Investigations Report 98-4044, Austin, Texas, 1998.

(4) California Department of Transportation, *Highway Design Manual*, May 2012.

(5) Chang Consultants, *FLUVIAL-12 Mathematical Model for Erodible Channels, User's Manual*, Rancho Santa Fe, California, January 2006.

(6) Federal Emergency Management Agency (FEMA), *Guidelines and Specifications for Flood Hazard Mapping Partners*, 2012.

(7) Federal Highway Administration, *Debris Control Structures, Evaluation and Countermeasures*, Third Edition, Hydraulic Engineering Circular No. 9, October 2005.

(8) Federal Highway Administration, *Design of Riprap Revetment*, Hydraulic Engineering Circular No. 11, March 1989.

(9) Federal Highway Administration, *Hydraulic Design of Energy Dissipators for Culverts and Channels*, Hydraulic Engineering Circular No. 14, Third Edition, July 2006.

(10) Federal Highway Administration, *Hydraulic Design of Highway Culverts*, Hydraulic Design Series No. 5, May 2005.

(11) FEMA: Hydraulic Numerical Models Meeting the Minimum Requirement of the National Flood Insurance Program (NFIP), www.fema.gov/flood-maps/products-tools/numerical-models/hydraulic (last accessed 8/10/2023).

(12) FLO-2D Software, Inc. www.flo-2d.com.

(13) Frederick, R. H., V. A. Meyers, and E. P. Auciello, *Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States*, NOAA Technical Memorandum NWS HYDRO-35, National Weather Service, Silver Spring, MD, June 1977.

(14) Garcia, M. H., ed., *Sedimentation Engineering, Processes, Measurements, Modeling, and Practice*, ASCE Manuals and Reports on Engineering Practice No. 110, 2008.

(15) Hershfield, D. M., *Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years*, U.S. Weather Bureau, Technical Paper No. 40, Washington D.C., May 1961. www.weather.gov/gyx/TP40s.htm (last accessed 8/10/2023).

(16) Maidment, D. R., Editor, *Handbook of Hydrology*, McGraw Hill, 1993.

(17) National Weather Service, *Point Precipitation Frequency Estimates from NOAA ALTAS 14*, *Precipitation Frequency Data Server*, National Oceanic and Atmospheric Administration. hdsc.nws.noaa.gov/hdsc/pfds/ (last accessed 8/10/2023).

(18) Natural Resources Conservation Service, *Computer Program for Project Formulation Hydrology*, Technical Report No. 20, Washington D.C., February 1992

(19) Natural Resources Conservation Service, *Urban Hydrology for Small Watersheds*, Technical Report No. 55, Washington D.C., June 1986.

(20) Pima County Roadway Design Manual, Fourth Edition, 2013.

(21) Texas Department of Transportation, *Hydraulic Design Manual*, September 2019. onlinemanuals.txdot.gov/txdotmanuals/hyd/index.htm (last accessed 8/10/2023).

(22) U.S. Army Corps of Engineers, *HEC-1 Flood Hydrograph Package,* Davis, California, 1990.

(23) U.S. Army Corps of Engineers, *Hydrologic Engineering Center - Hydrologic Modeling System (HEC- HMS)*, Version 4.8,April 2021.

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

8. 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 16:47:14 -07'00'

January 30, 2024

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

Date