Enhancements to Products and Tools

Recommendations for Improving FEMA's Product Suite

September 2007

FEMA

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Appendix A. Requirements from FEMA’s Forms, Instructions, and Publications A-1

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1. Overview of Recommendations

Customers who initiate business with FEMA's National Flood Insurance Program (NFIP) seek official FEMA decisions and actions that affect real property[1] in which the customer has an interest. Such business includes requests for or documentation of interpretations of FEMA geospatial flood hazard data, requests to amend or revise such data, and requests for flood insurance.

To conduct such activities, customers or their agents must provide information from FEMA's geospatial flood hazard data in their applications. Such information includes identification of communities, NFIP map panels and indexes, and Letters of Map Change; effective dates of information; Special Flood Hazard Areas and other regulated areas; Base Flood Elevations and their vertical datums and flood depths; point locations and their horizontal datums; and other interpretations of mapped information.

FEMA provides products and services to support customer interaction with the NFIP. These products include NFIP map panels and indexes; Letters of Map Change; digital scans of NFIP maps and indexes (FIRMscan data) and related tools; Digital Flood Insurance Rate Map (DFIRM) databases and related tools; and the National Flood Hazard Layer and related tools. These products have similar information content and contain (or provide the information from which to interpret) the information required of customers.

Recommended enhancements focus on ensuring that the tools provide a means to identify and print information required for official purposes, ensuring that the tools work with all versions of the products for which they are targeted, improving the usability of the products and tools, and adding capabilities so that the tools support new requirements (such as the display of preliminary data in a way different from that used for effective data). The recommended enhancements include:

- NFIP map panels, indexes, and Letters of Map Change: No recommendations.
- FIRMscan data and related tools: Upgrade the Flood Image Map Tool to work with two-color FIRMscan data.
- DFIRM databases and the DFIRM View Tool: For the databases, require that they be edgematched and that they do not contain overedge data. For the tool, correct defects, allow customers to save their preferences, improve the display of flood hazard data, provide a more understandable response to queries, and provide cautions that warn customers to review estimates made by the tool.
- National Flood Hazard Layer and related tools: For the database, use the Letter of Map Amendment process to provide a more accurate position for the Letters, convert elevations to the same vertical datum, and consider providing more flexibility in options for obtaining copies of NFHL data. For the web-based map viewer, re-tailor the tool from the general capability to view multiple hazards to the narrower task of finding and working with flood

[1] Real property is land including land improvements, structures, and appurtenances thereto.

hazard data. This effort includes correcting defects, sharpening the information content of map displays and response to queries, refashioning the controls to support the narrower purpose of the tool, and providing the ability to view data and print results that can be used for official purposes. For the web map service, ensure that the map returned by the service is legible and distinguishes among data of different status (that is, effective, pre-effective, or preliminary) or other important characteristics (for example, vertical datums), investigate the possibility of providing for attribute queries and hyperlinks to other data as part of the service, and package the service for use with tools such as Google Earth. New opportunities to leverage the National Flood Hazard Layer (such as the use of new methods for distributing data or new outlets for viewing data) also should be investigated and, if found promising, implemented.

For all products and tools, documentation that leads customers through the use of products and tools for the typical tasks required to gather the information necessary to complete FEMA application forms would be a helpful addition to the generic tool documentation already available.

Two broader improvements also would help customers. The first is the development of guidelines for a "FEMA view" for the display of flood hazard data on computer screens and printed output. Ideally these guidelines would be designed so that there is a "family resemblance" for FEMA-supported portrayals of flood hazard data among different products and tools. This approach would help customers efficiently use and move among FEMA's flood hazard data, products, and tools. The second is providing customers the ability to enter legal descriptions of property, portray the results, and use the information in queries of flood hazard data.

2. Information Required to Conduct Official Business

To identify information that customers must provide from FEMA's geospatial flood hazard data, MOD personnel reviewed FEMA business forms and applications. The forms were:

- *Standard Flood Hazard Determination* (FEMA Form 81-93, December 2005)
- *How to Request a Flood Hazard Determination Review from FEMA* (available at http://www.fema.gov/business/nfip/lomri.shtm)
- *Floodproofing Certificate for Non-residential Structures* (FEMA Form 81-65, August 1999)
- *Residential Basement Floodproofing Certificate* (FEMA Form 81-78, May 2004)
- *Elevation Certificate* (FEMA Form 81-31, February 2006)
- *MT-EZ: Application Form for Single Residential Lot or Structure Amendments to NFIP Maps* (FEMA Form 81-92, December 2005)
- *MT-1: Application Form for Conditional and Final Letters of Map Amendment and Letter of Map Revision Based on Fill* (FEMA Form 81-87, September 2002)

- *MT-2: Application Forms for Conditional Letters of Map Revision and Letters of Map Revision* (FEMA Form 81-89, September 2004)
- *Flood Insurance Application* (Parts 1 and 2) (FEMA Form 81-16, August 2006)
- *Flood Insurance Preferred Risk Policy Application* (FEMA Form 81-67, August 2006)
- *Flood Insurance General Change Endorsement* (FEMA Form 81-18, August 2006)
- *V-Zone Risk Factor Rating Form* (FEMA Form 81-25, August 2006)
- *Base Flood Elevations in Zone A Areas* (Appendix 10) in *Managing Floodplain Development in Approximate Zone A Areas: A Guide for Obtaining and Developing Base (100-Year) Flood Elevations* (FEMA Publication 265, April 1995)

MOD personnel also reviewed FEMA's *Floodplain Management Requirements* (FEMA Publication 480, February 2005) and *Flood Insurance Manual* (May 2007). The latter is especially helpful because it provides instructions for forms related to flood insurance applications.

Based on this review, the categories of information that customers must provide from FEMA's geospatial flood hazard data are:

- Community information, such as NFIP community name and number, county, and State.
- Flood hazard map identification information such as map panel number, revision suffix, effective or revised date, and post-FIRM date.
- Letter of Map Change identification information such as date and case number.
- Flood hazard map index information such as the date of the index map.
- Special Flood Hazard Area (SFHA), Coastal Barrier Resources System (CBRS), and Other Protected Area (OPA) zone information, such as verification that the property is located in a zone, the identification of the type of zone, and the designation date for CBRS or OPA units.
- Base Flood Elevation (BFE) or base flood depth and the source of the value provided.
- Vertical datum for elevation values. Some applications instruct that elevation data be supplied for a specific datum and others request that applicant identify the datum for the elevations provided.
- The horizontal datum for places identified using longitude-latitude coordinates.
- Information interpreted from the base map for the flood hazard data, including the location of a property, the name of a flooding source, and the distance between a property and a flooding source.
- The fact that flood hazard data do not exist for the property.

Some applications also require the customer to include copies of the official FEMA geospatial flood hazard data and other evidence such as elevation certificates. Such evidence often carries information from the list above even if the application form does not require the information.

In addition to simple copying of information from the flood hazard data to the forms, completion of an application might require the customer to read a map, locate the property using the base map (such as an annotated orthophoto or a base map containing annotated roads, streams, railroads, boundaries, and other features), measure the longitude-latitude coordinates for the location of the property, measure distances, and interpolate BFEs. The last task often requires the customer to use the geospatial flood hazard data with its companion Flood Insurance Study (FIS) report. In the most rigorous application, the request for a Letter of Map Revision, the customer takes existing geospatial flood hazard data and FIS reports, adds new information to develop changes to these data, and submits the changes and supporting information to FEMA for adoption as an official change.

Appendix A provides a detailed analysis of the information required from FEMA's geospatial flood hazard data by FEMA forms, publications, and instructions.

3. FEMA Geospatial Flood Hazard Data and Related Tools

FEMA publishes such geospatial flood hazard data as paper maps, digital scans of maps, and databases. It also provides tools for use with digital products.

The products have similar information content, and provide the information customers need to do business with FEMA. Therefore, the recommended enhancements focus on ensuring that the tools provide a means to identify and print information required for official purposes (see page 3), ensuring that the tools work with all versions of the products for which they are targeted, improving the usability of the products and tools, and adding capabilities so that the tools support new requirements.

The products and tools, and recommendations of enhancements that would improve them, are described below. Information about the products is based on a review of the *Guidelines and Specifications for Flood Hazard Mapping Partners*, the *Document Control Procedures Manual*, documentation of the tools, examination of samples of the products, and use of the tools. Appendix B provides a detailed analysis of the information found in FEMA's geospatial flood hazard data. The appendix also provides a summary table that describes the extent to which the major products and tools convey the information required of customers listed on page 3 and the recommendations that would address major shortcomings.

3.1. NFIP Maps and Letters of Map Change

FEMA publishes map-based forms of geospatial flood hazard data through NFIP map panels and map indexes for the panels, and publishes updates to the maps through Letters of Map Change (LOMCs).

Two types of NFIP maps[2] provide flood insurance risk zone and base flood elevation data: Flood Insurance Rate Maps (FIRMs) and Flood Hazard Boundary Maps (FHBM).

- The FIRM is the insurance and floodplain management map that identifies, based on detailed or approximate analyses, the areas subject to flooding during the base (1-percent-annual-chance) flood event. The main graphic components of a FIRM panel are the map body and the surrounding items of title block, map legend, notes to users, and (if needed) the CBRS legend:
  - The map body shows Special Flood Hazard Areas, CBRS and OPA units, and other flood hazard data and related features such as hydraulic structures overlaid on a base map. The map body of a panel may contain overedge information from adjoining panels to help map readers interpret information on the panel. Elevation data are referenced to the vertical datum identified in the map legend and/or notes to users.

    Newer maps compiled on an accurate base map have references to coordinate systems and are cast in the horizontal datum and map projection identified in the map legend and notes to users. The maps are published at one of three scales.
  - The title block provides information about the type(s), name(s), and number(s) of the community (or communities) shown on the FIRM; identifying information for the map (such as map number, panel number, and suffix; effective date; and the relationship of the panel to others in a set); and, if the panel contains a CBRS or OPA unit, information about the units included in the map.
  - The map legend provides an explanation of the symbols and labels used in the map body, a north arrow, the map scale described using a bar scale(s) and verbal statement, and notes describing the name and location of the local map repository for the map (or reference to the index as the source of such information), NFIP map dates, dates of changes made in previous revisions to the map (or a reference to the document where they can be found), and other general FIRM legend notes. If the panel contains a community that has CBRS or OPA units, the map legend also includes revision notes about changes to the units.
  - The notes to users provide general information about specific items on the FIRM, background and reference information about sources of data used to prepare the FIRM, and sources of additional information pertinent to specific items on the FIRM.
  - If the panel contains a community or county that has CBRS or OPA units, the panel includes the CBRS legend and abbreviated coastal barrier identification notes. This section lists, in chronological order, an identification note for each classification of CBRS or OPA unit displayed on all of the map panels for the community or county.

[2] The third type of NFIP map, the Flood Boundary and Floodway Map, is the floodplain management map issued by FEMA that depicts, based on detailed flood hazard analyses, the boundaries of the 1-percent-annual-chance (100-year) and the 0.2-percent-annual-chance (500-year) floodplains and, when appropriate, the regulatory floodway. The FBFM does not show flood insurance risk zones or base flood elevations.

- The Flood Hazard Boundary Map (FHBM) is the initial insurance map issued by FEMA that identifies, based on approximate analyses, the areas of the 1-percent-annual-chance (100-year) flood hazard within a community. The main graphic components of these maps are:
  - A map body that shows the approximate flood hazard zones overlaid on a base map.
  - A title block that contains the community name and number, map panel number and suffix, and effective date.
  - A map legend that provides an explanation of the symbols for flood hazard zones, a north arrow, map scale, and explanatory notes.

An NFIP map that has the same SFHA zone throughout its extent is not printed. The information for the panel is published on the NFIP map index that references the panel.

An NFIP map index provides an overview of NFIP map panels available for the subject area such as a county or community. The main graphic components of an index are the map index body and notes, index title block, and, for countywide map indexes, lists of communities and map repositories.

- The map index body shows a diagram of map panels that portray the area overlaid on a generalized base map (which includes the boundaries of communities). The diagram (or a related table) includes the panel number, effective date, and "panel not printed" footnote (if any) for each panel.
- The map index title block identifies the type and name of the area mapped by the index, the index map number and date, and a list of map panel numbers for all printed panels.
- On a countywide map index, the listing of communities provides the relationship between the communities included in the FIS report for the area mapped by the index and the map panels portrayed on the map index. The table includes the community name and number, the FIRM panels on which the community is mapped in whole or in part, the initial NFIP map date, the initial FIRM date, and the most recent FIRM panel date. A related note to users clarifies the meaning of the dates.

  The countywide map index also provides a list of map repositories for each community.

NFIP map panels and indexes are available as printed maps and digital scanned images of the maps from FEMA's Map Service Center. The scanned images and related tools are discussed in section 3.2 below.

Letter of Map Change (LOMC) is a collective term used to describe official amendments and revisions to NFIP maps. These changes are accomplished by administrative procedure and disseminated by letter instead of issuance of a revised map. Of interest are two forms of LOMCs: the Letter of Map Amendment (LOMA) and Letter of Map Revision (LOMR).

- A LOMA is the official FEMA determination that a property has been inadvertently included in an SFHA, as shown on an effective map panel, and is not subject to inundation by the base flood. The content of a LOMA includes the LOMA case number, the community name and number, the number and date of the affected map panel, the name of the flooding source, the flood zone, and the flood elevation and related vertical datum. The LOMA also identifies the property by legal description, lot, block/section, and subdivision, and street address. A LOMA is referenced to the map panel it affects, regardless if the panel is printed or not.
- A LOMR is a letter issued by FEMA to revise a map panel and/or FIS report for a community to change base flood elevations, floodplain and floodway boundary delineations, and coastal high hazard areas. The content of a LOMR includes the LOMR case number; the name and number, county, and State of the affected community or communities; the effective date of the revision made by the LOMR; the type, number and effective date of the NFIP map(s) being revised; the flooding source(s) and revised reach(es); a summary of the revisions; and the relationship of the LOMR to FEMA map production activities. A portion of the affected NFIP map annotated with changes also is included.

LOMCs are available as an Adobe® Portable Document Format (PDF)[3] files that can be downloaded through the web from the Map Service Center.

A challenge for customers is the need to be diligent in identifying, obtaining, and evaluating all documents that provide flood hazard data and subsequent changes for their property. In many cases an NFIP map panel alone will provide the needed information. In other cases customers will need NFIP map panels and indexes, LOMCs, and FIS reports. The Map Service Center allows users to identify the LOMC(s) that affect each map panel and obtain them with the panel. The Map Modernization Program is developing digital databases to provide customers with access to integrated information from the maps and LOMCs (see section 3.4 below).

Many older map panels were not compiled on an accurate base map and so coordinate locations cannot be determined from the map. Newer map panels are compiled on accurate base maps which allow customers to estimate the grid and longitude-latitude coordinates from the map. The map modernization program seeks to recompile flood hazard data on accurate base maps.

[3] Names of products are provided for descriptive purposes only and do not represent an endorsement by the United States Government.

The maps and letters of map change are the original method the NFIP used to publish flood hazard data. The system is mature and no enhancements are recommended.

3.2. Digital NFIP Map Images: FIRMscan Data and Related Tools

Through FIRMscans and related tools, FEMA provides customers the convenience of obtaining a digital NFIP map image through the web or on computer media. FEMA also provides web-based (FIRMette) and stand alone[4] (Flood Map Image Tool (F-MIT)) software tools to view a FIRMscan image and print portions of it.

After viewing the FIRMscan data, customers still must inspect LOMCs for updates to the information shown on the NFIP map panels.

3.2.1. FIRMscan Data

FIRMscans are digital pictures of NFIP map panels and map indexes. With the FIRMscan, a customer can view, print, and otherwise process the contained map image with software the customer provides. FIRMscans for black-and-white NFIP maps are provided as Tagged Image Format Files (TIFFs) and two-color NFIP maps are provided as Portable Network Graphics (PNG) formatted files.

The FIRMscans have the information content and limitations of the NFIP maps and map indexes described above in section 3.1.

3.2.2. Web-based FIRMette Tool

The FIRMette tool is a web-based capability that allows users to view NFIP map panels and map indexes. Customers can pan and zoom to examine any part of the map sheet.

Customers can save portions of a FIRMscan as PDF files or TIFFs for later viewing and printing. These FIRMette files typically include a portion of the map body at the same scale as the original map, the title block, the map scale, and the north arrow from the map. These files can be saved in one of three page sizes. Pages printed from the files have the same official status as the NFIP map panels from which they are derived.

A limitation of the tool is that, because of space limitations on the printed page, the map legend, notes to users, and CBRS legend parts of NFIP maps are not included in the normal FIRMette file that customers save. With a little ingenuity customers can save and print these parts instead of the map body with the “print area” function of the tool.

The FIRMette tool is a mature technology and no enhancements are recommended.

[4] Not connected to the Internet.

3.2.3. Flood Map Image Tool (F-MIT)

The F-MIT tool is a stand alone capability that allows users to view black-and-white (1-bit) TIFF FIRMscans. Customers can pan and zoom to examine any part of the map sheet.

Customers can print or save as a PDF file all or part of a FIRMscan image. They also can save as a PDF or print a FIRMette-formatted image that includes a portion of the map body at the same scale as the original map, the title block, the map scale, and the north arrow from the map. These files can be saved in one of three page sizes. Pages printed from the files have the same official status as the NFIP panels from which they are derived.

The FIRMette capability of the F-MIT has the same limitations as that of the web-based FIRMette tool described in section 3.2.2 above. Because the tool mimics this mature capability no enhancements are recommended.

The F-MIT tool does not work with two-color PNG-formatted FIRMscan files. Customers might not notice the format of the FIRMscan file they receive or they might not realize that the tool may not work with their FIRMscan data. It would be useful to enhance the tool to work with any FIRMscan file.

3.3. DFIRM Databases and the DFIRM View Tool

Through DFIRM databases and a related tool, FEMA provides geospatial flood hazard data in the form of a spatial database. Although not intended to be used to produce an exact replica of a FIRM, a DFIRM database is designed to allow a geographic information system (GIS) software user access to all of the information conveyed on a FIRM in a way that best takes advantage of the software's automated analysis capabilities. Such databases can be used by customers to create, view, and print maps; to query and analyze attribute data; and to combine the DFIRM data with other user-supplied data for spatial analyses.

Customers can receive DFIRM databases by online download and on computer media in three GIS data formats from the Map Service Center.

FEMA also has a stand alone software tool (DFIRM View Tool) to view a DFIRM database, interact with the data, and print all or part of the database. This tool has not been released to customers.

After using DFIRM databases, customers must inspect LOMCs for updates made after the DFIRM database was created.

3.3.1. DFIRM Databases

A DFIRM database is composed of spatial data describing the location of features on the earth and tabular data that describe the characteristics of these spatial features. The standard DFIRM database content includes:

- Flood hazard areas (1-percent and 0.2-percent-annual-chance flood hazard areas and floodways), Base (1-percent-annual chance) Flood Elevation (BFE) lines, mapped cross section lines, including the BFEs added from the Flood Insurance Study; and coastal transects.
- Hydraulic structures such as dams, bridges, culverts, weirs, and levees.
- CBRS areas and OPA units.
- FIRM panel areas, including their effective date, size, scale, and corner coordinates.
- Information about LOMRs incorporated into the DFIRM database. (This information usually is removed before the database is released.)
- Base map data including digital orthophotos or transportation features with feature labels; other transportation features such as railroads; the Public Land Survey System; hydrographic features (such as streams, lakes, and shorelines); river marks; boundaries of counties, communities, and other units of government and public lands such as national parks, forests, and military lands; permanent benchmarks; and USGS 7.5-minute topographic map quadrangle boundaries.

The flood hazard data contained in DFIRM databases are compiled on an accurate base map. The horizontal datum and map projection are the same within a database but vary among databases; the vertical datum can vary within a DFIRM database.

The database covers the entire geographic area being mapped, which typically is a county or a community. The geographic coverage for a database might contain overedge information (outside the boundary of the county or community) if the databases' FIRM panels at the boundary include overedge information. FEMA specifications call for edgematching between adjoining DFIRM databases. An enhancement would be to ensure that edgematching among adjoining databases is completed during the production process and that there are no overlapping data among DFIRM databases.

The DFIRM database schema is complex and customers seeking to use it for the first time might have a steep learning curve. One enhancement is database documentation that would help guide customers to the tables and fields in the database that have the information needed most frequently.

3.3.2. DFIRM View Tool

The DFIRM View Tool would allow a customer to use a DFIRM database without the need for proprietary GIS software. The tool works with DFIRM databases stored in ESRI™ Shapefile

format, one of three formats distributed by the Map Service Center. The tool has not been released to FEMA's customers.

The tool would allow customers to open and view DFIRM databases with pre-set standard symbology, control how data layers are displayed (that is, turn data on and off and change color, symbology, and labeling), zoom and pan, zoom to a customer-identified map panel or point, select features, view the attributes of selected features, list coordinate pairs (that is, x and y coordinates) of selected features, display the attributes for features and attribute tables for layers, compute floodplain areas, buffer features, interpolate Base Flood Elevations, add their own GIS data to the viewer, draw new graphics on-screen and save them[5], and view related documents such as metadata and FEMA specifications[6].

The tool would allow a customer to create a one-page Point Location Map, and to print the page or save it as a PDF file. To make a Point Location Map, the customer would select a point on the screen or enter a street address[7]. The tool then creates a map based on the map view on the screen that shows the location of the point and lists database information available for the point, including the point coordinates, address (if entered by the customer), community name and number, FIRM panel number, effective date, flood hazard zone, floodway status, estimated BFE, CRBS and OPA unit information (if any), and other information. The map also displays a bar scale and map title entered by the customer.

Enhancements that would improve the tool are listed below. (The recommendations assume that the viewer will be restricted to viewing one DFIRM database at a time[8].)

- Resolve software defects in the tool. Use of the tool resulted in run-time and other errors.
- Provide the ability to save a customer's settings and work between sessions with the tool.
- Allow a user to reset settings to the initial configuration for the tool.
- Develop guidelines for a "FEMA view" for the display of flood hazard data on computer screens and implement the guidelines for the tool. Ideally these guidelines would be designed so that there is a "family resemblance" among FEMA-supported portrayals of flood hazard data among different products and tools. This approach would help customers efficiently use and move among FEMA's various flood hazard data, products, and tools. See section 3.5.1 below for more discussion. In the absence of such guidelines:
  - Graphically differentiate preliminary, pre-effective, and effective flood hazard data. (This recommendation assumes that the viewer will be made available to recipients of preliminary, pre-effective, and effective DFIRM databases.)
  - As the default, use symbols more like those found in other FEMA flood hazard products.

[5] This function was not tested for this review.
[6] The viewing of some related documents requires a connection to the Internet.
[7] Use of this function requires a connection to the Internet.
[8] If the tool was changed to allow more than one database to be open at a time or to open an extract from the National Flood Hazard Layer, additional enhancements to help customers detect differences among the DFIRM databases might be needed.

  - Update the legend to show new map symbols.
  - Ensure that all labels for polygons are displayed in their polygon or have a leader from the label to the polygon.
  - When labeling features from DFIRM databases, do not label features if the value is a null value (such as "unknown") or other "not populated" entries.
  - Provide cautions if pre-effective or preliminary data are displayed.
- For functions for which there might be a slow response to the customer, provide an indication that activity is underway. An example of such a function is "interpolate elevation," for which there can be a delay while the tool selects the BFEs or cross sections nearest to the entered location.
- Add the "zoom to address" function for interactive use, and use a geocoding service supported by FEMA.
- Provide the ability to zoom to a customer-entered map scale.
- Fix the "remove all layers" function so that it clears the screen of all information.
- Redesign the "identify" function to improve the usefulness of the results returned to customers.
  - Consider not returning fields and values, such as internal database identifiers, that are of little use to most customers. As an alternative to this recommendation, provide a "simple" identify function that returns fields of interest to those who need to do business with FEMA; such a function would return information relevant to customers regardless of the database table on which the information resides.
  - Replace field names and values encoded with acronyms or codes with descriptions that customers can recognize and understand. As an alternative to this recommendation, provide additional hyperlinked help so that users can look up the meaning of the acronyms and codes.
- Change the interactive "interpolate elevation" function so that it only computes elevations for points within appropriate flood hazard zones.
- For data tables that the customer can view, provide a means of sorting tables by field.
- Update the Uniform Resource Locators (URLs) in the "Links" section.
- Complete the data dictionary, especially the "description" field.
- Improve the Point Location Map so that it has the same official status as a FIRMette, and can be used in the same manner:
  - Develop guidelines for a "FEMA view" for the display of flood hazard data on printed output and implement the guidelines for the tool. Ideally these guidelines would be designed so that there is a "family resemblance" among FEMA-supported portrayals of flood hazard data among different products and tools. This approach would help customers use and move efficiently among FEMA's various flood hazard data, products, and tools. Compliant printed output should be eligible for use for official purposes. See section 3.5.1 below for more discussion. In the absence of such guidelines:
    - Graphically differentiate preliminary, pre-effective, and effective flood hazard data.
    - As the default, use symbols more like those found in other FEMA flood hazard products.

  - Update the legend to show new map symbols.
  - Ensure that all labels for polygons are displayed in their polygon or have a leader from the label to the polygon.
  - When labeling features from values from DFIRM databases, do not label features if the value is a null value (such as "unknown") or other "not populated" entries.
  - Provide cautions if pre-effective or preliminary data are displayed.
  - Ensure that maps printed on black-and-white printers are legible.
  - Print the map at the same map scale as the effective NFIP map panel.
- Update the "zoom to address" function to use a geocoding service supported by FEMA.
- Change the "interpolate elevation" function so that it computes elevations only within appropriate flood hazard zones.
- Change the "interpolate elevation" function to allow users to review and change the BFEs and cross sections used for computation. As an alternative to this recommendation, highlight the BFEs and cross sections used for the interpolation on the map and strengthen the printed warning to the user about the values provided.
- Report the post-FIRM date and LOMR case numbers (if any). These are the two items missing from the information required of customers to do business with FEMA.
- Ensure that information in the table below the map is listed correctly, especially items for which the result must be based on distance from the point. For example the "nearest stream" reported is sometimes wrong (or not very "near" the point). As an alternative, add a printed warning to users about the reliability of the information reported.
- Make a slight formatting and wording change to label the community number clearly and distinguish it from the map panel number and suffix.

• Help customers by documenting how to use the tool to meet their information needs.

3.4. The National Flood Hazard Layer and Related Tools

The National Flood Hazard Layer (NFHL) spatial database is a national compilation of the spatial[9] and tabular data from DFIRM databases. A version of the NFHL that contains updates from subsequent LOMRs and points representing the approximate locations of LOMAs is to be released in late 2007. Related tools provide access to the NFHL through a web-based map viewer and a web map service (WMS)[10]. FEMA also is implementing the capability for customers to receive GIS data from the NFHL on computer media through the Map Service Center.[11]

After viewing the data from the NFHL, customers still must inspect LOMAs for amendments made after the NFHL data were created. The point data for LOMAs in the NFHL are to be hyperlinked to the LOMA case documents at FEMA's Map Service Center to help customers find LOMAs relevant to their property efficiently.

[9] Excluding orthophoto data used as base maps.
[10] A web map service provides a georegistered map image created from a spatial database over the Internet. Such a service complies with specifications developed by the Open Geospatial Consortium.
[11] This capability is in development and so is not reviewed in detail in this report.

3.4.1. National Flood Hazard Layer

The content of the NFHL includes the information in its component DFIRM databases. Subsequent changes from LOMRs are being integrated into these data, and point locations for LOMAs and related attribute data are being added.

Data loaded into the NFHL are converted to a common horizontal coordinate system (longitude-latitude) and datum (the North American Datum of 1983). Elevation data have the same vertical datum as their source DFIRM database, so the vertical datums vary within the NFHL. The conversion of all elevation data to the same vertical datum would be a useful enhancement.

The NFHL is organized to hold nationwide data coverage. Data are available for the parts of the Nation for which there are DFIRM databases. As discussed in section 3.3.1 above, a consequence of a lack of edgejoining between DFIRM databases is that there are gaps in coverage or overlapping data at the boundaries of adjoining DFIRM databases. Data also might not be compatible across such boundaries; for example, flood hazard zones might be different on opposing sides of a boundary or overlapping data might have conflicting depictions of flood hazard information. An enhancement would ensure that edgematching among adjoining DFIRM databases is completed during the production process and that data do not overlap among DFIRM databases.

The updating of the NFHL data by the LOMA process would be a useful enhancement. The simplest enhancement would be to improve the positional accuracy of the point used to represent the location of the LOMA by selecting the point interactively on NFHL flood hazard and base map (including orthophoto) data.

FEMA is implementing the capability for customers to receive GIS data from the NFHL on computer media through the Map Service Center. Initial plans call for the distribution copies of NFHL data to be partitioned geographically using the boundaries of FEMA regions. These distribution copies would be refreshed periodically from the NFHL. A useful enhancement would be to provide customers options for obtaining NFHL data in customer-defined geographic partitions, coordinate systems, and data formats, and to provide the ability for customers to request “on demand” the most current version of the NFHL data.

Like the DFIRM database, the NFHL schema is complex and customers seeking to use it for the first time might have a steep learning curve. One enhancement is database documentation that would help guide customers to the tables and fields in the database that have the information needed most frequently.

3.4.2. Web-based NFHL Map Viewer

The web-based NFHL map viewer allows a customer to view NFHL and other data online. The tool allows customers to view symbolized and labeled NFHL data, read the legend for the map symbols, zoom and pan on the map, zoom to a place or point based on several options (for example, zoom to a street address or to a community), turn data layers off and on, view the attributes of all

displayed features at a customer-selected point, save settings between sessions, and view related metadata for data created by FEMA.

Additional databases available through the viewer provide customers the option of viewing base maps other than those in the NFHL, additional NFIP map program information, FEMA's Q3 data, and other types of hazards. A button that toggles between "DFIRM View" and "Default View" switches the view between viewing NFHL data (only) and NFHL and other data available through the viewer.

A print function creates a one-page document that includes the map being viewed, a user-supplied map title, a north arrow and scale bar, other text (including a caution that the map is for advisory purposes only), and (if selected by the customer) a legend for map symbols.

Enhancements[12] that would improve the tool include:

- Resolve software defects in the tool. The toolbar icons occasionally do not display correctly and the map view sometimes does not refresh after a command is entered.
- Shorten the delay in the viewer's response to user commands. Provide an indication that the tool is working for tasks that are time-consuming.
- Organize the default content and display of data:
  - Establish three scale and purpose-specific map views:
    1. National status view to show general status (effective, pre-effective, and preliminary DFIRM data, non-DFIRM NFIP maps, and no NFIP map) information and a relevant base map.
    2. Regional status and index view to show status (see above), NFIP map panel boundaries and identifiers, and a relevant base map. (Allow users to create a regional flood hazard view with flood hazard data by providing access to relevant data layers, but start with these layers turned off.)
    3. Local flood hazard view to show detailed flood hazard information. The initial scale of the view should be that of the map panel. Base maps will include the DFIRM base map data and external data services. Allow for status information to be displayed.
  - Display and distinguish from other mapped information the availability of non-DFIRM NFIP maps and places for which there are no NFIP maps.
  - Remove or hide from the customer reference to any data not required or appropriate for these views.
- Develop guidelines for a "FEMA view" for the display of flood hazard data on a computer screens and implement guidelines for the tool. For the viewer, these guidelines would be used for the local flood hazard data view. Ideally these guidelines would be designed so that there is a "family resemblance" among FEMA-supported portrayals of flood hazard data among different products and tools. This approach would help customers use and

[12] These enhancements include recommendations from Ken Stern's (IBM) analysis of the usability of the viewer.

move efficiently among FEMA's various flood hazard data, products, and tools. See section 3.5.1 below for more discussion. In the absence of such guidelines:

- Graphically differentiate BFE and cross section lines by vertical datum of their elevation values.
- Graphically differentiate among flood hazard data that are preliminary, pre-effective, and effective.
- Graphically differentiate LOMRs that are pre-effective and effective.
- Update the legend to show new map symbols.
- Ensure that all labels for polygons are displayed in their polygon or have a leader from the label to the polygon.
- Ensure that labels are legible.
- When labeling features from values in the NFHL data, do not label the feature if the value is one of the DFIRM database specification's "not populated" entries. See page L-35 in Appendix L of Guidelines and Specifications for Flood Hazard Mapping Partners for the list of "not populated" values.
- Provide cautions if pre-effective or preliminary data are displayed.
- Investigate and implement (if feasible) the ability to display data in the map projection of the map panel for an area.

- Upgrade the "screen navigation" suite:
  - Retire the "single click" zoom.
  - For "rubber band" zoom, allow user to zoom to other map scales but stop at pre-set upper and lower map scale limits (to be determined).
  - For map scale zoom: Move map scale from the geocoder to the navigation area. Display map scale denominator continually and allow user to enter a map scale to zoom to a precise scale. Accept the "enter" key or a separate "zoom" command to initiate the zoom.
  - Repurpose the overview map to show major areas of the United States (coterminous United States, Alaska, Hawaii, etc.) and allow users to zoom to the national status view for an area by clicking on the overview map. Continue to use the overview map to show the location of the area portrayed in the map view.
  - Retire the controls in the "quick zoom" function suite.
  - Repurpose and retitle the "zoom to initial extent" function to reset the viewer to the standard opening view (national status centered on the coterminous United States).
  - Provide a "back" button to return the customer to their previous view.
  - The default response to a cursor action on the screen should be pan, not zoom.
  - Remove the "identify" function from the "navigation" suite and move it to the new "identify" suite.
- For the "quick zoom" function suite, provide three controls that allow a customer to view the national and regional status and local flood hazard views in reference to a point entered on the screen. (This suite is separate from the "screen navigation" suite because it changes the zoom and the content of the view.)

- Upgrade the feature management and selection suite for the viewer:
  - Organize the headings so that there are (at most) two levels of headings (the main headings and their subheadings).
  - Provide a better order for options on the list. For example, under DFIRM data, group the flood hazard layers, panel and LOMR layers, and base map and other reference layers. The list on page 10 provides a starting point.
  - Provide a better organization and distinction among base map options (DFIRM base map data, viewer base map data, and imagery base map data).
  - Clicking a heading off should click off and turn off all data in the heading and subordinate subheadings. Clicking a heading should turn on all data in the heading and subordinate subheadings.
  - Ensure all features in the feature list display correctly. For example, it is not clear if the two choices for Public Land Survey System (PLSS) layers display correctly.
  - Ensure that all layers (as appropriate) have FGDC and (if appropriate) NFIP-compliant metadata and that the headings and subheadings are hyperlinked to their metadata.
  - Hide from the customer or remove from the viewer extraneous data layers that have no use to customers interested in NFIP business information.
- Move the "refresh" function above the map view and near the other controls, especially those that control the selection of layers (for which the "refresh" function is most relevant).
- Retitle "Select zoom filter" suite to a more descriptive and customer-friendly title. Provide text to alert customers that choices are available. Ensure that all choices are obvious (including zoom to State and zoom to zip code).
  - For point location entries (such as street addresses or coordinate locations), zoom to the local flood hazard view centered at the point location and at the scale of the related map panel. If there are no NFHL data for the location but non-DFIRM NFIP maps are available, warn the customer and ask if he or she would like to see the area in the viewer or be transferred to the appropriate NFIP map at the Map Service Center. Transfer them to the appropriate web page at the Map Service Center if requested by the customer. If there are no NFIP maps for the location warn the user and ask if they would like to see the area in the viewer or remain at the current map display. Act appropriately to the customer's response.
  - For other entries zoom to the national status or regional status and index view (outcome depends on the map scale) centered on the feature identified by the customer.
  - Review the final choices available through this function to ensure that all are alike. Avoid the temptation to make this function a "catch-all" for ways to interact with the viewer.
- Create a new "identify" suite that has a "simple" identify function and retain a modified version of the current capability as the "advanced" identify function:
  - The "simple identify" function would be for those customers interested in using the viewer to do business with FEMA, but not interested in the full range of DFIRM data attributes. In response to a point entered by the customer, return the information listed on page 3 regardless as to whether the related data layers are turned on or not.
  - The renamed "advanced identify" function would provide the full set of DFIRM attributes as it does now. Replace field names and values encoded with acronyms or codes with descriptions that customers would recognize and understand. As an alternative to this

recommendation, provide additional hyperlinked help so that users can look up the meaning of the acronyms and codes.

  - Hide or remove those extraneous attributes and values not useful to customers interested in NFIP business information.
  - Ensure that the results of the "identify" function are visible to the customer. Consider the use of a new web page for the response.

- For the "file" function suite, rename the suite to "save work." Retire the "temporary save" function (and the corresponding "saved location" function). Move the "print" function to be part of a new "print" suite.
- Establish one area for all messaging to the customer or use other means to ensure that messages to the customer are obvious.
- Create a "print" function suite. (Note that the products need more design work.)
  - Retitle the current "print" function as a new "print screen" function. Some redesign is needed for the page that is the outcome of this action.
  - Create a new "official print" function. The information content will include the local flood hazard view at the scale and map projection of the NFIP map panel, and related map panel, LOMR, and community information, north arrow, and scale bar. The design would be patterned after the FIRMette and DFIRM view tool output pages. If needed for clarity, a second page will be a map providing an index to map panels, LOMRs, and communities, each identified with appropriate NFIP business information (such as map panel identifiers, effective dates and vertical datums; LOMR case numbers and effective dates; community names and numbers; and cautions (as needed) if some or all of the data displayed are not effective). As an option, allow a user to enter a point and print (possibly as a third page) the result of a "simple identify" for the point.
  - Develop guidelines for a "FEMA view" for the display of flood hazard data on printed output and implement the guidelines for the tool. Ideally the guidelines would be designed so that there is a "family resemblance" among FEMA-supported portrayals of flood hazard data among different products and tools. This approach would help customers efficiently use and move among FEMA's various flood hazard data, products, and tools. Compliant printed output should be eligible for use for official purposes. See section 3.5.1 below for more discussion. In the absence of such guidelines:
    - Graphically differentiate flood hazard data that are preliminary, pre-effective, and effective.
    - Graphically differentiate Base Flood Elevation and cross section lines by vertical datum of their elevation values.
    - Graphically differentiate pre-effective and effective LOMRs.
    - Update the legend to show new map symbols.
    - Ensure that all labels for polygons are displayed in their polygon or have a leader from the label to the polygon.
    - Ensure that the text is large enough to be read.
    - When labeling features from values in the NFHL data, do not label the feature if the value is one of the DFIRM database specification's "not populated" entries. See page L-35 in Appendix L of *Guidelines and Specifications for Flood Hazard Mapping Partners* for the list of "not populated" values.

  - Provide cautions if pre-effective or preliminary data are displayed.
  - Ensure that the maps created are legible if printed on black-and-white printers.
- Add the ability to display, as an alternate base map, imagery from web map service(s) provided by the U.S. Geological Survey for use in regional and local flood hazard views.
- Add the ability to display the point locations of LOMAs, and provide a hyperlink from the points to the display of the related LOMA case document available through the Map Service Center.
- Provide a link from the display of NFIP map boundaries and identifiers, especially for non-DFIRM NFIP map panels, to their complementary products at the Map Service Center.
- Create advanced capabilities:
  - Provide customers the option to add data from external sources, such as web map services.
  - Establish a URL that allows external calls that open the viewer to a URL-specified location and view.
  - Provide the ability for customers to make length measurements.
- Help customers by documenting how to use the tool to meet their information needs.

3.4.3. NFHL Web Map Service (WMS)

In response to a web request, the NFHL web map service returns over the web a georegistered map image created from data in the NFHL. These map images can be added to Internet-based applications, including GIS software, web-based map viewers, and other applications. The symbology and labels for the map are controlled by the service.

The service is organized as a set of data layers that users can view. They include the NFHL data layers:

- Base Flood Elevation
- Bench marks
- CBRS protected areas
- Coastal transect lines
- Cross section lines
- DFIRM panels
- DFIRM streets
- Flood hazard zone boundaries
- Flood hazard zones
- Floodways
- General structures
- LOMRs
- PLSS sections

- PLSS township range lines
- Political boundaries
- Political jurisdictions
- River distance markers
- Streams
- USGS quads
- Water bodies

The service also provides access to additional NFIP map program information and FEMA's Q3 data through the layers:

- Flood data availability (at two map scales)
- Preliminary maps issued
- Q3 flood hazards

Listed below are enhancements that would improve the service. Note that enhancements to the web map service alone are unlikely to convey all information needed to complete FEMA application forms. Portrayal of the needed attribute data as map labels is not likely to be an effective means of conveying the information.

- Develop guidelines for a "FEMA view" for the display of flood hazard data on computer screens and implement the guidelines for the tool. Ideally this guideline would be designed so that there is a "family resemblance" among FEMA-supported portrayals of flood hazard data among different products and tools. This approach would help customers efficiently use and move among FEMA's various flood hazard data, products, and tools. See section 3.5.1 below for more discussion. In the absence of such guidelines:
  - Graphically differentiate BFE and cross-section lines by vertical datum.
  - Graphically differentiate among flood hazard data by status (preliminary, pre-effective, and effective) for the statuses that are made available through the service.
  - Graphically differentiate LOMRs that are pre-effective and effective.
  - Update the legend to portray new map symbols.
  - Ensure that all labels for polygons are displayed in their polygon or have a leader from the label to the polygon.
  - Ensure that labels are legible in different viewers, including Google Earth.
  - When labeling features from values in the NFHL data, do not label the feature if the value is one of the DFIRM database specification's "not populated" entries. See page L-35 in Appendix L of *Guidelines and Specifications for Flood Hazard Mapping Partners* for the list of "not populated" values.
  - Provide cautions if pre-effective or preliminary data are displayed.
  - Ensure that data layers are displayed correctly. Add the ability to display and distinguish among preliminary, pre-effective, and effective status of NFHL data for status views.

  - Investigate standard combinations of data layers targeted to different applications.
- Investigate the ability to provide an "identify" capability that would return attribute information for use with the service. If such a capability is possible, develop an "identify suite" similar to that described in section 3.4.2 above. If such a capability is not possible, consider developing an enhanced map view that presents as map labels the attributes used most often:
- Investigate the means to hyperlink portions of a view. If such a capability is possible, link displayed data to metadata and map panel information to corresponding products at the Map Service Center.
- Provide a stable URL for the description of the service and the static legend for the maps portrayed in the service.
- Improve access to the service from Google Earth™ by refining the "alpha" version of the Keyhole Markup Language (KML) file to provide better access to metadata, legend, instructions, and other information. Publish the KML file through the Map Service Center.
- Help customers by documenting how to use the tool to meet their information needs.

3.4.4. Investigate Additional Means of Leveraging the NFHL

The NFHL and the data it contains represent a large investment by FEMA and its mapping partners and are a valuable national resource. While not an enhancement per se, another recommendation is that FEMA investigate additional means of providing access to the NFHL. Two avenues of investigation are:

- New methods for distributing data. As new methods of distributing data through the Internet become available, FEMA should investigate their capabilities and, if they provide value to FEMA and its stakeholders, implement them. Two current potential opportunities are the use of a Web Feature Service and Keyhole Markup Language.
- Additional viewing outlets. FEMA has a basic capability to view the NFHL WMS in Google Earth™. FEMA should evaluate how it and its stakeholders could take advantage of other outlets, such as Microsoft® Virtual Earth™.

3.5. Product- and Tool-Independent Enhancements

In addition to the product and tool-specific recommendations, customers would benefit from two other enhancements: the development and implementation of guidelines for a "FEMA view" for flood hazard data and tools and the ability to enter and use legal descriptions of property with flood hazard data.

3.5.1. Guidelines for a "FEMA view" for Products and Tools

Guidelines for a "FEMA view" for the display of flood hazard data on computer screens and printed output would describe a "family resemblance" among FEMA-supported portrayals of flood hazard

data among different products and tools. This approach would help customers efficiently use and move among FEMA's various flood hazard data, products, and tools by lessening the effort required to relearn how to use different products and tools.

Candidate items to be included in the guidelines include the portrayal of flood hazard data (symbology and labeling requirements), information that must be available to users by query (such as the list of items on page 3), requirements for printed output accepted for official use (which could include such items as information displayed on the map, characteristics of the map (such as map scale, projection, coordinate reference, and need for compatibility with printed NFIP products), and other NFIP information, such as the identification of the community, map panel, and datums).

The current NFIP map panel and index design probably would be an anchor for the guidelines, and other products and tools (such as the viewers) would offer additional examples to be considered.

3.5.2. Ability to Add Property Boundaries for Display and Query

To do business with FEMA, customers often need to relate flood hazard data to their property. FEMA-supported tools provide access to flood hazard data and base map information; for the rest of their efforts, customers work outside of the tools. Enhancements that allow customers to add geospatial data such as the location or boundaries of their property for portrayal on maps or queries of flood hazard data would be useful.

Appendix A. Requirements from FEMA's Forms, Instructions, and Publications

The content of Appendix A, provided separately, provides a detailed analysis of information elements required by FEMA's forms, instructions, and publications. See the worksheet "FEMA Forms" in the associated Excel spreadsheet "Map Elements Forms and Tools (Final)."

Appendix B. Review of FEMA Geospatial Flood Hazard Data and Related Tools

The content of Appendix B, provided separately, provides a detailed analysis of the information content of FEMA's geospatial flood hazard data. See the worksheet "FEMA Products" in the associated Excel spreadsheet "Map Elements Forms and Tools (Final)."

Table B 1 provides a summary of the extent to which major products and tools convey the information required of customers, which is listed on page 3. Note that the web map service (see section 3.4.3) is excluded from the list. Enhancements to the map image from the service are unlikely to provide all information needed to complete FEMA application forms. Portrayal of the necessary attribute data as map labels is not likely to be an effective means of conveying the information.

Table B 1. Overview of major tools and recommendations related to their official use.

Information element \ Product	Modernized NFIP maps and FIRMscan (assumed to be the same as the maps) (including display with F-MIT)	FIRMette (from modernized NFIP maps) (online and with F-MIT)	Digital Flood Insurance Rate Map (DFIRM) data (DFIRM databases and National Flood Hazard Layer)	Upgraded National Flood Hazard Layer (as new LOMRs are integrated with existing data and LOMA points are added)	National Flood Hazard Layer viewer (map and query)	National Flood Hazard Layer viewer (printed map only)	Standalone DFIRM viewer (map and query, including opening associated tables)	Standalone DFIRM viewer (printed "point location map")
Community information	Complete	Complete	Complete	Complete	Complete; need to convert numeric FIPS codes to text	Incomplete; data are available but some are not printed	Complete	Complete
Map, panel, and LOMC identification	Incomplete; requires the additional use of LOMCs	Incomplete; requires the additional use of LOMCs and creative use of the tool	Incomplete; requires the additional use of LOMCs	Complete (incorporates LOMRs and provides access to LOMAs)	Incomplete; requires the additional use of LOMCs	Incomplete; data are available but some are not printed and requires additional use of LOMCs	Incomplete; requires the additional use of LOMCs	Incomplete; requires the additional use of LOMCs
FIRM index	Complete	Incomplete; requires creative use of the tool	Contains information found on index	Contains information found on index	Incomplete; data are available but some are not displayed	Incomplete; data are available but some are not printed	Contains information found on index	No
SFHA, CBRS, and OPA zones	Complete	Complete	Complete; map legend not applicable	Complete; map legend not applicable	Complete	Incomplete; data are available but some are not printed	Complete	Complete
BFEs and flood depths	Complete	Complete	Complete	Complete	Complete	Incomplete; data are available but some are not printed	Complete	Complete
Vertical datum	Complete	Incomplete; requires creative use of the tool	Complete	Complete	Complete	Incomplete; data are available but some are not printed	Complete	Complete
Base map	Complete. Requires additional effort to obtain coordinates or measurements	Complete. Requires additional effort to obtain coordinates or measurements	Complete. Requires additional effort to obtain coordinates or measurements	Incomplete; requires additional service to provide orthoimagery. Requires additional effort to obtain coordinates or measurements	Incomplete; requires additional service to provide orthoimagery, data are available but some are not displayed, and no coordinate readout or measurement capability	Incomplete; requires additional service to provide orthoimagery and data are available but some are not printed. Requires additional effort to obtain coordinates or measurements	Complete. Requires additional effort to convert coordinates to longitude and latitude.	Complete. Requires additional effort to obtain coordinates or measurements
Recommendations and comments regarding "official use" of the item.	Mature product eligible for official use. Enhance F-MIT tool to handle two-color FIRMscan files.	Mature product eligible for official use. "Creative use of the tool" entails capturing areas of the image other than the map body.	DFIRM data are a mature product eligible for official use with approval of the "Digital as Official" policy. Edgejoin DFIRM databases in production. Distribute NFHL data.	DFIRM, LOMR, and LOMA data are mature products eligible for official use with approval of the "Digital as Official" policy. Distribute NFHL data. Complete enhancement of adding LOMC data.	DFIRM data are a mature product eligible for official use with approval of the "Digital as Official" policy, but some data fields are not accessible. Upgrade query capability to provide access to information needed to complete FEMA application forms. Provide imagery base map data. Provide for display and query of LOMA data. Approve viewer for official use.	DFIRM data are a mature product eligible for official use with approval of the "Digital as Official" policy, but some data fields are not accessible. Upgrade print capability to print a map image and related information needed to complete FEMA application forms and approve output for official use. Provide imagery base map data.	DFIRM data are a mature product eligible for official use with approval of the "Digital as Official" policy. Approve viewer for official use.	DFIRM data are a mature product eligible for official use with approval of the "Digital as Official" policy. Enhance print capability and approve output for official use.