Guidance for Flood Risk Analysis and Mapping

Flood Risk Database

February 2018

FEMA

Requirements for the Federal Emergency Management Agency (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) Program are specified separately by statute, regulation, or FEMA policy (primarily the Standards for Flood Risk Analysis and Mapping). This document provides guidance to support the requirements and recommends approaches for effective and efficient implementation. Alternate approaches that comply with all requirements are acceptable.

For more information, please visit the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping webpage (www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping). Copies of the Standards for Flood Risk Analysis and Mapping policy, related guidance, technical references, and other information about the guidelines and standards development process are all available here. You can also search directly by document title at www.fema.gov/library.

Table of Revisions

The following summary of changes details revisions to this document subsequent to its most recent version in November 2016.

Affected Section or Subsection	Date	Description
Sections 5.0 and Section 9.0	February 2018	In order to promote more flexibility and simplicity in the FRD, removed S_Pol_Ar, FRD_Study_Info, FRR_Custom & FRR_Project, L_Claims, and L_Source Citation. These feature classes and tables are no longer in the Flood Risk Database Schema. Added reference to MIP submittal for Flood Risk Products.

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1.0 Overview

The Flood Risk Database (FRD) provides a standard, systematic method for FEMA to collect, store, and distribute comprehensive flood risk data to the public and others in a digital format. The FRD contains geospatial data layers, attribute lookup tables, supporting files, and other information necessary to create all the flood risk datasets.

The technical specifications and database schema of the FRD are outlined in the Flood Risk Database Technical Reference. The FRD deliverable formatting requirements are also specified in the Data Capture Technical Reference. It should be noted, though, that as long as the required formats are delivered, other formats of the data within the FRD can also be delivered to the community and end user if deemed valuable. For example, a Keyhole Markup Language (KML) file of the Changes Since Last FIRM (CSLF) dataset could be produced and delivered to the community who prefers to use Google Earth to view their data. Database tables could also be augmented with additional fields or aliases, provided that the required attributes are populated and the database schema is otherwise adhered to and documentation is provided to explain the additions. Acceptable documentation can be included in the required FRD metadata file or provided in a companion narrative. However, users should not change or make edits to the approved FRD fields or underlying attribute domains.

2.0 Data Accuracy and Integrity

In many cases, the core spatial data compiled for the FRD is derived from other FEMA datasets (e.g., the S_CSLF_Ar feature class is derived from the S_Fld_Haz_Ar feature class from the National Flood Hazard Layer (NFHL) and new Flood Insurance Rate Map (FIRM) databases,. These FEMA datasets should have been compiled to FEMA specifications as described in the FIRM Database Technical Reference and other FIRM Database Guidance. In this regard, the flood risk datasets should inherit much of the quality and integrity with which their parent datasets were created.

The assigned Mapping Partner should perform a thorough Quality Control (QC) review before submitting data to FEMA, following the Quality Management Guidance specific to the flood risk products.

3.0 FRD Spatial Extents and Data Tiling

The S_FRD_Proj_Ar feature class in the FRD defines the extents of the project footprint. The single “best” polygon that reflects the project area should be used. Generally, the project footprint will be defined at the Hydrologic Unit Code 8, or HUC-8, watershed level. However, there may be cases where the project area covers portions of multiple HUC-8 sub-basins, or only a portion of a single HUC-8. In each case, the project area should encompass all work elements as defined in the Statement of Work (SOW), Mapping Activity Statement (MAS), or Inter-Agency Agreement (IAA) and for which a Case Number has been assigned by FEMA. In the event that a Flood Risk Project is scoped to cover multiple HUC-8 watersheds (such as for coastal projects), the Project Team, as an outcome of the Discovery process, should determine if the project will be delivered as:

1. A single FRD for the entire project extents, or

2. Multiple FRDs that comprise the full project area. In this scenario, there would normally be a separate FRD for each HUC-8, but there could be circumstances where this is not practical.

If the project footprint is not able to be defined at a watershed level, it is recommended that the project footprint align with Flood Insurance Rate Map (FIRM) panel boundaries to the extent possible, as shown in Figure 1, Figure 2, and Figure 3.

Guidance specific to the Changes Since Last FIRM (CSLF), Flood Depth and Analysis Grids, Flood Risk Assessments, and Areas of Mitigation Interest (AoMI) datasets, as it relates to the spatial extents of the data delivered in the FRD, should be referenced when producing each dataset. As a general rule, feature classes and associated tables should be delivered as single, complete layers at the project footprint level, rather than tiling them at a county, FIRM panel, or other tiling scheme level within the database. For example, the FRD for a watershed that covers portions of six counties should have only one CSLF layer (S_CSLF_Ar) covering all the changes within the watershed, rather than one separate S_CSLF_Ar data layer for each county. There should also only be one riverine 1-percent-annual-chance depth grid in the FRD, rather than separate depth grids for each flooding source.

Figure 1: Watershed-based FRD Project Area

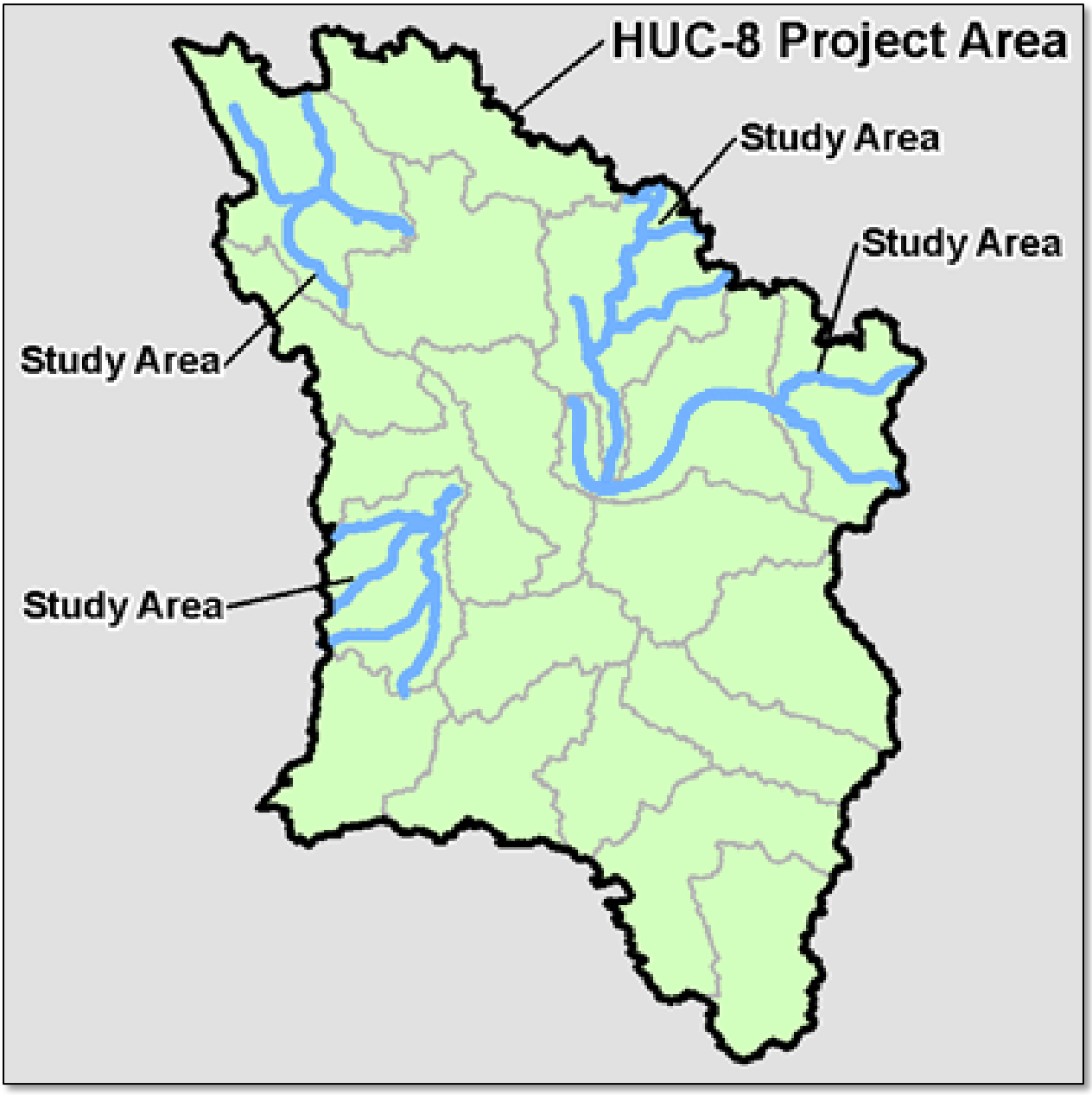


Figure 2: Coastal FRD Project Area

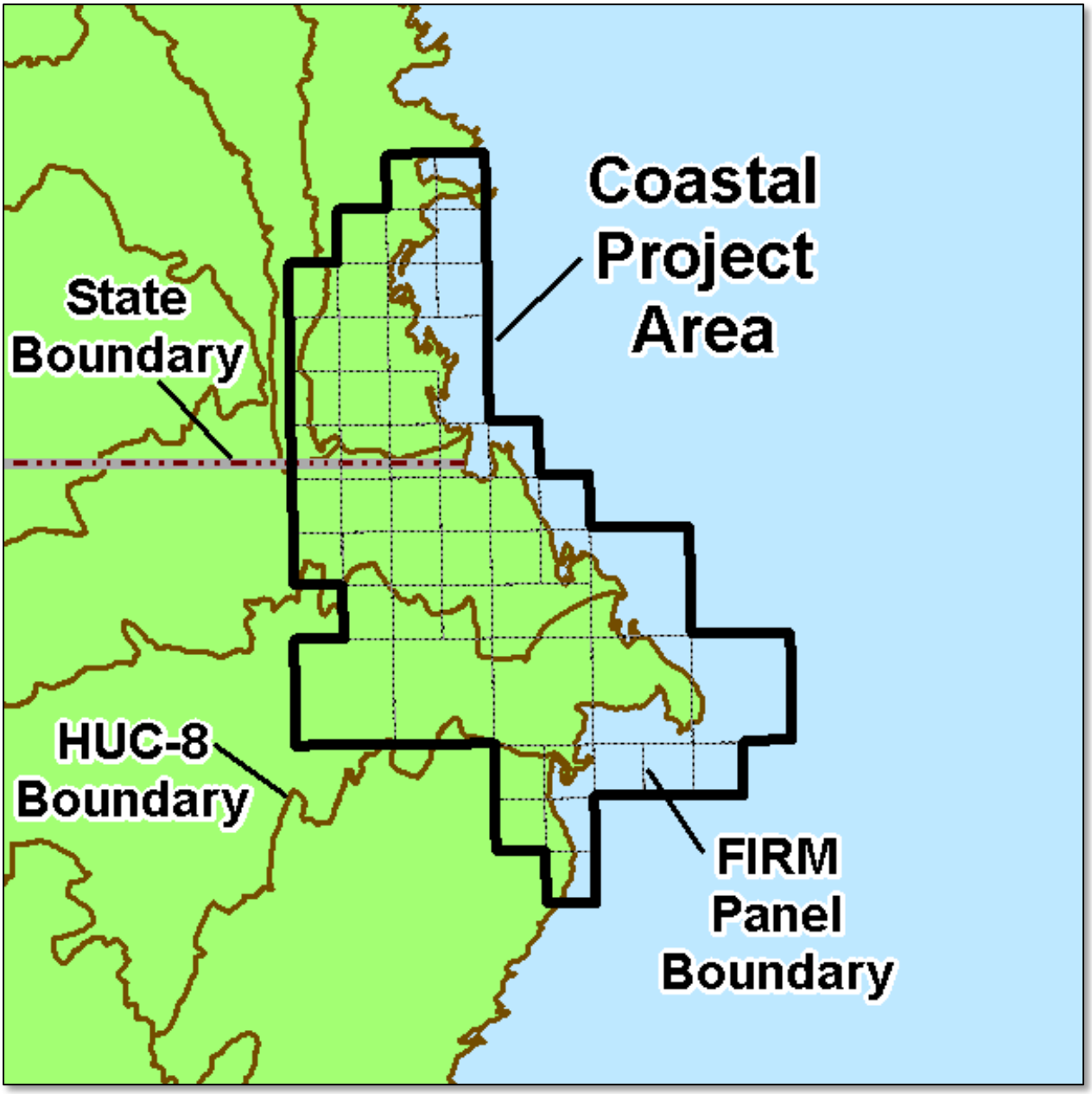
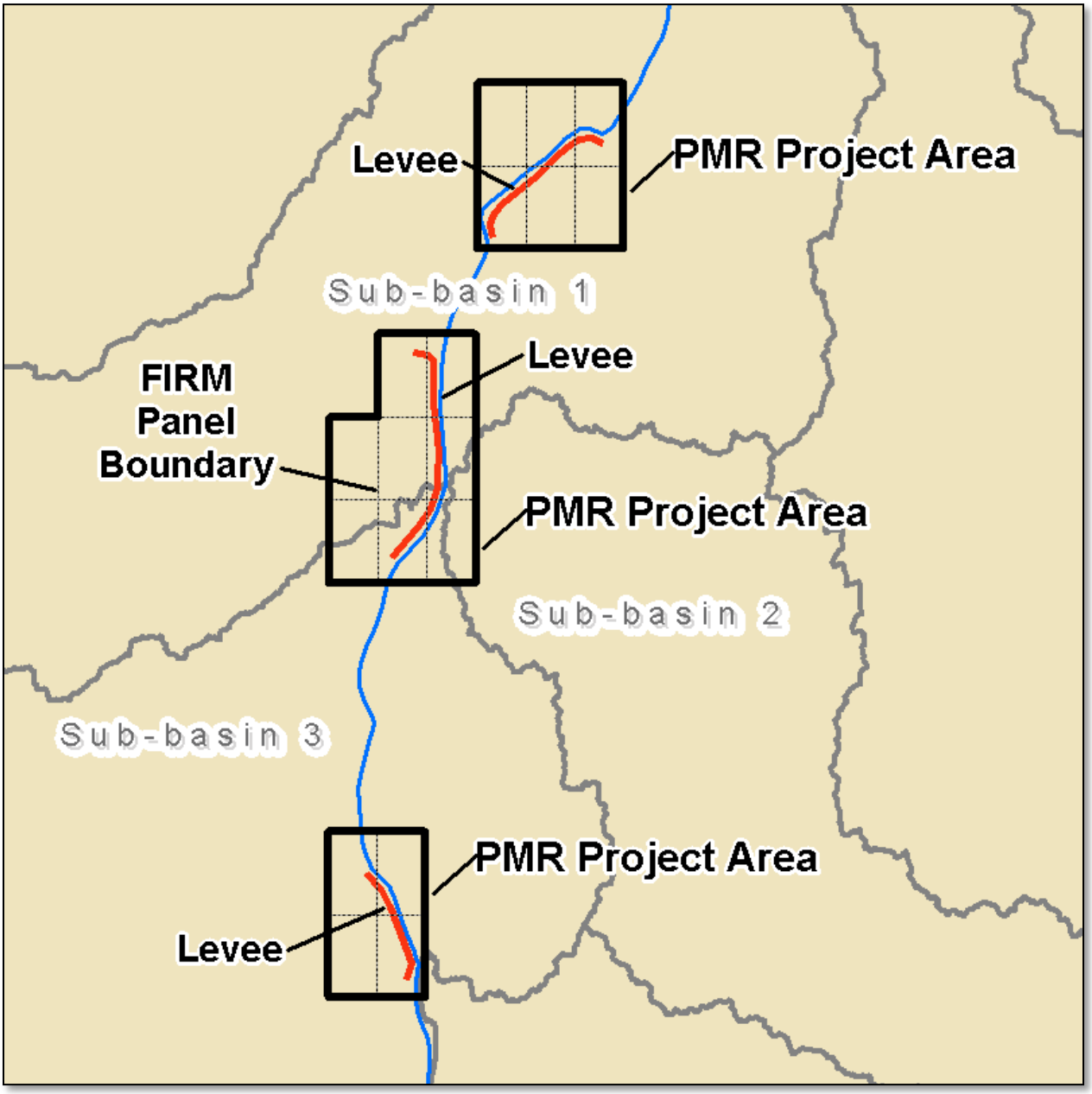


Figure 3: Example Levee FRD Project Areas



The following contains examples of the types of project footprints that could be produced and general guidance specific to each.

3.1 Watershed Project Areas

Flood Risk Projects defined at the watershed level may have a majority of its streams studied, or may only have certain identified areas, within the watershed, scoped for study, as shown in Figure 1. Certain datasets, such as CSLF and Depth Grids, are often only produced where new or updated studies have been performed. Other datasets, such as Flood Risk Assessments and AoMI, are often available for areas beyond those that are studied. As an outcome of the Discovery process, it is important to clarify the extents of each dataset to be produced.

For watershed level Flood Risk Projects, the Watershed Boundary Dataset (WBD), which is a companion dataset to the National Hydrography Dataset (NHD), should be the source for the S_FRD_Proj_Ar layer in the FRD.

Naming convention for the FRD should follow the guidance outlined in the Data Capture Technical Reference.

3.2 Coastal Project Areas

Coastal Flood Risk Project extents rarely align with watershed boundaries. Therefore, a few options exist for how the project footprint can be defined. For coastal Flood Risk Projects, the FRD project footprint should generally also not extend inland beyond the coastal-influenced areas, unless riverine flooding sources have also been studied and are part of the project. There are several acceptable options for defining the footprint of coastal Flood Risk Projects.

Option 1: As shown in Figure 2, define the project footprint to cover the entire coastal study area. In these cases it is recommended that the project area be generated to align with FIRM panel boundaries, if possible.

Option 2: Since coastal studies often cover a large geographic area, it may be appropriate to sub-divide the overall project area into smaller project footprints, and to produce representative FRDs for each. This could be done at a county level, multi-county level, or other logical break. To the extent possible, however, the project footprint should still be aligned with FIRM panel boundaries. Overlapping FRD project footprints should be avoided.

Option 3: Within the overall coastal project area, an FRD for each affected HUC-8 watershed can be produced. Since coastal flooding does not terminate at watershed boundaries, this may be easiest to do by generating all of the associated flood risk datasets for the entire study area, and then clipping them to the HUC-8 watershed boundaries prior to finalizing the FRD.

3.3 Other Project Areas

Some types of Flood Risk Projects may not lend themselves well to being generated at the watershed level. Certain Physical Map Revisions (PMRs), such as ones that involve addressing levees, may fall into this category. If not part of a larger watershed project, a Flood Risk Project focused solely on addressing one or more levees may be more appropriate to have its project footprint defined around the levee-impacted area, as shown in Figure 3. The project footprint

should align to the FIRM panel boundaries affected. If there are multiple, disconnected levee systems within the project area, as Figure 3 also shows, it is acceptable to have a multi-part polygon stored in S_FRD_Proj_Ar and used as the project footprint to cover all the affected areas.

3.4 Updates and Maintenance

To the extent possible, once an FRD has been produced for a HUC-8 watershed, all subsequent Flood Risk Projects within that watershed should append, replace, and/or revise the data within that FRD, and ultimately redeliver the FRD at the HUC-8 extent. The flood risk datasets corresponding to the revised areas should be compared against the existing data in the FRD from the surrounding unrevised areas for reasonability and agreement. Since many of the flood risk datasets are derived from the regulatory information, it could reasonably be expected, for example, that updated Water Surface Elevation (WSEL) grids for revised flooding sources should tie-in with previously produced WSEL grids on adjacent reaches of stream, following the same tie-in checks that one might employ for the regulatory data. However, depending on the date and type of topographic data used for the revised studies, the depth grids, for example, may not tie-in at the same level of precision as their associated WSEL grids.

4.0 Required vs. Enhanced Datasets, Tables and Fields

The FRD was designed to house various required and enhanced flood risk datasets that could be produced for riverine or coastal studies, as well as those enhanced datasets specific to areas affected by dams or levees. The Standards for Flood Risk Analysis and Mapping enumerate the flood risk datasets that must be produced as part of each Flood Risk Project. Most of the flood risk datasets consist of multiple feature classes and tables in the FRD. The Flood Risk Database Technical Reference specifies when each feature class and raster is required to be created, vs. which ones are enhanced. The Technical Reference also indicates specific data fields designated as enhanced.

5.0 Table-Specific Guidance

The respective guidance documents for each of the flood risk datasets and products (CSLF, AoMI, Flood Risk Assessments, Depth & Analysis Grids, Coastal-Specific Flood Risk Datasets, etc.) should be referenced for more specific guidance regarding their applicable FRD tables and elements. However, there are other features in the FRD that are applicable to the overall database. Guidance specific to those are included below.

5.1 S_FRD_Proj_Ar

Section 3 of this guidance document provides additional information regarding how this feature class should be defined, depending on the type of Flood Risk Project. This feature is used to clip the extent of spatial data submitted in the FRD, excluding S_CSLF_Ar, S_FRAC_Ar, and the raster datasets.

5.2 S_HUC_Ar

The boundaries delivered in the S_HUC_Ar feature class should be based on the Watershed Boundary Dataset (WBD) obtained from the United States Geological Survey (USGS) or Natural

Resources Conservation Service (NRCS). For watershed-based projects, this polygon should match the S_FRD_Proj_Ar project footprint polygon (see Section 3.1 for more details).

5.3 Images

mages is an optional table that can be populated to store custom images. If populating this table, each image stored in this table is stored as a “Raster” type. Rasters can be loaded directly into the database forms within ArcGIS by loading each image into the IMG_BINARY field.

5.4 L_Source_Cit

All spatial tables in the FRD have a SOURCE_CIT field tied to values in the L_Source_Cit lookup table. Each distinct data source should have its own source citation type abbreviation (e.g. BASE1, BASE2, BASE3, etc.)

Since many of the flood risk datasets are related to, or partially derived from, data in the FIRM databases, many of the records for the L_Source_Cit table can be compiled from the L_Source_Cit tables in the individual FIRM databases. In order to minimize work by having to sequentially renumber all the SOURCE_CIT values from combining the L_Source_Cit tables from multiple FIRM databases, the Mapping Partner may prefix the SOURCE_CIT from the source FIRM database with the DFIRM_ID to provide a unique identifier.

6.0 Raster Guidance

Additional guidance can be found within the Flood Depth & Analysis Grids Guidance document for each of the following raster datasets:

- CstDpthxxxpct (Coastal Flood Depth Grid)
- Depth_xxxxxx (Riverine Flood Depth Grid)
- DVS_xxxxxxx (Depth times Velocity Flood Severity Grid)
- Pct30yrChance (Percent Chance of Flooding over a 30-year Period Grid)
- PctAnnChance (Percent Annual Chance of Flooding Grid)
- Vel_xxxxxxx (Velocity Grid)
- WSE_xxxxxx (Water Surface Elevation Grid)
- WSE_Change (Water Surface Elevation Change Grid)

Guidance can be found within the Dam-Specific Non-Regulatory Flood Risk Dataset Guidance document for each of the following raster datasets:

- Arrv_xxxxxxxx (Dam Arrival Time Grid)
- FID_xxxxxxx (Dam Flood Inundation Duration Grid)
- Peak_xxxxxxx (Dam Time to Peak Grid)

Note that for any raster dataset based on the results of a dam release analysis, the extents should be based on the inundation area for the peak flow rate for the scenario being considered. For example, when developing the arrival time raster, the extents of the raster should be based on the inundation area for the peak flow, not the flow at the initial arrival time.

The Flood Risk Assessment Guidance document contains additional guidance for the creation of the composite flood risk assessment depth grid raster, which is used in the creation of the Flood Risk Assessment dataset:

- RAdpth_xxxxxx (Composite Flood Risk Assessment Depth Grid)

7.0 Non-Standard Tables and Rasters

As part of a Flood Risk Project, it is possible that additional flood risk datasets may have been produced for which no predefined schema exists in the Flood Risk Database Technical Reference. The Flood Risk Database is flexible in that it can be used to store these non-standard, flood risk-related feature classes, tables, and rasters. For example, a riverine erosion risk feature class that had been produced or obtained by a FEMA Region, or one of its Mapping Partners, could be included in the FRD to enhance risk communication with local stakeholders. Since no defined schema exists for such a dataset, it is left to the discretion of FEMA, and the Mapping Partner, to identify the appropriate feature class, table, or raster name for inclusion in the FRD including its associated table attributes, where relevant. For feature classes and tables, a SOURCE_CIT attribute should be defined in order to properly link the dataset with additional information in the metadata. The citation type abbreviations from L_Source_Cit should be used to populate this attribute. Additional dataset information will also be captured in the FRD metadata.

8.0 Metadata

Only one FRD metadata file is necessary for each Flood Risk Project. The Metadata Profiles Technical Reference provides information related to populating the metadata for the Flood Risk Database. Additional FRD-specific metadata guidance is provided below:

8.1 Data Quality Information

Because the FRD uses the Geographic Coordinate System as its spatial reference system for final delivery, the original source and production projection information from which area and length attributes in the FRD were calculated should also be stored in the metadata.

In order to adequately explain the data sources used to perform flood risk assessments, the following information should be properly documented:

- Site-specific flood risk assessments
    - Source of building footprints, parcel centroids, or other points/polygons used to store site-specific data
    - Source of building-specific information (replacement values, finished floor elevations, building occupancy, etc.)

- Census block-based flood risk assessments
    - Version of Hazus used and type of census block data (homogenous or dasymetric)
    - Source of updated General Building Stock data that was incorporated into the risk assessment (if applicable)

8.2 Source Information

If any non-standard feature classes or tables were added to the FRD, its source citation abbreviation should be included and explained in this section.

8.3 Entity and Attribute Information

The Overview Description section should include a list of all FRD feature classes and tables included in the submittal. In this list, those tables without data should be identified.

For each non-standard feature class, table, or raster that has been added to the FRD, an "Entity and Attribute Overview" and "Entity and Attribute Detail Citation" entry should be added to the metadata. The "Entity and Attribute Overview" entry should include the general description of the data and what it communicates. The "Entity and Attribute Detail Citation" entry should describe each attribute of the feature class or table, or for a raster should indicate what the value and units of each grid cell represent.

9.0 Delivery Timeline

The Data Capture Technical Reference provides information regarding the format and naming conventions of the Flood Risk Database. The final FRD, and optional Flood Risk Report (FRR) and/or optional Flood Risk Map (FRM), are submitted to the MIP, as well as delivered to the Map Service Center (MSC) once they are considered final by the FEMA Regional office. For flood risk products that are produced as part of a Flood Risk Project that also includes updates to the regulatory products, the FRD, FRR (optional), and FRM (optional) should be submitted to the MSC with the final Technical Support Data Notebook (TSDN), no later than 30 days after the Letter of Final Determination (LFD) date.

In addition to this, the applicable flood risk products should also be provided to affected communities at other times within the Flood Risk Project lifecycle, so that the communities can use them for various risk communication and mitigation activities. Information regarding the timing of delivery of the FRD to communities is provided below.

9.1 Sharing of Draft Data

The goal of sharing draft flood risk products with the community is to encourage proactive, actionable discussions about flood risk and mitigation prior to the release of preliminary FIRMs, and where appropriate, to show the community how to use the data to help identify mitigation opportunities on their own. To accomplish this, the draft FRD should be provided to communities as soon as its datasets are at a point in their development where they can be used to support these focused discussions on flood risk. It is not necessary that all elements of the FRD be populated or complete prior to sharing the data at this stage, as long as the conditions of the product(s) are adequately explained to the community.

Providing a draft of the flood risk products is most effective when presented as part of a meeting with community leaders and stakeholders. For example, the draft Flood Depth and Analysis grids, Areas of Mitigation Interest, and Flood Risk Assessment data could be provided to communities just prior to, or immediately following, a Flood Risk Review Meeting during which specific areas of the community, and the flood risk data in those areas, were discussed. The draft FRD could be delivered prior to a Resilience Meeting, after having provided examples of how the flood risk data can help identify specific areas within the community that may warrant additional discussions..

If the CSLF dataset has been created, it should be shared with the affected communities prior to preliminary issuance of any updated FIRMs. Because of the timing of the creation of the CSLF dataset, it may be more appropriate to provide two iterations of the draft FRD to the community:

1. Prior to, or associated with, a Flood Risk Review or Resilience Meeting (without CSLF)

2. Just prior to preliminary issuance of the updated regulatory products (with CSLF)

The draft FRD should be provided to the community in either file geodatabase (fGDB) or shapefile (SHP) format, following the schema outlined in the Flood Risk Database Technical Reference. However, if providing the data at this stage of the Flood Risk Project in an alternative format (e.g. Google Earth KML file, posting it on a website rather than providing the actual data, etc.) would provide more value or usability to the community, doing so is acceptable.

For Flood Risk Projects that involve regulatory product updates, an updated version of the draft FRD should be provided to communities after issuance of the preliminary FIRMs if the FRD was modified since the last time the community received it. This is preferably done near the time of the Consultation Coordination Officer (CCO) Meeting,

9.2 Final Delivery

As mentioned previously, for Flood Risk Projects that include updates to the regulatory products, the final products should be submitted to the MSC no later than 30 days after the LFD date. If any changes to the regulatory floodplain boundaries occurred during the post-preliminary process (e.g. as a result of an appeal, revised preliminaries, etc.), the raster datasets (especially the Water Surface Elevation grids) and the CSLF dataset in the FRD should be updated prior to final submittal. Optionally, the other affected flood risk datasets (such as the associated risk assessments) can be updated accordingly. The decision to do so should be made in conversation with the FEMA Project Officer.

If the Flood Risk Project did not include regulatory product updates, the final flood risk products should be submitted when the final TSDN is submitted.

10.0 Uses in Outreach, Collaboration, and Flood Risk Communication

Preparing the data in digital format has significant advantages. Digital data allow for a more efficient storage, update, search and distribution of information. The most significant advantage is that the FRD is explicitly designed to work within a Geographic Information System (GIS) environment. This means that the FRD can be used to support automated analyses and can be

coupled with other readily-available GIS and tabular data in order to increase the understanding and mitigation of flood risk. In addition, the FRD can be used to support outreach efforts and can be widely disseminated online through web applications and interfaces.