

Flood Map Modernization Mid-Course Adjustment

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FEMA

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Executive Summary

Flood Map Modernization is a multiyear Presidential initiative supported by Congress that is directed at improving and updating the Nation's flood hazard identification maps. These flood maps were initially intended to be used principally by insurance agents, floodplain managers, and others charged with implementing the National Flood Insurance Program (NFIP). However, over the years the flood maps have become essential tools for a much wider range of users, from builders and developers to real estate agents and lenders to local planners and citizens attempting to make informed decisions about the degree of flood risk faced by particular pieces of property.

As the Flood Map Modernization initiative reaches the halfway point, FEMA has performed a mid-program evaluation that considered input from Congress, the U.S. Government Accountability Office (GAO), the Department of Homeland Security's Inspector General (IG), and other stakeholders. As a result of this evaluation, FEMA is implementing changes that will result in providing better-targeted and more accurate flood data, while also producing digital flood maps for a significant portion of the Nation. These changes respond to Congressional direction that the quality of the modernized maps not be sacrificed in order to produce a larger number of maps. At the end of the initiative, it is estimated that 90 percent of the Nation's flood risk will have been mapped based on factors such as population, flood history, growth potential, and other similar characteristics. This approach will delay reaching the goal of having a complete national digital flood layer. Specifically, it is now estimated that at the end of the 5-year Map Modernization initiative:

- Digital flood map products will be available for 92 percent of the Nation's population.
- 30 percent of the stream miles mapped will be based on new, updated, or validated engineering analyses, affecting 40 percent of the Nation's population.
- Digital flood map products will cover 65 percent of the land area of the continental United States.
- 80 percent of the Nation's population will have maps that encompass stream miles that meet the 2005 Floodplain Boundary Standard.

Purpose of the National Flood Insurance Program

The U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968 (P.L. 90-448). The NFIP was envisioned as a program that over time would provide management measures to reduce vulnerability to flood damage while providing a flood insurance safety net for individuals. Flood insurance was not generally available through the commercial markets, and remains so today.

The NFIP enables property owners in participating communities to purchase insurance as a protection against flood losses. A community's participation in the NFIP is voluntary and is based on an agreement between communities and the Federal Government. If a community adopts and

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enforces a floodplain management ordinance to reduce future flood risk to new construction in floodplains, the Federal Government will make flood insurance available within the community.

The NFIP provides an alternative to continual outlays in Federal disaster assistance funds in two ways. First, the floodplain management and mitigation measures that are put in place in communities that participate in the NFIP operate to reduce future flood damage to buildings and their contents. Second, the flood insurance policies purchased by individual property owners not only help people recover from flooding more quickly but also partially shift the costs of flooding from the Federal taxpayers to those whose properties are at risk.

To determine which areas are prone to flood hazard, the 1968 Act authorized the Federal Government “to identify and publish information with respect to all floodplain areas, including coastal areas located in the United States” that have floodprone areas and then “to establish or update flood-risk zone data in all such areas, and make estimates with respect to the rates of probable flood caused loss for the various flood risk zones for each of these areas.” Over the years, the NFIP developed several types of paper maps and related products to identify flood hazards in accordance with this direction, including detailed engineering studies of floodprone areas, maps of the floodplain boundary, zones of different levels of risk, maps of the floodway portion of the floodplain, and other information as needed.

Modernization of Flood Maps

For 35 years FEMA, charged with administration of the NFIP, used the prevailing paper-based cartographic production methods when creating flood maps for the Nation. However, with the development of computer-based geographic information system (GIS) technologies, the paper mapmaking procedure has given way to an improved digital process.

The Map Modernization initiative was established to provide a technology-based, cost-effective, long-term process for updating, maintaining, storing, and distributing the flood risk information portrayed on the flood maps. A corollary intention is that engineering tools and analysis be used to update the flood maps so that they reflect physical changes that have occurred since the original mapping. Digital maps have tremendous advantages over paper maps, including improved and more detailed topographic detail, ease of modification and updating, electronic access and transmission, and lower long-term production and maintenance costs.

In addition to providing digital flood maps, Map Modernization was designed to provide for engineering updates, which include the update or validation of existing flood data or the development of new flood data for stream miles or areas not previously studied. In some cases the existing flood data is adequate, based on a current evaluation of the flood history within the community and whether significant changes have taken place that might have changed the severity of the flood hazard. Flood data that is adequate and that requires no update is considered validated.

The modernization of flood maps had its origins in the NFIP Reform Act of 1994 (P.L. 103-325). The Act mandated a 5-year review cycle for all flood maps, and established the Technical Mapping Advisory Council (TMAC) to provide FEMA with expert input on mapping issues. TMAC and FEMA worked collaboratively to shape a program for modernizing maps.

As a result of these efforts, FEMA developed an initial strategy for Map Modernization, and provided a vision for a 5-year, \$1 billion program. This approach targeted the creation of a digital flood layer for the Nation as the highest priority. This vision was formalized in 1997 and subsequently updated and refined in 1999 and 2001. Map Modernization was designed to achieve this vision, as well as to respond to Congressional intent and stakeholder input, by leveraging program resources through partnerships with other Federal agencies and State and local governments involved in the NFIP.

The goals of the Map Modernization initiative in 2001, as stated in *Modernizing FEMA's Flood Hazard Mapping Program: A Progress Report*, were to convert approximately 80 percent of existing paper map panels to digital format with a high-quality base map, update 20 percent of the existing panels with new flood risk information while converting them to digital format, and add 13,700 completely new panels (also in digital format) to cover previously unmapped communities.

In 2003, funding for the Map Modernization program was initially appropriated and since then FEMA has been implementing a program consistent with that described in the 2001 progress report. However, as implementation of the initiative has progressed, FEMA's understanding of the Nation's mapping needs and how best to meet them has deepened.

First, as FEMA gained experience in modernizing the maps, it became apparent that a better standard was necessary for transferring the existing flood boundaries from the paper maps to the much more exacting digital product. This led to the adoption of a new Floodplain Boundary Standard.

Second, as the initiative got underway, new procedures were developed to collect information on where flood data and mapping needed to be updated and improved. This additional, more accurate information and the mechanisms for obtaining continual input have led to a broader and more detailed picture of the Nation's mapping needs. These procedures also have served as an impetus for important State and local government involvement.

Finally, since FY 2003, Congress, GAO, the IG, and initiative stakeholders have urged improved measures for evaluating and monitoring the Nation's flood risks and the progress made with Map Modernization. The insights gained from this input have resulted in more effective management of the initiative by FEMA, including the use of tools that help track progress, incorporate feedback, and monitor schedules and resources.

The result of this experience and stakeholder involvement is that FEMA now has a more-informed perspective on how to implement the Map Modernization initiative. The more flexible processes

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and enhanced products will support the identification of flood hazards in the Nation so that flooding impacts can be reduced.

Summary of Output to Date

Progress in the production of modernized flood maps for the Nation can be assessed in three ways: (1) the percentage of the Nation's population with digital flood maps available; (2) the proportion of stream or coastal miles mapped that is based on new, updated, or validated engineering; and (3) the land area covered by digital maps. FEMA has developed and adopted these measurements as additional ways to assess progress towards initiative goals. These measures also respond to recommendations and requests from Congress, the Office of Management and Budget, GAO, the IG, and stakeholders. As of the end of FY 2005, FEMA estimates this progress in Map Modernization:

- Digital flood map products are available for 39 percent of the Nation's population.
- 11 percent of the stream miles mapped have been based on new, updated, or validated engineering analysis, covering 4 percent of the population.
- Digital flood map products cover 15 percent of the land area of the continental United States.

Summary of Progress in the Mapping Process

With Map Modernization well underway, FEMA is managing a large and complex group of mapping partners, including other Federal agencies and State and local entities, that produce new flood maps directly for FEMA. FEMA provides the management system, guidelines, technology, and digital Web-based infrastructure necessary to support the Map Modernization initiative and to standardize the flood map study production cycle. The major advances FEMA has made in the process for modernizing the Nation's flood maps are listed below.

- **Standardized Guidelines**—A major achievement in coordinating and fostering accuracy and consistency in flood mapping nationwide was the release of FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners*. This document and its appendixes define the technical requirements and product specifications for flood hazard maps and related NFIP products, and also reflect changes to processes and products that have come about with Map Modernization, such as data capture standards and guidelines.
- **Plans and Schedules**—Another critical implementation aid developed by FEMA is the *Multi-Year Flood Hazard Identification Plan* (MHIP), which details FEMA's plan for prioritizing and delivering modernized flood maps for the Nation. A standardized procedure for refining the MHIP annually is based on input from States and other stakeholders.
- **Flood Boundary Standard**—Section 7 of FEMA's *FY04–FY08 Multi-Year Flood Hazard Identification Plan* (Version 1.0, issued November 2004) established a Floodplain

Boundary Standard that must be met in order for a map to be considered “modernized.” Guidance on implementation of the standard was issued to mapping partners in September 2005. This single step goes a long way toward alleviating the concerns of map users that the boundaries that were improperly drawn on the paper maps would simply be transferred to the digital maps.

- **Mapping Information Platform**—In 2004, FEMA launched the Mapping Information Platform (MIP) as the foundation of the Web-based infrastructure that provides the ability to manage, extract, share, and produce mapping information for Map Modernization. The MIP is enhanced continually to provide upgraded engineering and mapping tools to FEMA’s mapping partners. FEMA is already seeing benefits of the MIP’s capacity for streamlining the process of turning data into useful information.
- **Risk-based Mapping Priorities**—FEMA has instituted a ranking/prioritizing process (called “sequencing”) to determine which areas of the Nation should be given the highest priority in receiving modernized maps. Using a series of such factors as population and growth, housing units, flood insurance policies and claims, and repetitive flood losses, every county in the Nation has been assigned a “risk factor.” In general, counties with the highest risk factor are high-priority targets for new maps.
- **Census Block Groups**—Beginning with FY 2006 funding, the sequencing described above will be based on prioritized census block groups—a smaller geographic unit than counties. This adjustment will allow for additional focus on those areas that comprise 90 percent of the Nation’s risk, and account for 92 percent of the Nation’s population.
- **Stream Mile Measurements**—The higher level of detail and accuracy available with digital mapping techniques is enabling FEMA to shift to the use of stream miles (including shoreline for the open ocean, lakes, and ponds) as a measure of progress, rather than map panels. The number of stream and coastal miles in the Nation is fixed and thus provides a standard against which progress can be measured. Using stream miles rather than rectangular panels also allows depiction of a specific potential hazard so that differing vulnerabilities to flooding can be targeted individually, and a more precise identification of areas that need additional attention.

A Course Adjustment

To achieve the crucial goal of national coverage described above, it has become necessary to slightly modify FEMA’s approach to Map Modernization. During the initial planning for Map Modernization, FEMA determined that the initiative’s first priority should be the full digitization of all flood maps in the Nation. The plan was that, during the initiative, those maps that required engineering updates first would be converted to a digital format. Then, during the planned maintenance phase that would follow the initiative, they would be updated with new engineering data.

With 2 years of program experience and based on input from Congress, requests for engineering updates submitted through annual State business plans, adoption of the 2005 Floodplain Boundary Standard, and feedback from stakeholders, FEMA has determined that delaying the goal of having a

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nationwide digital flood layer, in favor of having more focus on ensuring compliance with the 2005 Floodplain Boundary Standard and providing additional resources for engineering analysis, will better meet the near-term needs of the map users and the Nation. The enhancement of existing standards and the additional gains in product quality that will result from this adjustment also are responsive to Congressional direction that quality not be sacrificed for quantity in modernizing the flood maps.

Accordingly, in FY 2006, FEMA began prioritizing funding based on mapping 90 percent of the Nation's flood risk using the census block group level of detail. This, combined with implementation of the 2005 Floodplain Boundary Standard, will address many of the more immediate needs of the program, even though it will lead to a delay in achieving a national digital flood layer. By the end of the Map Modernization initiative, FEMA will have achieved its targets of success as described below.

Rationale for an Adjustment

FEMA believes the “adjusted” course it is now implementing for Map Modernization is responsive to user and Congressional input and, based on improved data collected as part of the initiative, reflects a sound direction for the future. Recognizing that demand for new products may exceed current budgets, FEMA is attempting to balance several competing objectives. FEMA's modified objectives for the initiative are (1) producing new digital products; (2) providing new, updated, or validated engineering analysis; and (3) integrating the 2005 Floodplain Boundary Standard into the digital maps.

The new estimates of the digital products that will result from the new course direction (expressed on the basis of population) are:

- 92 percent of the Nation's population will have new digital flood maps.
- 40 percent of the Nation's population will have maps that encompass stream miles based on new, updated, or validated engineering analysis.
- 80 percent of the Nation's population will have maps that encompass stream miles that meet the 2005 Floodplain Boundary Standard.

With the adjusted course, more engineering analysis will take place and there will be a higher level of compliance with the Floodplain Boundary Standard than would have been possible under the course originally intended. On the other hand, there will be a decrease in the total land area being mapped and the percentage of the U.S. population that receives a digital map product.

The initial program vision was one of providing a digital flood layer for the entire Nation. The first objective, producing a digital layer, continues to be an important program goal because it will simplify the development, update, and distribution of flood maps, and provide immediate benefit to many areas that simply needed an improved base map or the benefit of being able to work with digital data. While this remains important, achieving 100 percent nationwide coverage will

necessarily be delayed in favor of the vitally important goals of providing more detailed and accurate digital maps for those parts of the Nation that have the highest flood risk and ensuring that the floodplain delineations on the digital maps meet the Floodplain Boundary Standard. This method of prioritization is in keeping with Congress's continual encouragement of FEMA's partnership with State and local governments, who have indicated a preference for focusing on risk areas within counties.

In furtherance of the second objective, providing new, updated, or validated engineering analysis, FEMA has collected additional data about mapping needs as part of the Map Modernization initiative. Funding of the Map Modernization initiative has led to the development of State-led business cases and the creation of other tools that now are identifying a colossal demand for new flood data and mapping that far exceeds the scope that was originally envisioned. Slowing down the digital conversion and providing additional resources for engineering analysis will alleviate some of this demand.

The third objective of the initiative is compliance with FEMA's 2005 Floodplain Boundary Standard. High quality has been an important goal throughout the Map Modernization effort. As experience was gained with converting existing maps to digital format during Map Modernization, the need for a new standard for delineating the boundary of the floodplain was revealed.

When engineering data is being moved to the new digital platform there is necessarily an additional objective of ensuring that the data depicted corresponds to the configuration of the land surface and other ground-level conditions. FEMA determined that the best means of ensuring consistency in the flood data shown on the new digital maps was to include a step that entailed matching the existing flood boundary to the best available topographic information. Because this new standard was introduced halfway through the initiative, those stream miles mapped before the effective date of the new standard need to be checked, and touchups made to some of them, to ensure that they meet this essential standard.

Future Directions

At the end of the 5-year period of FEMA's Map Modernization initiative, with the course adjustment described above, the Nation can expect digital flood maps to cover 92 percent of the population of the United States and 65 percent of its land area. Overall, 75 percent of the mapped stream miles will meet the 2005 Floodplain Boundary Standard, meaning that the floodplain boundary on the maps is drawn using the best available topographic data. This covers 80 percent of the population. Of the stream miles mapped, 30 percent will be based on new, updated, or validated engineering analysis, covering 40 percent of the population.

FEMA will accomplish these final outcomes of the Map Modernization initiative provided that funding levels are maintained through FY 2008. No additional funding or schedule adjustments are required to meet FEMA's new targets as outlined in this report.

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From the inception of the Map Modernization initiative and continuing through to the present, there always has been an identified need for a post-Map Modernization phase that will account both for map maintenance and for other unmet needs. This anticipated maintenance phase is not affected by FEMA's adjustments in implementation of the initiative. Specifically, areas that must be addressed during that phase include:

- Completion of a digital flood layer for the Nation, focusing on the low-risk areas that were not addressed during the Map Modernization initiative.
- Meeting additional needs for new flood data that either had not been identified or could not be accommodated during the initiative.
- Normal maintenance activities associated with the 5-year review mandated under Section 575 of the National Flood Insurance Reform Act of 1994 (every year, 20 percent of the existing maps will be evaluated to determine what revisions and updates are needed).
- Ensuring that, as technology improves, the modernized maps and the process FEMA uses to produce them evolve as well.

The conversion from a paper map system to a digital system is a monumental step forward and revolutionizes how flood maps are maintained, stored, and distributed. The use of digital tools is resulting in dramatically improved efficiency in the process of making, using, and updating flood maps and also enhancing their accuracy.

The course adjustment FEMA is making in implementing the Map Modernization initiative will yield cost-effective benefits in terms of timely realization of digital flood map coverage for those areas of the Nation in which it is most needed. Over the long term, these modernized flood maps will more accurately portray flood hazards so that risks to life and property can be assessed and appropriate action taken. Flood maps support the creation of safer communities and contribute to effective risk management nationwide.

Terms Used in this Report

Census block group: A subdivision of a census tract (or, before 2000, a block numbering area), a block group is the smallest geographic unit for which the Census Bureau tabulates sample data.

Digital conversion: Process for digitizing a current Flood Insurance Rate Map to create a Digital Flood Insurance Rate Map (DFIRM) for a community.

Digital GIS flood data available online: DFIRM data available to the public that meets the definition of a modernized map. The DFIRM must have at least been issued to the local community as a preliminary DFIRM for review and comment.

Modernized map: A modernized map has the following attributes:

- Must result in a DFIRM and include a DFIRM database
- Must have a base map that meets the current specifications
- Must result in a DFIRM that covers at least the entire area of one community—no “partial” DFIRMs are counted toward the metrics
- Must have floodplain boundary delineations that comply with the Floodplain Boundary Standard outlined in Procedure Memorandum #38, dated September 2, 2005.

Panel with high-quality base map: A DFIRM with a base map meeting current specifications outlined in the *Guidelines and Specifications for Flood Hazard Mapping Partners*.

Stream miles: Linear length of a flooding source, used to measure percentage of population at risk of flooding and the percentage of the Nation’s population that have received a modernized flood map. Stream miles include the miles of coastline and/or shoreline for the open-ocean, lakes, and ponds.

Updates: Updates to flood hazard analyses occur when additional engineering analyses (hydrology or hydraulics) are performed to add and/or improve the flood hazard data depicted on a DFIRM. Updates can be done to detailed studied areas or to approximately studied areas if a hydraulic model is used to compute the approximate elevations used for the delineation. A DFIRM may be modernized without being updated.

Validated map: During Flood Map Modernization, evaluations are made of certain mapped areas to determine whether the existing data and map are adequate. This evaluation is based on the flood history within the community and whether significant changes have taken place that might have changed the severity of the flood hazard. Flood data and maps that are adequate and require no update are considered validated.

1. Introduction

1.1. Purpose of Report

Flood Map Modernization is a multiyear Presidential initiative supported by Congress that is directed at improving and updating the Nation's flood hazard identification maps. These flood maps have been produced and used for 35 years under the National Flood Insurance Program (NFIP), originally for the identification and depiction of flood hazard areas in communities and for setting flood insurance rates. However, they have come to be much more widely used for many purposes, including local planning, emergency preparedness and response, and natural resource management.

The modernization of the flood maps, which had been produced, printed, and distributed with traditional paper mapmaking methods, had its origins in the National Flood Insurance Reform Act of 1994 (P.L. 103-325). Funding for Flood Map Modernization was first appropriated in fiscal year (FY) 2003, with additional funding provided in FY2004, FY2005, and FY2006.

As the Flood Map Modernization initiative reached the halfway point, FEMA performed a mid-program evaluation that considered input from Congress, the U.S. Government Accountability Office (GAO), the Department of Homeland Security's Inspector General (IG), and other stakeholders. Progress towards initiative goals has been assessed, and FEMA is making changes in its implementation of the initiative that will result in better-targeted and more accurate flood data, while also producing digital flood maps for a significant portion of the Nation. The results of that evaluation are presented in this report.

1.2. Background

The U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968 (P.L. 90-448). The NFIP was envisioned as a program that, over time, would provide management measures to reduce vulnerability to flood damage while providing a flood insurance safety net for individuals. Then, as now, flood insurance was not generally available through the commercial markets.

The NFIP is a Federal program that enables property owners in participating communities to purchase insurance as a protection against flood losses. A community's participation in the NFIP is voluntary and is based on a partnership between the community and the Federal Government. If a community adopts and enforces a floodplain management ordinance (including adopting the FEMA-created flood hazard map for the community) to reduce future flood risk to new construction in floodplains, the Federal Government will make flood insurance available to individual property owners within the community as a financial protection against flood losses.

The NFIP provides an alternative to continual outlays in Federal disaster assistance funds in two ways. First, the floodplain management and mitigation measures that are put in place by

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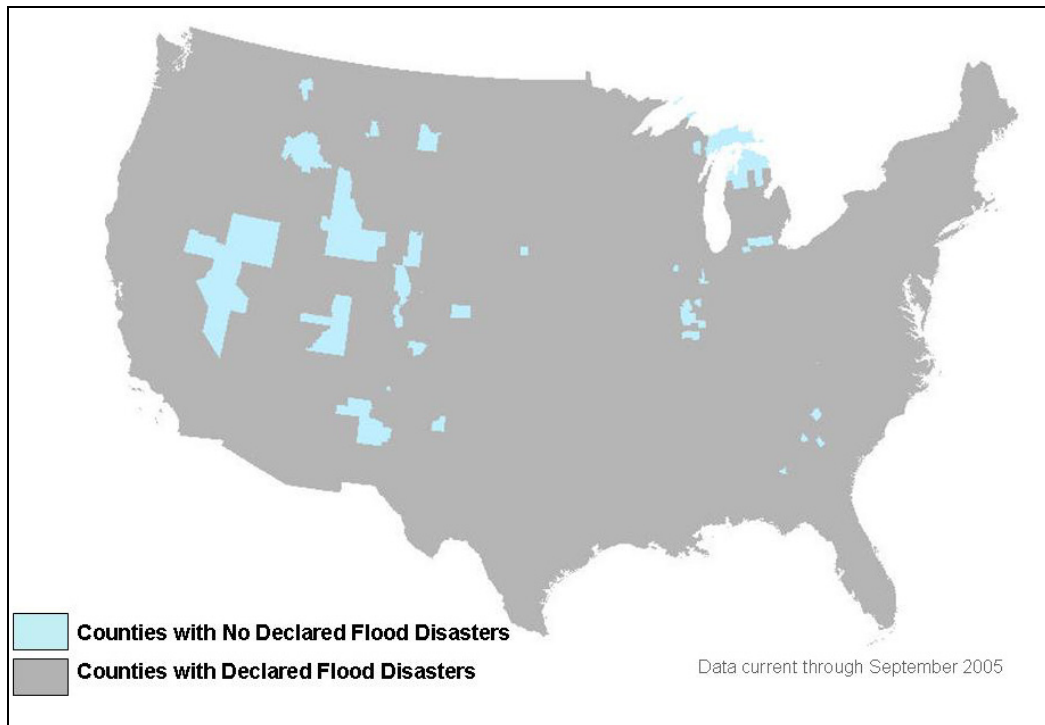


Figure 1-1. Presidential disaster declarations for floods are made throughout the Nation.

communities that participate in the NFIP operate to reduce future flood damage to buildings and their contents. Second, the flood insurance policies purchased by individual property owners in those communities not only help people recover from flooding more quickly but also partially shift the costs of flooding from the Federal taxpayers to those whose properties are at risk (figure 1-1).

To determine which areas are prone to flood hazard, the 1968 Act authorized the Federal Government “to identify and publish information with respect to all floodplain areas, including coastal areas located in the United States” that have such areas and then “to establish or update flood-risk zone data in all such areas, and make estimates with respect to the rates of probable flood caused loss for the various flood risk zones for each of these areas.” Over the years, the NFIP developed several types of paper maps and related products to identify flood hazard areas in accordance with this direction, including detailed engineering studies of floodprone areas, maps of the floodplain boundary, zones of different levels of risk, maps of the floodway portion of the floodplain, and other information as needed.

Most of the over 20,000 floodprone communities in the United States that participate in the NFIP have been mapped. Each of those communities has received one or more paper map sheets (or “panels”). Supporting engineering data, flood profiles, and additional information have also been provided to many of these communities. Through the NFIP, over 100,000 flood map panels have been produced for the Nation.

The Flood Map Modernization initiative was established to provide a more cost-effective, long-term solution for updating, maintaining, storing, and distributing the flood risk information portrayed on these flood maps. Digital technology had overtaken traditional cartographic techniques and brought the potential for vastly improved maps, more efficient production, enhanced flexibility, and easier updating. In addition, there were some concerns about the accuracy of the older maps, as conditions on the ground had changed with growth and development. Section 575 of the 1994 National Flood Insurance Reform Act (P.L. 103-325) prescribed for the first time that the need to revise and update the flood maps be reviewed on a 5-year cycle. Further, Section 576 of the legislation established the Technical Mapping Advisory Council (TMAC) to advise FEMA on mapping.

TMAC operated from 1995 to 2000 as a forum through which FEMA obtained expert input on various mapping issues, including the modernization of the mapping program. The TMAC forum allowed for the collaborative development of the map modernization effort by FEMA, other Federal agencies, and key stakeholders, as defined by the legislation. TMAC published annual reports in each of the 5 years of its existence, including a final summary report that was presented to the FEMA Director (Technical Mapping Advisory Council, 2000).

FEMA developed an initial strategy for Flood Map Modernization, and provided a program vision for a 5-year, \$1 billion program. Recognizing these limited resources and the fact that digital maps could dramatically improve the Nation's flood loss reduction efforts, FEMA determined that the best management approach was to emphasize a total conversion of the paper map inventory to a digital format including a high-quality base map. In addition, it was planned that flood risk data for about 20 percent of the existing maps would be updated. Flood Map Modernization was designed to achieve this vision, as well as to respond to Congressional intent and stakeholder input, by leveraging program resources through partnerships with other Federal agencies and State and local governments involved in the NFIP. This vision was first released in 1997 and subsequently updated and refined in 1999 and 2001 in *Modernizing FEMA's Flood Hazard Mapping Program: A Progress Report*.

1.3. Vision of Flood Map Modernization

The overall vision of Flood Map Modernization is to use a technology-based foundation to improve the manner in which flood risk maps are made, distributed, and revised, while using improved engineering tools and analysis to update the flood maps so that they reflect physical changes that have occurred since the original mapping.

In addition to providing digital flood maps for the Nation, Flood Map Modernization was designed to provide for engineering updates, which include new engineering analysis, validation of existing flood data, or the development of new flood data for stream miles or areas not previously studied. In some cases, the existing flood data is found to be adequate based on a current evaluation of the flood history within the community and whether significant changes have taken place that might

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have altered the severity of the flood hazard. Flood data that is determined to be adequate and that requires no update is considered validated.

The Flood Map Modernization initiative also contributes to the strategic plan goals of the Department of Homeland Security, specifically the third goal: “Safeguard our people and their freedoms, critical infrastructure, property and the economy of our Nation from acts of terrorism, natural disasters, or other emergencies.” Identifying the risk is the first step in safeguarding the public, and Flood Map Modernization plays an essential role in providing this foundation for managing flood hazards.

The goals of the Flood Map Modernization initiative as stated in 2001 (based on an inventory of 105,700 panels) were:

- Transform the current paper inventory into a digital product that includes detailed base maps and other information that will enhance the utility and usefulness of the maps.
- Produce 74,500 digital map panels to replace existing paper maps.
- Produce 17,500 digital map panels to replace existing paper maps and also incorporate updated flood information. (An estimated 38,500 stream miles would be updated.)
- Produce 13,700 digital map panels with updated flood information for communities that had not been mapped. (An estimated 60,000 stream miles would be added.)

In other words, the Flood Map Modernization vision in 2001 was to convert approximately 80 percent of existing paper map panels to digital format with a high-quality base map, update 20 percent of the existing panels with new flood risk information while converting them to digital format, and add 13,700 completely new panels (also in digital format) to cover previously unmapped communities.

This allocation of effort was guided by the budget of \$1 billion, recognition of the fact that the flood data on many maps was still adequate, and an appreciation that the risk information provided on the map should match the end user’s needs. For example, for many low-population areas with little or no growth potential it was considered appropriate to convert the existing flood maps from paper to digital form, but not to spend additional resources to provide engineering data that would quantify the risk in detail.

Compared to paper maps, digital maps have several advantages:

- Communities are provided with a high-quality, up-to-date base map. This vastly improves map utility because many more roads and other features are shown than on the paper maps.
- The map can be updated easily, by adding or removing data without having to change all the other elements in the map. For example, if the street system of a growing community is expanded, the new street data can be inserted into the digital map without the time and expense of recreating the other information.

What is a Map Panel?

A “map panel” is a representation of geographic area that depicts flood risk information as well as such basic features as the road network and community boundaries. A small community could have its entire flood hazard area depicted on one map panel, while it could take hundreds of panels to portray the floodprone area of a geographically large county. Under the original scheme it has taken an estimated 100,000 panels to cover the most floodprone areas of the Nation. Because of the flexibility in the scale of digital cartographic methods, it is estimated that a seamless digital map from coast to coast would require at least 250,000 panels. Two typical map panels are shown below: an older, paper panel on the left, and a digital panel of the same area on the right.



- Map data and the output from engineering flood analysis models can be communicated electronically, which makes data transfer more efficient and more accurate.
- Updated topographic information can be inserted to better match flood data to the land surface.
- Information can be stored in an electronic data network rather than in a warehouse. This facilitates storage, retrieval, and version control, and eliminates the deterioration that is inevitable with paper products.
- Maps and supporting data can be shared via the Internet.
- The costs for maintenance and update are reduced. This advantage is extremely important because flood risk is continually changing as our Nation’s watersheds are developed and the land surface is transformed into a more urbanized setting. Floodplain maps must be periodically updated to reflect changing flood risks.

- The digital system allows FEMA to delegate more easily portions of the mapmaking processes to its State and local partners.

The many practical uses of flood maps, and the benefits of modernizing them, are explored in section 3 of this report.

1.4. Challenges in Implementation

The four challenges discussed below have been the main drivers of the future course of Flood Map Modernization. FEMA's resolution of each of them, combined with other lessons learned and the original vision of the initiative, have resulted in the course adjustment FEMA is now implementing (described in more detail in section 2.3).

1.4.1. More Mapping Needs

The impressive results being achieved with digital products, coupled with the program's momentum, have resulted in FEMA's receiving two to three times as many requests from State and local partners to update flood risk data on more map panels than originally envisioned, in addition to converting the maps to digital format. It has been recognized that, for certain areas, additional updates may be essential to ensure the usefulness and the acceptability of flood maps.

1.4.2. Accuracy of Floodplain Boundaries

An early concern of Congress, the GAO, and Flood Map Modernization's stakeholders was that some of the mapped flood risk zone boundaries that were planned to be digitally transferred would not adequately reflect the true flood boundary.

This concern is due to two changes in the characteristics of the mapping process. First, in the paper mapmaking process, horizontal distortions occur that can be corrected in the digital environment. Second, in the digital environment, it is possible for a mapping specialist to compare various other data layers such as photos, ground topography, and base maps that ensure that the transferred boundary is adequately positioned to reflect the "field" condition. By matching the transferred boundary to the ground topography, it is possible for the specialist to make adjustments that allow for the transferred boundary to provide a "best fit" of the ground condition. One must use techniques of matching available flood data to digitized elevation data to alleviate these inaccuracies. This step of matching the floodplain boundary to topography, while certainly a good practice, was not a specified standard.

A new Flood Boundary Standard was implemented to correct this potential problem (see section 2.2). Adherence to the new standard requires a mapping specialist to compare the flood boundary with the topography and make adjustments needed to ensure that the boundary properly follows the terrain. This single step helped rectify many of the basic concerns expressed by Congress and stakeholders.

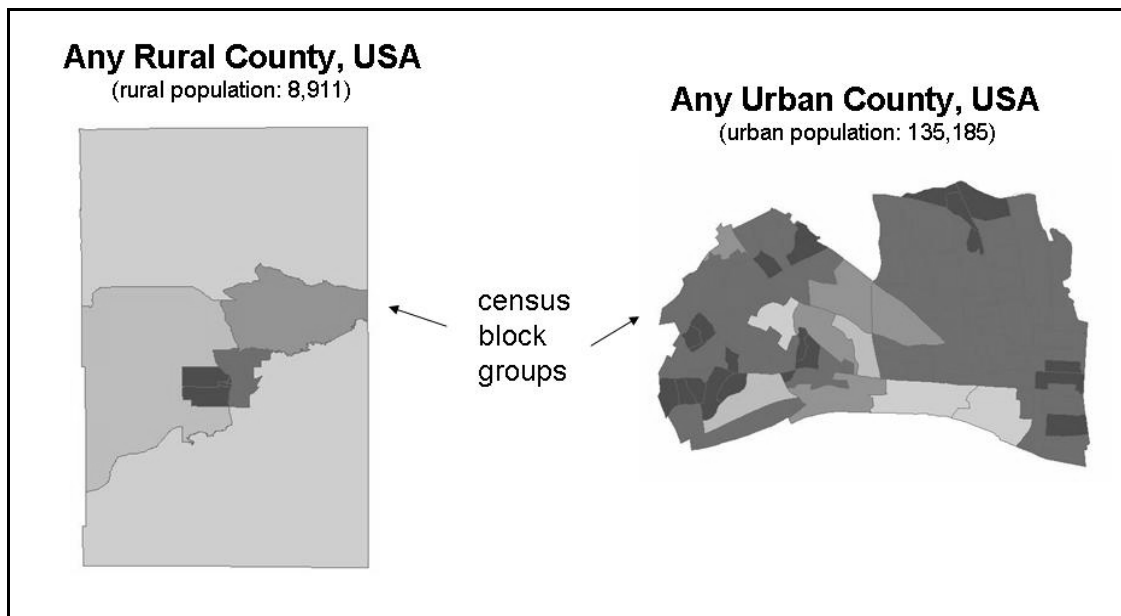


Figure 1-2. Flood mapping by census block group allows for more detailed attention to areas with higher flood risk.

Because many flood maps had been produced before this standard's adoption in September 2005, FEMA began looking back at the flood hazard maps that were produced before the standard was established to determine the condition of the flood hazard data reflected on the maps. FEMA determined that the implementation plan for Flood Map Modernization should be adjusted to allow for relatively minor touchups to the maps of those stream miles that do not meet the new standard.

1.4.3. Risk-based Priorities

The fact that certain parts of the Nation are developing rapidly and need to be studied to determine the flood hazard before risky construction takes place sharpened appreciation for the possibility that some high-risk areas may need attention ahead of the projected schedule. To account for this situation, FEMA refined its method for prioritizing mapping funds by county so that the projects effectively target the specific portions of counties that have the most need for a flood study.

Beginning with FY2006 funding, FEMA is allocating mapping funds based on prioritized census block groups rather than on prioritized counties (figure 1-2). Block groups are the smallest geographic unit for which the U.S. Census Bureau tabulates sample data. This adjustment will allow for additional focus on those areas that comprise 90 percent of the Nation's risk, and account for 92 percent of the Nation's population.

1.4.4. Measurements of Progress

Before Flood Map Modernization, counting map panels was a convenient way to inventory the Nation's flood maps, because each panel covered a given area and the number remained fairly constant for a region. With geographic information systems (GIS), however, the scale of a flood map can readily be tailored to show whatever details are needed for its purpose. Thus the size of the "panels" and the number of panels needed to cover the Nation are no longer constant. A different metric now is required to more effectively measure progress. FEMA determined that stream miles (including shorelines of the open ocean, lakes, and ponds) were a more effective means of monitoring the progress of the mapping program.

The number of stream and coastal miles in the Nation, unlike the number of map panels, is fixed and thus provides a standard against which progress can be measured. Using stream miles rather than rectangular panels also allows depiction of a specific potential hazard so that differing vulnerabilities to flooding can be targeted individually. Further, it permits more precise identification of areas that need additional attention, whether it be new flood data or a review of whether the mapping standards are being met along that reach of stream.

2. Flood Map Modernization Output and Progress

The conversion from a paper map system to a digital system is a monumental step forward and revolutionizes how flood maps are maintained, stored, and distributed. The nationwide conversion to digital maps yields a dramatic improvement in the efficiency of the process of making, using, and updating flood maps.

Along the way, there have been changing expectations of the Federal role in modernizing the existing flood hazard maps. While continuing along the original course set for the 5-year Flood Map Modernization initiative, FEMA also has solicited input from stakeholders and has adopted refinements to this course that are necessary to meet the additional needs articulated by stakeholders and the unanticipated challenges of entering a fully digital flood map world.

Although the primary emphasis so far has been to push forward for a complete digital conversion, FEMA determined that a course adjustment is now warranted. This decision is based on FEMA's deepened understanding of the Nation's map modernization needs as a result of its experience in the first few years of implementing the initiative. The challenges listed above (and described in more detail throughout this section) have been met, and FEMA has developed ways to adjust the course of Flood Map Modernization (see section 2.3) so that more attention can be given to more of the at-risk areas of the Nation, while still producing high-quality digital maps.

2.1. Initial Program Schedule and Projections

The initial schedule and projected achievements for Flood Map Modernization were developed over a number of years as program managers and stakeholders came to realize fully the broad scope of the uses of FEMA's flood hazard maps, the need to bring them into a digital format, and the need to update maps that no longer accurately depicted flood risk. The key milestones in the conceptualization of Flood Map Modernization (also shown in figure 2-1) have been:

1. Technical Mapping Advisory Council (TMAC) formed
2. Recommendations for the modernization process and policy articulated by TMAC
3. Flood Map Modernization vision articulated by FEMA in 1997, 1999, and 2001
4. Office of Management and Budget planning for 5-year Presidential initiative
5. Flood Map Modernization defined (balanced scorecard approach applied, performance indicators defined)
6. Flood Map Modernization initiative underway
7. Additional mapping needs identified by State and local officials
8. *Multi-Year Flood Hazard Identification Plan* published, with its appendix, "Detailed Production Report: Sequencing by County"
9. Cycle of refinement to original plan.

Output and Progress

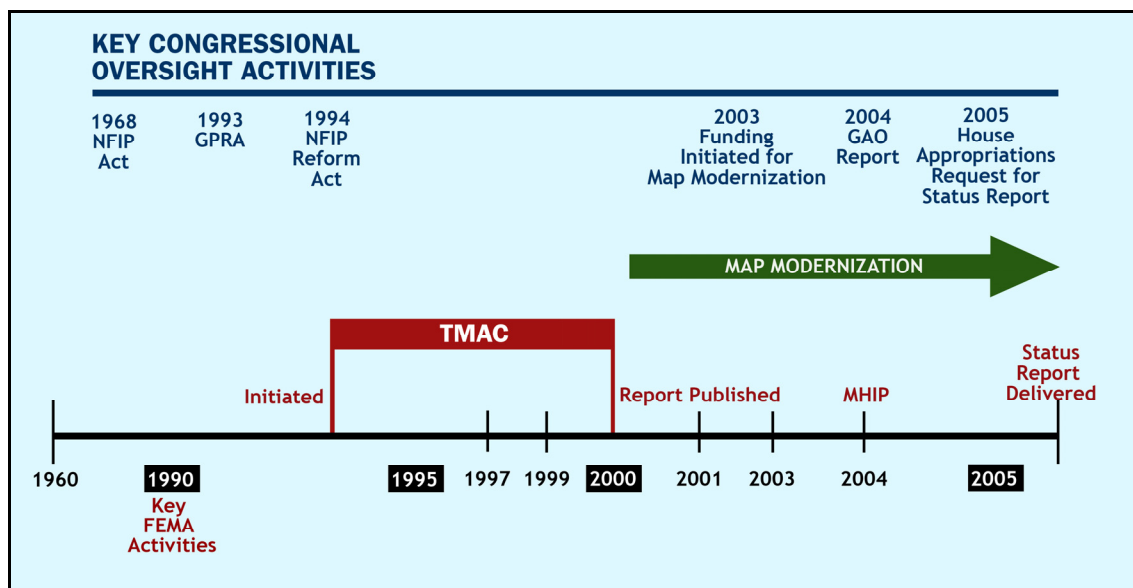


Figure 2-1. Key milestones have marked the progress of the Flood Map Modernization initiative.

FEMA's original vision for Flood Map Modernization was to provide modernized flood hazard maps to all floodprone areas of the Nation. The goals of the initiative as stated in *Modernizing FEMA's Flood Hazard Mapping Program: A Progress Report* (2001) were to convert approximately 80 percent of existing paper map panels to digital format with a high-quality base map, update 20 percent of the existing panels with new flood risk information while converting them to digital format, and add 13,700 completely new panels (also in digital format) to cover previously unmapped communities.

2.2. Status of Flood Map Modernization Output

Progress in the production of modernized flood maps for the Nation can be assessed in three ways: (1) the percentage of the Nation's population with digital flood maps available; (2) the proportion of stream miles mapped that is based on new, updated, or validated engineering; and (3) the land area covered by digital maps. One of the challenges noted above was that the anticipated measure of progress (number of map panels converted and updated) was discovered to be an ineffective means of tracking how much of the Nation's flood risk had actually been committed to digital format. Hence, FEMA developed and adopted these three measurements as additional ways to assess progress towards initiative goals. These measures also respond to recommendations and requests from Congress, the Office of Management and Budget (OMB), GAO, the IG, and stakeholders. As of the end of FY2005, FEMA estimates this progress in Flood Map Modernization:

- Digital flood map products are available for 39 percent of the Nation's population.
- 11 percent of the stream miles mapped have been based on new, updated, or validated engineering analysis, covering 4 percent of the population.

- Digital flood map products cover 15 percent of the land area of the continental United States.

2.2.1. Percentage of Population with Modernized Flood Maps

In response to GAO recommendations, FEMA adopted goals for Flood Map Modernization that could be tied to progress over the 5-year initiative in easily measurable ways. This approach is commonly called the “balanced scorecard approach” and is structured around “key performance indicators.”

Two indicators that tie directly to the output of the Flood Map Modernization initiative are:

- Population with digital GIS flood data available online
- Population with adopted flood maps.

These are meaningful, measurable indicators of Flood Map Modernization performance. (More discussion of the performance indicators and the balanced scored can be found in section A.2 of appendix A.) Independently, they indicate the dissemination of the modernized maps in a preliminary format to end users and the acceptability of the modernized maps through their adoption by the communities that use them for floodplain management. To be counted toward these two measurements, the mapping project must meet the “modernized map” definition, which includes:

- Must result in a Digital Flood Insurance Rate Map (DFIRM) and include a DFIRM database
- Must have a base map that meets the current specifications
- Must result in a DFIRM that covers at least the entire area of one community—no partial DFIRMs are counted toward the metrics
- Must not have already been counted toward the metrics.

By the end of FY2005, FEMA had provided 39 percent of the Nation’s population with digital flood data. This includes the population that benefits from each project once it is issued in preliminary form to the county and/or communities within each county. By the end of the second quarter of FY2006, FEMA anticipates that the percentage of the population covered will have risen to 45 percent.

Modernized maps have been officially adopted by jurisdictions that represent 13 percent of the Nation’s population. This includes the population that benefits from each project once it is adopted by the governing body of the county and/or communities within each county. Through the second quarter of FY2006, FEMA anticipates that the percentage of the population with adopted modernized maps will have reached 15 percent.

2.2.2. Stream Miles with Modernized Maps

There are approximately 3.5 million stream miles of floodplains in the United States. Before Flood Map Modernization, the flood risk of about 1 million of these stream miles had been depicted on the paper maps as the product of either an approximate or a detailed engineering study. Of the unstudied 2.5 million miles, it is estimated that nearly 1 million lie on Federal lands or in areas so remote that the need to map their flood hazard is quite unlikely. This means that, as the Nation continues to grow, the potential inventory of mapped flood hazards will be between 1 million and 2.5 million stream miles.

At the end of FY2005 it is estimated that one-third of the nation's stream miles (approximately 1.3 million miles out of 3.5 million total miles) had been evaluated. Of the 1.3 million miles evaluated, 400,000 miles are included on FEMA mapped products. The unmapped stream miles typically are areas with minimal current flood hazard, or those with insufficient development potential to warrant current expenditures of mapping dollars.

At the conclusion of Flood Map Modernization, it is estimated that a 20 percent increase in the number of stream miles mapped will be realized, resulting in 1.2 million stream miles being captured on FEMA flood maps.

2.2.3. Areal Extent of Modernized Flood Maps

The status of Flood Map Modernization also can be assessed in terms of the areas of the Nation for which maps have been modernized—that is, the county has received some Flood Map Modernization funding for its project, the modernized map for the county has been issued in preliminary form, or the modernized map has been adopted for floodplain management use by local officials. Digital flood map products cover 15 percent of the land area of the continental United States. A map displaying this data is updated at the end of every fiscal year and is published in FEMA's *Multi-Year Flood Hazard Identification Plan* (MHIP) as a report of production to date.

2.3. A Course Adjustment

During the initial planning for Flood Map Modernization, FEMA determined that the initiative's first priority should be the full digitization of all flood maps in the Nation. The plan was that, during the initiative, about 80 percent of the map panels would simply be converted to a digital format, about 20 percent of the map panels would require both engineering updates and a digital conversion, and another 13,700 new digital panels would be created for areas that had not been mapped previously.

With 2 years of program experience and based on input from Congress, requests for engineering updates submitted through annual State business plans, adoption of the 2005 Floodplain Boundary Standard, and feedback from stakeholders, FEMA decided that a course adjustment is warranted. FEMA determined that delaying the goal of having a nationwide digital flood layer, in favor of having more focus on ensuring compliance with the 2005 Floodplain Boundary Standard (described

in section 2.4.6 below) and providing additional resources for engineering analysis, will better meet the near-term needs of the map users and the Nation.

Accordingly, beginning in FY2006, FEMA is prioritizing funding based on mapping 90 percent of the Nation's flood risk using the census block group level of detail (described in section 2.4.4). This, combined with implementation of the 2005 Floodplain Boundary Standard, will address many of the more immediate needs of the program, even though it will lead to a delay in achieving a national digital flood layer.

FEMA designed the "adjusted" course it is now implementing for Flood Map Modernization to be responsive to user and Congressional input and, based on improved data collected as part of the initiative, to provide a sound direction for the future. Recognizing that demand for new products may exceed current budgets, FEMA is attempting to balance several competing objectives. FEMA's modified objectives for the initiative are (1) producing new digital products; (2) providing new, updated, or validated engineering analysis; and (3) integrating the 2005 Floodplain Boundary Standard into the digital maps.

The new estimates of the digital products that will result from the new course direction (expressed on the basis of population) are:

- 92 percent of the Nation's population will have new digital flood maps.
- 40 percent of the Nation's population will have maps that encompass stream miles based on new, updated, or validated engineering analysis.
- 80 percent of the Nation's population will have maps that encompass stream miles that meet the 2005 Floodplain Boundary Standard.

Table 2-1 shows that, with the adjusted course, more engineering analysis will take place and there will be a higher level of compliance with the Floodplain Boundary Standard than would have been possible under the course originally intended. On the other hand, there will be a decrease in the total land area being mapped and the percentage of U.S. population receiving a digital map product.

Providing a digital flood layer for the entire Nation continues to be an important program goal because it will simplify the development, update, and distribution of flood maps, and provide immediate benefit to many areas that simply needed an improved base map or the benefit of being able to work with digital data. While this remains important, achieving 100 percent nationwide coverage will necessarily be delayed in favor of the vitally important goals of providing more detailed and accurate digital maps for those parts of the Nation that have the highest flood risk and ensuring that the floodplain delineations on the digital maps meet the Floodplain Boundary Standard. FEMA's decision to prioritize mapping needs based on census block groups allows for

Output and Progress

Table 2-1: Comparison of Flood Map Modernization Output, Original Course vs. Adjusted Course

	Original Course	Adjusted Course
Percentage of mapped stream and coastal miles meeting 2005 Floodplain Boundary Standard	57%	75%
Percentage of population covered by maps meeting 2005 Floodplain Boundary Standard	32%	80%
Percentage of mapped stream and coastal miles with new, updated, or validated engineering analysis	22%	30%
Percentage of population covered by maps with new, updated, or validated engineering analysis	15%	40%
Percentage of land area of continental United States covered by digital flood maps	100%	65%
Percentage of U.S. population covered by digital flood maps	100%	92%

deployment of resources in a manner that optimizes benefits for the largest proportion of the Nation’s population.

In furtherance of the second objective, providing new, updated, or validated engineering analysis, FEMA has collected additional data about mapping needs as part of the Flood Map Modernization initiative. Before Flood Map Modernization, it was generally understood that insufficient funding existed to provide timely, comprehensive updates to flood maps. Funding of the Flood Map Modernization initiative has led to the development of State-led business cases and the creation of other tools that now are identifying a colossal demand for new flood data and mapping that far exceeds the scope that was originally envisioned. Slowing down the digital conversion and providing additional resources for engineering analysis will alleviate some of this demand.

The third objective of the initiative is compliance with FEMA’s 2005 Floodplain Boundary Standard. High quality has always been an important goal throughout the Flood Map Modernization effort. FEMA issued several standards to ensure that flood maps achieve an appropriate degree of consistency and quality, ranging from the engineering analysis to how maps are created to the final visual presentation of the map itself. As experience was gained with converting existing maps to digital format during Flood Map Modernization, the need for a new standard for delineating the boundary of the floodplain was revealed.

Digital conversion of the paper map was the major impetus of this standard. If the task is to provide a digital representation of the existing map, then the map can simply be converted. However, when engineering data is being moved to the new digital platform, there is necessarily an additional objective of ensuring that the data depicted corresponds to the configuration of the land surface and other ground-level conditions. FEMA determined that the best means of ensuring consistency in the flood data shown on the new digital maps was to include a step that entailed matching the existing flood boundary to the best available topographic information. Because this new standard was introduced halfway through the initiative, those stream miles mapped before the effective date of the new standard need to be checked, and touchups made to some of them, to ensure that they meet this essential standard.

2.4. Status of the Flood Map Modernization Process

With Flood Map Modernization well underway, FEMA is managing a large and complex program that utilizes both FEMA resources and the resources of other Federal agencies and State and local entities that produce new flood maps directly for FEMA. FEMA provides the management system, guidelines, technology, and digital Web-based infrastructure necessary to support the Flood Map Modernization initiative and to standardize the flood map study production cycle. The essential components of this effort were identified as applying upgraded tools and software to the production process, requiring that rigid guidelines and specifications be adhered to, and instituting data capture standards. The major advances FEMA has made in the process for modernizing the Nation's flood maps are listed below.

2.4.1. The Mapping Information Platform

In the fall of 2004, FEMA launched the Mapping Information Platform (MIP) as the basic building block of Flood Map Modernization's Web-based infrastructure. In subsequent months, it enhanced this environment to provide upgraded engineering and mapping tools to its partners. The MIP serves as a management platform for all flood map study projects nationwide, serves as a "dashboard" for program managers and the public to determine the current status of Flood Map Modernization, and is the Web-based location where all of FEMA's partners post and share data developed for all flood study projects. The MIP can be accessed at <http://www.hazards.fema.gov> (figure 2-2). The MIP is enhanced continually to provide upgraded engineering and mapping tools to FEMA's mapping partners. FEMA is already seeing the benefits of the MIP's capacity for streamlining the process of turning data into useful information.

Output and Progress



Figure 2-2. The Mapping Information Platform is the Web-based location for posting and sharing flood study data.

2.4.2. The Multi-Year Flood Hazard Identification Plan

FEMA has published a detailed plan for modernizing the Nation's flood maps—the *Multi-Year Flood Hazard Identification Plan* (MHIP) (figure 2-3). A critical element of the MHIP is the Detailed Production Report: Sequencing by County (Appendix A), which lists every county in the Nation and the dollars that FEMA anticipates applying toward the modernization of its maps during fiscal years 2004 through 2008. The detailed Production Report further identifies the year in which every project is anticipated to be funded, maps are issued in preliminary form, and maps go into effect. The MHIP can be accessed at http://www.fema.gov/plan/prevent/fhm/mh_main.shtm.

The purpose of the MHIP is to identify FEMA's plan for prioritizing and delivering modernized flood maps for the Nation and provide a means to share that plan with affected communities; Federal, State, and local flood mapping partners; and the various users of flood maps. It also reports to Congress, OMB, and other national stakeholders how FEMA is delivering digital flood maps for the Nation. As more and more information is entered into the Web-based MIP and the MIP becomes more fully utilized, it will provide great detail on each flood map modernization project's plan and schedule. The MHIP will continue to provide a national view of the flood map delivery funding and schedule.

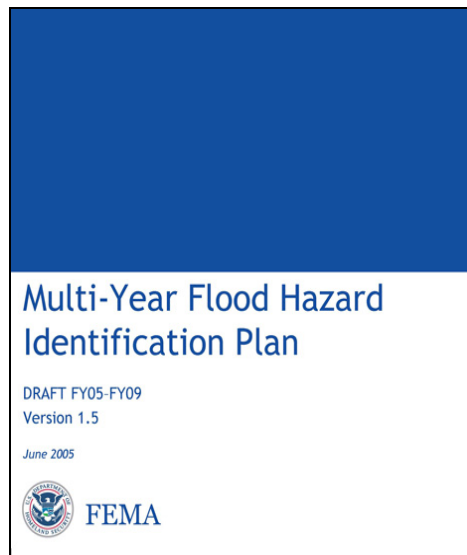


Figure 2-3. The *Multi-Year Flood Hazard Identification Plan* gives details on the plans and schedules for Flood Map Modernization.

FEMA first provided the MHIP on its Flood Hazard Mapping Web site in November 2004. After this initial sequencing, FEMA established an ongoing “cycle of refinement” that allows for improvement to and adjustment of the original MHIP (figure 2-4). The MHIP was updated in June 2005 and will be updated at least annually based on the State and regional business planning process and feedback from stakeholders. The following planning activities occur at least annually and are carried out by a variety of Flood Map Modernization partners. There is an interdependency among:

- Annual State business planning
- Annual regional business planning
- Adjustments to sequencing for the current fiscal year and remaining future fiscal years
- Continuous stakeholder engagement (special meetings, conference participation, MHIP comment cycle, etc.).

Every year, States are provided the opportunity to refine their existing flood map modernization business plans using guidance and funding provided by FEMA. These plans offer the State-level interpretation of and expectations for Flood Map Modernization. Upon receipt, FEMA’s 10 regional offices review and analyze the State business plans. With this awareness, the regional office staff can make revisions, as needed, to the sequence and funding distribution at the State and county levels. The regional office staff then documents these decisions in the Regional business plan for Flood Map Modernization.

Output and Progress

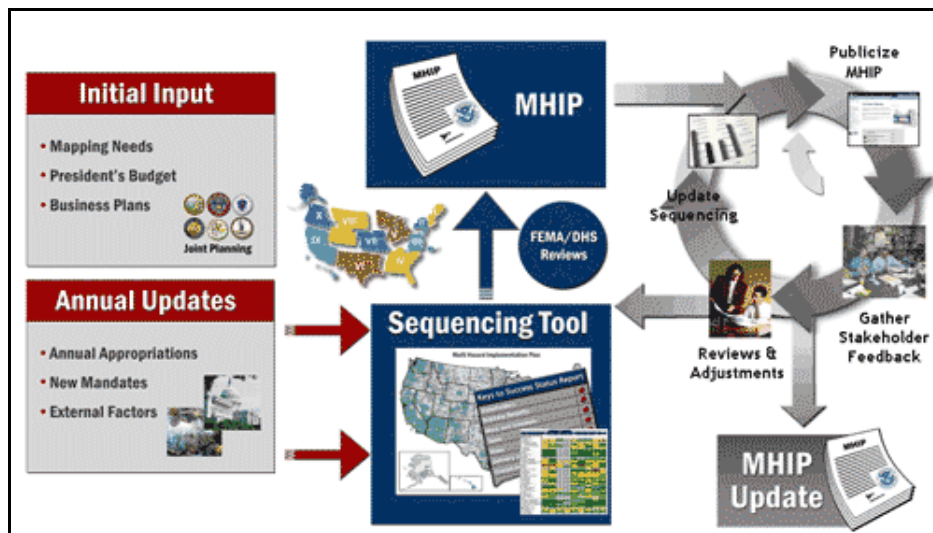


Figure 2-4. The Multi-Year Flood Hazard Identification Plan is refined annually.

Each year, when the published MHIP reflects the latest sequencing, FEMA conducts a formal comment period that solicits feedback from stakeholders on the plan. This has proven to be an effective communication strategy for FEMA over the past year and a half.

In an effort to continuously engage stakeholders, FEMA consistently hosts special meetings, participates in conferences, and responds to comments that are submitted during the formal comment period for the MHIP.

2.4.3. Risk-based Mapping Priorities

FEMA has instituted a ranking/prioritizing process (called “sequencing”) to determine which areas should be given the highest priority in receiving modernized maps (the Detailed Production Report that appeared as appendix A of the *Multi-Year Flood Hazard Identification Plan* (Version 1.0, November 2004). Using a series of contributory factors, every county in the Nation has been assigned a “risk factor.” This is the value used by FEMA to assign each county a place in the FY2004 to FY2010 timeline and make decisions about effective allocation of study funds and priorities. The factors used in this monumental task were:

- Population
- Population growth
- Housing units
- Flood insurance policies
- Flood insurance claims
- Repetitive loss claims
- Repetitive loss properties annually
- Declared flood disasters.

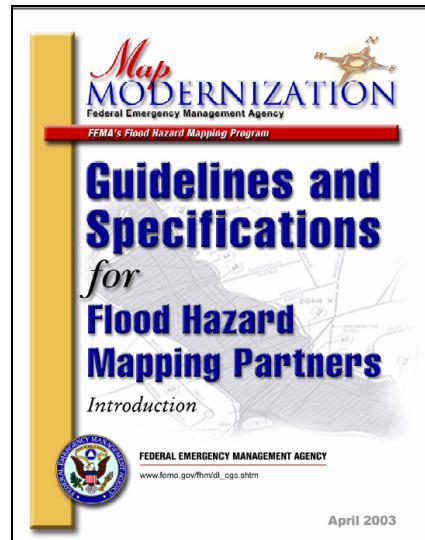


Figure 2-5. *The Guidelines and Specifications for Flood Hazard Mapping Partners helped standardize flood mapping nationwide.*

In general, counties with relatively high population density and population growth between 1990 and 2000 have the highest risk factors and are high-priority targets for new maps. More rural counties that have lower population density and in some cases, even population decline, along with less flood risk, are in the lowest groups.

2.4.4. Census Block Groups

Beginning with FY2006 funding, the sequencing described above will be based on prioritized census block groups rather than on prioritized counties. Block groups are the smallest geographic unit for which the U.S. Census Bureau tabulates sample data and thus they allow FEMA to carefully target resources to the smallest necessary area. This adjustment will allow for additional focus on those areas that account for 90 percent of the Nation's risk and 92 percent of its population.

2.4.5. Specifications for Flood Mapping

A major achievement in coordinating and fostering accuracy and consistency in flood mapping nationwide was the release of FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners* (figure 2-5) (available at http://www.fema.gov/plan/prevent/fhm/gs_main.shtm). In this document, FEMA defines the technical requirements and product specifications for flood hazard maps and related NFIP products, and associated coordination and documentation. The guidelines combine FEMA's technical, programmatic, and administrative procedure publications, guidance documents, and memoranda on flood hazard mapping. They also reflect changes to processes and products that have come about with Flood Map Modernization, such as the data capture standards

and guidelines. When needed, FEMA updates the *Guidelines and Specifications* by first proposing draft changes to its mapping partners. Along with every draft change, FEMA conducts a formal comment period to solicit feedback before finalizing changes to the guidelines.

The *Guidelines and Specifications* are broken into three volumes and 14 appendixes pertaining to specific and unique aspects of flood map modernization.

- Volume 1 explains the activities involved in the completion of Flood Map Projects and provides guidelines for performing those activities in five phases: mapping needs assessment, project scoping, topographic and flood hazard data development, map and report production, and preliminary/post-preliminary processing.
- Volume 2 provides guidelines for conditional and final revisions and amendments to flood hazard maps initiated by communities and other mapping partners.
- Volume 3 gives guidelines and specifications for support activities performed for FEMA by mapping partners, such as program coordination, technical and program support, and public outreach.
- Appendixes A through N of the *Guidelines and Specifications* give guidance on the processes and products associated with aerial mapping and surveying; datum conversions; hazard analyses and mapping of riverine, coastal, shallow, ice-jam, and alluvial fan flooding; evaluation and mapping of flood protection systems; digital data and DFIRM database preparation; and data capture standards, which require that all data developed in support of flood hazard maps meet a standardized file format and fashion when uploaded to the MIP.

2.4.6. Ongoing Guidance on Flood Mapping

Procedural memoranda are published as needed to resolve and document emerging issues and establish standards that must be adhered to by mapping partners. These memoranda allow FEMA to communicate these requirements in between more rigorous updates of the *Guidelines and Specifications*. Section 7 of FEMA's *FY04-FY08 Multi-Year Flood Hazard Identification Plan* (Version 1.0, issued November 2004) established a Floodplain Boundary Standard that must be met in order for a map to be considered "modernized." Guidance on implementation of the standard was issued to mapping partners in Procedure Memorandum No. 38, "Implementation of Floodplain Boundary Standards (Section 7 of MHIP V1.0)."

This Floodplain Boundary Standard was developed through a series of meetings in the summer and fall of 2004 involving FEMA regional and headquarters staff, as well as floodplain management officials at various levels of government (State, local, and multijurisdictional). The publication of this standard and the subsequent guidance for implementing it are two significant strides that FEMA has made to listen to stakeholders and to specify clearly to its mapping partners the expectation that all modernized maps must meet these flood hazard boundary standards.

With the standard in place, the potential inaccuracy of simply transferring an improperly drawn boundary from a paper map to the digital format is avoided. Maps that were converted to digital format before the standard was in place are being checked and touchups made as needed so that all Flood Map Modernization products will meet the standard. At the end of the 5-year Flood Map Modernization initiative, FEMA can present this information as documentation of some of the needs that were not met.

2.4.7. Stream Mile Measurements

The higher level of detail and accuracy available with digital mapping techniques is enabling FEMA to shift to the use of stream miles (including shoreline for the open ocean, lakes, and ponds) as a measure of progress, rather than map panels. The number of stream and coastal miles in the Nation is fixed and thus provides a standard against which progress can be measured.

Using stream miles rather than rectangular panels also allows depiction of a specific potential hazard so that differing vulnerabilities to flooding can be targeted individually. Further, it permits more precise identification of areas that need additional attention, whether it be new flood data or a review of whether the mapping standards are being met along that reach of stream.

There are about 3.5 million stream and coastal miles of floodplains in the United States. Of those, about 1 million lie within Federal lands (such as national parks and military bases). Of the remaining 2.5 million miles that are or could be subject to some degree of flood risk due to development, about 1 million have been the subject of some type of flood hazard analysis. Thus, full digital flood map coverage of those portions of the Nation that face some flood risk will range between 1 and 2.5 million stream miles.

2.4.8. Federal, State, and Local Leverage

As part of the 5-year Flood Map Modernization initiative, FEMA was encouraged to share the responsibility for modernizing the flood hazard maps with State and local partners by providing grants to them to complete tasks associated with Flood Map Modernization. Also, FEMA identified partners who were already developing data and performing activities that would ultimately benefit Flood Map Modernization by elevating the condition of the final flood hazard map products.

FEMA established two performance indicators to track progress toward these goals:

- Percentage of leveraged contributions toward digital flood data
- Percentage of funds sent to Cooperating Technical Partners.

Approximately 40 percent of the value of the Flood Map Modernization initiative now can be attributed to the value of leveraged data that has been contributed by FEMA's Federal, State, and local partners.

3. Flood Maps—Their Practical Uses and the Benefits of Modernization

3.1. Practical Uses and Benefits of Flood Maps

Flood maps produced by FEMA were initially intended to be used principally by insurance agents, floodplain managers, and others charged with implementing the NFIP. However, over the years the flood maps and the supporting Flood Insurance Studies and other products have become essential tools for a much wider range of users, from builders and developers to real estate agents and lenders to local planners and citizens attempting to make informed decisions about the degree of flood risk faced by particular pieces of property.

It has been estimated that flood maps are used for approximately 2 million development permit reviews each year. In 2002 there were more than 30 million uses of flood maps by lenders and insurance agents. Flood maps are used an estimated 15 million times annually for:

- Planning for emergency response and mitigation
- Applying State and community floodplain management regulations
- Planning for land use and water resources management
- Implementing Executive Order 11988 for Floodplain Management
- Calculating flood insurance premiums
- Determining whether property owners are required by law to obtain flood insurance
- Defining flood insurance premiums as a condition of obtaining mortgage loans or federally related financial assistance.

3.1.1. Preparedness, Response, and Reconstruction

Local governments use the flood maps for emergency response planning to determine areas and evacuation routes subject to flooding. For example, as Hurricane Rita was making landfall on September 23, 2005, television stations were covering the inland evacuation of thousands of people from the coast. Because of the congestion, many people were delayed and drove their cars off the roads into parking lots and side streets to wait out the hurricane. Many of these areas along the roadways were at risk from riverine flooding as the storm progressed inland. Bob Dunn, Mayor of Natchitoches, Texas, said in an interview that they had pulled out the flood maps to determine where the 100- and 500-year floodplains were so they would know where to direct these motorists so that they would be out of harm's way while they waited out the storm.

Flood maps are frequently used after a flood to help reconstruct flood conditions and assess damage. After Hurricane Katrina, FEMA Mitigation Assistance Teams toured devastated areas with copies of the FEMA map panels to guide their assessments of the effectiveness of building standards in different flood risk zones. Maps were used to obtain an early approximation of the elevation of flood waters. For example, local residents who weathered the storm were interviewed

to obtain their observation of high water marks, and buildings and trees were observed for silt lines and debris scour marks above ground level. These height estimates were compared to spot elevations provided on flood maps to estimate elevations of the observed high water marks. The information then is used to assist in post-disaster reconstruction and redevelopment.

3.1.2. Floodplain Management and Resource Management

Floodplain management is the careful combination of land use planning and regulation, flood control, and flood hazard mitigation (including flood insurance) and it all starts with accurate and current maps. Floodplain management cannot be successful if the hazard has not been identified and accurately depicted on up-to-date base maps.

Floodplain management requires that Federal, State, and local agencies work toward a common goal. In addition to the NFIP, administered by FEMA, numerous Federal programs and initiatives are critical to sound floodplain management, including those administered by the U.S. Army Corps of Engineers, the Natural Resources Conservation Service, the National Park Service, the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, the Tennessee Valley Authority, and the Environmental Protection Agency.

States must authorize local governments to adopt and implement land use regulations and then provide technical, legal, and administrative support. State agencies can set or encourage standards for floodplain management regulations that exceed the minimum standards established by the NFIP. Higher standards have been demonstrated to improve floodplain management greatly, reduce the rate of growth of floodprone buildings, and minimize actual flood damage. But higher regulatory standards start with accurate and current maps of the flood hazard.

Local governments must adopt and administer floodplain zoning ordinances, based on the data used to produce a flood map. This data helps regulate new development so that it is either located outside the SFHA or elevated to or above the Base Flood Elevations shown on the flood map. In addition, a local government should develop a hazard mitigation plan to remove or protect older at-risk structures that were built before management of the floodprone area commenced.

Hazard mitigation can employ a combination of structural measures (levees, floodwalls, and dams) and non-structural measures. Non-structural techniques include public acquisition of the floodprone land and demolition or removal of floodprone structures from the floodplain. It can also include elevation-in-place of buildings subject to low or moderate flood depths.

Adopting and administering floodplain zoning, and planning and implementing flood hazard mitigation are difficult tasks in situations where the maps are inaccurate or outdated. Both activities are impossible if flood maps do not exist.

- Communities and regional entities use the maps for land use planning, implementing floodplain zoning regulations, and hazard mitigation planning.

Uses and Benefits of Flood Maps

- Flood maps are used by county and State highway agencies in the design of bridges over rivers and in the plans for roadways in floodprone areas.
- State agencies responsible for floodplain management use the maps to help their local communities and counties in the adoption and implementation of floodplain zoning ordinances. They also use the maps to encourage other State agencies to site new buildings out of harm's way and to encourage the purchase of flood insurance for State-owned buildings that are within flood hazard areas.
- Builders and developers use the maps and studies to make more informed decisions on where and how to construct homes and commercial buildings.
- Surveyors use the maps to identify floodplain limits on subdivisions and to complete and file elevation certificates, which are required by FEMA for new construction in mapped floodplains. The benchmark notations on the maps help in the location of local elevation reference points.
- Real estate agents use the maps to inform prospective buyers if a property is subject to potential flooding.
- Many people looking to purchase property use the flood maps, which are now available over the Internet, in deciding where to buy.
- The maps are used to locate and identify delicate environmentally sensitive areas that are subject to the protections of the Coastal Barrier Resources Act.
- Federal agencies use the maps to enforce the mandatory purchase requirements of the NFIP, to prepare National Environmental Policy Act reviews, and to comply with Executive Order 11988.

An excellent example of how communities are benefiting from digital map products, even without new engineering data, can be found in Whatcom County, Washington. Because the flood data has been provided in a digital database the county has been able to merge it with other digital data making both much more useful. Whatcom County has georeferenced all permits and, by merging the digital flood map database with the permit database, is able to produce maps that show where new development is occurring relative to the flood risk.

3.1.3. Flood Insurance

Flood insurance and floodplain management work together to reduce the loss of life and property over the long term and make flood insurance more affordable nationwide, protecting citizens against much of the financial loss of flooding. Flood maps are one of the tools used to implement this strategy, not only to identify the floodprone areas so that land use and construction can be managed there, but also so that the need or requirement for flood insurance can be determined.

Within the flood hazard area of a community, FEMA further defines flood risk on the flood map through the use of flood insurance risk zones that are indicative of the flood hazard (for example, still flood water, flowing floodway, high velocity coastal flood zone, etc.). This information is vital to making several insurance-related decisions.

- Insurance agents and companies use the maps to assess their clients' current risk, offer the proper protection, and determine the proper rates depending upon a structure's location and elevation in relation to the base flood.
- Lenders use the maps when a loan application is filed to determine if a property is in an SFHA and, if so, require that flood insurance be purchased and maintained throughout the life of the loan.
- In a 2003 survey, the National Flood Determination Association found that their members performed over 33 million flood zone determinations for their clients, which include lenders, insurance companies and agents, and community officials. These determinations can only be made by consulting the flood maps.

Flood maps also help increase flood insurance participation. As part of mortgage transactions the flood maps are used to determine whether the property is within the SFHA and whether insurance might be required. This can prove to be an excellent opportunity to educate the home buyer that flood damage usually is not covered by a standard homeowners insurance policy but is available through the NFIP. This knowledge increases when individuals intend to build structures in floodprone areas and obtain floodplain development permits to identify the relationship of their building to mapped flood hazard zones. Growth in the flood insurance policy base since 2004, particularly in the special lower-cost policies for properties exposed to lower flood risk, can be partially attributed to increased public awareness of the flood hazard, which comes in part from the existence of the flood maps.

3.1.4. Quantifying Risk Reduction

Statistics on annual and monthly flood damage are compiled by FEMA. These data can be used to quantify the value of flood hazard maps in reducing national flood losses.

For example, insurable structures built in flood hazard areas before the publication of a Flood Insurance Rate Map are known as "pre-FIRM" structures, while structures built after that are termed "post-FIRM" structures. The pre-FIRM structures usually are not built to flood-resistance standards, because before there was a map, localities had no effective way of knowing which areas to regulate, or what construction standards to require. An analysis of historical FEMA claims data indicates that, on average, those pre-FIRM structures are twice as likely to suffer flood damage resulting in the filing of a claim against the insurance policy as are the post-FIRM structures. Every year, the proportion of policies on pre-FIRM structures on which claims are filed exceeds the proportion of claims filed on post-FIRM structures.

3.1.5. Flood Studies and Data

The Flood Insurance Study (FIS) report has a variety of information and uses. Important products from the FIS report are the publication of flood discharges in addition to the 100-year discharge. Estimates of the 10-, 50-, 100-, and 500-year discharges; comparable stillwater elevations for coastal areas; and pertinent water surface profiles are provided in an appendix to the report. The

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data in the FIS report help users who need information on more frequently occurring flood conditions.

For example, highway departments may use the data in the design of bridges or culverts when the level of service of the roadway crossing the floodplain requires a design discharge lower than the 1% annual chance flood. The flood frequency data can be used to demonstrate the likelihood of flood damage to a property in an event smaller than the 1% annual chance flood. For example, the 10-year flood has a 96 percent chance of occurring over the life of a typical 30-year mortgage. FEMA prepared a voluntary model ordinance in 2002 as part of an effort to encourage the implementation of higher regulatory standards to balance development and the natural and beneficial functions of the floodplain. The ordinance calls for new structures to be set back as far as possible from waterways and describes ways in which the 10- and 50-year floodplain limits can be used to guide building setbacks.

3.2. Benefits of Flood Map Modernization

The benefits and uses of flood maps discussed above are, of course, still realized when the maps are modernized and, in fact, are enhanced due to the flexibility of the digital format and the improved accuracy. But the Flood Map Modernization initiative itself also yields benefits to a large number of stakeholders through the processes of both preparing and applying the map products. In addition, the Federal involvement yields benefits in terms of increased cost-effectiveness of operating at a large scale and sharing and receiving data from other Federal agencies. The digital data developed along with the modernized maps is widely used, and the risk reduction benefits of more accurate flood risk data are greater than before. With Flood Map Modernization, States and localities are involved in the production process and are building capability that will show up as better future maintenance and application of the maps.

3.2.1. The Range of Stakeholders

The information contained on the Nation's flood maps is designed to benefit two main groups. The first group includes those who are looking for specific information associated with the physical characteristics of flooding, so that wise decisions can be made about appropriate land management and/or new construction. The second group includes those that are seeking information to manage financial risk associated with insurance and lending. This group consists of a growing number of stakeholders ranging from Federal agencies to individual property owners.

Critical to the success of Flood Map Modernization is the need to identify and understand the interests of the stakeholders who are helping to prepare the flood maps, will use them in planning, or will be affected by the resulting land use management and financial decisions. The wide variation of stakeholders in Flood Map Modernization is illustrated by the following list:

- Federal departments and agencies
- Congressional members, staff, and offices
- State officials

- State legislators
- County and municipal officials
- Regional planning organizations
- Other organizations (e.g., soil and water districts, zoning districts)
- Schools (e.g., K-12, universities)
- Land developers and builders associations
- Engineering companies and surveyors
- Insurance companies and agents
- Real estate agents
- Mortgage lending institutions
- Flood zone determination companies
- Public information media
- Home owners and renters
- Non-residential property owners.

Stakeholders involved in the development and application of floodplain management and flood insurance programs are interested in nationwide consistency of flood mapping standards and compliance of the program with other legislative and executive mandates. Political entities desire wise expenditures of taxpayer money. The community and local audiences consist of partners and stakeholders who represent the entities that must adopt and use the hazard maps. They want to comply with NFIP regulations and maintain flood insurance for their constituents, and they appreciate the flexibility of a digital format and benefit from the enhanced accuracy of the modernized maps.

3.2.2. The Benefits of Federal Involvement

There are compelling reasons for the Federal Government to remain integrally involved in flood map production and maintenance. Given the range of interest in flood mapping, the variety of stakeholders, and the national scope of the program, it makes sense for management to take place at the highest level feasible. In addition, the flood maps are among the Nation's most valuable resources for mitigating flood losses, so the Federal Government has a stake in nurturing this asset. The goal of minimizing future Federal disaster costs is advanced partly through flood mapping, because of the role the maps play in mitigation, and because the mapping program itself leverages non-Federal resources into the process. Modernized maps will yield other national-level benefits as well.

Standardized flood hazard mapping is a key tool in achieving the NFIP objective of reducing the financial burden on the Federal Government and taxpayers of flood disaster aid and losses. Flood disasters are the most frequent cause of Presidentially declared disasters and cost the Nation billions of dollars each year. Therefore, a primary Federal interest in Flood Map Modernization is to

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overhaul and modernize the flood hazard mapping process, so map updates can be expedited now and into the future to better reflect the Nation's ever-changing flood risks.

The costs of flood hazard studies and of map production, distribution, and archiving all are minimized when one system is used nationwide, rather than area by area. Conducting the modernization of maps on a large, national basis, enables FEMA to take advantage of economies of scale. The multi-year contracts with study contractors made available through a nationwide initiative eliminate repeating the procurement process each time a re-study is initiated. Standardized agreements with mapping partners mean fewer reviews and faster implementation. Unified study and mapping procedures reduce both turnaround time and unit costs.

A significant product of FEMA's Flood Map Modernization will be nationwide geospatial coverage of flood hazard data. In response to OMB Circular A-16, tremendous efforts have been made to increase interagency cooperation and reduce duplication in the production of this and other national geospatial data. FEMA has joined in several Federal mapping partnerships including the OMB Geo-Spatial One-Stop, which involves the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers, the National Oceanic and Atmospheric Administration (NOAA), the Bureau of the Census, and others. Widespread and growing interest in digital data and geographic information system (GIS) technology suggests that the spatial data generated from Flood Map Modernization will attract even more Federal partners in future years as the National Spatial Data Infrastructure continues to be developed.

FEMA's Flood Map Modernization also benefits Federal programs beyond specific mapping interests. The National Flood Mitigation Data Collection Tool, the National Dam Safety program, the National Hurricane Program, and others, benefit from data and methods developed under Flood Map Modernization. For example, coastal flood hazard studies conducted under the Flood Map Modernization initiative will provide valuable data to the National Tsunami Hazard Mitigation Program, a Federal/State program led by NOAA and supported by FEMA. Also, an ongoing collaboration between FEMA, NOAA, and the USGS under the Flood Map Modernization initiative will establish new guidelines for tsunami risk investigations and other hazard mapping.

Much of the basic data used to prepare flood hazard maps come from other Federal agencies. For riverine flood mapping, USGS stream flow data from gauges is often used to estimate the 1% annual chance flood discharge that defines Base Flood Elevations. In coastal flood mapping, extreme tidal stillwater elevation estimates are made using tide gauge data from NOAA and offshore wave data available from the Corps of Engineers Wave Information System.

3.2.3. Benefits of Other Map Products and Tools

Many other products are prepared during the production of flood maps. These materials are published in a Technical Support Data Notebook to document the flood study process and include general documentation, engineering analyses, FIS report data, mapping information, and reference materials. The FIS report data become the content of the FIS report that accompanies the flood

maps. The FEMA Map Service Center now provides these reports to the public on the Internet through the FEMA Flood Map Store at <http://store.msc.fema.gov>.

Another significant product from flood studies is the terrain data obtained and compiled for use in hydraulic computer models and as the base mapping for DFIRMs. These data have a multitude of uses beyond the creation of the flood map. For example, NFIP communities can broaden the use of their digital flood map data to identify multiple hazards for hazard mitigation planning.

To facilitate implementation of Flood Map Modernization, FEMA has designed the Mapping Information Platform (MIP) accessible at <http://hazards.fema.gov>, which provides stakeholders with state-of-the-art engineering, mapping, and management tools to facilitate flood hazard mapping. Tools are available at no expense to mapping partners and can be used through the MIP to scope out flood study projects, compile terrain data, and incorporate field survey information, prepare input data for hydrologic and hydraulic models, and create DFIRMs that meet the current guidelines and specifications of the program.

3.2.4. Reduction of Flood Risk

Flood Map Modernization stakeholders are being informed of the value and benefits of flood maps and are getting involved in their preparation and application for planning purposes. This increased awareness and involvement is linked to a substantial reduction in flood risk. As discussed below, existing flood hazard maps have reduced flood risk in the past and the Flood Map Modernization initiative is matching the level of effort to the level of risk to cost-effectively reduce the Nation's future flood risks.

3.2.4.1 Risk Reduction Benefits to Stakeholders

In many cases, the flood hazard maps—and the hydraulic models used to create them—are used as a “baseline condition,” or the no-action alternative, against which proposed floodplain development projects are compared to assess the impacts of the proposed action on flood elevations at upstream and downstream properties. Conditional approval for projects is provided where a proposed project is determined to comply with the minimum standards of the NFIP.

More benefits of the Nation's flood maps are identified through other venues. One example was the first Gilbert F. White National Flood Policy Forum, sponsored by the Association of State Floodplain Managers (ASFPM) Foundation and held in Washington D.C. in September 2004. The forum brought together national floodplain experts to address the adequacy of the 1% annual chance flood standard—the metric central to the construction of FEMA's flood hazard maps. In the course of its discussion, the forum identified several benefits of FEMA's floodplain mapping and its modernization:

- Within the mapped 1% annual chance floodplain, insured structures constructed since regulations began are safer and in post-disaster surveys are found to sustain less damage.

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- Management of development within the mapped floodplain, and restriction of development within the regulatory floodway, has led to the protection of thousands of acres of riparian land, conserving the natural and beneficial functions of floodplains.
- Technological advances made in cartography, computing, modeling and other fields have enhanced and simplified many aspects of mapping and information dissemination (ASFPM Foundation, 2005).

3.2.4.2 Risk Reduction Beyond the Floodplain

One fundamental use of the flood maps is to determine if a particular location is “in or out” of the flood risk area. In this regard, the mapping program benefits entities with interests outside of mapped flood boundaries as well as those within the boundaries.

Floods occur frequently in areas designated at moderate or minimal flood risk outside of mapped SFHAs. In fact, about 25 percent of all flood insurance claims occur in these areas and since 1978 the NFIP has paid over \$2.8 billion in claims—over 20 percent of all claims paid to date—on properties outside of mapped SFHAs. In many portions of the country, development tends to cluster at the edge of the 1% annual chance floodplain boundary. For example, in Boulder, Colorado, hundreds of structures have been built outside of the 1% annual chance floodplain (100-year) but within the 0.2% annual chance (500-year) floodplain (ASFPM Foundation, 2005). Map updates conducted as part of Flood Map Modernization and the potential for more efficient map maintenance, through the use of digital data, will provide the ability for more refined and frequent future map updates to guide new development away from such changing flood risks.

3.2.5. Building Local Capacity

To maintain the eligibility of their residents for flood insurance, NFIP-participating communities must submit new data to FEMA when they become aware of changes that may invalidate floodplain boundaries and elevations shown on the maps (44 *CFR* 65.3). This and the desire to have accurate maps for risk reduction motivate communities to keep their maps current. FEMA recognized this and in the late 1990s initiated the Cooperating Technical Partners (CTP) program, now an integral part of Flood Map Modernization (see description in appendix B). To date, approximately 42 percent of the Flood Map Modernization initiative dollars have been provided by FEMA to CTPs. CTPs are encouraged to contribute 20 percent of the cost of their mapping projects as a way to leverage FEMA funding. When they contribute data and local knowledge, communities that participate in the map production process obtain maps that reflect their intimate understanding of flood risk for their area, facilitating effective floodplain management.

3.2.6. Optimizing Benefits and Minimizing Costs

A benefit-cost analysis is recommended by OMB over other methods to assess the desirability and future effects of a Federal program that will last three or more years. In *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (OMB Circular A-94), OMB provides guidance to Federal agencies on efficient resource allocation. In a benefit-cost analysis the basic

criterion upon which a government program can be economically justified is net present value, or the discounted future value of net benefits (benefits minus costs). The net benefits of a Federal program are assessed relative to society and not the Federal Government. Social net benefits are the basis for evaluating Federal programs that affect private citizens or other levels of government.

A benefit-cost analysis of the Flood Map Modernization initiative showed the plan to be “economically sound and in the Nation’s best interest”¹ (Federal Emergency Management Agency, 1997, p. i). Even with this favorable assessment, the costs can be further minimized and the benefits further maximized.

The costs of Flood Map Modernization can be minimized by:

- Continuing public education campaigns to increase the NFIP policy base and increase funding from fees to offset program costs
- Increasing the use of FEMA-provided tools to reduce the pre-mapping costs of data development relating to flood studies
- Increasing the use of FEMA-provided tools to automate more aspects of the map production process and therefore decrease associated labor and expenses necessary to create the maps
- Utilizing the digital platform to support electronic distribution of flood maps with “print on demand” capability.
- Encouraging state and local governments to take ownership of the maps and fund an increasingly larger share of future map maintenance efforts
- Increasing mentoring and training of communities not experienced in flood studies and mapping so that they may eventually take on more technical and financial responsibilities.

The benefits of Flood Map Modernization can be maximized by:

- Providing wider dissemination of flood hazard data via the Mapping Information Platform
- Formulating “lessons learned” from disasters and translating this knowledge into refinements of floodplain management policy, guidance, mapping, and building standards
- Assigning economic value to the ecological benefits both provided by floodplains (e.g., filtering contaminants, scouring air pollutants, sequestering greenhouse gas emissions, supporting wildlife, cooling water to protect fish, providing green space for people, and enhancing property values) and protected by regulatory measures
- Identifying and assessing additional benefits that cannot be assigned monetary value.

¹The benefit/cost ratio as determined from the analysis was 2.1.

4. A Look to the Future

At the conclusion of FEMA's Flood Map Modernization initiative, with the course adjustment described above, the Nation can expect that:

- Digital flood maps will cover 92 percent of the population of the United States.
- 40 percent of the Nation's population will have maps that encompass stream miles based on new, updated, or validated engineering analysis.
- 80 percent of the Nation's population will have maps that meet the 2005 Floodplain Boundary Standard.

FEMA will accomplish these final outcomes of the Flood Map Modernization initiative provided that funding levels are maintained through FY2008. No additional funding or schedule adjustments are required to meet FEMA's new targets as outlined in this report.

The conversion from a paper map system to a digital system is a monumental step forward and revolutionizes how flood maps are maintained, stored, and distributed. The use of digital tools is resulting in dramatically improved efficiency in the process of making, using, and updating flood maps and also enhancing their accuracy.

Over the long term, these modernized flood maps will more accurately portray flood hazards so that risks to life and property can be assessed and appropriate action taken. Flood maps support the creation of safer communities and contribute to effective risk management nationwide. Today's investments in modernized flood maps reduce future flood losses and Federal outlays for flood disasters.

4.1. Maintaining Modernized Maps

At the end of the Flood Map Modernization initiative, the Nation will want to protect its investment in digital flood risk mapping and flood information updates. Beginning at the inception of the Flood Map Modernization initiative and continuing through to the present, there has always been an identified need for a post-Flood Map Modernization phase that will account both for map maintenance and for other unmet needs.

Specifically, areas that must be addressed during that phase include:

- Completion of a digital flood layer for the Nation, focusing on the low-risk areas that were not addressed during the Flood Map Modernization initiative.
- Meeting additional needs for new flood data that either had not been identified or could not be accommodated during the initiative.
- Normal maintenance activities associated with the 5-year review mandated under Section 575 of the National Flood Insurance Reform Act of 1994. Every year, 20 percent

of the existing maps will be evaluated to determine what revisions and updates are needed. Maintenance and update would mean adding or improving engineering data in order to capture changes in flood risk for existing floodplains, reflect new development or similar local changes, and add additional flood risk zones based on development pressures or the flooding history within that area.

- Ensuring that, as technology improves, the modernized maps and the process FEMA uses to produce them evolve as well.
- Supporting and mentoring FEMA’s partners in the maintenance roles they have assumed.
- Continuing to process “map amendments and revisions” that are generated by property owners and developers. These result mostly from ongoing growth and development of the Nation’s economy.
- Continuing to seek ways to reduce the cost of maintaining and distributing maps.

Section 575 of the 1994 National Flood Insurance Reform Act specifically directed FEMA to assess the maps every 5 years for purposes of revising and updating them. In addition, the Government Performance Reform Act (P.L. 103-62) requires that all line-item initiatives in the Federal budget account for maintenance costs in their implementation plans.

Flood maps need to be updated for several reasons. The most fundamental is that the severity of flooding may change with time while, conversely, flood maps provide a static “snapshot” of the estimated 1% annual chance flood at one point in time. Natural processes and human interventions lead to changes in flooding and floodplains:

- Changes in flood conditions brought about by development can modify flood risk. The addition of pavement, impervious roofs, and other forms of development alters the natural drainage patterns and the timing and volume of runoff to floodplains (figure 4-1), leading to changes in the size and extent of floodplains.
- The NFIP minimum standard allowing development or filling in floodplain fringe areas—outside of the regulatory floodway, but within the 1% annual chance floodplain—can raise flood elevations up to one foot (figure 4-1).
- The original design criteria used to build flood control infrastructure—dams and levees—may become invalid as the structure’s design life is approached or exceeded or maintenance practices change and allow structures to deteriorate.
- Changes in weather or in watershed conditions can significantly alter the flood risks.
- The magnitude and extent of ongoing floods changes the underlying statistics of hydrologic data used in previous flood studies to estimate flood elevations.
- Channel migration and erosion can cause changes in riverine and coastal flood risk zones (figure 4-2) or the failure of a flood protection system, such as a levee or other flood control work.

A Look to the Future

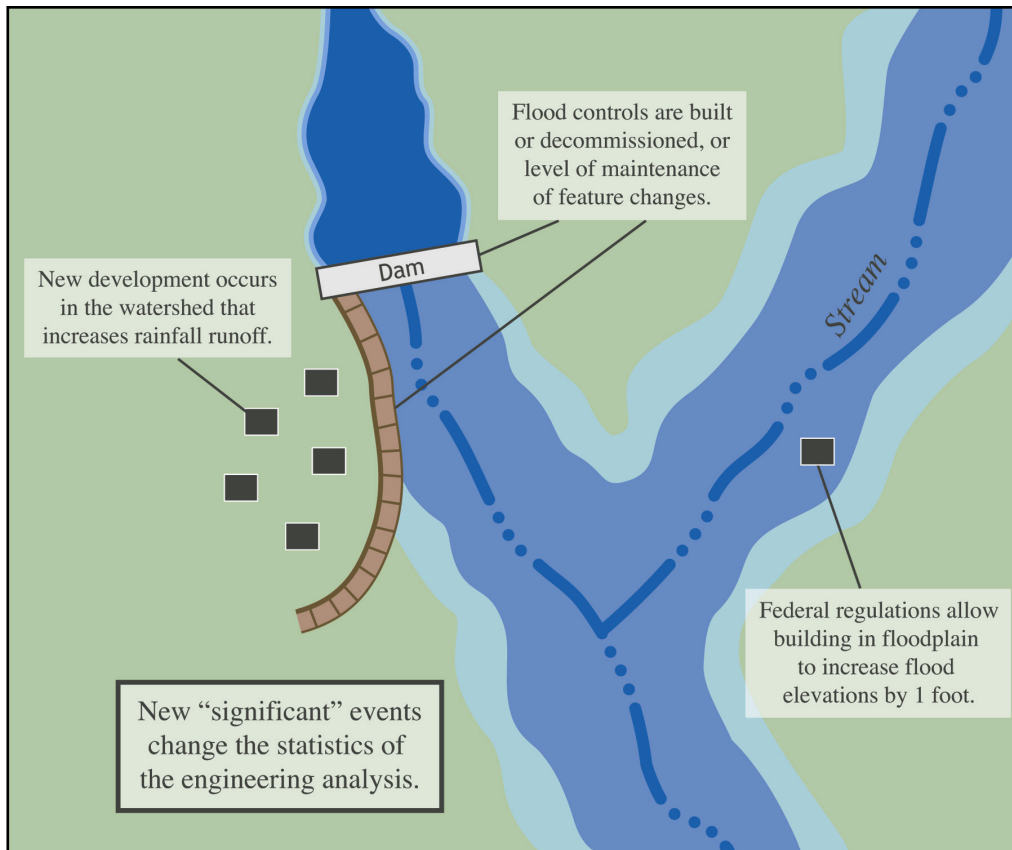


Figure 4-1. Development and other changes alter the flood risk.

- Some parts of the country, particularly coastal areas, are experiencing ground subsidence, which results in a higher level of flooding than that depicted on the maps.
- Where the population is growing, new flood risk zones need to be added to the maps.
- Technological changes affect the way the maps are used.

A large category of future mapping needs will come from areas where growth is projected. By the year 2030, it is estimated by the U.S. Census that the Nation's population will increase by 82 million people (29 percent growth). Through the maintenance phase of Flood Map Modernization, it will be important to map growth areas so that good floodplain data is available before development takes place.

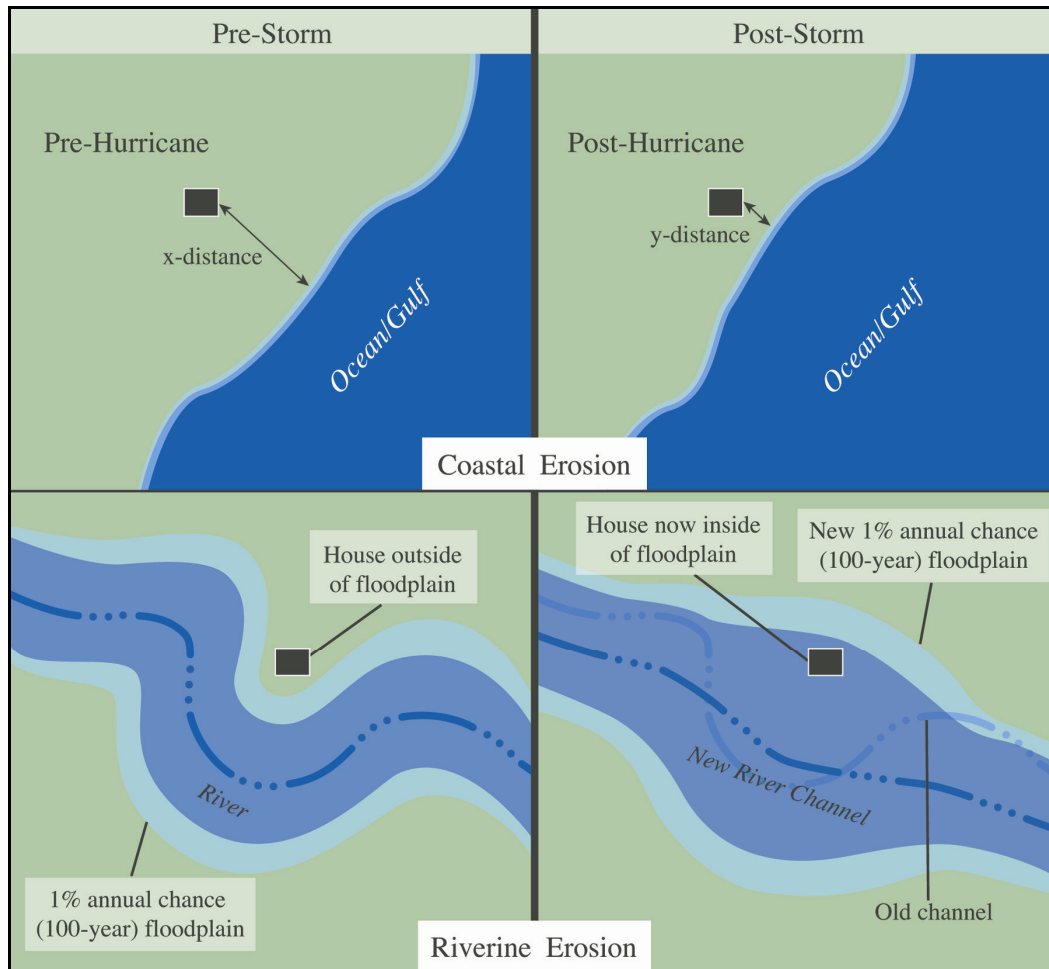


Figure 4-2. Channel migration and erosion affect flood risk zones.

A goal shared by FEMA and the stakeholders is to move from the intensive Flood Map Modernization initiative into a sustainable maintenance phase for the flood maps. A sustainable maintenance phase would be one in which the flood risk information is kept up to date, digital technology is current, and funding is stable and comes from Federal, State, and local resources.

Increased Flood Damage from Population Growth

The U.S. Census estimates that the population increase from the year 2000 to the year 2030 will add approximately 82 million new residents to the United States, or about a 29 percent increase in total population. Floodplain maps are one means of reducing the potential for escalating flood damage in the areas of growth.

As a conservative estimate, assuming that flood disaster damage increases at the same rate as growth, and assuming that annual flood damage is approaching \$6 billion (an estimate widely used before the 2005 hurricane season), flood damage associated solely with expected population growth could add as much as \$1.8 billion per year to flood damage nationwide. Floodplain mapping and the resulting floodplain management and insurance activities are an effective means of slowing increases in flood damage.

Table 4-1. Projected U.S. Population Increase 2000–2030, by FEMA Region

FEMA Region	FEMA Regional Office Location	Region's Population Increase	% of Nation's Increase
I	Boston	1,417,433	1.7%
II	New York City	2,172,127	2.6%
III	Philadelphia	4,961,427	6.0%
IV	Atlanta	24,729,234	30.1%
V	Chicago	4,870,078	5.9%
VI	Denton	13,647,051	16.6%
VII	Kansas City	1,687,057	2.1%
VIII	Denver	2,925,178	3.6%
IX	Oakland	20,693,332	25.2%
X	Seattle	5,059,612	6.2%

4.2. Beyond Flood Map Modernization

Although it is yielding impressive products that will significantly improve flood loss reduction in the Nation, the Flood Map Modernization initiative, when completed, will still leave the Nation with unmet flood mapping needs. Besides the need for ongoing maintenance of the flood maps, the future will bring the following additional challenges for flood hazard mapping:

- It will be important, for example, to continue to acknowledge variation in flood risk among communities, so that the level of effort in studying and depicting the flood hazard is commensurate with the risk faced by the communities, detail in risk mapping, etc.

- Work should continue on improvements to techniques for analyzing flood risk, to produce more accurate maps.
- There are significant challenges associated with mapping floodplains in and around inland levees and coastal seawalls and levees. The budget request for mapping was developed assuming that local, State, or other Federal partners would be able to provide information on whether an existing levee is structurally sound and whether it could be certified to pass a 1 percent flood. As it has turned out, these certifications are not readily available. This has left FEMA with the task of having to make reasonable, albeit conservative, engineering assumptions about the performance of these levees. Although the cost of doing this for a single levee is not necessarily large, the effort required to do this for all the levees in question is more costly than the initiative can afford within current budgets. After Hurricane Katrina, Congress began discussions on establishing a levee inventory, inspection, and safety program within the U.S. Army Corps of Engineers. If implemented, this program should result in the development of these necessary certifications.

4.2.1. Estimated Needs after Flood Map Modernization Initiative

Flood Map Modernization provides a large number of improvements to the Nation's flood map inventory. All of the needs, however, will not be met at the end of Map Modernization. This is demonstrated by three primary indicators: the percentage of the population covered by digital flood maps; the percentage of population covered by new, updated, or validated engineering analysis; and the percentage of the population covered by floodplains that meet the 2005 Floodplain Boundary Standard.

The first factor, the Nation's population covered with digital flood maps, will be at 92 percent of the population. Even though just 8 percent of the Nation's population will not be covered by flood maps at the completion of the Flood Map Modernization initiative, this small proportion of the population translates into 35 percent of the land area of the Nation, excluding Alaska. This means that digital floodplain maps will not be available to aid in response, recovery, reconstruction, and mitigation when disasters occur in these more rural areas. FEMA projects that providing flood mapping that covers 99 percent of the nation's population and 98 percent of the land area of the continental United States would significantly enhance the use of flood maps and aid in reducing future flood disasters.

At the end of Flood Map Modernization, 40 percent of the population will be covered by new, updated, or validated engineering analysis and maps. The baseline for this factor changes every year. Every year, additional development occurs within watersheds and that development results in increases in the flood elevations or in other flood characteristics. When the water surface elevations change by a certain amount, the engineering analyses need to be updated. It is recognized that over time, new, updated or validated engineering should be made available incrementally for as much of the population as feasible, and that over the long term, FEMA should work towards a goal of providing this updated coverage to 90 percent of the Nation's population.

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Appendix A. Management of Flood Map Modernization

FEMA's management of the Flood Map Modernization initiative provides the direction and framework for achieving the initiative's goals. The approach to managing Flood Map Modernization includes:

- Forming collaborative relationships among FEMA Headquarters, the Regional offices, and other stakeholders as required
- Using performance-based management to produce results and outcomes rather than rote compliance with specifications
- Using proven program management processes, specifically detailed in the Organizational Project Management Maturity Model, as the program management standard for Flood Map Modernization
- Using collaborative, multidisciplinary, integrated teams to facilitate change and overall management.

FEMA's approach to managing the Flood Map Modernization initiative has been reviewed twice by independent organizations. The first examination was conducted by the GAO in March 2004, and the second by the Department of Homeland Security's Inspector General (IG) in September 2005. Both reports helped guide FEMA's continuing efforts to manage the Flood Map Modernization initiative as efficiently and as effectively as possible.

Specific management improvements implemented since the GAO report include the creation of a Human Capital Plan to address staff capacity issues. Also, FEMA implemented the balanced scorecard method of tying performance results to the goals of the initiative and the agency. This was useful in addressing the GAO's other management-related recommendation, which was to implement performance measures that define FEMA's progress in increasing stakeholder awareness and use of the new maps.

The IG Report focused on the limitations of Flood Map Modernization, improvements that could be made in program management, communication and coordination, and information technology issues. The report recommended a focus on high risk areas and ensuring that the new Floodplain Boundary Standard was being implemented. The course adjustment described within this report, towards prioritizing risk on a census-block group level, to a large extent will help FEMA to better meet the objectives identified by the IG.

The details of FEMA's management of the Flood Map Modernization initiative span 13 management areas and are contained in an equal number of plans. This report focuses on the three main management areas:

- Management of program risks

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- Performance management
- Information technology management.

These three areas form the core of FEMA's management approach and are described in more detail below. These areas are of special importance to the Information Technology Management Reform Act (ITMRA) and the Government Performance Results Act (GPRA). More detailed guidance in these areas is provided by OMB in its Circulars A-11 and A-130.

A.1. Management of Program Risks

FEMA has developed a Risk Management Plan to guide the management, identification, prioritization, and mitigation of risks to the initiative. In its statement of objectives for the Flood Map Modernization initiative, FEMA included the requirement to develop an approach for managing program risks associated with performance of the Flood Map Modernization initiative. FEMA manages program risks in accordance with GPRA and ITMRA requirements using OMB guidelines.

The objectives of FEMA risk management are to:

- Identify key resources who can identify, manage, and mitigate risks
- Identify risks on an ongoing basis and report on them at least quarterly
- Compile a list of risk triggers
- Define criteria against which the consequences of risks are measured
- Analyze risks for their probability of occurrence and severity of impact on the program
- Develop and prioritize risk response plans and mitigation strategies
- Regularly prioritize and reprioritize significant program risks
- Execute mitigation plans effectively.

The Risk Management Plan presents FEMA's overall approach and describes processes for executing a proactive risk management program as part of the overall management of the Flood Map Modernization initiative. The Risk Management Plan also satisfies DHS requirements contained in DHS Management Directive 1400 and:

- Sets forth approaches for avoiding or mitigating risk so that cost, schedule, and performance goals are protected
- Helps staff make decisions on budget and funding priorities
- Provides risk information
- Guides continuous monitoring of the program's health
- Provides guidelines for periodic reporting on risks, risk management strategies, and risk status in keeping with OMB Exhibit 300 reporting requirements.

FEMA involves and collaborates with its business, technical, executive, and mapping partners to effectively manage risks. The risk management team includes individuals from the FEMA Mitigation Division, FEMA regional offices, and others as needed to collect, categorize, prioritize and mitigate risks to the initiative.

The periodic report documenting the state of risk management within the Flood Map Modernization initiative is the Risk Management Inventory. The inventory contains all of the risks to the initiative, highlights the top risks, and provides schedules for mitigating critical risks. It is used to populate OMB's Exhibit 300 and is consistent with OMB Circular 123.

A.2. Performance Management

The Flood Map Modernization initiative tracks actual performance and verifies that it corresponds to the planned results as required by GPRA and the ITMRA. The three main tools that FEMA uses are:

- Life cycle management
- Balanced scorecard
- Earned value management.

Life Cycle Management

FEMA has a detailed program life cycle consisting of three phases: planning, acquisition, and maintenance. For Flood Map Modernization, both planning and acquisition began in FY2003. A minimal level of maintenance was ongoing in 2002. The last year of the initiative is FY2008, when the last study contracts begin. The investment continues to FY2010, when the last of the modernized maps is adopted, with the initiative's acquisition dollars committed in FY2008.

Map maintenance is ongoing throughout the initiative, but the major thrust will begin in 2009. The first congressionally-recommended 5-year maintenance period concludes in FY2013. Maintenance costs are estimated through 2018 to illustrate expected trends in maintenance between the first and second 5-year maintenance periods.

In addition to the three phases as mandated by OMB, the work is categorized into four cost and spending areas:

- Engineering and mapping
- Customer care and outreach
- Technical support and tools
- Program management and support.

Funding for the cost and spending categories comes from three sources—congressional appropriations, NFIP fees, and partner contributions. The Flood Map Modernization life cycle is

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monitored periodically and as required by specific events. The program manager for Flood Map Modernization is responsible for the initiative's life cycle.

Balanced Scorecard

FEMA adopted the balanced scorecard to clarify its vision and strategy for Flood Map Modernization and to translate them into action. The scorecard provides feedback on both the internal business processes and external outcomes in order to improve performance and results continuously.

The Flood Map Modernization initiative follows FEMA's Strategic Plan by viewing the initiative from four perspectives: customer/stakeholder; financial; operations; and people, learning, and growth. FEMA develops metrics for each perspective, collects data for the metrics, and analyzes the initiative's results against the metrics.

FEMA uses the balanced scorecard to incorporate feedback about internal business process outputs and the outcomes of its business strategies. Flood Map Modernization develops metrics based on the priorities of the FEMA Strategic Plan, which provides the key business drivers and criteria for the metrics.

Information relevant to the metrics is collected and reduced to numerical form for storage, display, and analysis. Decision makers examine the outcomes of various measured processes and strategies and track the results; this serves to guide the initiative and provide feedback. The value of metrics is in their ability to provide a factual basis for identifying:

- Strategic feedback to show decision makers the present status of Flood Map Modernization from many perspectives
- Diagnostic feedback on various processes that can lead to continuous improvement
- Trends in performance over time as the metrics are tracked
- Feedback about the measurement methods themselves, and which metrics should be tracked
- Quantitative inputs to forecasting methods and models for decision support systems.

FEMA categorizes the metrics for the Flood Map Modernization initiative into key process indicators. These indicators are linked to the five main processes in the initiative, and the results from the process areas are reported in the balanced scorecard each quarter.

Earned Value Management

FEMA manages the budget and resource requirements for the Flood Map Modernization initiative through an earned-value management system. This is the means by which FEMA reports the status of the initiative's cost and schedule.

Flood Map Modernization develops a time-phased contract budget baseline against which the status of the cost and schedule is assessed. Both schedule and cost elements are related to the work

breakdown structure. Monthly earned-value reports show the cumulative values for the budgeted cost of work scheduled, the budgeted cost of work performed, the actual cost of work performed, and an estimate at completion. These values are reported at the appropriate level of detail for the task being tracked in the work breakdown structure. Any variance greater than 10 percent beyond the expected values is explained.

The monthly earned-value reports are reviewed and the current schedule performance index, cost performance index, and estimate at completion are validated. FEMA maintains a running plot of these factors for trend analysis. If any corrections are required to resolve variances, they are developed and implemented. Additionally, FEMA reconciles the baseline information and the cost or schedule variances with the data submitted in OMB Exhibit 300.

FEMA pushes earned-value concepts down to the mapping project level as well. Earned-value data collected for mapping projects include:

- Start date
- End date
- Negotiated cost
- Physical percentage of work completed
- Actual cost of labor expended to date.

From these factors, the cost performance index and schedule performance index are derived and converted to a “stoplight” indicator at the project level (green = healthy, yellow = at risk, red = bad news, e.g., well over budget and/or well behind schedule).

A.3. Information Technology Management

FEMA purchased a premiere, Web-based system to help with the management of the Flood Map Modernization initiative. This system is known as the Mapping Information Platform (MIP). The MIP includes engineering and mapping tools to help the industry build more efficient skills in producing the NFIP’s modernized map products.

FEMA manages this technology in accordance with the ITMRA and OMB guidance. Although many of these requirements are simply good performance management practices, which are discussed in the Performance Management section above, two of these requirements specifically relate to information technology:

- Enterprise architecture
- System security.

The MIP is a data production, management, and dissemination system for the national flood layer and other geospatial hazard information. The MIP is accessible through the Internet to all stakeholders, partners, and customers. The MIP provides the data, technology, and analytical tools

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that enable users to be better informed, to analyze hazard data, and to make appropriate decisions and act upon them to reduce vulnerability to natural or human-caused hazards. The system promotes FEMA's objectives of sharing data openly to enable States and local communities to significantly increase their role in developing and maintaining data about hazards.

The MIP includes the following features and capabilities:

- Access to hazard data managed by FEMA and its partners via easy-to-navigate geospatial tools that can be used to locate maps and data, program news, and information
- An automated, workflow-driven process for flood map production
- Access to state-of-the-art flood map production tools
- Capture of intermediate engineering and mapping deliverables (data) to reduce the cost of revisions
- Tools for managing, monitoring, reporting, and tracking flood mapping studies, including access to legacy systems
- Secure, single sign-on to key MIP capabilities and multiple levels of access based on user needs
- Access to training and education for contractors, partners, and the general public
- Access to interoperable, standards-based Web services such as Geospatial One-Stop and other business systems used by partners.

The MIP provides users with engineering tools and mapping tools needed to produce DFIRMs. Additionally, the MIP delivers the workflow processes and supporting information technology infrastructure needed to manage studies and amend and revise DFIRMs. The use of intermediate data controlled by the MIP content management system provides seamless integration between workflow and engineering/mapping tools.

FEMA prepares a security plan for each release of the MIP, and the security certification and accreditation process provides quality control techniques for computer security and increases security awareness. FEMA has prepared a MIP security risk assessment plan, a MIP continuity of operations plan, and a privacy impact assessment. The MIP Security Plan complies with the Computer Security Act of 1987 and OMB Circular No. A-130, *Management of Federal Information Resources*, and was developed in accordance with the method described in the National Institute for Standards and Technology Special Publication 800-18, *Guide for Developing Security Plans for Information Technology Systems*.

The plan provides the Flood Map Modernization initiative with a management process that eliminates and/or controls vulnerabilities inherent in complex information systems or computer applications that might be exploitable by threats, internal and external, to FEMA. The plan is the foundation for ongoing evaluation of risk (physical and logical), identification of mitigation alternatives, an analysis of costs versus benefits, and decisions about final implementation of security measures.

The purpose of the MIP security plan is to:

- Provide an overview of the security services and security components
- Describe the management, operational, and technical controls in place or planned for meeting those requirements
- Delineate the responsibilities and expected behavior of all individuals who access the system.

Appendix B. Evolution of Flood Maps

B.1. Why There is a National Flood Insurance Program

Although the overall policy basis for the Federal Government to support floodplain mapping relates to managing future disaster costs, the floodplain map is most typically used as part of the NFIP. The NFIP was developed in response to the fact that, generally speaking, the private insurance industry has not been able to offer flood insurance coverage in the United States. Over the years, companies have reported that there are many reasons for their inability to offer this product, but two are paramount.

First, the phenomenon of “negative selection” operates in the flood risk arena. In this situation, only owners of the most floodprone (high-risk) properties are inclined to purchase flood insurance, thus making rates for purchasers prohibitively high. Second, insurance companies have been unable to accumulate the reserves necessary to cover catastrophic losses. As a result, the only form of individual relief from flood disasters for the first part of the 20th century was from specific post-disaster acts of Congress, assistance from charities such as the American Red Cross, and local and State efforts.

The Federal Government became increasingly involved in the costs of flooding through specific relief legislation passed periodically when a major flood disaster resulted in particularly high costs and levels of damage. This disaster assistance offered no incentive to local or State governments or to property owners to solve the problem of mounting flood losses and became an increasing burden on the Federal taxpayers.

With the creation by Congress of the NFIP in 1968, property owners could obtain flood insurance in exchange for community agreements to establish, implement, and maintain floodplain management measures targeted at reducing future flood damage. This provided a means by which individuals could protect their property, Federal expenses could be minimized, and localities would have an incentive to manage their floodprone areas in ways that would reduce future flood losses.

Today, typical homeowners’ insurance policies and commercial carries still exclude damage due to flooding. Because it is a catastrophe-type coverage, the Federal Government is viewed as the most effective insurer for floods due to its ability to spread the risk across policyholders nationwide and also to tie the provision of coverage to required mitigation measures and to community-wide eligibility for Federal disaster assistance.

Flood insurance today is written by licensed insurance agents in more than 20,000 participating communities nationwide. The insurance companies receive a fee for writing and servicing the policies under their own names, but the NFIP retains the underwriting responsibilities and the risk. About 95 percent of the policies today are written by private agents through the NFIP’s Write Your Own (WYO) Program, with the remainder being written directly with the NFIP.

B.2. How the National Flood Insurance Program Works

The Flood Disaster Protection Act provides strong incentives for community participation in the NFIP. Flood insurance is made available only within communities that choose to participate in the program. Once a flood map is issued identifying the community's Special Flood Hazard Area (SFHA), that community has six months to join the NFIP. Participation requires that a community agree to regulate development in the floodprone area so that it is less susceptible to flood damage. Adoption of a land use ordinance based on the flood map is usually necessary. If a community fails to adopt an ordinance or enforce its regulations, it can be suspended from the program and flood insurance will no longer be available. This means that lenders will not be able to write loans on properties in SFHAs and that disaster assistance will be limited for flood victims.

The regulations that are adopted by local government must be applied, at a minimum, in those areas of the community that have been identified as being within the 1% annual chance (100-year) floodplain on the community's flood map. Communities can participate in the NFIP even if an official map has not been provided, although this often leads to ineffective or no local regulation of land use.

The purchase of flood insurance is now mandatory for most loans on properties in high risk areas. Federal agencies; private market lenders that are federally regulated, insured, or supervised; and government sponsored enterprises, like Fannie Mae and Freddie Mac, must require loans on properties that are located within SFHAs to be insured against flooding, at least to the limit of the loan. This requirement of the Disaster Protection Act of 1973 and the National Flood Insurance Reform Act of 1994 gives an additional incentive to local officials to join the NFIP. In communities that are not participating in the NFIP, these lenders cannot offer loans, so potential buyers cannot obtain traditional mortgages.

B.3. History of Flood Maps

The NFIP was based on the concept that local governments would adopt land use management techniques that would reduce flood losses over time. Those techniques included special zoning for areas subject to significant flood risks and, in those areas, requiring that new, substantially improved, or substantially damaged development be properly designed and constructed to resist flooding. In return, the Federal Government would underwrite flood insurance for residents of those communities.

It was recognized that land use management required two distinct components: an ordinance describing how property is to be managed and buildings constructed, and a map depicting where those rules are to be applied. Absent a map, the regulations would fail to meet both legal and practical requirements that the floodprone property be identified so that proper and safe construction could be effectuated. Absent a map, the appropriate property owners could not be made aware of the desirability of purchasing flood insurance. Absent a map, future purchasers and

developers of the property could not be put on notice of the special requirements attendant to building and occupying an especially floodprone property.

Over the years, the NFIP has developed several products to identify “Special Flood Hazard Areas” (SFHAs)—those areas expected to be inundated by a 1% annual chance flood. This is the level of flood that has at least a 1 percent chance of occurring in any given year. This “1% annual chance flood” is often referred to as the base flood or “100-year” flood.

History of Mapping Products

The fundamental and most widely used mapping product is the Flood Insurance Rate Map (FIRM). FIRMs were intended to be used primarily by lenders and insurance agents, but also by other stakeholders such as emergency managers, developers, planners, real estate agents, and Federal agency personnel involved in environmental review and determinations under Presidential Executive Order 11988.

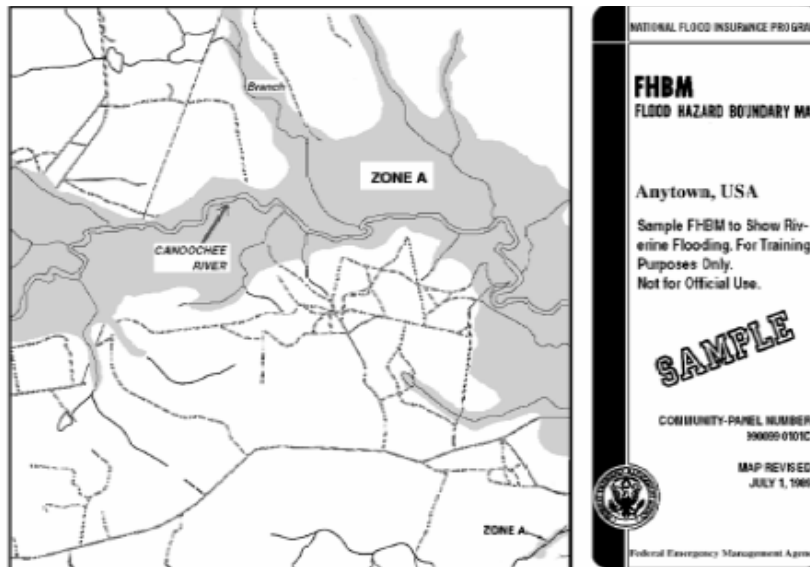
Two other products, the Flood Boundary Floodway Map (FBFM), and the Flood Insurance Study (FIS) report, were produced for use by local officials for land use regulations. The FBFMs depicted the floodplain boundaries, identical to the boundaries shown on the FIRM, but also showed the floodway of the river or stream. This is important information because floodways are encouraged to be left undeveloped to allow for the passage of floodwaters. Additionally, the FIS text included important technical data that is useful in the implementation of a floodplain ordinance, such as flood profiles and floodway data tables.

The “two-map” system was used through approximately the first 15 years of the NFIP, but it presented some challenges. When physical changes took place in the floodplain, but there was no change in the floodway boundary, the FIRM was modified but not the FBFM. This soon resulted in maps that looked very different being used by different users. Maps used by lenders and insurance agents for flood insurance purposes had different boundaries than the FBFM maps used at the local level for land use management and permitting. These differences led to confusion and misunderstanding.

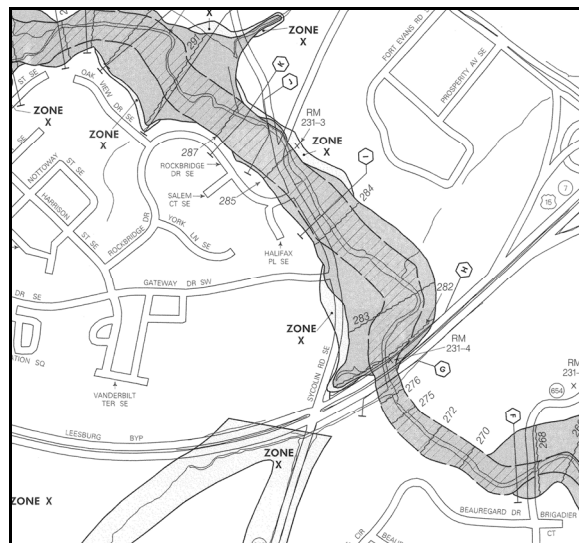
Another difficulty was that because the NFIP was designed around community participation, the maps were created first for cities and later for the unincorporated county. The intent was to cover the populated area first and then map the less-populated areas, but this resulted in some unintended oversights. Quite often, by the time the county was studied and mapped, the cities had grown through annexations. Areas that were annexed after a city had been studied were not mapped when the county was studied. This left gaps in the flood mapping. As a consequence, areas that could be very prone to flooding were perceived as hazard-free simply because they were not mapped on either the city’s or the county’s map.

Products to Identify Flood Hazard Areas for the NFIP

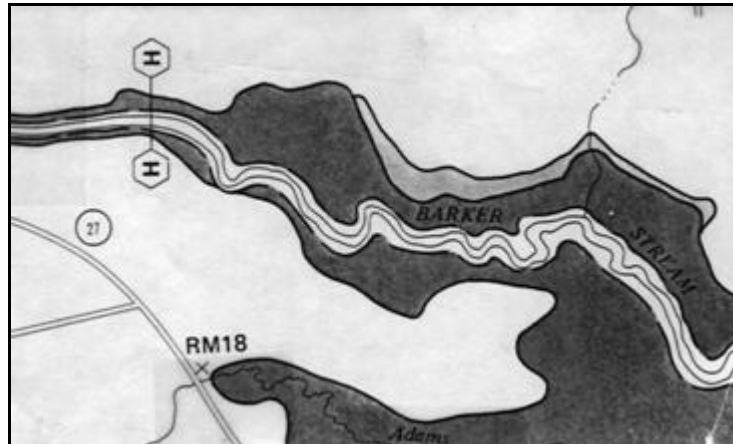
- Flood Hazard Boundary Maps (FHBM) were prepared using approximate study techniques. These maps do not provide some critically needed information, such as the elevation of the 1% annual chance or “base” flood. FHBMs were the initial maps produced under the NFIP and were to be replaced over time with FIRMs and FBFMs maps.



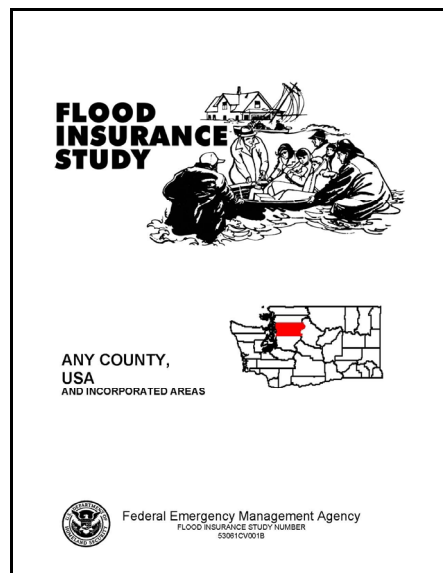
- Flood Insurance Rate Maps (FIRMs) include Base Flood Elevations and flood zones.



- FBFMs include floodways and cross-sections.



- The Flood Insurance Study (FIS) text is an explanation of the procedures used, the summary of the data collected and derived, and the flood profiles. It also lists special considerations needed for the management of any unusual flood hazards in the community.



- Digital Flood Insurance Rate Maps (DFIRMs) combine the features of all of the above into digital layers that can be used in conjunction with available local data, including roadways and streets, hydrography, topography, and parcel information.

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In 1985, FEMA undertook a survey of users to evaluate different map formats and identify ways to improve its flood hazard identification. The Map Initiatives Project canvassed local floodplain administrators, engineers, surveyors, lenders, real estate agents, and insurance agents for their advice and suggestions on the level of detail shown on flood maps and their appearance. Floodplain administrators, engineers, and surveyors universally sought more detail, such as building footprints and topography, while insurance agents and real estate agents usually suggested less detail and maps that would, in their opinion, be easier to read. Two common recommendations received from most reviewers were:

- Publish a single map by placing Base Flood Elevations, cross-section locations, floodplain boundaries, and floodway limits on the same map and dispense with the two-map format.
- Conduct studies and publish FIRMs on a county-wide basis to avoid leaving areas unmapped.

The outcome of this evaluation was the decision to combine the floodway and other information onto a single map, the FIRM. That is the format in use today, but there are many communities still using the old two-map format FFBMs and lenders using the old FIRMs because there were insufficient resources to update these maps.

At about the same time (the mid-1980s), FEMA realized that it likely would not be able to complete detailed hydrologic and hydraulic studies to determine Base Flood Elevations for all participating communities to transform the FHBMs to FIRMs. This shortfall came about because, at the outset of the NFIP, the number of communities expected to be studied and mapped was greatly underestimated. The effort anticipated covering about 5,000 communities, but the number turned out to be much larger (over 20,000 communities participate in the NFIP in 2005).

A policy decision was made, therefore, to reprint thousands of FHBMs as FIRMs. This began in the mid 1980s and was done, for the most part, in small-population communities or communities that had little or no growth. It did, however, result in thousands of communities receiving FIRMs with no Base Flood Elevations or established floodways. This lack of information on the nature and extent of the flooding limited (and still limits) the community's ability to regulate the flood hazard area, thus increasing the potential for making decisions that place property at risk. This lack of information also inhibits the ability of property owners, developers, property purchasers, real estate agents, and others to comprehend the flood hazard at a particular site and make a well-informed decision about the purchase of flood insurance.

Some communities insisted that FIRMs that were not supported by a detailed study and accompanied by Base Flood Elevations should not be issued. FEMA was left with the dilemma of either doing studies or rescinding the FHBMs. Since the funds were not available to do all the studies, hundreds of maps were simply rescinded. Adding to the problem, there are vast areas of the country where population is sparse or growth is slow that have never received maps. Even today, there are many communities participating in the NFIP that do not have a map upon which to base an ordinance or to guide new development.

Level of Detail in Flood Maps

Flood maps, digital or otherwise, are produced using one of several approaches. They range from “approximate study” to “limited detailed study” to “detailed study” techniques. The major difference is the amount of information that is used in the study process.

For example, most of the original FHBMs were produced using very simple, quick techniques. The best available topographic data, often a U.S. Geological Survey quadrangle, was used as the base map and the limits of flooding were mapped based on an estimated height above the bank of the river or stream.

Today, automated tools and digital topographic data together provide a better prediction of the floodplain limits. If the tools are used without benefit of any field survey data, the study would be considered an approximate study. If the tools are used with some data collected in the field, for example, sketches of bridges to determine the clear opening, it would be considered a limited detailed study. A study done using these same tools and same base map, but also using field-surveyed cross-sections and field surveys of bridges, culverts, and dams would be considered a detailed study.

Detailed studies provide Base Flood Elevation information and flood profiles, whereas approximate studies do not. Limited detailed studies may or may not include elevations and profiles, depending on the amount of information that was available.

It is preferable to conduct detailed studies that result in Base Flood Elevations and flood profiles. Unfortunately, the costs may be prohibitive. Implementing land use regulations without having elevations to work with can present challenges for local floodplain managers. It also presents challenges for insurance agents selling flood insurance because structures need be rated based on the elevation of the lowest floor compared to the Base Flood Elevation. Techniques are available for estimating the flood elevation but they are not as accurate as detailed studies.

On the other hand, for many areas of the country—probably even the majority of stream miles in the Nation—there is little or no development pressure and therefore little need for the detailed engineering study, data, and map information that local officials need to manage land use and construction in the face of flood threats. An efficient and cost-effective approach used by FEMA for these areas is the approximate study and map, which results in basic identification of the floodprone area. With this information, local officials have notice that a flood threat does exist, so that if demand for building sites increases in the future, they can take appropriate steps to obtain additional information about the flood risk and then proceed to manage that development.

B.4. Toward Modernization of Flood Maps

For 35 years FEMA, charged with administration of the NFIP, used the prevailing paper-based cartographic production methods when creating flood maps for the Nation. However, with the

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development of computer-based geographic information system (GIS) technologies, the paper mapmaking procedure has given way to an improved digital process.

Partly in response to these advances in technology and to continued concerns about the flood maps, in one section of the National Flood Insurance Reform Act of 1994, Congress directed FEMA to establish the Technical Mapping Advisory Council (TMAC). Congress' direction to the TMAC was to provide recommendations to FEMA on ways to improve flood maps and the mapping process. The TMAC included:

- The Director of FEMA (or his or her designee)
- The Under Secretary of Commerce for Oceans and Atmosphere (or his or her designee)
- A member of recognized surveying and mapping professional associations and organizations
- A member of recognized professional engineering associations and organizations
- A member of recognized professional associations or organizations representing flood hazard determination firms
- A representative of the U.S. Geological Survey
- A representative of State geological surveys
- A representative of State National Flood Insurance Coordination offices
- A representative of a regulated lending institution
- A representative of the Federal Home Loan Mortgage Corporation (now called Freddie Mac)
- A representative of the Federal National Mortgage Association (now called Fannie Mae).

SEC. 576. TECHNICAL MAPPING ADVISORY COUNCIL

(a) ESTABLISHMENT.-- There is established a council to be known as the Technical Mapping Advisory Council (in this section referred to as the "Council").

* * *

(c) DUTIES.--The Council shall--

- (1) make recommendations to the Director on how to improve in a cost-effective manner the accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps;
- (2) recommend to the Director mapping standards and guidelines for flood insurance rate maps; and
- (3) submit an annual report to the Director that contains--
 - (A) a description of the activities of the Council;
 - (B) an evaluation of the status and performance of flood insurance rate maps and mapping activities to revise and update flood insurance rate maps, as established pursuant to the amendment made by section 675; and
 - (C) a summary of recommendations made by the Council to the Director.

The TMAC made a series of recommendations about the maps, their format, and procedures for production and distribution. The four highest-priority recommendations are listed in the box. A complete description is in the final summary report at

Recommendations of the Technical Mapping Advisory Council

- Acquire additional financial and technical resources for map programs.
- Build constituent interest and public support for modernizing the mapping program. Develop a proactive, long-term, public awareness and educational program that focuses on the need for improved mapping of flood hazard areas.
- Build partnerships among Federal, State, and local governments, universities, and the private sector to accomplish NFIP objectives and improve both the FIRMs and the mapping processes.
- Create a fully digital environment for floodplain mapping and all related information. Distribute data electronically rather than storing and distributing paper flood maps and associated information.

http://www.fema.gov/plan/prevent/fhm/dl_tmcfcr.shtm.

All recommendations of the TMAC were embodied in the Flood Map Modernization initiative to the extent that resources allowed, except that of mapping riverbank and coastal erosion. Studies are underway to determine cost-effective ways to identify, map, and manage those areas.

Congress initiated funding in FY2003 for Flood Map Modernization. The Flood Map Modernization initiative was established to provide a technology-based, cost-effective, long-term process for updating, maintaining, storing, and distributing the flood risk information portrayed on the flood maps. A corollary intention is that engineering tools and analysis be used to update the flood maps so that they reflect physical changes that have occurred since the original mapping. Digital maps have tremendous advantages over paper maps, including improved and more detailed topographic detail, ease of modification and updating, electronic access and transmission, and lower long-term production and maintenance costs.

FEMA has encouraged and supported communities, States, and regional agencies to participate actively in Flood Map Modernization and is providing significant resources to jump-start their involvement. FEMA's goal is to develop capacity and stimulate continued participation by local, regional, and State agencies in maintaining the maps long after funding for Flood Map Modernization runs out.

State and local agencies have made and are continuing to make significant contributions to the updating and maintenance of flood maps under the Cooperating Technical Partners program. Under

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this program, States, communities, and regional agencies that have the interest and capability can enter into an agreement with FEMA to perform one or more flood mapping activities themselves. This enthusiastic and fruitful participation demonstrates their recognition of the importance of accurate and current maps for the long-term well-being of their citizens.

In addition to providing digital flood maps, Flood Map Modernization was designed to provide for engineering updates, which include the update or validation of existing flood data or the development of new flood data for stream miles or areas not previously studied. In some cases the existing flood data is adequate, based on a current evaluation of the flood history within the community and whether significant changes have taken place that might have changed the severity of the flood hazard. Flood data that is adequate and that requires no update is considered validated.

Since 2003 FEMA has been implementing a program consistent with that described in the 2001 progress report. However, as implementation of the initiative has progressed, FEMA's understanding of the Nation's mapping needs and how best to meet them has deepened.

First, as FEMA gained experience in modernizing the maps, it became apparent that a better standard was necessary for transferring the existing flood boundaries from the paper maps to the much more exacting digital product. This led to the adoption of a new Floodplain Boundary Standard.

Second, as the initiative got underway, new procedures were developed to collect information on where flood data and mapping needed to be updated and improved. This additional, more accurate information and the mechanisms for obtaining continual input have led to a broader and more detailed picture of the Nation's mapping needs. These procedures also have served as an impetus for important State and local government involvement.

The result of this experience and stakeholder involvement is that FEMA now has a more-informed perspective on how to implement the Flood Map Modernization initiative. The more flexible processes and enhanced products will support the identification of flood hazards in the Nation so that flooding impacts can be reduced.

Appendix C

—Appendix C is provided separately and includes:—

- Results of Government Accountability Office Recommendations
- Results of the Inspector General Recommendations
- Appropriations Language
- Detailed Flood Map Modernization Status Update
- Past Congressional Notes and Documents
- Flood Map Modernization Plan, Funding Options Report, August 1999
- Cost Estimate for the Flood Modernization Plan, August 27, 1999 Draft
- Modernizing FEMA’s Flood Hazard Mapping Program, Fiscal Year 1999 Progress Report
- Government Performance Results Act artifacts
- Clinger-Cohen artifacts
- Glossary.