

# Instructions for Form 2 - Riverine Hydrology and Hydraulics

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This form should be used for revision requests that involve new or revised hydrologic and/or hydraulic analyses of rivers, streams, ponds, or small lakes. A separate form should be used for each flooding source.

Download [Form 2 - Riverine Hydrology and Hydraulics](#).

## Section A: Hydrology

This section is to be completed when discharges other than those used in the effective Flood Insurance Study are proposed.

1. Indicate the reason for the new or revised hydrologic analysis. For revisions based on alternative methodologies or improved data, explain why the alternative methodology or improved data provides better results over the Flood Insurance Study and support that explanation throughout the form. The discharges resulting from the new or revised hydrologic analysis should result in a statistically significant difference when compared to the effective flood discharges. Statistical significance is defined in Section 6.0 of the [Guidance for Flood Risk Analysis and Mapping: General Hydrologic Considerations](#) available on FEMA's website.
2. Compare the effective 1%-annual-chance discharges to the revised 1%-annual-chance discharges at three representative locations.
3. In accordance with National Flood Insurance Program regulations, if only a portion of a detailed-study stream is revised, a transition to the unrevised portion must be ensured to maintain the continuity of the study. Attach an explanation of how the proposed discharge in the revised portion of the stream transitions to the effective discharge in the unrevised portion of the stream, and vice versa.
4. Specify the method used for the new hydrologic analysis.
5. Precipitation/Runoff Model, Statistical Analyses of Gage Records and Regional Regression Equations



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- a. Precipitation/Runoff Model Attach any additional backup computations and supporting data, such as GIS data, Digital Elevation Model (DEM), drainage area map, soils map, soil group names, time of concentration computations, curve numbers, source of rainfall data, storm duration, or node-link diagram (if applicable). Models submitted in support of a revision request must meet the requirements of the National Flood Insurance Program regulations at the Code of Federal Regulations Title 44, Chapter 1, Subparagraph 65.6(a)(6). A list of hydrologic models accepted by FEMA can be found on FEMA's website.
- b. Statistical Analyses of Gage Records Indicate the gaging record location and identification number and the methodology used for the analysis. Bulletin 17C, "Guidelines for Determining Flood Frequency," is the recommended approach for analyzing gage records. Refer to the [Subcommittee on Hydrology of the Advisory Committee on Water Information](#) website to view Bulletin 17C. If Bulletin 17C was not used in the gage analysis, please provide the reasons it was not applicable. Submit the historical records of the flow data for the gaged data and statistical model results.
- c. Regional Regression Equations Indicate the source of the most recent regional regression equation and provide the description and justification of the parameters used in the regression equation. U.S. Geological Survey (USGS) regression equations are available nationwide and recommended for use. If the most recent USGS regression equations were not used, please provide the reasons these equations are not applicable.
- d. Other Please attach a description of any hydrologic analysis method used that is different from above.
- e. If approval of the new or revised hydrologic analysis is required by a local, state or federal agency, indicate if the analysis and resulting peak discharge value(s) have been approved by the appropriate agency and attach evidence of the approval.
- f. In locations where sediment transport affects hydrology, the effects of sediment transport should be considered in the hydrology. In addition, Section F of Riverine Structures Form 3 should be submitted. Note: FEMA does not map Base Flood Elevations based on bulked flows, as stated in Section F of Riverine Structures Form 3.



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## Section B: Hydraulics

This section is to be completed when the request involves a hydraulic analysis for riverine flooding that differs from that used to develop the Flood Insurance Rate Map.

- Indicate the reach of stream to be revised. The area of the revision is defined by an effective tie-in at the upstream and downstream limits. For streams that have a detailed study, an effective tie-in is obtained when the revised Base Flood Elevations are within 0.5 foot of the effective elevations, and the revised floodway encroachment stations match the effective floodway stations at both the upstream and downstream limits. For streams that do not have a detailed study, an effective tie-in is obtained when the revised Base Flood Elevations are within 0.5 foot of the pre-project conditions model at both the upstream and downstream limits. Please note that the area of revision and the project area are not necessarily the same. If the revised model does not tie into the effective study at the project limits, the model must be extended upstream and downstream until it ties into the effective study.
- Indicate the hydraulic method/model used for the revision. A list of hydraulic models accepted by FEMA can be found on the FEMA website. If using a hydraulic model that does not appear on the list of accepted models, please provide documentation showing that the model meets the requirements of the National Flood Insurance Program regulations at the Code of Federal Regulations Title 44 Section §65.6(a)(6). For unsteady state hydraulic models, ensure that the hydrology section of this form is also filled out and relevant hydrologic backup data are provided. For two-dimensional models, indicate the grid size used.
- Indicate if the CHECK-RAS program was used to verify that the hydraulic estimates and assumptions in the model are comparable to the assumptions and limitations of HEC-RAS. [CHECK RAS](#) is a review tool to identify areas of potential error or concern. These tools do not replace engineering judgment. FEMA recommends that you review your [HEC-RAS](#) models with CHECK-RAS. If you disagree with the comment messages provided by CHECK-RAS, attach an explanation of why the messages are not valid in each case. To reduce processing time, review your hydraulic model and resolve valid modeling discrepancies before submitting it for review.



- Indicate the hydraulic model(s) submitted. Provide the name(s) of the plans used, if HEC-RAS models are submitted. Also, indicate the vertical datum used for each of the submitted hydraulic models.

### **Duplicate Effective Model**

The duplicate effective model is a copy of the hydraulic analysis used in the effective Flood Insurance Study, referred to as the current effective model. The current effective model should be reproduced on the requester's equipment to produce the duplicate effective model. This is required to ensure that the current effective model's input data have been transferred correctly to the requester's equipment and to ensure that the revised data will be integrated into the effective data to provide a continuous Flood Insurance Study model, upstream and downstream of the revised reach.

A duplicate effective model is required for all Letters of Map Revision where there is an effective model, even if it is not being used as a base for the revised modeling, so that it can be compared to the revised modeling. If the effective model is being updated to produce the revised conditions modeling, run the revised conditions modeling using the same model version as the effective, unless the entire modeled reach is being revised. This is to avoid discrepancies outside of the revised reach due to running the model in a different version.

If an effective HEC-2 model is converted to HEC-RAS, this is considered a duplicate effective model.

If the effective model is not available from FEMA, the requester should check to see if it is available from the community or any other agency involved with floodplain management in the area of interest. If the effective model is not available, or is available only in PDF format, then a duplicate effective model may not be required.

Refer to the MT-2 Guidance document to determine if a duplicate effective model is required and if the modeling should be truncated. If the entire reach is being revised it is not necessary to use the duplicate effective model as a base model, but it should be used as a reference for cross section placement and Base Flood Elevation comparisons. Communication from the FEMA engineering library to document that the effective model was requested but is not available should be



included with the MT-2 submittal.

### **Corrected Effective Model**

The corrected effective model is the model that corrects any errors in the duplicate effective model, adds any additional cross sections to the duplicate effective model, or incorporates more detailed topographic information than that used in the current effective model. The corrected effective model must not reflect any manmade physical changes that have occurred since the date of the effective published study.

Generally, the updated topography should reflect the physical conditions of the area at the date of the Flood Insurance Rate Map which incorporated the effective modeling. Physical changes in the hydraulic condition of the stream may have occurred after the date of the effective published study. Sometimes the changes are the result of natural changes, such as a channel “cut-off” at a bend, which may be included in the corrected effective model. Sometimes these are the result of manmade changes which should not be included in the Corrected Effective Model.

An error could be a technical error in the modeling procedures or it could be any construction in the floodplain that occurred prior to the date of the effective model but was not incorporated into the current effective model.

### **Pre-Project (Existing) Conditions Model**

The duplicate effective model or corrected effective model is modified to produce the pre-project conditions model. This reflects any physical modifications that have occurred within the floodplain since the date of the current effective model. This is prior to the construction of the project for which the revision is being requested.

If no modification has occurred since the date of the current effective model, this model would be identical to the corrected effective model or duplicate effective model. The pre-project conditions model may be required to support conclusions about the actual impacts of the project associated with the revised or post-project conditions model or to establish more up-to-date models on which to base the revised or post-project conditions model.

### **Revised or Post-Project Conditions Model**



The pre-project conditions model (or duplicate effective model or corrected effective model, as appropriate) is modified to reflect revised or post-project conditions. This model must incorporate any physical changes to the floodplain since the current effective model was produced, as well as the effects of the project. When the request is for a proposed project (i.e., a Conditional Letter of Map Revision), this model must reflect proposed conditions.

The information requested on this form is intended to document the steps the requester took while preparing the Revised or Post-Project Conditions hydraulic model and the resulting revised Flood Insurance Study information. The following guidelines should be followed when completing the form:

- All changes to the Duplicate Effective Model and subsequent models must be supported by certified topographic information, bridge plans, construction plans, survey notes, etc.
- Changes to the hydraulic models should be limited to the stream reach for which the revision is being requested. Cross sections upstream and downstream of the revised reach should be identical to those in the Effective Model. If this is done, water-surface elevations and topwidths computed by the revised models should match those in the effective models upstream and downstream of the revised reach, as required.
- There must be consistency between the revised hydraulic models, revised floodplain and regulatory floodway boundary delineations, revised flood profiles, topographic work map, annotated Flood Insurance Rate Map panel(s) and/or Flood Boundary Floodway Map (FBFM) panel(s), construction plans, bridge plans, etc.

#### **Submittal Requirements for Hydraulic Analyses:**

Digital copies of all hydraulic analyses must be submitted, along with all supporting data (e.g., description of vegetation and land use map) for the source of input parameters used in the models listed above. The summary must include a description of any changes made from model to model (e.g., Duplicate Effective Model to Corrected Effective Model).

At a minimum, the Duplicate Effective Model (if available) and the Revised or Post-Project Conditions Model must be submitted for Letters of Map Revision. For



Conditional Letters of Map Revision, a Pre-Project Conditions Model must also be provided. Hydraulic analyses must be performed for all flood frequencies published in the effective Flood Insurance Study report. If an effective regulatory floodway exists, revised floodway analyses must also be submitted.

## Section C: Mapping Requirements

A certified topographic map of suitable scale, contour interval, and planimetric definition must be submitted, showing the applicable items indicated on the form. If available, a digital version of the map may be submitted so that the Flood Insurance Rate Map can be more easily revised. The vertical datum used to reference the topographic elevations must be specified and should be consistent with the datum used to reference the elevations in the hydraulic analysis.

Attach an annotated Flood Insurance Rate Map panel (and Flood Boundary Floodway Map panel, if required) showing the revised 1%-annual-chance floodplain boundaries (for approximate Zone A revisions) or the revised 1%-annual-chance floodplain, 0.2%-annual-chance floodplain, and regulatory floodway boundaries (for detailed Zone AE, AO, and AH revisions). The revised boundaries must tie into the effective boundaries at the upstream and downstream limits of the area of revision. The annotated Flood Insurance Rate Map (and Flood Boundary Floodway Map, when appropriate) panel(s) ensures that FEMA is aware of how the requester anticipates the Flood Insurance Rate Map (and Flood Boundary Floodway Map, when appropriate) will be revised.

Indicate if annotated Flood Insurance Rate Map and/or Flood Boundary Floodway Map panels and digital mapping data (Geographic Information System or Computer Aided Drafting and Design) are submitted. If digital data are submitted, please include any supporting documentation or metadata with the data submission, including relevant projection information. Current mapping standards use the Universal Transverse Mercator (UTM) projection and State Plane Coordinate System, in accordance with FEMA mapping standards. Data not submitted in ESRI mapping format can be submitted in any supported data format, which includes AutoCAD, MicroStation, and MapInfo.

## Section D: Common Regulatory Requirements



- Indicate if the Conditional Letter of Map Revision or Letter of Map Revision request causes the flood hazards to increase, compared with the information shown on the effective Flood Insurance Rate Map, due to a project or updated modeling, including Base Flood Elevations and/or base flood depths, Special Flood Hazard Area (SFHA) boundaries, zone designations, and/or regulatory floodway boundaries. If the proposed revision or revision causes increases in the flood hazards, the affected property owners must be notified; the acceptance of these changes is not required. This notification may be done via individual letters or a newspaper notice. Please refer to the templates (Figures 3 through 6) on pages 20 23 of the MT-2 Instructions.
  - For Conditional Letter of Map Revision requests, determine if the following situations will occur:
    - Projects that will have construction within the regulatory floodway that causes the Base Flood Elevations to increase (more than 0.00 feet), or
    - Projects that will have construction within the floodplain of streams that have a detailed effective study, but for which a regulatory floodway has not been established, which causes the Base Flood Elevations to increase more than 1.0 foot (or any other more stringent requirement set by the community or state).
  - If either of these previous two situations occurs, then the conditions in the National Flood Insurance Program regulations at the Code of Federal Regulations Title 44, Section §65.12 must be met. The conditions of 44 CFR §65.12 include:
    - An evaluation of alternatives that would not result in a Base Flood Elevation increase above that permitted, demonstrating why these alternatives are not feasible;
    - Documentation of individual legal notice to all affected property owners within and outside of the community, explaining the impact of the proposed action on their property (refer to template on page 22);
    - Concurrence of the Chief Executive Officers of any communities affected by the proposed actions; and
    - Certification that no structures are in areas that would be affected by the increased Base Flood Elevation.
- Indicate if the placement of fill is involved with the revision request. Fill is defined as material from any source placed to raise the ground to or above the Base Flood Elevation. In accordance with the National Flood Insurance Program regulations at the Code of Federal Regulations, Title 44 Section



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§65.2(c), if fill has been placed to remove an area or structure from the Special Flood Hazard Area, the community must sign the appropriate section of Form 1. Signing Form 1 certifies that the area to be removed from the Special Flood Hazard Area includes any structures or proposed structures, meets (or will meet) all the standards of the local floodplain ordinances and is reasonably safe from flooding.

“Reasonably safe from flooding” means that the base floodwaters will not inundate the land or damage the structures to be removed from the Special Flood Hazard Area and that any subsurface waters related to the base flood will not damage existing or proposed buildings. Information on ensuring that structures built on fill in or near the Special Flood Hazard Area are reasonably safe from flooding may be obtained from FEMA Technical Bulletin 10, [“Ensuring That Structures Built on Fill In or Near Special Flood Hazard Areas Are Reasonably Safe from Flooding.”](#)

- Indicate if the request involves a floodway revision. If the regulatory floodway is being revised, the requirements of the National Flood Insurance Program regulations in the Federal Code of Regulations Title 44 Section §65.7 must be met. These requirements include submitting a copy of a public notice distributed by the community stating the community’s intent to revise the regulatory floodway, or a statement by the community that it has notified all affected property owners and affected adjacent jurisdictions. Templates for notification of a regulatory floodway revision are shown in Figures 3 through 6 on pages 15-19 of the MT-2 Instructions.
- For Conditional Letter of Map Revision requests, indicate if the revision request has the potential to impact endangered species. Section 9 of the Endangered Species Act of 1973 (ESA) prohibits anyone from “taking” or harming endangered species. If an action might harm an endangered species, please provide necessary documentation for compliance with Section 9 and/or Section 7(a)(2) of the Endangered Species Act. Please refer to page 38 of the MT-2 Instructions for more details.

In locations where sediment transport affects hydrology, the effects of sediment transport should be considered in the hydrology and Section F of Form 3 should be submitted. Note: FEMA does not map Base Flood Elevations (BFEs) based on bulked flows, as stated in Section F of Form 3.

