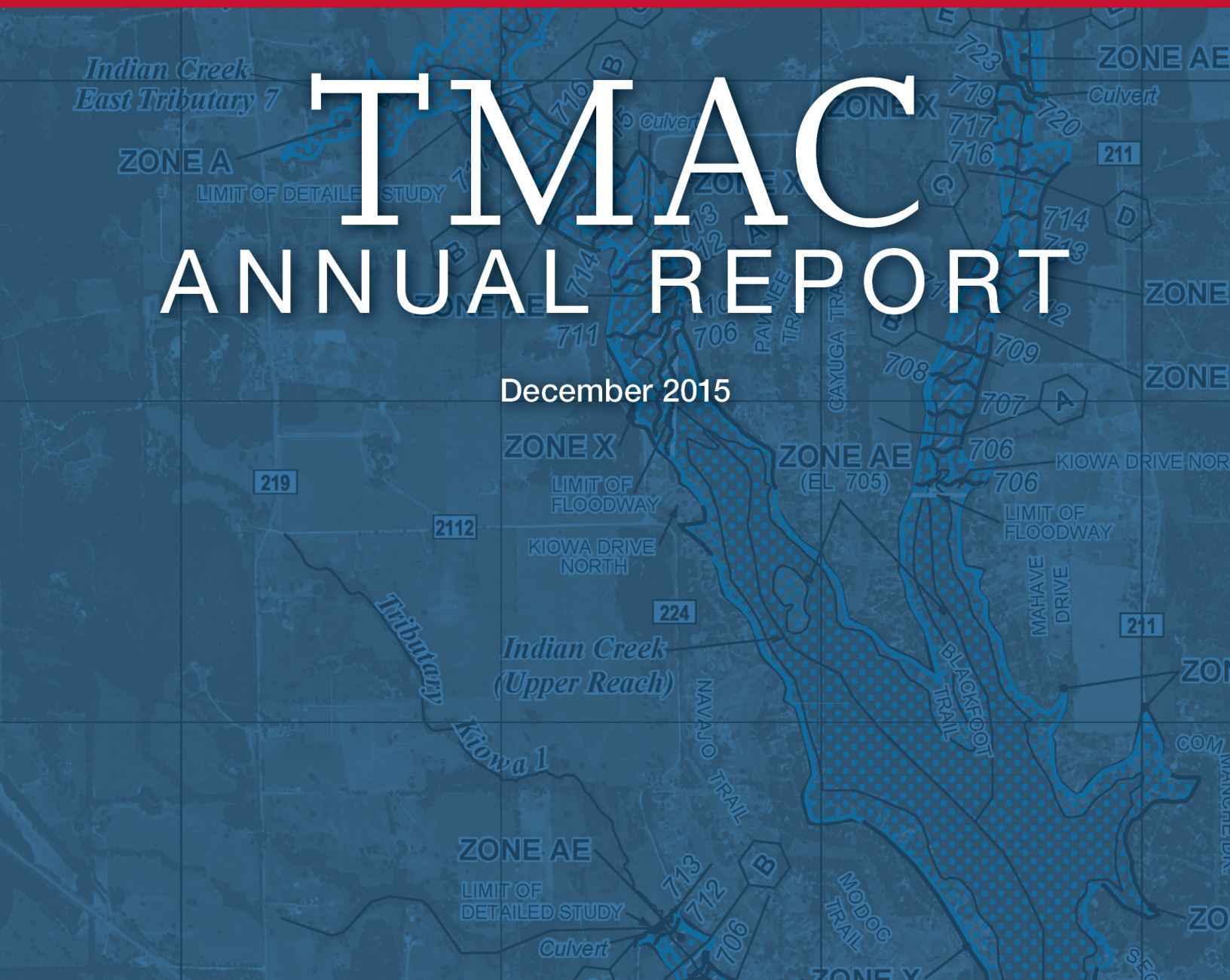




TMAC ANNUAL REPORT

December 2015



TECHNICAL MAPPING ADVISORY COUNCIL

TMAC 2015 ANNUAL REPORT

December 2015

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Foreword

The Biggert-Waters Flood Insurance Reform Act of 2012 (BW-12) mandated that the Federal Emergency Management Agency (FEMA) establish a Federal advisory committee to review the national flood mapping program and its products and to assess future conditions as they relate to flooding. In 2012, the Technical Mapping Advisory Council (TMAC or Council) was established pursuant to BW-12.

The TMAC is required to submit recommendations to FEMA every year on ways to improve the national flood mapping program and its products. This report, *TMAC 2015 Annual Report* (Annual Report), is herewith presented to the Administrator of FEMA in partial fulfillment of the TMAC's BW-12 mandate. A summary of the *TMAC 2015 Annual Report* is provided in the *TMAC 2015 Annual Report Summary*.

The Annual Report refers to the "national flood mapping program," which is used in BW-12 and can be defined as the existing national programs involved in flood mapping (Risk Mapping, Assessment and Planning and the National Flood Insurance Program), but the Annual Report uses "National Flood Hazard and Risk Assessment Program" when referring to the future vision of the program.

The TMAC developed recommendations in accordance with the following goals:

- Goal 1 Accurate, comprehensive data, models, displays and risk assessments associated with present and future flood hazards.
- Goal 2 Time- and cost-efficient generation and process management of flood hazard and risk data, models, assessments and displays.
- Goal 3 Effective utilization of efficient technologies for acquisition, storage, generation, display, and communication of data, models, displays and risk.
- Goal 4 Integrated flood risk management framework of hazard identification, risk assessment, mitigation, and monitoring.
- Goal 5 Strong confidence, understanding, awareness and acceptance of flood hazard and risk data, models, displays, assessments, and process by the public and program stakeholders.
- Goal 6 Robust added value coordination, leveraging and partnering with local, state, federal, and private sector organizations.
- Goal 7 Permanent, substantial funding that supports all program resource requirements.

The Annual Report presents the TMAC's recommendations in the following topics:

- Community of Users and Uses
- Flood Hazard Identification – Program Goals and Priorities
- Flood Hazard Identification – Core Data, Models, and Methodology
- Flood Hazard Identification – Production Processes
- Flood Risk Assessment and Communication
- Data Management and Distribution

- Federal Partner Collaboration
- Cooperating Technical Partners
- Maintenance and Funding

The TMAC is also required to consult with scientists, technical experts, FEMA and other Federal agencies, States, and local communities to develop recommendations on how to ensure that the assessment of flood risk and the development of National Flood Insurance Rate maps use the best available climate science and to ensure that FEMA uses the best available methodology for examining the impact of sea level rise and future developments on flood risk. The recommendations are presented in the *TMAC Future Conditions Risk Assessment and Modeling Report*, which complements the Annual Report, and the two reports should be considered together.

1. Introduction

The Technical Mapping Advisory Council (TMAC or Council) is a Federal advisory committee established to review and make recommendations to the Federal Emergency Management Agency (FEMA) on matters related to the national flood mapping program. Section 1 provides the TMAC's statutory authorization and requirements, a description of the TMAC, and the 2015 members.

1.1 Congressional Charter

Pursuant to the Biggert-Waters Flood Insurance Reform Act of 2012, as amended (BW-12) (42 U.S.C. §§ 4001–4130),¹ the charter filed with Congress on July 29, 2013, formally established the TMAC. The TMAC was established in accordance with and operates under the provisions of the Federal Advisory Committee Act of 1972, as amended (FACA) (5 U.S.C. App 2).

The TMAC Charter outlines the principles and functions of the Council, including the objectives and scope of TMAC activities, description of duties, member composition, frequency of meetings, and other pertinent items relating to the Council's establishment and operation (see Appendix A).

1.2 TMAC Responsibilities

The TMAC provides advice and recommendations to the Administrator of FEMA to improve the preparation of Flood Insurance Rate Maps (FIRMs) and flood hazard information. Among its responsibilities, the TMAC examines the national flood mapping program's performance metrics, standards and guidelines, map maintenance activities, delegation of mapping activities to State and local mapping partners, interagency coordination and leveraging, and other requirements mandated by the authorizing BW-12 legislation.

The TMAC Bylaws establish and describe rules of conduct, regulations, and procedures regarding Council membership and operation (see Appendix B).

1.3 TMAC Duties

The TMAC's duties as mandated by BW-12 are as follows:

- (1) recommend to the Administrator how to improve in a cost-effective manner the –
 - (A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data; and
 - (B) performance metrics and milestones required to effectively and efficiently map flood risk areas in the United States;
- (2) recommend to the Administrator mapping standards and guidelines for –
 - (A) flood insurance rate maps; and
 - (B) data accuracy, data quality, data currency, and data eligibility;
- (3) recommend to the Administrator how to maintain, on an ongoing basis, flood insurance rate maps and flood risk identification;

¹ BW-12 was amended by the Homeowner Flood Insurance Affordability Act of 2014 (HFIAA) (Public Law 113–89, 128 Stat. 1021–22)

- (4) recommend procedures for delegating mapping activities to State and local mapping partners;
- (5) recommend to the Administrator and other Federal agencies participating in the Council –
 - (A) methods for improving interagency and intergovernmental coordination on flood mapping and flood risk determination; and
 - (B) a funding strategy to leverage and coordinate budgets and expenditures across Federal agencies; and
- (6) submit an annual report to the Administrator 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 required under section 4101b of this title; and
 - (C) a summary of recommendations made by the Council to the Administrator (42 U.S.C. § 4101a(c)).

The TMAC is also required by BW-12 to:

- ... consult with scientists and technical experts, other Federal agencies, States, and local communities to –
 - (A) develop recommendations on how to –
 - (i) ensure that flood insurance rate maps incorporate the best available climate science to assess flood risks; and
 - (ii) ensure that the Federal Emergency Management Agency uses the best available methodology to consider the impact of –
 - (I) the rise in the sea level; and
 - (II) future development on flood risk; and
 - (B) not later than 1 year after the date of enactment of this Act, prepare written recommendations in a future conditions risk assessment and modeling report and to submit such recommendations to the Administrator (42 U.S.C. § 4101a(d)).

1.4 TMAC Creation and Composition

Since the National Flood Insurance Program's (NFIP's) inception in 1968 under the National Flood Insurance Act of 1968, as amended (42 U.S.C. §§ 4001–4129), additional legislation has been enacted to encourage community participation in the national flood mapping program, strengthen the flood insurance purchase requirement, and address other priorities. BW-12 sought to make the program more financially sound, directing FEMA to raise flood insurance rates to reflect true flood risk and implement other changes. The TMAC was originally established under the National Flood Insurance Reform Act of 1994, as amended (42 U.S.C. §§ 4001 et seq.), for a term of 5 years. In 2012, FEMA was directed by BW-12 to re-establish the TMAC.

Current TMAC members were appointed based on their demonstrated knowledge and competence regarding surveying, cartography, remote sensing, Geographic Information Systems (GIS), or the technical aspects of preparing and using FIRMs. In addition, the legislation requires that the TMAC's membership have to the maximum extent practicable a balance of Federal, State, local, tribal, and private members and include geographic diversity, including representation from areas with coastline on the Gulf of Mexico and

other States containing areas identified by the Administrator as at high risk for flooding or as areas having special flood hazards.

Per FACA requirements, nominations were solicited through various professional organizations and a public submission process that was published in the *Federal Register*. To establish the TMAC as a Federal advisory committee, the FEMA Administrator selected the most qualified candidates in each membership category, ensuring that, together, the nominees provided a balance of geographically diverse professional opinions from a mix of State, local, and private-sector organizations. Following a rigorous vetting process, FEMA announced the membership and establishment of the Council in July 2014.

TMAC members serve 1- or 2-year terms at the discretion of the Administrator to allow refresh and ensure that the required expertise is represented. The FEMA Administrator or designee may reappoint serving members for additional 1- or 2-year periods. When new members must be appointed, the same process that was used to appoint members in 2014 will be followed. When the TMAC terminates, all TMAC appointments will also terminate.

The 2015 TMAC members, subcommittee members, and Designated Federal Officers (DFOs) are listed in Tables 1-1, 1-2, and 1-3, respectively. See Section 1.6 for information on the TMAC subcommittees.

Table 1-1: 2015 TMAC Members

TMAC Member	BW-12 TMAC Membership Requirement	TMAC Member Role
Mr. John Dorman, CFM Assistant State Emergency Management Director for Risk Management, North Carolina Emergency Management	State Cooperating Technical Partner Representative	TMAC Chair Annual Report Subcommittee Member
Mr. Scott Edelman, P.E. Senior Vice President North America AECOM Water Resources	Mapping Member (recommended by Management Association for Private Photogrammetric Surveyors)	TMAC Vice Chair Future Conditions Subcommittee Chair
Mr. Doug Bellomo, P.E., CFM Senior Technical Advisor, U.S. Army Corps of Engineers	Federal Emergency Management Agency Designee (member through May 2015)	Annual Report Subcommittee Member
Ms. Juliana Blackwell Director, National Geodetic Survey, National Oceanic and Atmospheric Administration	National Oceanic and Atmospheric Administration / Commerce for Oceans and Atmosphere Designee	Annual Report Subcommittee Member Future Conditions Subcommittee Member
Ms. Nancy Blyler Lead Geospatial Community of Practice, U.S. Army Corps of Engineers	U.S. Army Corps of Engineers Designee	Annual Report Subcommittee Member Future Conditions Subcommittee Member
Mr. Richard Butgereit, GISP Geographic Information System Administrator, Florida Division of Emergency Management	State Geographic Information System Representative	Annual Report Subcommittee Member

Table 1-1: 2015 TMAC Members (cont.)

TMAC Member	BW-12 TMAC Membership Requirement	TMAC Member Role
Mr. Mark DeMulder Director, U.S. Geological Survey National Geospatial Program (Ret.)	U.S. Geological Survey Representative	Annual Report Subcommittee Member
Ms. Leslie Durham, P.E. Floodplain Management Branch Chief, Office of Water Resources, Alabama Department of Economic and Community Affairs	State Cooperating Technical Partner Representative	Annual Report Subcommittee Chair
Mr. Steve Ferryman, CFM Mitigation Branch Chief, Ohio Emergency Management Agency	State Mitigation Officer	Future Conditions Subcommittee Member
Mr. Gale Wm. Fraser, II, P.E. General Manager and Chief Engineer, Clark County (Nevada) Regional Flood Control District	Regional Flood and Stormwater Member (recommended by National Association of Flood and Stormwater Management Agencies)	Annual Report Subcommittee Member
Ms. Carrie Grassi Deputy Director for Planning, New York City Mayor's Office of Recovery and Resiliency	Local Cooperating Technical Partner Representative	Future Conditions Subcommittee Member
Mr. Christopher P. Jones, P.E. Registered Professional Engineer	Engineering Member (recommended by American Society of Civil Engineers)	Annual Report Subcommittee Member Future Conditions Subcommittee Member
Dr. Howard Kunreuther James G. Dinan Professor of Decision Sciences and Public Policy, Wharton School, University of Pennsylvania	Risk Management Member (recommended by the Society for Risk Analysis)	Future Conditions Subcommittee Member
Ms. Wendy Lathrop, PLS, CFM President and Owner, Cadastral Consulting, LLC	Surveying Member (recommended by the National Society of Professional Surveyors)	Annual Report Subcommittee Member
Mr. David Mallory, P.E., CFM Program Manager, Floodplain Management Program, Urban Drainage and Flood Control District, Denver, Colorado	Local Cooperating Technical Partner Representative	Future Conditions Subcommittee Member
Mr. Robert Mason, P.E. Chief, Office of Surface Water, Department of Interior, U.S. Geological Survey	U.S. Department of the Interior Designee	Annual Report Subcommittee Member
Ms. Sally Ann McConkey, P.E., CFM, D. WRE Principal Engineer, Illinois State Water Survey Prairie Research Institute, University of Illinois	State Floodplain Management Member (recommended by Association of State Floodplain Managers)	Annual Report Subcommittee Member

Table 1-1: 2015 TMAC Members (cont.)

TMAC Member	BW-12 TMAC Membership Requirement	TMAC Member Role
Mr. Luis Rodriguez, P.E. Branch Chief, Engineering Management Branch, Federal Insurance and Mitigation Administration, Federal Emergency Management Agency	FEMA Designee (beginning May 2015)	Annual Report Subcommittee Member
Mr. Javier E. Ruiz Acting Director, National Geospatial Center of Excellence, Natural Resources Conservation Service	U.S. Department of Agriculture Designee	Annual Report Subcommittee Member
Ms. Christine Shirley, CFM NFIP Coordinator, Oregon Department of Land Conservation and Development	National Flood Insurance Coordination Office Representative	Future Conditions Subcommittee Member
Ms. Cheryl Small President, Small Consulting LLC	Flood Hazard Determination Firm Member (recommended by National Flood Determination Association)	Annual Report Subcommittee Member

Table 1-2: Additional 2015 TMAC Subcommittee Members

TMAC Subcommittee Member	TMAC Role
Ms. Laura Algeo, P.E., CFM Program Specialist, Federal Emergency Management Agency	Annual Report Subcommittee Member
Mr. Kenneth Ashe, P.E., PMP, CFM Senior Associate Engineer, Amec Foster Wheeler Environment & Infrastructure, Inc.	Annual Report Subcommittee Member
Mr. Dwayne Bourgeois, P.E. Executive Director, North Lafourche Conservation, Levee and Drainage District	Annual Report Subcommittee Member
Dr. Maria Honeycutt, CFM Coastal Hazards Specialist, National Oceanic and Atmospheric Administration	Annual Report Subcommittee Member
Mr. Douglas Marcy Coastal Hazards Specialist, National Oceanic and Atmospheric Administration	Future Conditions Subcommittee Member
Mr. Andy Neal Actuary, Federal Emergency Management Agency	Future Conditions Subcommittee Member
Mr. Patrick Sacbbit, P.E. Program Specialist, Federal Emergency Management Agency	Annual Report Subcommittee Member
Mr. Jonathan Westcott, P.E. Coastal Hazards Specialist, Federal Emergency Management Agency	Future Conditions Subcommittee Member
Dr. Kathleen D. White, P.E. Lead, Climate Preparedness and Resilience, Community of Practice, U.S. Army Corps of Engineers, Institute for Water Resources	Future Conditions Subcommittee Member

Table 1-3: TMAC Designated Federal Officers

TMAC Designated Federal Officers	TMAC Role
Mr. Mark Crowell Physical Scientist, Federal Emergency Management Agency	TMAC Designated Federal Officer Future Conditions Subcommittee Member
Ms. Kathleen Boyer Program Specialist, Federal Emergency Management Agency	TMAC Alternate Designated Federal Officer
Mr. Michael Godesky, P.E. Physical Scientist, Federal Emergency Management Agency	TMAC Alternate Designated Federal Officer

1.5 TMAC Mission and Guiding Principles

The TMAC's mission is to provide counsel to FEMA on strategies and actions that will efficiently and effectively advance the identification, assessment, and management of flood hazards and risk.

The TMAC believes the following guiding principles should underpin the future of the national flood mapping program:

- Credible products
- Efficient implementation
- Stakeholder acceptance
- Effective leveraging
- Financial stability

1.6 TMAC Program Vision and Goals

The TMAC believes the following statement reflects an appropriate end-state vision for the national flood mapping program:

A Nation more resilient to flood hazards through the effective identification and communication of flood hazards and risk.

Toward this end-state vision, the TMAC believes the following goals and subsequent recommendations should be established and monitored:

- Goal 1 Accurate, comprehensive data, models, displays and risk assessments associated with present and future flood hazards.
- Goal 2 Time- and cost-efficient generation and process management of flood hazard and risk data, models, assessments and displays.
- Goal 3 Effective utilization of efficient technologies for the acquisition, storage, generation, display, and communication of data, models, displays, and risk.
- Goal 4 Integrated flood risk management framework of hazard identification, risk assessment, mitigation, and monitoring.

- Goal 5 Strong confidence, understanding, awareness and acceptance of flood hazard and risk data, models, displays, assessments, and process by the public and program stakeholders.
- Goal 6 Robust added value coordination, leveraging and partnering with local, state, federal, and private sector organizations.
- Goal 7 Permanent, substantial funding that supports all program resource requirements.

1.7 Activities of the TMAC

As a Federal advisory committee, the TMAC open business meetings were announced to the public in a notice published in the *Federal Register* (www.federalregister.gov). The notices included meeting details, the agenda, general information, and direction to the public website (www.fema.gov/tmac) where interested parties can obtain certified public meeting summaries. These materials were made available for the public comment period 15 days prior to each TMAC meeting.

To facilitate public participation, members of the public were invited to provide written comments on the issues to be considered by the TMAC prior to the meetings. In addition, the public was given an opportunity to provide oral comments during designated public comment periods at each meeting.

The TMAC conducted seven in-person public meetings and two virtual public meetings between September 2014 and October 2015 that were guided by the TMAC's mission (see Section 1.5) and vision (see Section 1.6) and were in accordance with the requirements mandated under BW-12 and the Homeowner Flood Insurance Affordability Act of 2014 (HFIAA) (Public Law 113–89, 128 Stat. 1021–22).

The business objectives that were achieved in the TMAC meetings from September 2014 through October 2015 were as follows:

- Nominate, deliberate, and vote on the TMAC Chair
- Develop the TMAC vision and mission statement
- Form the subcommittees
- Research topics in the form of subject matter expert (SME) briefings
- Produce two reports required by BW-12 and HFIAA:
 - A future conditions risk assessment and modeling report containing recommendations for future conditions risk assessment and modeling
 - An annual report containing recommendations to improve the effectiveness of the national flood mapping program and products

The TMAC also established three subcommittees: Future Conditions Subcommittee; Flood Hazard and Risk Generation Subcommittee; and Operations, Coordination, and Leveraging Subcommittee. In March 2015, the Flood Hazard and Risk Generation Subcommittee and the Operations, Coordination, and Leveraging Subcommittee were combined into the Annual Report Subcommittee. The subcommittees presented their work at TMAC meetings.

The purpose of the subcommittees was as follows:

- **Future Conditions Subcommittee** – Consult with scientists, technical experts, other Federal agencies, States, and local communities to develop recommendations on how to ensure that FIRMs incorporate

the best available climate science to assess flood risks and that FEMA uses the best available methodology to consider the impacts of the rise in sea level and future development on flood risk.

- **Flood Hazard and Risk Generation Subcommittee** – Recommend the following to the Administrator:
 - How to improve in a cost-effective manner the accuracy, general quality, ease of use, and distribution and dissemination of FIRMs and risk data
 - Improve in a cost-effective manner the performance metrics and milestones required to effectively and efficiently map flood risk areas in the United States
 - Map standards and guidelines for FIRMs
 - Map standards and guidelines for data accuracy, data quality, and data eligibility
- **Operations, Coordination, and Leveraging Subcommittee:**
 - Recommend to the Administrator how to maintain FIRMs and flood risk assessment on an ongoing basis
 - Recommend to the Administrator and other Federal agencies a funding strategy to leverage and coordinate budgets and expenditures across Federal agencies
 - Recommend to the Administrator and other Federal agencies how to delegate mapping activities to State and local mapping partners
 - Recommend to the Administrator and other Federal agencies participating on the Council methods for improving interagency and intergovernmental coordination on flood mapping and flood risk assessment

A summary of the TMAC meetings and meeting activities is shown in Appendix D.

1.8 Presentations / Research / Subject Matter Experts

As part of the TMAC and subcommittee agendas, SMEs were invited to TMAC and subcommittee meetings to present information that was critical to achieving the TMAC's objectives and producing the required reports. Although some presentations were organized by subcommittees, they were all open to all TMAC members. The presentations are listed in Appendix E.

2. Background

Section 2 provides background information on the NFIP, regulatory mapping products, flood zones, the Flood Map Modernization Initiative, and the Risk Mapping, Assessment and Planning (Risk MAP) program.

2.1 National Flood Insurance Program

FEMA administers the NFIP through the Federal Insurance and Mitigation Administration. Created with the passage of the National Flood Insurance Act of 1968, the NFIP is an insurance, mapping, and floodplain management program that makes federally backed flood insurance available to home and business owners and renters in communities that participate in the program. Since 1968, a number of laws have strengthened the NFIP to improve its fiscal soundness and inform its mapping and rate setting. In 2012, Congress passed BW-12, which authorized and funded the national flood mapping program (FEMA, 2015e). By participating in the NFIP, communities agree to adopt ordinances and enforce minimum building requirements that reduce the risk of flooding.

The NFIP comprises three central interconnected activities:

- **Flood Insurance** – Making flood insurance available to help property owners recover following a flood
- **Floodplain management** – Minimizing the economic impact of flood events using a combination of mitigation efforts and community-adopted floodplain ordinances
- **Floodplain identification and mapping** – Identifying and mapping community areas that are subject to flooding

Currently, more than 22,000 communities across the Nation participate in the NFIP (FEMA, 2015a) and 5.1 million flood insurance policies are in force (FEMA, 2015i). The program has grown to include more than 138,000 FIRM panels that include 1.13 million miles of riverine and coastal flood mapping (Sacbibit, 2014).

Since 1978, the NFIP has paid out a total of \$51 billion on more than 2 million flood damage claims. For Hurricane Katrina and Hurricane Sandy, the two costliest storms in the history of the NFIP, the NFIP paid out nearly half of these claims, with \$16.3 billion for Hurricane Katrina and \$8 billion for Hurricane Sandy (FEMA, 2015o).

2.2 Flood Hazard Identification

Flood hazard identification is an integral part of the NFIP. FEMA provides flood hazard information in five regulatory mapping products (see Section 2.2.1), which are used to carry out NFIP functions related to floodplain management, flood insurance, mitigation, and flood provisions of building codes. Flood hazard identification consists of identifying and mapping the flood zone that will be inundated by a flood event that has a 1-percent-annual-chance of being equaled or exceeded in a given year. Section 2.2.2 provides an overview of flood zones.

2.2.1 Regulatory Products

FEMA provides five regulatory mapping products as part of the national flood mapping program. The products are defined in Section 5 (Glossary) and described below.

A Flood Insurance Study (FIS) is a compilation and presentation of flood hazard data for specific watercourses, lakes, and coastal flood hazard areas within a community. The final regulatory products of an

FIS are the FIRM, FIS Report, and FIRM Database (FIRM DB; described below). The FIS process identifies the base flood elevation (BFE) and spatial extent of the base flood. The base flood is the flood having a 1 percent chance of being equaled or exceeded in any given year. BFEs are referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29), North American Vertical Datum of 1988 (NAVD 88), or a local datum if NGVD 29 and NAVD 88 are not available. FEMA's current policy is to ensure that all new and updated maps are referenced to NAVD 88, if available.

Regulatory products are used as the basis for official actions required under the NFIP, such as determining mandatory insurance purchase requirements for a property, determining the insurance rate for a property, and enforcing minimum building standards for construction in a floodplain.

- **Flood Insurance Study Report (FIS Report)** – When an FIS is completed, the information and maps are assembled into an FIS Report. The FIS Report contains detailed flood elevation data in flood profiles and data tables.
- **Flood Insurance Rate Map (FIRM)** – The results of the FIS are used to produce the FIRM, which is the official flood map showing the delineation of Special Flood Hazard Areas (SFHAs) and the flood zones and BFEs that are applicable to a community. New format FIRM panels are 36 inches x 24 inches (FEMA, 2015c). Smaller portions, called FIRMettes, are available for downloading and printing. A FIRM may be revised or amended through the Letter of Map Change (LOMC) process (FEMA, n.d.).
- **FIRM Database (FIRM DB)** – The FIRM DB contains the Geographic Information System (GIS) data representing information presented on the FIRMs and in the FIS Report as of the Effective date of publication. The FIRM DB is not updated as Letters of Map Revision (LOMRs) are issued. The GIS data are designed to provide the user with the ability to determine the flood zone, BFE, and the floodway status for a particular location. The FIRM DB also includes information on the NFIP community, map panel, cross sections, hydraulic structures, Coastal Barrier Resource System² if applicable, and base map information such as road, stream, and public land survey data. FIRM DBs are accessible with widely available GIS software, including free programs that can open and view GIS shapefiles. LOMCs are not included in the FIRM DB (FEMA, n.d.).
- **National Flood Hazard Layer (NFHL)** – The NFHL is a digital database that contains flood hazard mapping data from the NFIP. The NFHL is a compilation of all digital FIRM DBs published by FEMA and any published LOMRs issued after the Effective date of the FIRM. Therefore, the FIRM (and FIRM DB) and NFHL quickly diverge as LOMRs are published. The NFHL is continuously updated to represent the current Effective flood data for the areas where maps have been updated.
- **Letters of Map Change (LOMCs)** – FEMA publishes LOMCs to revise or amend the flood hazard information shown on the FIRM without requiring the FIRM to be physically revised and republished. LOMCs include the LOMR, Letter of Map Revision Based on Fill (LOMR-F), and Letter of Map Amendment (LOMA). FEMA issues a formal determination letter, called an LOMC Revalidation or LOMC-VALID letter, when one or more previously published LOMCs are found to still be valid during a new flood mapping study of an area (FEMA, n.d.).

² For more information about the Coastal Barrier Resource System, see <http://www.fws.gov/ecological-services/habitat-conservation/coastal.html>.

2.2.2 Flood Zones

FIRMs depict various flood hazard areas, or flood zones, which are determined in a variety of ways. The flood zones are described below.

2.2.2.1 High Flood Risk Areas

In communities that participate in the NFIP, mandatory flood insurance requirements apply to all flood zones in high flood risk areas. These flood zones are known as Special Flood Hazard Areas (SFHAs). Riverine SFHAs are defined in Table 2-1, and coastal SFHAs are defined in Table 2-2.

Most riverine SFHAs are categorized as Zone AE, Zones A1–30, or Zone A and are determined using hydrologic and hydraulic (H&H) models or analysis procedures designed for riverine flood analyses. Storm surge or tide gage analyses and wave studies are used to determine Zone A's in coastal areas. These zones are collectively referred to collectively as Zone A's.³

Table 2-1: Flood Zones in High Flood Risk Riverine Areas (Riverine SFHAs)

Zone(s)	Description
A	Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no BFEs or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
AE, A1–30	Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. BFEs are shown. Mandatory flood insurance requirements and floodplain management standards apply. In general, AE is used on newer FIRMs, whereas Zones A1–30 were used on older FIRMs (approximately 1989 and older).
AH	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. BFEs derived from detailed hydraulic analyses are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
AO	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average flood depths derived from detailed hydraulic analyses are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply. Some Zone AO areas have been designated in areas with high flood velocities such as alluvial fans and washes. Communities are encouraged to adopt more restrictive requirements for these areas.
AR	Areas that result from the decertification of a previously accredited flood protection system that is determined to be in the process of being restored to provide base flood protection. Mandatory flood insurance purchase requirements and floodplain management standards apply.
A99	Areas subject to inundation by the 1-percent-annual-chance flood event but that will ultimately be protected upon completion of an under-construction Federal flood protection system. These are areas of special flood hazard where enough progress has been made on the construction of a protection system, such as dikes, dams, and levees, to consider it complete for insurance rating purposes. Zone A99 may only be used when the flood protection system has reached specified statutory progress toward completion. No BFEs or depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Source: Adapted from FEMA (2015h)

³ In this report, the term "Zone A's" refers to any zone that begins with the letter A (A, A1–30, AE, AH, AO, AR, A99).

Table 2-2: Flood Zones in High Flood Risk Coastal Areas (Coastal SFHAs)

Zone	Description
V	Areas along coasts subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves. Because detailed hydraulic analyses have not been performed, no BFEs or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
VE, V1-30	Areas subject to inundation by the 1-percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action. BFEs derived from detailed hydraulic analyses are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply. In general, Zone VE is used on newer FIRMs, whereas Zones V1-30 were used on older FIRMs (approximately 1989 and older).
A	Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate coastal flood methods. Because detailed hydraulic analyses have not been performed, no BFEs or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
AE, A1-30	Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using detail coastal flood models. BFEs are shown. Mandatory flood insurance requirements and floodplain management standards apply.
AO	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on the landward side of a dune or barrier subject to wave overtopping). Average depths in coastal Zone A are between 1 and 3 feet. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Source: Adapted from FEMA (2015h)

Coastal SFHAs categorized as Zone VE, Zones V1-30, or Zone V indicate flood hazard areas that are subject to high velocity wave action.

Coastal high flood risk areas are more hazardous than riverine high flood risk areas because wave effects can cause structural damage to buildings that would otherwise remain intact following inundation only. Consequently, NFIP floodplain management and construction requirements are more stringent (see Figure 2-1), and flood insurance premium rates are much higher in Zone Vs⁴ (Crowell et al., 2013). Building codes and standards extend Zone V design and construction requirements to Coastal A Zones subject to wave heights between 1.5 and 3 feet (see Figure 2-2).

Coastal A Zone

The term “Coastal A Zone” (CAZ) refers to the area between the landward extent of Zone VE and the Limit of Moderate Wave Action (LiMWA).

CAZ is not a regulatory flood zone but is a term that is tied to the LiMWA and is referenced by FEMA building science and building codes and standards. Building codes and standards apply Zone V design and construction requirements in the CAZ. CAZ is also recognized by the Community Rating System (CRS) program.

⁴ In this report, the term “Zone V’s” refers to any zone that begins with the letter V (V, V1-30, VE).

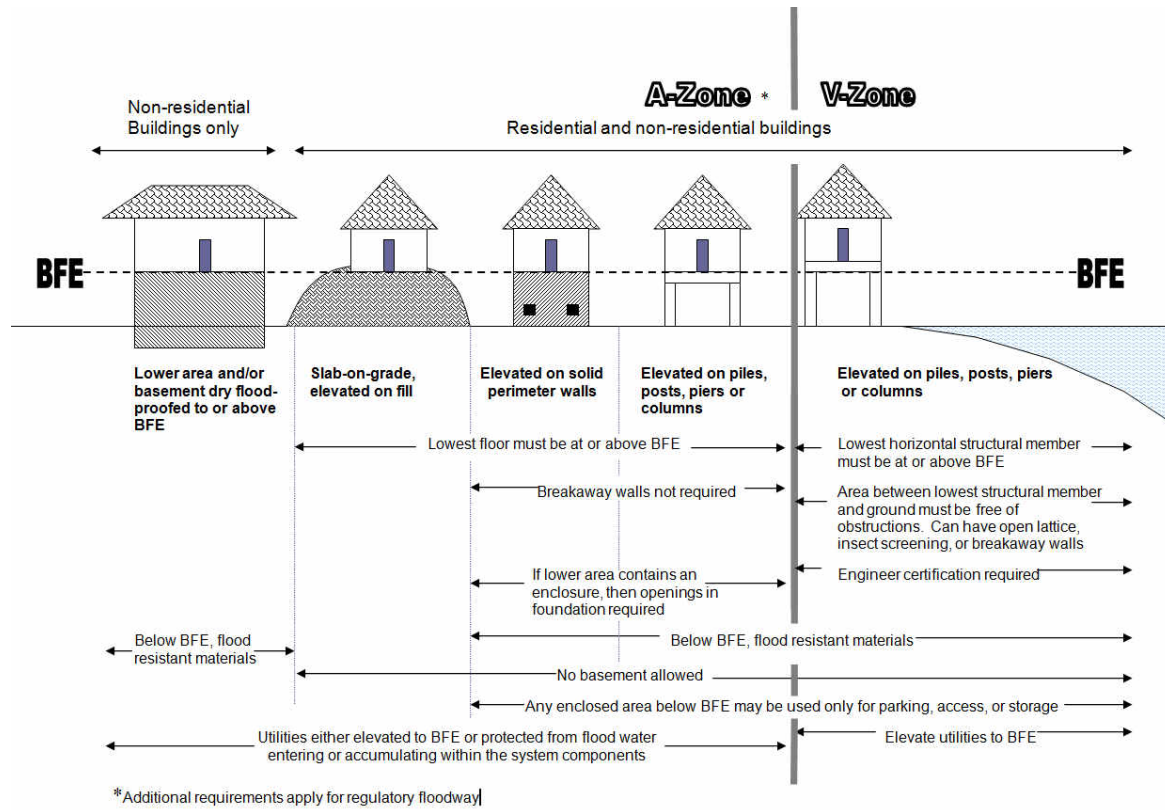


Figure 2-1: Summary of current minimum NFIP building requirements (Crowell et al., 2007; used with permission)

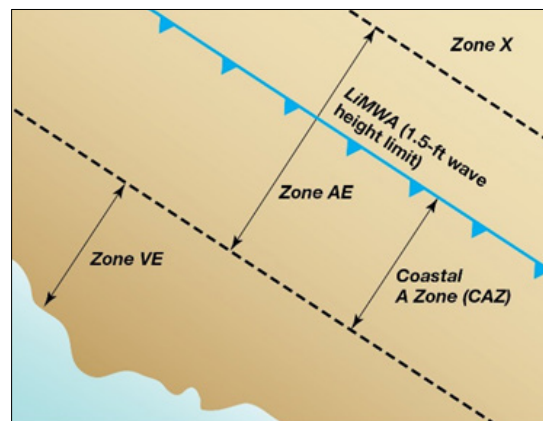


Figure 2-2: Coastal A Zone relationship to flood zones

2.2.2.2 Moderate-to-Low Flood Risk Areas

In communities that participate in the NFIP, flood insurance is available to all property owners and renters in moderate-to-low flood risk areas. Moderate-to-low flood risk areas are not considered to be within the SFHA because the area has less than a 1-percent-annual-chance flood hazard or the 1-percent-annual-chance flood depth is less than 1 foot. While purchasing flood insurance in these areas is encouraged, there is no federally mandated requirement to do so. The flood zones in the moderate-to-low flood risk area are defined in Table

2-3. Figure 2-3 is a schematic showing the relationship between riverine Zone A, coastal Zone A, Zone V, and Zone X (Crowell et al., 2013).

Table 2-3: Flood Zones in Moderate-to-Low Flood Risk Areas

Zone(s)	Description
B and X (shaded)	Areas subject to inundation by the 0.2-percent-annual-chance flood event; areas subject to inundation by the 1-percent-annual-chance flood event with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by accredited levees. Flood insurance is not federally mandated, but lenders can require the purchase of flood insurance in these areas. No minimum Federal floodplain management standards apply.
C and X (unshaded)	Areas determined to be outside the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains. Flood insurance is not federally mandated, but lenders can require the purchase of flood insurance in these areas. No minimum Federal floodplain management standards apply.

Source: Adapted from FEMA (2015h)

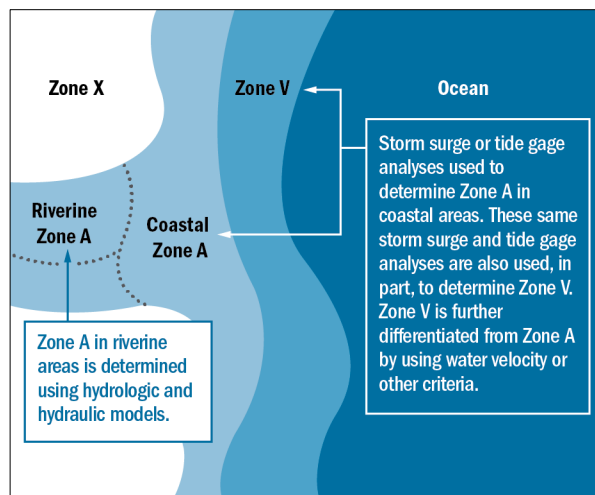


Figure 2-3: Relationship between riverine Zone A, coastal Zone A, Zone V, and Zone X (adapted from Crowell et al. [2013]; used with permission)

2.2.2.3 Undetermined Flood Risk Areas

In communities that participate in the NFIP, flood insurance is available to all property owners and renters in undermined flood risk areas. While purchasing flood insurance in these areas is encouraged, there is no federally mandated requirement to do so. The flood zone used for areas of undetermined flood risk is defined in Table 2-4.

2.3 Flood Map Modernization and Risk MAP

The Flood Map Modernization Initiative, commonly referred to as Map Mod, was created in 1997 to convert existing flood maps to a digital format and to ensure that all new flood maps were produced in a digital format. Map Mod improved and updated the Nation’s flood maps and provided 92 percent of the Nation’s population with FIRMs (see Section 2.3.2). FEMA’s Risk MAP program was developed in 2009 and was founded on the work that had been done under Map Mod.

Table 2-4: Flood Zone for Undetermined Flood Risk Areas

Zone	Description
D	Areas where there are possible but undetermined flood hazards. This zone designation is used for areas where no analysis of flood hazards have been conducted, in sparsely populated areas, and some areas protected by non-accredited levees. Flood insurance is not federally mandated, but lenders can require the purchase of flood insurance in these areas. No minimum Federal floodplain management standards apply.

Source: Adapted from FEMA (2015h)

2.4 Flood Map Modernization Initiative

In 1994, FEMA developed a prototype digital version of the FIRM and announced that it intended to expand the digital FIRM inventory for flood data management and map production efficiency. In 1997, then-FEMA Director James Witt delivered a 7-year strategic plan for a Flood Map Modernization Initiative to Congress, in which all new flood maps would be produced as digital FIRMs and the existing 100,000 FIRM panels would be converted to digital file format. The Flood Map Modernization Initiative (Map Mod) set out long-term plans for digital flood hazard map production and management of inventory to support Federal flood insurance coverage decisions (Morrissey, 2006). FEMA also mandated that all NFIP communities have digital FIRMs produced within 7 years (FEMA, 2001).

Map Mod used state-of-the-art technology and advanced engineering to increase the quality, reliability, and availability of flood hazard maps and data and used a collaborative process that involved State, regional, and local partners in mapping tasks. In addition to providing more accurate and up-to-date flood hazard information, Map Mod enhanced the decision making of community officials and citizens and their ability to manage risks and other issues locally.

Before Map Mod, 70 percent of the Nation’s FIRMs were over 10 years old due to the lack of funding for map maintenance. Through Map Mod, FEMA established a technology-based, cost-effective process for updating, validating, storing, and distributing flood risk data.

2.4.1 Risk Mapping, Assessment, and Planning Program

In 2009, at the request of Congress, FEMA produced a plan titled *Risk Mapping, Assessment, and Planning (Risk MAP) Multi-Year Plan: Fiscal Years 2010–2014* (FEMA, 2009). The plan outlines FEMA’s vision for building on the data produced during Map Mod to enhance and maintain the Nation’s map inventory and recommended significant changes to how risk is communicated to the public. The vision of the Risk MAP program is to “deliver quality data that increases public awareness and leads to action that reduces risk to life and property” (FEMA, 2012b, p. 1). Additional products were created under Risk MAP to help communicate both the flood hazard and the associated risk.

Risk MAP provides State, local, and tribal entities with quality flood information, flood mapping products, risk assessment tools, and planning and outreach support that strengthen the community’s ability to make informed decisions about reducing flood risk. Risk MAP focuses on products and services beyond the traditional FIRM by working with officials to help put flood risk data and assessment tools to use and effectively communicate risk to citizens, thereby enabling communities to enhance flood mitigation plans and actions.

2.4.1.1 Risk MAP Program Vision and Goals

The Risk MAP lifecycle, as shown in Figure 2-4, demonstrates the program’s focus to identify, assess, communicate, and mitigate risk. The goals under Risk MAP are as follows:

- **Flood hazard data** – Address gaps in flood hazard data to form a solid foundation for risk assessment, floodplain management, and actuarial soundness of the NFIP.
- **Public awareness/outreach** – Ensure that a measurable increase of the public’s awareness and understanding of risk results in a measurable reduction of current and future vulnerability.
- **Hazard mitigation planning** – Lead and support States, local, and tribal communities to effectively engage in risk-based mitigation planning resulting in sustainable actions that reduce or eliminate risks to life and property from natural hazards.
- **Enhanced digital platform** – Provide an enhanced digital platform that improves management of Risk MAP, disseminates information produced by Risk MAP, and improves communication and sharing of risk data and related products to all levels of government and the public.
- **Alignment and synergies** – Align risk analysis programs and develop synergies to enhance decision-making capabilities through effective risk communication and management.



Figure 2-4: Risk MAP lifecycle

2.4.1.2 Flood Risk Products

FEMA’s Risk MAP program produces a number of products referred to as flood risk products (FEMA, 2015k). Flood risk products are non-regulatory resources that can be developed as part of a Risk MAP project (referred to as a flood risk project by FEMA) and supplement the regulatory mapping products discussed in Section 2.2. While some of the flood risk products convey flood hazard information, not flood risk information, they are intended to help community officials and the public view and understand their flood risk.

The products, which are developed at the hydrologic unit code 8 (HUC8) watershed level (see the text box “Hydrologic Unit Code 8”), are as follows:

- **Flood Risk Report (FRR)** – Provides flood risk data at the HUC8 watershed level and also summarizes the flood risk information on a community-by-community basis for the portions of the Risk MAP project that affect each jurisdiction.

Hydrologic Unit Code 8

The USGS divided and subdivided the Nation into successively smaller hydrologic units (watershed areas), classified into four levels: regions, sub-regions, accounting units, and cataloging units. Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits (USGS, 2015a).

- **Flood Risk MAP (FRM)** – An element of the FRR that provides a visual overview of flood risk and related information for a project area, such as potential flood losses associated with the 1-percent-annual-chance flood event.
- **Flood Risk Database (FRD)** – Stores all flood risk data for a Risk MAP project, including the information shown in the FRR and on the FRM. The FRD comprises standard and enhanced datasets, which are summarized in Table 2-5.

Table 2-5: Summary of FEMA’s FRD Datasets

FRD Dataset	Description
Depth Grids	These datasets enable the analysis and 3-D visualization of the depth of flooding associated with specific flood-frequency events. These products provide a clearer view of areas that have a higher vulnerability to flooding risk.
Water Surface Grids	These datasets enable the analysis and 3-D visualization of the elevation of flooding associated with specific flood frequency events.
Probability Grids	These datasets communicate a better understanding of the relative probability of being flooded for any given location within the mapped floodplain. Additional datasets that are required for the construction of this product include water surface grids, depth grids, and building footprints.
Risk Assessment	This dataset is an assessment of potential financial consequences and other impacts associated with structures located in a SFHA. This dataset also enables communities to make informed decisions regarding future land development and community infrastructure
Changes Since Last FIRM	This dataset provides a visualization of planimetric changes to the floodplain and floodway extents. It also includes attribute data that provides insight as to potential reasons for the changes since the last FIRM was published.
Areas of Mitigation Interest	This dataset provides insight into a variety of flood risk mitigation issues. These issues range from potential flood risk mitigation project opportunities to success stories of effective flood risk mitigation activities that have already taken place.

3. Flood Hazard, Flood Risk, and Flood Information

In Section 3.1, the difference between flood hazard and flood risk is explained, followed by a description of the components of a flood risk assessment. The quality of flood hazard analyses and flood risk assessments depend on the data, models, and analysis used through the study process, and in particular, the precision, accuracy, and resolution of the information, as discussed in Section 3.2.1. Uncertainty is also an important factor in the quality of flood information and is discussed in Section 3.2.2.

3.1 Flood Hazard and Flood Risk

Discussions of flooding and its effects require certain terms to be defined. For TMAC purposes, the effects of flooding are divided into two categories: flood hazard and flood risk. Flood hazard generally refers to physical flood conditions, and flood risk generally refers to losses and other consequences of flooding.

- **Flood hazard** – Flood conditions (e.g., depth, wind, velocity, duration, waves, erosion, debris) with the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss (modified from FEMA, 1997a).
- **Flood risk** – Expected flood losses based on the likelihood and severity of flooding, the natural and manmade assets at risk, and the consequences to those assets (modified from Schwab et al., 1998).

Flood risk assessments build on flood hazard identification, taking into account the likelihood that various flood events will occur, and estimate the impacts of the flood events. The hazard identification and risk assessment depend on the quality of information (precision, accuracy, resolution, and uncertainty) that propagates throughout the hazard identification and risk assessment process.

Flood risk assessments have the four basic elements listed below and shown in Figure 3-1:

- Flood hazard
- Inventory of properties and their locations
- Vulnerability or susceptibility to damage of the structures at risk
- Loss estimates, both direct and indirect

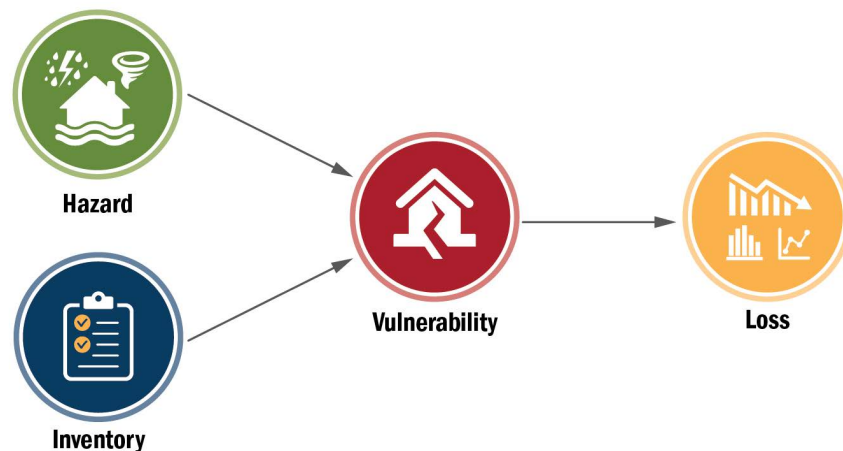


Figure 3-1: Four basic elements of a flood risk assessment

3.2 Quality of Flood Information

Flood insurance studies are estimates of complex H&H processes. Some FIRMs are based on detailed studies using recent terrain and hydraulic data, well-established calculation/modeling procedures, and modern mapping techniques, while others are less detailed, relying on less and/or older data, simplifying assumptions, and simplified calculations/modeling/mapping.

The quality of the FIS Report and FIRM, as well as any flood risk assessments based on the study, depends on the data, models, and procedures that are used. Inaccuracies, imprecision, and uncertainties present in the data, models, and the methodologies will propagate through to the final products. For this reason, data, models, and procedures should be appropriate to the physical setting and study purpose.

The quality of flood hazard and flood risk information can be characterized in terms of the precision, accuracy, resolution, and uncertainty of the data, models, and methodologies used in the study process. Understanding how these parameters impact quality is important when communicating flood hazard and flood risk information to users. A clear understanding of the parameters is critical for those who rely on FIRMs, FIS Report, and FIRM DB for decision-making and for those who are involved in planning resilient communities.

3.2.1 Precision, Accuracy, and Resolution

A reasonable expectation is that flood hazard and flood risk information is accurate and precise, meaning that the products and associated data provide information that is close to known or accepted values and that repeated estimates of hazard or risk will closely approximate each other.

Another reasonable expectation is that flood hazard and flood risk information has been produced at a resolution that is appropriate to the spatial variability in output parameters of importance (e.g., flood elevation, flood extents, structures affected, flood losses and effects). Precision, accuracy, and resolution are defined in Figure 3-2.

However, accuracy and precision come with a cost that can be associated with increased resolution of data, increased computational effort, and increased time. Depending on the ultimate use of the information, high levels of accuracy, precision, and resolution may not always be justified. Thus, accuracy, precision, and resolution must be clearly defined, and their implications must be communicated to the users.

3.2.2 Uncertainty

Flood insurance studies and flood risk assessments include several types of uncertainty. Uncertainty as modified from NRC (2000; 2009) is a measure of the imprecision of our knowledge of a process or outcome. Uncertainty associated with the data and study procedures can be classified as natural variability or knowledge uncertainty as follows:

- **Natural variability (aleatory uncertainty)** – Variability in the physical world; uncertainty arising from variations inherent in the behavior of natural phenomena; this variability is not reducible, even with additional measurements or observations.
- **Knowledge uncertainty (epistemic uncertainty)** – Uncertainty arising from imprecision in analysis methods and data. Arises from a lack of understanding of events and processes or from a lack of data; such lack of knowledge is reducible with further information (NRC, 2000; 2009).

PRECISION

How closely repeated measurements or observations come to duplicating measured or observed values.

—NOAA (2012)

Precision relates to the quality of the *method* by which measurements or observations are made and is distinguished from accuracy, which relates to the quality of the *result*.

—Modified from FEMA (2010)

ACCURACY

The closeness of a measured or computed value to a true or accepted value of a particular quantity.

—Modified from FEMA (2010)

RESOLUTION

The density of data or information shown on a map or display; spatial resolution is a measure of the finest detail distinguishable in an image.

—Modified from NRC (2007)

A digital elevation model created from the same source data at different resolutions. In this example, 3 different post spacings (30 meters, 10 meters, and 3 meters) are shown. Note the effect of post spacing (resolution) on the level of visible detail.

—Maune (2007)

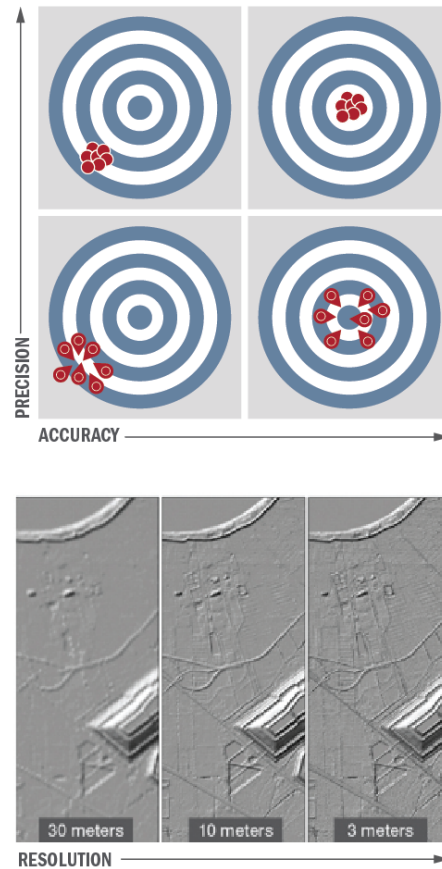


Figure 3-2: Definitions of precision, accuracy, and resolution

Additional uncertainties can be introduced by inaccuracies and approximations during the mapping process (e.g., interpolating between points where results are known; smoothing boundaries and lines; in coastal conditions, rounding BFEs to the nearest foot).

3.2.3 How Good Is Good Enough?

Although not every FIS requires the most accurate or least uncertain results, quantifying accuracy, precision, and uncertainty is important for every study. The implication is clear: if the data, models, and methodologies used in the FIS process are highly uncertain or highly inaccurate, decisions (e.g., permitting, development, design, and insurance rating) and products (including the FIRM, FIRM DB, and flood risk assessment) that are based on them can be affected. Further, since decisions and products based on flood hazard information can introduce additional inaccuracies and uncertainties, the overall effect of the uncertainties can be compounded.

On the other hand, not all users need or have the time and resources to produce FIRMs and risk estimates to the highest degree of accuracy, precision, and resolution. The needs of the users and the uses of hazard and risk information, coupled with resource constraints, should dictate the degree of accuracy, precision, and resolution of the information produced by flood hazard and flood risk studies. Improving flood hazard accuracy and reducing uncertainty can be costly. In some geographic areas (e.g., sparsely developed areas,

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areas with a low flood hazard), the expenditure of resources may not be justified to gather data and perform detailed modeling in order to obtain the highest quality flood hazard information.

“How good is good enough?” is a logical question for users to ask. There is no simple answer. Determining the necessary accuracy, precision, and resolution requires balancing competing needs with available resources as studies are planned and products are developed.

How Good Is Good Enough?

The accuracy, precision, and resolution of water surface elevations, flood zone boundaries, and other related information are a direct result of the quantity and quality of the underlying data and the use of models and methodologies that are appropriate to the physical setting and study purpose.

Not every flood hazard study requires the use of the latest, most detailed data and the most sophisticated models.

Not every flood hazard map needs to be updated frequently using the latest data. Flood hazard products should be reviewed and validated, but not every study requires frequent updates.

The key, then, is to establish guidelines for selecting appropriate data, models, and methodologies that result in flood hazard information that is consistent with user needs and the available resources.

4. 2015 Topics and Recommendations

Section 4 presents topics and associated recommendations identified by the TMAC for inclusion in this Annual Report. In Table 4-1, the “Topic Section” column shows the nine general topic areas described in the Annual Report. The “Recommendation” column identifies the TMAC’s recommendations associated with each topic area. The “Type of Recommendation” column identifies whether implementing the TMAC’s recommendation would require a policy or regulatory change. Recommendations identified as requiring a policy change may be either a short-term or a long-term goal while recommendations identified as requiring a regulatory change are long-term goals.

Table 4-1: Topics and Recommendations

Topic Section	Recommendation	Type of Recommendation
<p>4.1 Community of Users and Uses</p>	<p>Recommendation 1: FEMA should establish and implement a process to assess the present and anticipated flood hazard and flood risk products to meet the needs of the various users. As part of this process, FEMA should routinely:</p> <ul style="list-style-type: none"> a) Conduct a systematic evaluation of current regulatory and non-regulatory products (data, maps, reports, etc.) to determine if these products are valued by users, eliminating products which do not cost effectively meet needs; b) Consider user requirements prior to any updates or changes to data format, applications, standards, products, or practices are implemented; c) Proactively seek to provide authoritative, easy to access and use, timely, and informative products and tools; and d) Consider future flood hazards and flood risk. 	<p>Policy</p>
<p>4.2 Flood Hazard Identification – Program Goals and Priorities</p>	<p>Recommendation 2: FEMA should develop a national 5-year flood hazard and risk assessment plan and prioritization process that aligns with program goals and metrics (see Recommendation 3). This should incorporate a rolling 5-year plan to include the establishment and maintenance of new and existing studies and assessments in addition to a long-term plan to address the unmapped areas. Mapping and assessment priorities should be updated annually with input from stakeholders (e.g., Multi-Year Hazard Identification Plan). The plan should be published and available to stakeholders.</p>	<p>Policy</p>
	<p>Recommendation 3: FEMA should develop National Flood Hazard and Risk Assessment Program goals that include well-defined and easily quantifiable performance metrics. Specifically, the program goals should include metrics for the following:</p> <ul style="list-style-type: none"> a) Maintaining an inventory of valid (verified), expiring, unverified, and unknown flood hazard miles; b) Addressing the non-modernized areas of the Nation and unstudied flood hazard miles; c) Conducting flood risk analysis and assessments on the built environment; and d) Counting population having defined floodplains using a stream level performance indicator for a better representation of study coverage. 	<p>Policy</p>

Topic Section	Recommendation	Type of Recommendation
<p>4.3 Flood Hazard Identification – Core Data, Models, and Methodology</p>	<p>Recommendation 4: FEMA should work with Federal, State, local, and tribal partners to ensure topographic, geodetic, water-level, and bathymetry data for the flood mapping program are collected and maintained to Federal standards. Future FEMA topographic and bathymetric LiDAR acquisition should be consistent with 3DEP and Interagency Working Group on Ocean and Coastal Mapping standards, and all geospatial data for the flood mapping program should be referenced to current national datums and the National Spatial Reference System. Water level gage datums for active gages should be referenced to current national datums and the National Spatial Reference System, and to the extent practical, datums for inactive gages should be converted to meet these standards.</p>	<p>Policy</p>
	<p>Recommendation 5: FEMA should document the horizontal and vertical accuracy of topographic data input to flood study models and the horizontal and vertical accuracy of topographic data used to delineate the boundaries of the flood themes. These data should be readily available to users, and clearly reported with products.</p>	<p>Policy</p>
	<p>Recommendation 6: FEMA should periodically review and consider use of new publicly available statistical models, such as the proposed Bulletin 17C, for flood-frequency determinations.</p>	<p>Policy</p>
	<p>Recommendation 7 (riverine): FEMA should develop guidelines, standards, and best practices for selection and use of riverine and coastal models appropriate for certain geographic, hydrologic, and hydraulic conditions.</p> <ul style="list-style-type: none"> a) Provide guidance on when appropriate models would be 1-D vs 2-D, or steady state vs unsteady state; b) Support comparative analyses of the models and dissemination of appropriate parameter ranges; and c) Develop quality assurance protocols. 	<p>Policy</p>
	<p>Recommendation 7 (coastal): FEMA should develop guidelines, standards, and best practices for selection and use of coastal models appropriate for certain geographic, hydrologic, and hydraulic conditions.</p> <ul style="list-style-type: none"> a) Provide guidance on when appropriate models would be 1-D vs 2-D; b) Support comparative analyses of the models and dissemination of appropriate parameter ranges; and c) Develop quality assurance protocols. 	<p>Policy</p>
	<p>Recommendation 8: FEMA should develop standards, guidelines, and best practices related to coastal 2-D storm surge modeling in order to expand the utility of the data and more efficiently perform coastal flood studies.</p>	<p>Policy</p>
<p>4.4 Flood Hazard Identification – Production Processes</p>	<p>Recommendation 9: FEMA should review and update existing coastal event-based erosion methods for open coasts, and develop erosion methods for other coastal geomorphic settings.</p>	<p>Regulatory and Policy</p>
	<p>Recommendation 10: FEMA should transition from identifying the 1-percent-annual-chance floodplain and associated base flood elevation as the basis for insurance rating purposes to a structure-specific flood frequency determination and associated flood elevations.</p>	<p>Regulatory</p>

Topic Section	Recommendation	Type of Recommendation
<p>4.4 Flood Hazard Identification – Production Processes (cont.)</p>	<p>Recommendation 11: FEMA should modify the current work flow production process and supporting management system, Mapping Information Platform, to reduce unnecessary delays created by redundant tasks and inflexibility of the system. The process and system are currently not designed to properly manage non-regulatory products or products that do not fit predefined footprints. FEMA should modify the system to enable flexibility in project scope and size, such as the choice of watershed size, not limiting projects to only the hydrologic unit code 8 (HUC8).</p>	<p>Policy</p>
	<p>Recommendation 12: FEMA, in its update of guidance and standards, should determine the cost impact when new requirements are introduced and provide guidance to consistently address the cost impact to all partners.</p>	<p>Policy</p>
	<p>Recommendation 13: FEMA should develop guidelines and procedures to integrate a mass LiDAR-based LOMA process into the National Flood Hazard and Risk Assessment Program. As part of this process, FEMA should also evaluate the feasibility of using parcel and building footprint data to identify eligible “out as shown” structures as an optional deliverable during the flood mapping process.</p>	<p>Policy</p>
<p>4.5 Flood Risk Assessment and Communication</p>	<p>Recommendation 14: FEMA, and its mapping partners including the private sector, should transition to a flood risk assessment focus that is structure specific. Where data are available, FEMA and its partners should contribute information and expertise consistent with their interests, capabilities, and resources towards this new focus.</p>	<p>Policy</p>
	<ul style="list-style-type: none"> a) A necessary prerequisite for accurate flood risk assessments is detailed flood hazard identification, which must also be performed to advance mitigation strategies and support loss estimations for insurance rating purposes. b) FEMA should initiate dialogue with risk assessment stakeholders to identify potential structure-specific risk assessment products, displays, standards, and data management protocols that meet user needs. c) FEMA and its partners should develop guidelines, best practices, and approaches to implementing structure-specific risk assessments. 	<p>Policy</p>
<p>4.6 Data Distribution and Management</p>	<p>Recommendation 15: FEMA should leverage opportunities to frame and communicate messages to stakeholders in communities so they understand the importance of addressing the flood risk today and consider long-term resilience strategies. Messages should be complemented by economic incentives such as low-interest loans and mitigation grants that lead community leaders and individuals to undertake cost-effective risk reduction measures.</p>	<p>Policy</p>
	<p>Recommendation 16: FEMA should transition from the current panel-based cartographic limitations of managing paper maps and studies to manage NFIP data to a database-derived, digital-display environment that are fully georeferenced and relational, enabling a single digital authoritative source of information and database-driven displays. Towards this transition, FEMA should:</p> <ul style="list-style-type: none"> a) Prepare a multi-year transition plan to strategically transition all current cartographic and/or scanned image data to a fully georeferenced, enterprise relational database. b) Update required information for map revisions (MT-2 forms) and LOMC applications to ensure accurate geospatial references, sufficient data to populate databases, and linkages to existing Effective data. 	<p>Regulatory</p>

Topic Section	Recommendation	Type of Recommendation
<p>4.6 Data Distribution and Management (cont.)</p>	<p>Recommendation 16 (cont.)</p> <ul style="list-style-type: none"> c) Adopt progressive data management approaches to disseminate information collected and produced during the study and revision process, including LOMCs. d) Ensure that the data management approach described in (c) is sufficiently flexible to allow efficient integration, upload, and dissemination of NFIP and stakeholder data (e.g., mitigation and insurance data that are created and maintained by other Federal agencies), and serve as the foundation for creating all digital display and mapping products. e) Provide a mechanism for communities to readily upload jurisdictional boundary data, consistent with requirements to participate in the NFIP, as revised, allowing other stakeholders access. 	
<p>4.7 Federal Partner Collaboration</p>	<p>Recommendation 17: FEMA should consider National Academy of Public Administration recommendations on agency cooperation and federation (6, 7, 8, 9, 13, and 15) and use them to develop more detailed interagency and intergovernmental recommendations on data and program-related activities that can be more effectively leveraged in support of flood mapping.</p>	<p>Policy</p>
	<p>Recommendation 18: FEMA should work with Federal, State, local, and tribal agencies, particularly the U.S. Geological Survey (USGS) and the National Ocean Service, to ensure the availability of the accurate water level and streamflow data needed to map flood hazards. Additionally, FEMA should collaborate with USGS to enhance the National Hydrography Dataset to better meet the scale and resolution needed to support local floodplain mapping while ensuring a consistent national drainage network.</p>	<p>Policy</p>
<p>4.8 Cooperating Technical Partners</p>	<p>Recommendation 19: FEMA should develop and implement a suite of strategies to incentivize communities, non-government organizations, and private sector stakeholders to increase partnering and subsequent contributions for flood hazard and risk updates and maintenance.</p>	<p>Policy</p>
	<p>Recommendation 20: FEMA should work with Cooperating Technical Partners (CTPs) to develop a suite of measures that communicate project management success, competencies, and capabilities of CTPs. Where CTPs demonstrate appropriate levels of competencies, capabilities and strong past performance, FEMA should further entrust additional hazard identification and risk assessment responsibilities to CTPs.</p>	<p>Policy</p>
	<p>Recommendation 21: To ensure strong collaboration, communication, and coordination between FEMA and its CTP mapping partners, FEMA should establish a National Flood Hazard and Risk Management Coordination Committee. The role of the committee should be focused around the ongoing implementation of the 5-year Flood Hazard Mapping and Risk Assessment Plan. FEMA should add other members to the committee that have a direct bearing on the implementation of the plan.</p>	<p>Policy</p>
<p>4.9 Maintenance and Funding</p>	<p>Recommendation 22: FEMA should define the financial requirements to implement the TMAC's recommendations and to maintain its investment in the flood study inventory.</p>	<p>Policy</p>

4.1 Community of Users and Uses

In the past, the NFIP was described as a three-legged stool with each leg representing one of the three aspects of the program: floodplain identification and mapping, floodplain management, and flood insurance (FEMA, 2002). The image has evolved with the addition of a fourth leg— flood mitigation (see Figure 4-1). Undertaking mitigation measures that reduce or eliminate the long-term risk of flooding to individuals and property fosters community resilience and reduces response and resource requirements following a disaster. Although the program has evolved, flood hazard identification remains the foundation supporting floodplain management, flood insurance, and flood mitigation.

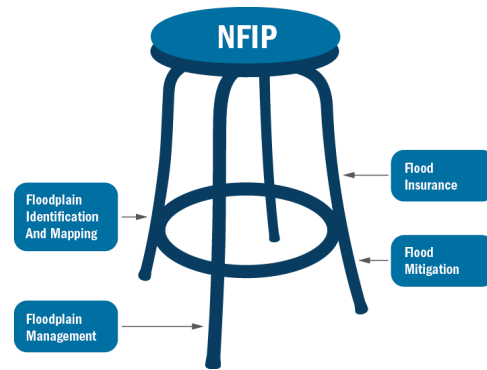


Figure 4-1: The four legs of the NFIP

Just as the image of a three-legged stool no longer fully captures all the uses of the products, the term “mapping” does not adequately convey the current array of products that support the NFIP as described in Section 2.2.1. Over time, the spectrum of users and uses of NFIP products have grown beyond what was originally envisioned, and the products have changed as a result of dramatic advances in technology. The community of users and uses includes the users and uses that influenced legacy products, the current users and uses whose product needs should be addressed, and the future users and uses that may be anticipated to develop a vision for future products.

NFIP products are needed that are efficiently produced, meet the user’s data requirements and that are timely and reliable. The array of current products as well as future products should be evaluated through the lens of how the products are used and who the users are. Understanding the uses of flood hazard and flood risk data will provide the background needed to assess the required data and product accuracy, precision, and resolution and the impacts of uncertainty. Meeting the user’s needs includes a consideration of delivery mediums, formats, and dissemination protocols. Also critical is an effective communication strategy to educate end users on the purpose and limitations of data and products.

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Section 4.1 (Community of Users and Uses) describes the users and uses of NFIP mapping products, followed by a summary of user needs in the issue analysis. The TMAC’s key findings and recommendations related to the product needs of community of users and uses are presented.

4.1.1 Products

NFIP products are used by a wide variety of professionals and the public who rely on flood hazard and flood risk data and products to support decision-making in issues such as avoiding high risk areas, determining whether flood insurance is required, pricing flood insurance premiums, identifying cost-effective mitigation, and planning for emergencies, response, and recovery. These decisions require different types of information on different spatial scales. For example, construction, property transfer, and insurance decisions require information on the flood zone, flood extent, and depth and frequency of flooding at the building level, whereas development, planning, and zoning decisions require information on the extent of inundation at a larger geographic scale. Effective flood risk reduction requires appropriate tools be provided to the practitioners who make the daily decisions.

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As described in Section 2.2.1 (Regulatory Products), FEMA provides traditional regulatory products (e.g., FIS Report, FIRM, FIRM DB, NFHL, LOMC). Through the Risk MAP program, FEMA has developed a suite of non-regulatory products with the intent of improving the communication of risk and subsequently improving the acceptance of identified flood hazards and increasing mitigation actions (FEMA, 2015k). See Figure 4-2.

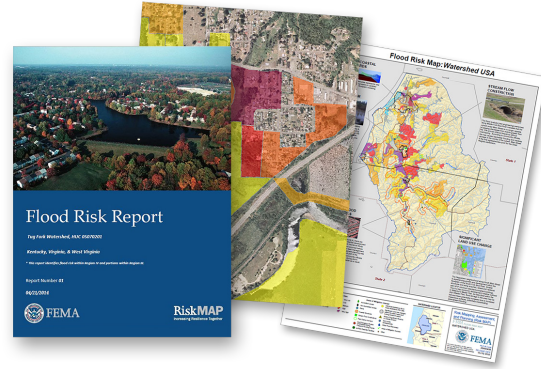


Figure 4-2: Non-regulatory products

Non-regulatory products include:

- Discovery Maps, which are used in project scoping
- Changes Since Last FIRM (CSLF), which shows how the footprint of a flood hazard has changed between the Effective date and an updated engineering study
- Depth and analysis grids, which show the flood hazard in different contexts (e.g., depth of flood water, chance of flooding over 30 years)
- FRRs and FRDs, which are produced at the hydrologic unit code 8 (HUC8) watershed level and summarize available, if not current, risk information by community

Non regulatory products are discussed further in Section 2.3.2.2.

FEMA’s Risk MAP flyer “What is Risk MAP?” states that through collaboration with State, local, and tribal, entities, Risk MAP delivers quality data that increase public awareness and lead to action that reduces risk to life and property. Risk MAP focuses on products and services beyond the traditional FIRM and on collaboration with officials to help put flood risk data and assessment tools to use, effectively communicating risk to citizens and enabling communities to enhance their mitigation plans and actions (FEMA, 2012b).

The Risk MAP program vision is admirable—to encourage communities and individual property owners to “own” their risk and take steps to reduce it. However, an evaluation of the accuracy and utility of both the traditional regulatory products and the non-regulatory products provided to users is needed to ensure needs are met and the products effectively support the Risk MAP vision. Figure 4-3 conveys the importance that accurate, precise data and the resulting products have on effective communication to achieve action.

Questions to be answered by an evaluation could include:

- Is the hazard identification and flood risk information that is provided accurate and credible? If not, why not?
- Is a new data/product better (more detailed, more precise, more accurate, more understandable) than what exists?
- How is the information provided in both regulatory and non-regulatory products?
- Do products collectively address the needs of all users?



Figure 4-3: Accurate and precise data: Foundation of effective flood risk communication and mitigation action

- Are the products efficiently produced and coordinated to avoid inconsistencies?
- Do flood risk products result in mitigation actions and changes in behavior by individuals and communities? Do these actions and changes rely on Federal funding? Would the actions and changes take place in the absence of Federal funding? Are individuals and communities truly “owning” their risk?
- What changes could be made to flood hazard and flood risk products to improve the quality and use of flood risk information?
- Is it cost-effective for flood risk assessments to be performed by FEMA, or is it more appropriate for other entities to do this? Are partnerships between FEMA and other entities preferred?

4.1.2 Product Uses

Uses of the products are as diverse as the community of users. Products prepared for one user group may not fill the needs of another, however all users expect the products provided by FEMA to be authoritative, easy to access and use, timely and coordinated, and date stamped. Some general use considerations are presented below.

- **Authoritative** – Users need mapping and data products that are supported by sound science and engineering. The core data and methods used to develop flood models and delineate inundation areas on a map should come from trusted, credible, and verifiable sources. Authoritative studies and maps build confidence in the NFIP.
- **Easy to access and use** – Products should be easy to access, formatted for ready integration with other data on common platforms (e.g., georeferenced digital data) with clear documentation.
 Georeferenced digital flood hazard products make possible the integration of data with local data (roads, jurisdictional boundaries, and zoning), which tend to change often. However, for consistent communication, local information must be accessible by other entities (e.g., lenders, insurance agents).
- **Timely and coordinated** – Flood hazards are not static; updates to maps and other products are part of a continual process. The built and natural environments and political boundaries change over time, and decision-makers need current as well as future conditions information. The need for up-to-the-minute information must be balanced with dependability and consistency for planning. Many NFIP communities are not allowed by State law to automatically adopt significant changes to regulatory FIRMs and must follow a longer process to effect change. FIS updates provided on a regular schedule provide consistency and predictability.

- **Date stamped** – Flood hazard data are updated continually, but tracking data Effective dates is becoming increasingly difficult. Decisions made today using FEMA products may need to be revisited in the future; thus, it is imperative for the effective date of the flood hazard identification to be documented and the history to be tracked. Date tracking is particularly important for demonstrating past compliance with NFIP regulations when, for example, the structure was built and the contemporary Effective flood hazard is used to determine the zone that is used for pricing flood insurance (“grandfathering”). Currently, the narrative in the FIS Report attempts to provide the history of the hazard identification. However, in a rapidly changing digital environment to which LOMRs are added routinely, the digital data need to be versioned (date stamped).

The following sections describe the primary uses of the NFIP products.

4.1.2.1 Floodplain Management (Land Use Planning, Development, and Zoning)

Floodplain management occurs at the community level where the authority to oversee land use exists. Flood zones and data are incorporated into local comprehensive plans and comprehensive plan maps, zoning maps, and development regulations. These planning instruments are developed through a public process that can take years to complete. Furthermore, these planning instruments tend not to change often to encourage investment in a predictable environment. Consequently, revised FIRMs and data need to be provided to NFIP jurisdictions on a predictable schedule to integrate into the long-standing practices of city and rural planning.

Parcel boundaries and building footprints in addition to roads, bodies of water, and other landmarks help floodplain managers locate properties and buildings in relation to flood hazards, which is necessary for permitting and NFIP compliance. Fully georeferenced flood hazard data, such as the NFHL, allow the integration of flood hazard and flood risk data with local data to support permitting decisions.

Flood hazard data must be accessible to floodplain managers on platforms they are accustomed to using or are required to use. While not all NFIP jurisdictions have the ability to use digital data, expertise is expected to increase in the use of georeferenced, relational data that integrate with multiple platforms. To be most useful, regulatory flood products should be designed accordingly.

FIRM DBs now include political boundaries and street layouts, but layouts change. Although these changes take place routinely, FEMA currently has no effective means of updating layout information in regulatory flood products in a timely manner, which results in discontinuities between local floodplain management, lending, and insurance communities. Fully georeferenced digital flood hazard data and maps would allow road and political boundary layers to be routinely updated and used with effective flood themes (e.g., zone, floodway). Updating the layers in a timely manner and providing general access to local data would prevent misunderstandings among stakeholders and incorrectly rating flood insurance policies.

Identified flood hazards change, sometimes as a result of an updated study that improves the hazard identification or due to a constructed project that reduces the flood risk. When the flood hazard identification changes, it is important to update flood hazard regulatory products in a timely manner, but processes to incorporate these changes, such as the physical map revision (PMR) process, require considerable time. Even when jurisdictions fund new engineering studies, revising regulatory flood maps to reflect new information can take years. The amount of time that is required to update regulatory flood maps

undermines the ability of local floodplain managers to effectively regulate development in and near flood zones.

4.1.2.2 Flood Zone Determination

The single greatest use of FIRMs is for determining the flood zone in which a structure is located to prepare a Standard Flood Hazard Determination Form, which is a required part of the making, increasing, renewing or extending a loan by a federally regulated lender when a structure is used as collateral.

Every year, more than 20 million loan and insurance transactions trigger the completion of a Standard Flood Hazard Determination Form. Financial institutions typically rely on third-party companies to complete these flood determinations. The companies use FIRMs to help identify whether a structure on the subject property is in an SFHA. This process is necessary for financial institutions to be compliant with the Federal requirement for mandatory flood insurance on structures located in the SFHA.

When FIRMs are updated, the flood zone status of a building may change, thus requiring lenders to continually monitor FIRM updates. Many lenders use third-party companies to monitor FIRM revisions and track structure determinations for the life of the loan. At any given time, approximately 100 million properties across the Nation are being tracked by third-party companies to help lenders maintain loan portfolios that are compliant with applicable laws and regulations.

Most flood zone determination companies operate in a fully georeferenced, digital environment. Timely delivery of updates to flood hazard information is essential for accurate determinations based on current data. Access to a single source for current political boundaries would reduce the potential for errors and improve efficiency.

4.1.2.3 Flood Insurance Underwriting and Rating

Insurance agents, Write Your Own insurance vendors, commercial insurers, and property owners are direct or indirect users of regulatory flood hazard and flood risk data to price as millions of policies are underwritten and rated each year. NFIP insurance rates are determined on the basis of the flood zone (e.g., Zones A, AE, V, VE) and for some zones, the difference between the height of the lowest floor elevation in the structure and the identified BFE at the site (elevation of the lowest horizontal structural member above the BFE may also be a factor in coastal Zone V areas). Rates for similar structure types and occupancies in similar zones with

Flood Response Legislation

The Flood Disaster Protection Act of 1973 requires financial institutions that are federally regulated, supervised, or insured by Federal agencies to determine the flood hazard status of a structure serving as collateral on a loan. If the structure is located in an SFHA (1-percent-annual-flood-hazard area depicted as Zone A or V on the FIRM), the lender is obligated by law to ensure that the collateral is protected by a flood insurance policy for the amount and term of the loan. These requirements apply to all collateral located in an SFHA for new, increased, extended, or renewed loans.

The National Flood Insurance Reform Act of 1994 strengthened lender compliance by imposing financial penalties and sanctions on those lenders that demonstrated a pattern and practice of failing to satisfy this requirement, by requiring the development of the Standard Flood Hazard Determination Form to document determinations and establishing requirements for lender-placed insurance.

BW-12 and HIFFA made further changes to the code requirements in the CAZ. CAZ is also recognized by the CRS program.

similar height differences above or below the BFE are uniform across the Nation and are published in the *Flood Insurance Manual* (FEMA, 2015d).

In addition to the flood zone and relative difference between the elevation of the lowest floor or horizontal structural member and the BFE, other criteria are used to determine the NFIP insurance rate including, but not limited to, the occupancy or use of the structure (e.g., single family, multi-family, non-residential), structure type (e.g., number of floors, with or without basement, crawlspace, other enclosure), and the location of the building's contents in relation to BFE. Furthermore, discounts and subsidies are provided for structures built before a community's first FIRM, for structures whose FIRM has changed since the structure was built, for structures behind certain levees under construction, and for structures in communities participating in the voluntary CRS program, which rewards communities for exceeding minimum floodplain management requirements through flood insurance discounts

Elevation Certificates, which are completed by licensed professionals (surveyors, engineers, and/or architects as allowed by jurisdictional State laws), are used to help determine flood insurance rates based on the relative elevation difference between the structure and the BFE. The professional completing the Elevation Certificate must determine the flood zone and BFE for the particular structure from the FEMA flood hazard data (regulatory maps and studies). The BFE is most commonly determined from the FIRM, profiles, or floodway data tables in the FIS Report accompanying a Detailed Study.

Detailed information about the flood hazard is needed at the building level to determine the insurance rate, community boundaries are necessary to determine the premium adjustment for communities in the CRS, and the history of the flood hazard identification (versioning) is needed for current premium setting.

4.1.2.4 Flood Insurance Actuarial Rate Setting

FEMA is responsible for establishing flood insurance rates. Rates are updated annually, but the methodology that is used to link the hazard, frequency, and damage has not been updated.

FIRMs originally showed more than 30 flood insurance rate zones. Numbered Zone A areas were shown on FIRMs where water surface elevations were computed, and unnumbered (or approximate) Zone A areas were used to identify areas with undetermined water surface elevations but thought to have a 1 percent chance of inundation. Lower risk zones were also depicted.

As mentioned previously, initially, 30 numbered Zone A areas were mapped, each representing a different level of flood risk based on the difference in feet between the 1- and 10-percent-annual-chance exceedance elevation. The level of risk assigned to each zone in FEMA's rate model was and is still based on limited data prepared in the early 1970s. Although current mapping standards do not use numbered Zone A areas but instead use the designation "AE," the risk assessment that was developed when the numbered A Zones were used is still in place.

In 2008, the Government Accountability Office (GAO) reviewed FEMA's method for setting full-risk rates for flood insurance and questioned the reliability of the method given the use out-of-date flood hazard data. See text box "Setting Full-Risk Rates."

Setting Full-Risk Rates

"FEMA's method for setting full-risk rates may not ensure that the rates accurately reflect the actual risk of flood damage. FEMA's model for setting these rates incorporates data on flood risks generated by a hydrologic model that is based on largely the same principles as hazard risk models used by private insurers and other federal agencies. More specifically, FEMA generates rates for flood insurance according to estimates of flood risk and expected flood damage.

However, a number of factors may affect the accuracy of rates generated by the process. First, the data that FEMA uses to define flood probabilities are outdated or inaccurate. For example, some of the data used to estimate the probability of flooding have not been updated since the 1980s.

Similarly, the claims data used as inputs to the model may be inaccurate because of incomplete claims records and missing data. Further, the maps FEMA uses to set premium rates remain substantially out of date despite recent modernization efforts. In addition, an NFIP policy decision allows certain properties remapped into riskier flood zones to keep their previous lower rates, which, like subsidized rates, do not reflect the actual risk of flooding to the properties and do not generate sufficient premiums to cover" (GAO, 2008, p. 3).

Additionally, FEMA asked the National Research Council (NRC) to review FEMA's rating practices. The NRC report, issued in 2015, states:

The PELV curves [surface elevation-probability functions, developed to relate hazard, frequency and damages] were derived in the early 1970s from a sample of water surface elevation-exceedance probability functions developed from detailed studies in communities nation-wide. Analysts parameterized these water surface elevation-exceedance probability functions using the difference between the 1 percent annual chance exceedance elevation (100-year elevation) and the 10 percent annual chance exceedance elevation (10-year elevation) (MacFadyen, 1974). Next, the water surface elevation exceedance probability functions were grouped, averaged, and smoothed to create 30 zones covering the range of hazard conditions. In each successively numbered A zone, the difference between the 1 percent and 10 percent annual chance exceedance water surface elevation increases, with differences ranging from 0.5 feet for Zone A1 (broad, shallow floodplains) to 20 feet for Zone A30 (narrow, steep mountainous valleys). Note that the classification by flood zone is not spatially or geographically oriented. Rather, it focuses on common hazard properties. Different locations in the United States will fall within the same zone if they have the same difference between the 1 percent and 10 percent annual chance exceedance water surface elevations without regard to the underlying causes of the hazard (NRC [2015b], pp. 27–28).

Development and use of a nationwide set of 30 PELV curves, instead of site specific, unique water surface elevation-exceedance probability functions, allowed a workable nationwide set of rate tables to be developed. However, reviews of NFIP insurance loss experience in the early 1980s revealed inconsistencies in losses among the 30 flood zones, in part because of inherent uncertainties in the flood hazard analysis and variations in hazard conditions (e.g., a debris jam could increase local water surface elevations). At the same time, the complexity associated with determining the appropriate zone for a structure and then using that in the rate setting increased the likelihood of error by agents who were using paper maps and rating manuals. Consequently, for rating purposes, the NFIP collapsed the 30 numbered flood zones into a smaller set of zones and weighted the resulting set in areas where NFIP policies were written (circa 1980s) for the computation of average annual loss (NRC, 2015b, p. 28).

The methodology used in the rate setting process may be improved through access and analysis of currently available data on flood hazards and damage, provided in a coherent and systematic format.

4.1.2.5 Emergency Management

The FIRMs and FIS Reports are used by Federal, State, and local emergency management professionals for numerous purposes. The accuracy and detail of the information in the FIRM and FIS Report inform emergency management plans and decisions that have a direct impact on lives and property. Emergency management professionals also use FIRMs and FIS Reports to design exercises that test responder capabilities, inform the common operating picture early in a flood event, locate potential high impact areas during damage assessment, locate critical facilities, and when other information does not exist, determine evacuation routes. Any actions that can be taken to improve the quality of the FEMA mapping products will have positive ripple effects on the various uses of the data in emergency management.



Figure 4-4: The four phases of emergency management

4.1.2.6 Mitigation

Mitigation is one of the four phases of emergency management (see Figure 4-4). Mitigation is defined as any sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects. If a hazard cannot be mitigated, plans must be made for how to respond to and recover from the hazard when it occurs. Mitigation helps reduce response and recovery resource requirements after a disaster and increases community resilience.

Mitigation Planning

States and communities undertake mitigation planning to identify a range of actions that will reduce risk from hazards that threaten vulnerable people, property, and critical infrastructure. The range of alternative actions considered in the mitigation planning process includes preventative measures, property protection measures, natural resource protection measures, emergency services, structural projects, and public information (see Figure 4-5).

The Disaster Mitigation Act of 2000 (42 U.S.C. § 5121



Figure 4-5: Examples of mitigation actions

note) amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (42 U.S.C. §§ 5121-5207) to require State and local hazard mitigation plans. The contents of local and State hazard mitigation plans are outlined in 44 CFR Part 201. States must have a FEMA-approved hazard mitigation plan to be eligible for Public Assistance and Hazard Mitigation Assistance (HMA) funds after a major disaster declaration. A FEMA-approved local mitigation plan is required for a community to be eligible for HMA funds.

Mitigation planning is a continual process. Local and State plans are required to be reviewed, updated, and approved by the State and FEMA every 5 years. The mitigation lifecycle is shown in Figure 4-6. Mitigation plans are a community’s blue print for reducing risk based on the hazard identification and risk assessment. FEMA requires mitigation plan flood risk assessments to include a description of the jurisdiction’s vulnerability in terms of the types and numbers of existing and future buildings located in hazard areas and an estimate of the potential dollar losses to these vulnerable structures (44 CFR § 201.6(c)(2)).



Figure 4-6: Mitigation lifecycle

FEMA flood hazard analysis and flood risk data and products are the primary sources of flood hazard data used to inform the mitigation planning process.

Mitigation Projects

FEMA’s HMA programs are the primary source of mitigation grant funds to communities. The suite of HMA grants includes the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) Program, and the Flood Mitigation Assistance (FMA) Program. These programs fund projects that reduce community vulnerability to disasters and their effects, promote individual and community safety and resilience, and reduce the amount of taxpayer dollars spent on disaster response and recovery (see Table 4-2).

To help ensure that limited mitigation dollars are used to fund projects with the most return on investment, FEMA requires that all HMA projects undergo a Benefit-Cost Analysis (BCA). Data generated as part of the NFIP FIS process are critical to the BCA for proposed mitigation projects. These data include:

- Flood elevations generated for various recurrence intervals (10-, 4-, 2-, 1-, and 0.2-percent-annual-chance occurrences, also referred to as 10-, 25-, 50-, 100-, and 500-year events) when developing Detailed Studies
- Location of the structure on the property in relation to the floodplain boundaries
- Stream discharge information that is part of the FIS

The most accurate BCAs can be generated for the proposed HMA projects when this information is available.

The NFIP FIS process can also encourage mitigation if flood insurance premiums are reduced for those who undertake flood loss reduction measures. Premium reductions would provide an additional economic incentive to undertake mitigation measures.

Table 4-2: Eligible HMA Activities

Eligible Activities	HMGP	PDM	FMA
1. MITIGATION PROJECTS	✓	✓	✓
Property Acquisition and Structure Demolition	✓	✓	✓
Property Acquisition and Structure Relocation	✓	✓	✓
Structure Elevation	✓	✓	✓
Mitigation Reconstruction	✓	✓	✓
Dry Floodproofing of Historic Residential Structures	✓	✓	✓
Dry Floodproofing of Non-residential Structures	✓	✓	✓
Generators	✓	✓	✓
Localized Flood Risk Reduction Projects	✓	✓	✓
Non-localized Flood Risk Reduction Projects	✓	✓	✓
Structural Retrofitting of Existing Buildings	✓	✓	✓
Non-structural Retrofitting of Existing Buildings and Facilities	✓	✓	✓
Safe Room Construction	✓	✓	
Wind Retrofit for One- and Two-Family Residences	✓	✓	
Infrastructure Retrofit	✓	✓	✓
Soil Stabilization	✓	✓	✓
Wildfire Mitigation	✓	✓	
Post-Disaster Code Enforcement	✓		
Advance Assistance	✓		
5 Percent initiative Projects	✓		
Miscellaneous/Other ⁽¹⁾	✓	✓	✓
2. HAZARD MITIGATION PLANNING	✓	✓	✓
Planning-Related Activities	✓		
3. TECHNICAL ASSISTANCE			✓
4. MANAGEMENT COST	✓	✓	✓

(1) Miscellaneous/other indicates that any proposed action will be evaluated on its own merit against program requirements. Eligible projects will be approved provided funding is available.

The U.S. Federal Housing Administration Limited 203(k) program⁵ or commercial home improvement loans could be used by property owners to fund flood mitigation activities and/or be used as matching funds for FEMA HMA grants.

4.1.2.7 Public

The vision of the Risk MAP program is to deliver “quality data that increases public awareness and leads to action that reduces risk to life and property” (FEMA, 2012b, p. 1). To achieve this goal, residents in or near the floodplain (both owners and renters) as well as non-resident property owners, buyers, and sellers need flood hazard and risk data and products that are reliable, accessible, understandable, and actionable.

⁵ http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/sfh/203k

Flood hazard and risk data and products for the public must be able to support informed decision-making about the level of flood hazards and risks where people are located, now and into the future, and connect to the options available to them to mitigate the risk. These options include purchasing flood insurance (and the required financial planning to do so), elevating structures or critical building systems to protect assets and property, and choosing not to purchase property in the floodplain.

As such, the public must be kept in mind when designing the presentation and communication of flood hazard and risk. Products should use clear and accessible terminology and symbology that address the dynamic nature of flooding and the true nature of the risk at various locations in the floodplain. The current FIRM shows a line on a static map demarking whether insurance is required, but the line does not effectively communicate the hazard nor does the terminology “1-percent-annual-chance” provide clear messaging of the risk.

In addition, FEMA’s FIRMs are currently presented to the public as stand-alone products without a clear, simple explanation of their connection to risk and insurance. Users must look in several places to find information, increasing the likelihood that the information will be ignored or overlooked.

4.1.2.8 Resource Management

FEMA’s flood hazard information and mapping products are pivotal to many State, local, and tribal land management and regulatory programs beyond traditional floodplain management and zoning.

Floodplains provide a myriad of habitats and natural resources that support fish, wildlife, plants (including forests and farms), and human populations. Floodplains also provide many water-related ecosystem services and functions, ranging from flood and climate regulation to water purification and provisioning. In managing these resources, State, local, and tribal governments often rely on FEMA’s mapped SHFAs to establish jurisdiction for resource management-focused laws, ordinances, and/or permits.⁶

Examples are:

- Shoreline Management Areas, which some locales define as the full SFHA or a set number of feet from the ordinary high water
- Criteria for establishing Critical Areas or Growth Management Areas, which have included frequently flooded areas (typically defined as the SHFA) and may have development requirements that equal or exceed NFIP minimum criteria
- Other special management areas or areas of environmental concern, which often include SFHAs

Beyond these uses of FEMA’s flood maps, natural resource managers, including managers of fisheries, endangered species, and related habitats, have for many years asked FEMA to add modeling of riverine erosion and mapping of channel migration zones to the FIRMs to help support State and local development restrictions.⁷ Since FEMA completed its riverine erosion mapping feasibility study in 1999, several States have developed mapping programs and continue to seek inclusion of these data on FIRMs.^{8,9}

⁶ B. Shorin, NOAA National Marine Fisheries Service, personal communication, 2015.

⁷ Ibid.

⁸ Ibid.

4.1.3 Issue Analysis

Table 4-3 lists many, but far from all, of the users of flood hazard and flood risk data, the uses and requirements, the decision scale for use, and the source of the requirement. The “Decision Scale” column indicates the level of detail needed to support the decision.

While not immediately obvious, timing (frequency) of updates is another factor. Patterns of flooding are not static, and land uses change over time, yet some consistency is needed for floodplain management and program administration at many levels. A balance is needed to deliver flood hazard data in a timely, predictable manner.

Table 4-3: Summary of Users and Requirements

User	Uses/Requirements	Decision Scale	Source of Requirement
Lender, Flood Zone Determination Companies	Determine whether structure is in an SFHA both prior to writing a mortgage and at the time of map updates	<ul style="list-style-type: none"> • Building 	42 U.S.C. § 4012a requires determination of whether building is in the SFHA
Insurance Agents	Determine flood zone and BFE for buildings located in an SFHA to properly rate flood insurance	<ul style="list-style-type: none"> • Building 	42 U.S.C. § 4001 requires insurance to be written on buildings
Floodplain Managers	Evaluate development proposals; transmit information about risk, land use restrictions, and applicable development standards	<ul style="list-style-type: none"> • Building • Parcel, Community 	42 U.S.C. § 4001 requires permits for development in SFHA, including buildings
Land Use Planners	Develop hazard overlay zones and accompanying regulations	<ul style="list-style-type: none"> • Neighborhood • Community • Watershed 	42 U.S.C. § 4001 requires that local jurisdictions direct development away from flood hazards
Building Officials	Apply building codes	<ul style="list-style-type: none"> • Building 	N/A
Surveyors	Produce Elevation Certificates; LOMC applications; Mark flood zone boundaries on real property and site plans	<ul style="list-style-type: none"> • Building • Parcel 	FEMA Standard 42 (FEMA, 2015p) requires elevation certificates to be completed by licensed land surveyors
Professional Engineers	Prepare Letter of Map Change Applications; estimate BFEs	<ul style="list-style-type: none"> • Community • Watershed 	N/A
Design Professionals (Engineers, Architects)	Specify design flood conditions and calculate flood loads	<ul style="list-style-type: none"> • Building • Parcel 	<ul style="list-style-type: none"> • Local floodplain management regulations and building code • Building code and design standards may require this information
Land/Building/ Co-op Owners in or Near SFHA	Understand risk, land use limitations, applicable construction practices, insurance purchase requirements, other mitigation actions	<ul style="list-style-type: none"> • Building • Parcel 	N/A

⁹ M. Kline, Vermont Department of Environmental Conservation, personal communication, 2015.

User	Uses/Requirements	Decision Scale	Source of Requirement
Real Estate Agents	Inform buyers and sellers of risk potential insurance requirement	<ul style="list-style-type: none"> • Building • Parcel 	N/A
Developers	Understand land use limitations, applicable construction practices	<ul style="list-style-type: none"> • Building • Parcel 	N/A
Elected Officials	Build support for mitigation and avoidance programs	<ul style="list-style-type: none"> • Community 	N/A
Public (not located in flood zone)	Understand general patterns of flooding for the purposes of avoidance	<ul style="list-style-type: none"> • Neighborhood • Community 	N/A
Federal Agencies (other than Department of Homeland Security [DHS])	Building and infrastructure projects	<ul style="list-style-type: none"> • Community • County • Watershed • State 	Executive Order 11988, Floodplain Management
State Agencies	Regulation, permitting, planning; flood mitigation projects; road and bridge design	<ul style="list-style-type: none"> • Community • County • Watershed • State 	<ul style="list-style-type: none"> • NFIP compliance • State regulations
Emergency Management Professionals	Planning, mitigation projects (e.g., buyouts, elevations, retrofits), risk communication, exercise design	<ul style="list-style-type: none"> • Building • Parcel Neighborhood • Community • Watershed • State 	Stafford Act (42 U.S.C. § 5121); mitigation planning requirements are in 44 CFR Part 201; HMA program guidance contains criteria for determining eligibility, feasibility and cost-effectiveness of proposed mitigation projects
Resource Managers	Planning, regulation, permitting	<ul style="list-style-type: none"> • Parcel • Community • Watershed • State 	N/A

N/A = not applicable

4.1.4 Key Findings and Recommendation 1

The TMAC’s key findings and a recommendation related to the community of users and uses are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- There are many users and uses of flood hazard and flood risk data. The users make daily decisions that cumulatively work toward reducing damages due to flooding. A key to program success is providing these users with authoritative, easy to access and use, timely, and informative data and tools. FEMA’s efforts in reaching various user groups must be ongoing and evolve as products and methods of presentation change.

- Different levels of accuracy, precision, resolution, and type of information are needed for various uses, and different platforms for dissemination must be considered for the various users.
- Effective and successful flood risk reduction requires that appropriate tools be provided to the practitioners who make the daily decisions.
- Data and product naming should be carefully considered, and consistent practices should be adopted. Given the broad application of the products, “Flood Insurance Rate Map” and “Flood Insurance Study Report” are no longer descriptive of the products. The distinction between the terms “hazard” and “risk” should be clearly articulated. Appropriate naming of data and products would help provide clarity and improve communication.
- FEMA must address whether different formats of data presentation are legal equivalents and whether modifications and extracts change legal status. While some products are clearly identified as to their legal weight for regulatory purposes (e.g., FIRMettes), not all are.
- While the subject of how FEMA relates the flood hazard to frequency and expected damage to risk was not researched in depth for this annual TMAC report, subsequent TMAC reports may include a consideration of both the GAO findings (2008) and the findings of the NRC (2009).

Recommendation 1

FEMA should establish and implement a process to assess the present and anticipated flood hazard and flood risk products to meet the needs of the various users. As part of this process, FEMA should routinely:

- a) Conduct a systematic evaluation of current regulatory and non-regulatory products (data, maps, reports, etc.) to determine if these products are valued by users, eliminating products which do not cost effectively meet needs;
- b) Consider user requirements prior to any updates or changes to data format, applications, standards, products, or practices are implemented;
- c) Proactively seek to provide authoritative, easy to access and use, timely, and informative products and tools; and
- d) Consider future flood hazards and flood risk.

Discussion of Recommendation 1

FEMA should consult with multiple stakeholder groups to understand data needs and formats and work to ensure that displays from database are helpful, useful, applicable, and easy to use. Such meetings should be for both collaboration and brainstorming. Data products should be designed giving consideration to multiple platforms for display and use now and into the future.

Flood hazard and risk data are used by many different stakeholders and should be understandable to all of them, across their wide range of applications. FEMA should develop a communication strategy for the

BW-12 Mandate

Pub. Law 112-141, Section 100215(c)

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data;

community of users, giving consideration to how information is disseminated, with clear explanations of the appropriate use of that information and its limitations.

Further, due to the range of NFIP products available, FEMA should clearly identify what constitutes a legal equivalent of a digital product. Do different formats of digital products carry the same legal weight, or do modifications/extracts change that? For example, there is a note on the title block of FIRMettes indicating that “this digital derivative is a legal equivalent to the full FIRM.” Other products and derivatives should be as clearly identified as to legal status.

Expanding the level of understanding across stakeholder groups would serve to improve the implementation of sound floodplain management practices, appropriate use of data, and public awareness of flood hazards and risks.

4.2 Flood Hazard Identification: Program Goals and Priorities

Through its Risk MAP program (see Section 2.3.2), FEMA identifies flood hazards, assesses flood risks, and collaborates with States and communities to provide accurate flood hazard and risk data to guide them as they implement mitigation actions. Congress requires FEMA to identify flood-prone areas and subdivide them into flood risk zones to provide the data necessary to administer community floodplain management regulations and rate flood insurance policies. FEMA maintains and updates data through FIRMs, FIS Reports, and FIRM DBs. See Section 2 (Background) of this report.

FEMA’s flood map inventory includes over 138,000 flood map panels (Sacbibit, 2014) that present flood hazard information for over 22,000 communities participating in the NFIP (FEMA, 2015a). Of the 138,000 panels, 85 percent, or 117,000 panels, are digital format FIRMs covering 2,200 counties or jurisdictions, and the remaining 15 percent are non-digitized paper format FIRMs.

With this inventory of map panels, FEMA has Preliminary or Effective FIRMs available for nearly 98 percent of the Nation’s population. The remaining 2 percent reside in largely unpopulated regions.

FEMA has initiated and/or completed coastal studies for all areas subject to coastal flood hazards, including the Great Lakes region. Coastal flood hazard miles are currently not included in FEMA’s inventory of mapping needs and information maintained in the Coordinated Needs Management Strategy (CNMS) (see Section 4.2.1.1), but once these studies are finalized and once FEMA finalizes the coastal CNMS framework, FEMA will incorporate coastal miles into CNMS. Section 4.2 focuses on the riverine flood hazard miles. The TMAC will consider the maintenance of the coastal flood hazard inventory in future reports.

Identifying the flood hazard is essential for communicating the risk of flooding and minimizing the damage to property and loss of life caused by floods. FEMA’s FIRMs are also used to promote public awareness of the degree of flood hazard within mapped areas. The maps allow expeditious identification and dissemination of flood hazard information. Without updated flood hazard information, development will continue to occur in flood-prone areas, and mitigation to reduce the flood risk is unlikely to occur.

Section 4.2 describes NFIP program goals and priorities related to prioritizing studies and updates and FEMA’s Risk MAP vision. The TMAC’s analysis and key findings and recommendations related to each of these topics are presented.

4.2.1 Prioritizing Studies and Updates

During the Map Mod (see Section 2.3.1), funding priorities for modernizing flood maps were determined based on factors commonly referred to as the Atlanta Factors. The Atlanta Factors are growth, population density, number of repetitive loss claims, number of flood insurance policies, and ability to leverage resources.

One of the goals of Map Mod was to convert paper maps to a digital map format on a countywide basis. FEMA developed a Multi-Year Hazard Identification Plan (MHIP) (FEMA, 2006) to outline the plan for prioritizing and modernizing flood maps in areas with the greatest flood risk. The plan was continually updated to provide details on projected flood map production sequencing, projected funding allocations, and stakeholder input and to show progress in meeting the goals and priorities of Map Mod.

FEMA currently prioritizes new Risk MAP projects in watersheds with:

- High risk of flooding
- Significant flood hazard data update needs (based on physical, climatological, or engineering methodology changes)
- Available data (e.g., elevation data, hydrologic or hydraulic data)
- Potential to generate community actions to reduce flood risk
- Potential for partner cost sharing

The FEMA Regions are given discretion to use their local knowledge and partnerships to weigh the above factors along with the Risk MAP program goals (defined in Section 2.3.2.1) to prioritize Risk MAP projects. States and local communities can affect this sequencing by contributing new engineering or flood studies that increase the efficacy of the mapping process, contributing funding toward the project, committing to furthering mitigation actions to reduce flood risk, or contributing funding that furthers mitigation goals.

State-level and certain multi-jurisdictional Cooperating Technical Partners (CTPs) that are engaged in supporting or completing multiple Risk MAP projects within their States provide input on prioritizing projects within their jurisdictions through the use of business plans. CTPs, specifically the State and local mapping partners, evaluate FIS needs and data availability to prioritize project sequencing at the local level. The Regions then coordinate with the CTPs or FEMA contractors on the funded projects.

The two basic areas of need in prioritizing projects are updates in areas that have already been studied and/or mapped and unmapped areas where the flood hazard has not been identified. As stated earlier, NFIP regulations require FEMA to evaluate existing flood hazard studies for validity and revise when needed.

4.2.1.1 Maintenance of Existing FIS Areas

Flood hazards and risks change constantly as a result of changes in topography, land use patterns, sea levels, storm patterns, and the development of more Detailed Study methods. All flood hazard studies require periodic updating, some more frequently than others. Data and maps need to be updated more often in areas that change more rapidly than in more rural areas with little growth and development.

Under the National Flood Insurance Act of 1968, as amended (42 U.S.C. § 4101(e)), FEMA is charged with revising and updating—on a 5-year cycle—all floodplain areas and flood risk zones that have been identified, delineated, or established based on an analysis of all natural hazards affecting flood risks. As a result, FEMA

has established a process that requires constant documentation of mapping needs and the tracking of technical and currency of existing studies.

FEMA uses GIS technology and develops policies, requirements, and procedures to coordinate the management of the riverine flood hazard mapping inventory, referred to as the CNMS. FEMA uses the CNMS to identify and track the lifecycle of mapping requests and FIS needs for the flood mapping program. FEMA is working to develop procedures to manage the inventory of coastal studies in CNMS; however, the discussion that follows focuses entirely on the riverine inventory.

Through the CNMS Validation Process, an FIS is inspected against a variety of possible changes that may have occurred since the date of the Effective FIS or FIRM. FEMA evaluates 17 elements (7 critical and 10 secondary) that include changes in land use, new or removed structures, the occurrence of recent flood events, and any new data available to communities. Studies are categorized through the Validation Process into one of the following three categories:

- **Valid** – Miles of stream where the underlying data and analysis meet FEMA technical and currency standards
- **Unverified** – Miles of stream where the underlying data and analysis do not meet technical and currency standards; these streams are prioritized by FEMA and its mapping partners for potential restudy
- **Unknown** – Miles of stream where the underlying data and analysis are not sufficient to determine validation status

Once the evaluation of a study has been completed, the CNMS database is updated with the New, Validated and/or Updated Engineering (NVUE) result of the study. All of the studies that have been inspected but have not been classified are designated as “assessed.”

Since FISs must be re-evaluated for validity and categorized as valid, unverified, or unknown, they have a shelf life of approximately 5 years. The shelf life can be extended and the studies validated as long as the flood hazard has not changed as a result of changes in topography, hydrology, or land development. The process evolves continually as new studies are conducted and development and/or new data invalidate existing studies.

Based on fiscal year 2015 (FY15) funding levels, FEMA plans to study approximately 9,000 stream miles per year. Of the 1.13 million miles of riverine flood hazard information currently in FEMA’s inventory (as of FY15 Q4), 473,535 miles are valid (NVUE-compliant) and 235,924 are unverified with 419,010 unknown. As new studies are conducted, the number of NVUE-compliant miles grows and the unverified miles and unknown miles shrink. However, as the mapping partners evaluate existing study miles against new development and data, NVUE-compliant miles can become unknown miles and unknown miles can become unverified miles. Figure 4-7 is a snapshot in time of the miles of NVUE-compliant, unverified, and unknown stream miles in FEMA’s FY15 plan.

4.2.1.2 Unmapped Areas

The national flood mapping program has traditionally prioritized the limited resources for the areas with the greatest population, the highest number of flood insurance policies, and the most flood losses. While this approach has produced modernized flood maps for 98 percent of the population, a considerable number of streams have not been mapped. Unmapped flood hazard areas present a serious threat to

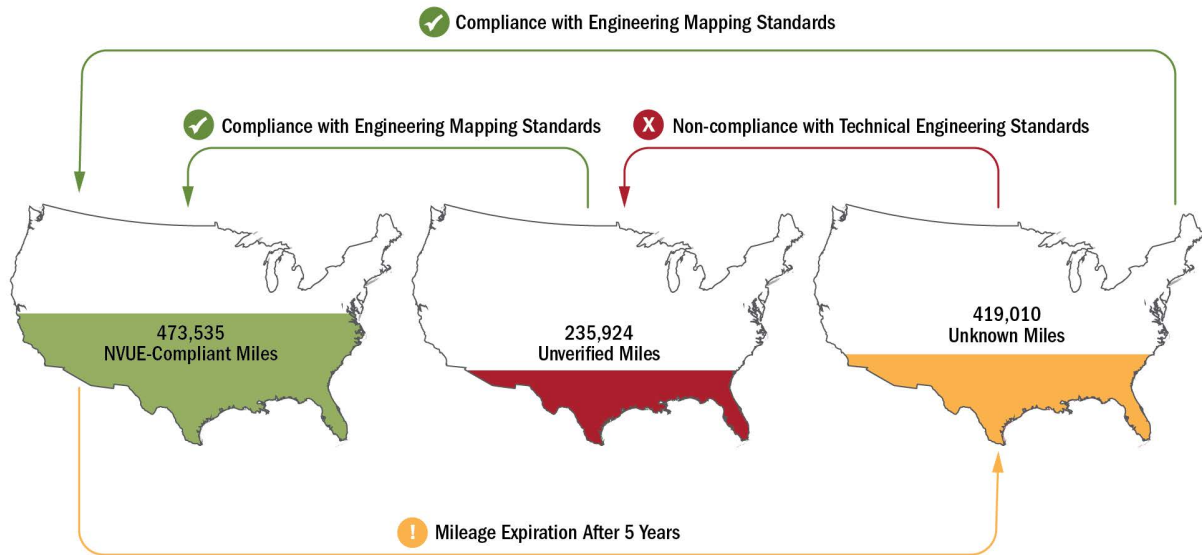


Figure 4-7: Categories of NVUE and the annual inventory

people who build within them (TMAC, 2000). The National Hydrography Dataset (NHD) encompasses the drainage area of 3.5 million miles of streams in the Nation, of which approximately 1 million miles are entirely on Federal lands (USGS, 2014). Of the 3.5 million miles of streams, the flood hazard has yet to be determined on approximately 1.4 million miles.

Figure 4-8 represents the 1.13 million miles of study currently in FEMA’s inventory of flood hazard mapping needs. The study miles are the result of a considerable investment of funding and other resources among FEMA and its State, local, and tribal mapping partners. While maintaining the validity of the current inventory is a priority, the lack of a plan to address the unmapped areas of the Nation is a concern.

4.2.1.3 Issue Analysis

The TMAC evaluated how the current Risk MAP program’s goals and prioritization process compares with the goals and prioritization process developed during the Map Mod program.

The national metrics and goals developed during the Map Mod program were a driver for the development of multi-year planning efforts and led to the development of 5-year business plans that are still being developed and maintained by many CTPs. Communities were able to identify mapping and study needs online in the MHIP, and the study needs were considered when funding was prioritized for areas. The MHIP has been replaced by the CNMS in which more detailed analysis is used to determine the validity of existing studies. The CNMS contains more detailed stream level study needs; however, the planning aspect and sequencing of FIS updates are not clear. Until recently, the CNMS has not been available to the communities, and the only stakeholder involvement has been captured during a Risk MAP project.

The identification and application of goals and priorities is not consistent across Regions. Each Region is geophysically different and has unique needs, but without a multi-year planning effort, Regions have no clear guidance on how to balance FIS needs and funding with other needs. Flood studies are not currently being funded at a level that is adequate to maintain their validity, and the number of verified study miles is decreasing as studies become outdated. Without a clear plan for prioritizing flood identification and risk

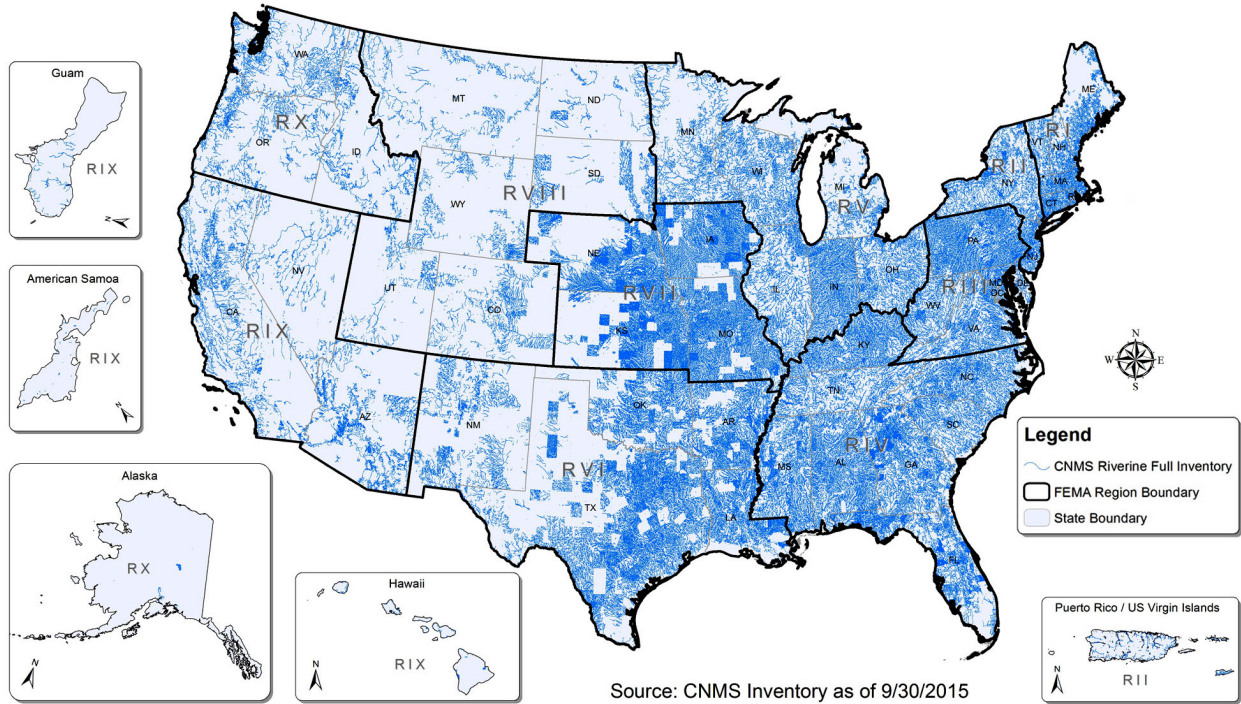


Figure 4-8: The Nation’s flood map inventory

assessment goals, the number of verified study miles will continue to decrease and unmapped areas will not be mapped.

4.2.1.4 Key Findings and Recommendation 2

The TMAC’s key findings and a recommendation related to prioritizing studies and updates are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

The national metrics and goals developed during Map Mod were a driver for the development of multi-year planning efforts and led to the development of 5-year business plans that are still being developed and maintained by CTPs. The 5-year business plans can still be used by CTPs to provide input into prioritizing projects within their jurisdictions.

- Prior to Risk MAP, communities were able to identify mapping and FIS needs through an online portal known as the Multi-Hazards Information Portal (MHIP), and these study needs were considered when prioritizing areas for funding. The MHIP has been replaced by the CNMS in which a more detailed analysis is used to determine the validity of existing studies, but no information is provided on how these needs will be met.
- Since flood hazard studies must be re-evaluated for validity and categorized as either valid, unverified or unknown, they have a shelf life of approximately 5 years. The process is continually evolving as new studies are conducted and development and/or new data invalidate existing studies.

- Uniform assessment and application of goals and priorities are more difficult when the responsibility for setting local priorities is largely placed within the discretion of each FEMA Regional Office. Each Region is given discretion on how to weight the funding priorities between identifying mitigation actions and conducting detailed flood studies. The discretion has led to wide variations between Regions in how priorities are set.

Recommendation 2

FEMA should develop a national 5-year flood hazard and risk assessment plan and prioritization process that aligns with program goals and metrics (see Recommendation 3). This should incorporate a rolling 5-year plan to include the establishment and maintenance of new and existing studies and assessments in addition to a long-term plan to address the unmapped areas. Mapping and assessment priorities should be updated annually with input from stakeholders (e.g., Multi-Year Hazard Identification Plan). The plan should be published and available to stakeholders.

Discussion of Recommendation 2

In 1997, FEMA conducted a BCA of Map Mod that showed a benefit to the taxpayer of over \$2 for every \$1 invested in flood hazard analysis and mapping (FEMA, 1997b). The State of North Carolina used the same methodology in a later analysis and calculated a Benefit-Cost Ratio of 2.3 to 1 (ASFPM, 2013), and the benefit is expected to increase with technological advances.

Flood hazard analysis and mapping also reduces disaster costs, with approximately \$1.5 billion in avoided damage every year for buildings constructed in compliance with NFIP standards (ASFPM, 2013). The investment in flood mapping is offset by losses avoided in just over 4 years.

While the cost benefits of flood mapping are significant, more transparency and planning in how these limited funds are spent is needed. Projects should be prioritized based on clear, understandable criteria that include factors such as the number of highly populated flood hazard areas and areas with a large number of NFIP policies and/or structures in the floodplain, CNMS information, and repetitive loss properties, supported by locally identified priorities. These criteria should be applied in a uniform manner across the Regions.

The development of a national 5-year flood hazard and risk assessment plan that is updated annually to reflect the actual projects that were initiated and the sequencing of future projects would help both mapping partners and communities to plan better for leveraged data, such as elevation or study data, and cost sharing. While the Risk MAP process focuses on community engagement once a study is underway, the lack of multi-year planning results in a lack of community and State involvement in prioritizing which studies are selected.

BW-12 Mandate

Pub. Law 112-141, Section 100215(c)

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (B) performance metrics and milestones required to effectively and efficiently map flood risk areas in the United States;
- (3) recommend to the Administrator how to maintain, on an ongoing basis, flood insurance rate maps and flood risk identification;

4.2.2 Risk MAP Vision and Goals

FEMA's strategy in the draft *Risk MAP Strategy* (FEMA, 2008) to expand the flood hazard analysis and mapping focus to improve the utility and accessibility of flood hazard and risk data stresses the need for the Risk MAP vision to be scalable yet flexible with programmatic goals that could be clearly articulated and adjusted according to level of funding. In developing the program, FEMA identified new strategies and products designed to achieve the Risk MAP vision. Additionally, four performance measures were created to assess Risk MAP progress toward this vision: Deployment, Quality Data, Awareness, and Action. These performance measures are defined in Section 2.3.2 and described in the following subsections.

4.2.2.1 Risk MAP Performance Measures

For a program as complex as Risk MAP, measures must be aligned across FEMA Headquarters (HQ) and Regional offices. FEMA uses four performance measures to assess Risk MAP progress: Deployment, Quality Data, Awareness, and Action.

Deployment

The metric for the deployment performance measure is the percentage of the population in the HUC8 watershed where Risk MAP has begun. The method of counting population is based on census blocks within the Risk MAP footprint (HUC8 watershed). If a portion of the census block is included in a study area, the population in the entire census block is counted in the deployment measure. The minimum criteria for a deployment of Risk MAP in a watershed are (1) holding a Discovery meeting to assess needs and (2) delivering required flood risk products for the entire watershed (see Section 2.3.2.3 for a description of Risk MAP flood risk products).

Risk MAP Discovery Meeting

Community meeting held to gather local data and assess flood hazard identification and risk assessment needs.

Each FEMA Region coordinates with FEMA HQ to establish the targets for deployment based on factors such as funding and anticipated State and local leverage and priorities. Deployment is currently measured using 2010 (the most recent) census data within the Risk MAP footprint. Populations are only eligible for deployment one time. Because Risk MAP deployment is related to risk awareness and not mapping (NVUE is the mapping measure), the entire population of a watershed could be counted as deployed even when the Discovery meeting concluded that no engineering studies should be performed.

Quality Data

As discussed earlier, the validity of existing flood hazard studies is maintained through a CNMS Validation Process to determine whether a mapped flood hazard is still valid. The concept of NVUE is used to determine whether a mapped flood hazard is still valid based on established technical and currency standards. FEMA and its mapping partners must systematically evaluate the validity of FEMA's mapped inventory for each flooding source to calculate the NVUE status. National targets are established every year based on the current inventory data and forecast, taking into consideration congressional funding levels. Each Region works with FEMA HQ to establish the targets based on factors such as funding and anticipated State and local leverage. The current quality data metric is to have 80 percent of the flood hazard stream miles identified as valid (attained). NVUE-related data are updated at various points within the Risk MAP project lifecycle, starting with the Discovery phase. A detailed overview of the status of FEMA's flood hazard inventory by Region is shown in Table 4-4 (FY15, Q4). This table is updated quarterly.

Table 4-4: NVUE Attained and Initiated per Region as of FY15 Q4

FEMA Region	Valid Miles	NVUE % Attained	NVUE Initiated Miles	NVUE % Attained + Initiated
I	5,881	18.1%	3,029	27.4%
II	15,310	46.0%	546	47.6%
III	43,472	54.3%	4,123	59.4%
IV	179,464	72.1%	2,971	73.3%
V	46,972	37.9%	15,898	50.7%
VI	55,633	22.6%	30,249	35.0%
VII	76,390	39.0%	9,870	44.0%
VIII	11,045	17.4%	3,766	23.3%
IX	35,793	59.2%	1,496	61.6%
X	3,575	8.2%	3,718	16.7%
National Total	473,535	42.0%	75,666	48.7%

Awareness

The metric for the awareness performance measure is the percentage of local officials who are aware of the flood risk affecting their community after engaging in the Risk MAP process. Since 2010, FEMA has surveyed local officials and community stakeholders annually to determine awareness and understanding of flood risk, mitigation actions, communicating flood risk, and need for assistance on communicating risk. Data from the survey are used to improve FEMA's general understanding of flood risk perceptions, inform community engagement strategies, and evaluate Risk MAP progress in the identification, mitigation, and communication of risk. The survey is authorized by the U.S. Office of Management and Budget (OMB) and is summarized and analyzed by the National Business Center. The survey results are posted on FEMA's website.¹⁰

Actions

The action performance measures are the primary measure used to evaluate the success of the Risk MAP program since it indicates which communities are taking action to reduce flood risks. FEMA tracks mitigation actions throughout the Risk MAP lifecycle in a community using two action measures:

- Action 1 is the number of communities where Risk MAP has helped identify new or improved mitigation actions to reduce flood risk.
- Action 2 is the number of communities that has either advanced or initiated a mitigation action.

FEMA has developed a web-based tool known as the Mitigation Action Tracker to enable multiple users to search, view, and update mitigation actions, ideas, or projects. Information on mitigation actions is also collected at various times during a Risk MAP project.

¹⁰ For more information about FEMA's nationwide study of flood risk awareness, see <https://www.fema.gov/local-official-survey-findings-flood-risk>.

4.2.2.2 Issue Analysis

Prior to Risk MAP, FEMA measured the population with “modernized” FIRMs and the percentage of NFIP communities adopting updated FIRMs and FIS Reports. The performance metrics under Risk MAP are complex and do not clearly address the need for maintaining the current inventory of flood studies or the unmapped areas of the Nation. The TMAC’s analysis of the current performance measures are as follows:

- FEMA’s current performance measures are not clear and with the focus on mitigation actions, do not provide an accurate metric to measure and track the effectiveness of the flood mapping program.
- The current deployment performance metrics over report the total population affected by Risk MAP by counting all census blocks within watersheds as receiving Risk MAP products when only a small portion has new flood hazard studies or mapping. The current metric for deployment is directly related to the total population in a watershed even if no streams within that census block or community are studied. This population metric has two challenges:
 - The current deployment performance metric only counts the presence of flood mapping in the census block, not whether the mapping is based on older digitized FIRMs or newer modernized FIRMs.
 - The way the deployment metric is applied results in an overcounting of the percentage of population covered by flood hazard mapping. The overcounting occurs because the current metric counts 100 percent of the population within a HUC8 watershed even when only a small percent of the stream miles within the watershed are studied. For example, if the footprint of a Risk MAP project (HUC8 watershed) has 10 miles of stream and only 1 mile is studied, the current metric counts 100 percent of the population that is within the project footprint as opposed to only 10 percent of the population as long as Discovery was conducted for the entire footprint area and a FRD, FRM, and FRR are provided for the entire project footprint area.
- The current quality data measure is based on data that are maintained in separate systems. New flood studies (initiated miles) in NVUE are provided by FEMA’s P4 tool¹¹ and updated with studies that are complete or re-validated (attained). The P4 tool is populated by the FEMA Regions based on each Region’s priorities and goals; however, due to funding and other uncertainties, this project sequencing is subject to change. While planned projects are captured as initiated study miles in NVUE, the difference between planned studies and funded studies is not consistently reconciled.
- Flood risk assessments are a primary component of Risk MAP and are directly related to effectively communicating flood risk. A considerable amount of data and resources is needed to develop useful flood risk assessments, yet FEMA does not include a performance measure for conducting risk assessments on the built environment.

4.2.2.3 Key Findings and Recommendation 3

The TMAC’s key findings and a recommendation related to program goals are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

¹¹ <https://p4.msc.fema.gov>

Key Findings

- FEMA identified new strategies and products designed to achieve the Risk MAP vision and created four performance measures to assess Risk MAP progress: Deployment, Quality Data, Awareness, and Actions.
- FEMA’s current performance measures are focused too heavily on mitigation, resulting in the loss of an accurate metric to measure and track the effectiveness of the flood mapping and risk assessment program and the remaining unmapped areas.
- The method used to develop the deployment metric is easily misunderstood and can lead policymakers to believe that more of the Nation’s population is covered by modern flood maps than is actually the case. This overcounting can lead to a belief that more of the Nation’s flood risk has been identified than is the case.
- The method used to determine the quality data metric is not consistent and is not updated based on project funding. The concept of tracking both initiated and attained study miles for new studies is unclear, and counting all prioritized studies as initiated, whether funded or not, leads to confusion on the actual number of newly studied stream miles and the impact on the NVUE status.
- While a significant number of mapping partners are going beyond the minimal requirements for flood risk assessments, FEMA currently does not have goals or performance metrics related to flood risk analysis and assessments on the built environment.

Recommendation 3

FEMA should develop National Flood Hazard and Risk Assessment Program goals that include well-defined and easily quantifiable performance metrics. Specifically, the program goals should include metrics for the following:

- a) Maintaining an inventory of valid (verified), expiring, unverified, and unknown flood hazard miles;
- b) Addressing the non-modernized areas of the Nation and unstudied flood hazard miles;
- c) Conducting flood risk analysis and assessments on the built environment; and
- d) Counting population having defined floodplains using a stream level performance indicator for a better representation of study coverage.

Discussion of Recommendation 3

Developing clear, measurable goals for the future National Flood Hazard and Risk Assessment Program that include metrics to track the maintenance of the current inventory of flood hazard miles would improve the validity and utility of the program. While FEMA’s current Risk MAP performance metrics have validity, they are based on the entire HUC8 watershed level and can overcount population coverage and the stream miles studied.

BW-12 Mandate

Pub. Law 112-141, Section 100215(c)

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (B) performance metrics and milestones required to effectively and efficiently map flood risk areas in the United States;
- (3) recommend to the Administrator how to maintain, on an ongoing basis, flood insurance rate maps and flood risk identification;

The impact area performance metrics should be measured at the stream level, rather than at the watershed level, for a better representation of study coverage.

FEMA should consider a stream level Key Performance Indicator (KPI), as defined in Section 4.4, that relates to population.

Many populations across the Nation are not covered in updated, valid flood studies and are therefore subject to unknown flood risk. Completion of converting the paper inventory to a digital product and mapping the unstudied streams should continue. The suggestion is not that FEMA allocate a significant portion of its limited resources to studying and mapping stream miles across the Nation that are not currently mapped using modern methods but rather that FEMA develop a goal to address these areas.

4.3 Flood Hazard Identification – Core Data, Models, and Methodologies

A flood hazard is identified and characterized through an engineering study to determine the magnitude of a flood event with an expected frequency of occurrence. The magnitude of the event can be characterized by the area of inundation, depth of water, velocity of flow, or wave impact. The flood event with a 1 percent annual chance of occurrence has been and continues to be used to delineate the boundaries of land area subject to floodplain management regulations and where flood insurance is required.

As noted in Section 4.1.1 (Users, Uses, and Products), users need mapping and data products that are supported by sound science and engineering. Section 4.3 speaks to the following technical issues that are identified in BW-12: the data, models, and methodologies that are used to calculate the magnitude of the 1-percent-annual-chance flood event with a focus on standards for quality products. The same data, models, and methodologies are commonly used to provide information on other events such as the 10-, 4-, 2-, and 0.2-percent-annual-chance events. The quality of the flood hazard identification depends on the core data, models, and methodologies that are used, all of which should come from trusted, credible, and verifiable sources. Authoritative studies and maps build confidence in the NFIP.

Hazard

A hazard is defined as an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss (FEMA, 1997a, p. xxv).

Coastal and riverine flooding requires vastly different approaches to performing flood studies, but many accepted models and methodologies are available in both settings to simulate the flood hazard. However, different models and methodologies can lead to different results, which can lead to controversy, challenges, and a lack of confidence in the results.

Users need mapping and data products that are supported by sound science and engineering. Thus, the data, models, and methodologies used to identify flood hazards must meet quality standards and be kept up-to-date with advances in knowledge and technology. This section covers important aspects of core data, models and methodologies, but it is not a comprehensive review. Additional topics will be addressed in later reports.

The section begins with a discussion of FEMA's standards, guidelines, and best practices and the importance of understanding accuracy, precision, and uncertainty followed by the TMAC's evaluation of the core data

(including datums, topography, and bathymetry) and models (both riverine and coastal) used to calculate the 1-percent-annual-chance flood event.

4.3.1 FEMA's Standards and Guidelines

FEMA maintains guidelines and standards for NFIP flood risk analysis and mapping, the performance of flood risk projects and processing of LOMCs and related Risk MAP activities. FEMA also provides information on best practices that lead to reliable and consistent identification of the flood hazard.

As of July 16, 2015, FEMA has revised and reorganized the *Guidelines and Standards for Flood Risk Analysis and Mapping* (FEMA, 2014b) (Guidelines and Standards) as a hierarchy as described below and shown in Figure 4-9:

- **Program Standards** – Required element of the Risk MAP program. Exceptions to program standards can only be granted by program leadership through an exemption process.
- **Working Standards** – Required element usually at a higher level of specificity than the program standards. Working standards are applied by specialists (e.g., engineers, planners, technicians, scientists) and have minimal ethical, political, and legal impacts to the Risk MAP program. FEMA Regional offices may occasionally grant exceptions to working standards.
- **Guidance** – Recommended approach to meet the standards. Accepted approaches are not limited to the recommended approach; mapping partners may use other methods to meet or exceed the standards.
- **Best Practices/Lessons Learned** – Any method, in addition to guidance, that meets or exceeds the standard. Best practices are shared by Regions and mapping partners following successful approaches to program activities.

All of the standards for the Risk MAP program have been published as a FEMA policy (FEMA, 2015f). The policy supersedes all of the standards in the previous *Guidelines and Specifications for Flood Hazard Mapping Partners* (G&S) (FEMA, 2003) and associated procedure memorandums. However, useful guidance is still available in these documents.

4.3.2 Precision, Accuracy, and Uncertainty

As discussed in Section 3.3.1, the accuracy of flood maps, as well as the accuracy of all underlying core datasets, such as topographic or bathymetric Light Detection and Ranging (LiDAR), digital elevation models (DEMs), and hydrologic observations, is of paramount importance to homeowners and all industries with a stake in the flood insurance industry. Improved processes and technological advances allow the NFIP to improve the accuracy of its products.

Precision refers to how close repeated measurements are to each other. Good surveying procedures, new technology, and high-resolution data can all contribute to precise measurements. However, measurements that are repeatable are not necessarily accurate. Accuracy describes how well measurements of the same thing average to the truth.



Figure 4-9: Hierarchy of FEMA's Guidelines and Standards (FEMA, 2014b)

One way to evaluate the accuracy of measurements and maps is to compare new or existing information to a known reference system, such as the National Spatial Reference System (NSRS). The NSRS is the most up-to-date version of positional truth available in the United States, so data referenced to the NSRS inherently gains the built-in accuracy of that system. For this reason, LIDAR data collection must include tying the data to the NSRS as part of the quality assurance and quality control (QA/QC) procedures.

The accuracy, precision, and uncertainty of the identified flood hazard depend on the availability of data; the accuracy, precision, and uncertainty of the data; the methodology; the quality of the models; and how these factors interact.

FEMA defines different levels of study. For example, the levels of riverine studies are described in some literature as "Approximate," "Limited Detailed," and "Detailed." These levels are loosely based on the methodology that is used in the study. For example:

- An Approximate Study uses regional regression equations to calculate discharges, stream channels are defined by topographic data without benefit of field survey, and the resulting SFHA is displayed without BFEs or floodway.
- A Detailed Study in most cases uses streamflow or precipitation gage data, land use information, field surveyed cross sections, and hydraulic structure data. The model is generally tested and refined with calibration runs. The resulting SFHA is displayed with BFEs and floodway information.

These different methods of identifying the flood hazard yield different results with different levels of accuracy, precision, and uncertainty when applied to the same locations. The level of effort and hence costs varies. Different levels of accuracy are reasonable for different locations. For example, Approximate Studies provide sufficient information for rural areas, while a Detailed Study level of effort is appropriate in more populated areas.

Transparent application of best practices for flood studies will lead to confidence in results. Given limited resources, the appropriate level of study that meets the need should be determined. The precision, accuracy, and uncertainty must be clearly communicated to the users.

4.3.3 Core Data

Core data for flood hazard models includes, but are not limited to, datums, topography, bathymetry, and water-level data. Each is critical to mapping the flood hazard.

The referenced geodetic datum is the foundation of the quality of the data used to conduct an FIS. Newly acquired geospatial data are referenced to North American Datum of 1983 (NAD 83) and NAVD 88, but many legacy products, including FIRMs, are still referenced to superseded geodetic datums, such as the NGVD 29.

4.3.3.1 Datums and the National Spatial Reference System

Consistent datums, or reference frames, must be used to ensure the accuracy of geospatial products. Any use of inconsistent datums can confuse mapping product users. Surveyors use geodetic datums as starting points for determining positions and elevations for flood maps, property boundaries, construction surveys, levee design, and other work requiring accurate coordinates that are consistent with one another. All Federal mapping agencies must reference their spatial data products to the current geodetic datums of the NSRS (OMB, 2002), which is defined by the National Oceanic and Atmospheric Administration's (NOAA's) National

Geodetic Survey (NGS). The current official horizontal and vertical datums of the NSRS are the NAD 83 and the NAVD 88.

While the NGS will always provide a consistent reference frame for mapping products, NAD 83 and NAVD 88 have been identified as having shortcomings that are best addressed through defining new horizontal and vertical datums. NGS plans to replace NAD 83 and NAVD 88 in 2022. The new reference frames will rely primarily on Global Navigation Satellite Systems (GNSS), such as the Global Positioning System (GPS), as well as an updated and time-tracked geoid model. As a result, the modernized NSRS will be easier and more cost-effective to maintain than today's datums that rely on permanent survey markers, which deteriorate over time.

Replacing NAVD 88 will also greatly improve the accuracy of vertical reference frame. To that end, the NGS is completing Gravity for the Re-Definition of the American Vertical Datum (GRAV-D), which is a long-term multi-year effort to collect gravity data and build an improved national gravimetric geoid model. GRAV-D will ultimately lead to more accurate elevations for all types of positioning and navigational needs, including flood mapping. Leveson (2009) estimated that full implementation of a new vertical reference system through the GRAV-D initiative would save the U.S. economy approximately \$240 million from improved floodplain management.

The new geometric reference frame that will replace the NAD 83 will change the latitude and longitude, and the ellipsoid height between 0 and 2 meters. In the conterminous United States, the new vertical reference frame to replace NAVD 88 will change heights an average of 50 centimeters, with an approximately 1-meter tilt toward the Pacific Northwest.

4.3.3.1.1 Issue Analysis

FEMA faces two issues related to datums used in flood mapping products. The first is the existence of core datasets and legacy mapping products that reference superseded geodetic datums. The second is that even new core data or new maps that reference NAD 83 and NAVD 88 will be superseded in the coming years as more accurate referencing datums are adopted by NGS.

The magnitude of change with the new datums will vary depending on the current datum being used and the geographic location. Consistent, transparent reporting of the topographic data positional accuracy will help reduce confusion and communicate the accuracy of the underlying data to users.

Tools will be available to transform geospatial data from NAD 83 and NAVD 88 to the new reference frame in 2022, but FEMA should begin planning and improving its data management now in anticipation of the changes.

Legacy latitude, longitude, and ellipsoid height information should be transformed to NAD 83(2011), NAD 83(PA11), and NAD 83(MA11)¹² (NOAA, 2015) as appropriate. With respect to orthometric heights, legacy data should be transformed from NGVD 29 to NAVD 88.

In addition to updating the datums used in the FIS process, it is important to require and store complete metadata for all mapping products, and original data should be retained for reprocessing. Critical metadata

¹² 2011 (North America tectonic plate); PA11 (Pacific plate); MA11 (Mariana plate). For more information, see NOAA (2015).

include the datum name and datum epoch for all geospatial files. Critical metadata will simplify future datum transformations.

4.3.3.2 Topography and Bathymetry

FEMA participates in two national elevation efforts: the 3D Elevation Program (3DEP) and the Interagency Working Group on Ocean and Coastal Mapping's (IWG-OCM's) National Coastal Mapping Strategy (NCMS) for coastal LiDAR elevation mapping. Together, they form a "3D Nation," uniting terrestrial and coastal/ocean mapping to achieve an authoritative national geospatial foundation in support of national mapping needs.

3D Elevation Program

The purpose of 3DEP is to collect high-resolution elevation (topography) data throughout the United States. Led by the U.S. Geological Survey (USGS), with participation from FEMA and many other Federal and State agencies, the program creates elevation models and several other products using airborne LiDAR and interferometric synthetic aperture radar (IFSAR) data (IFSAR is used only in Alaska). The 3DEP coordination model provides significant cost efficiencies and is a highly effective means of coordinating data collection activities among Federal, State, and municipal participants.

The national flood mapping program uses 3DEP to provide high-quality elevation data. FEMA has consistently supported and helped fund 3DEP.

Interagency Working Group on Ocean and Coastal Mapping National Coastal Mapping Strategy

The IWG-OCM NCMS for coastal LiDAR elevation recognizes that mapping to acquire high quality coastal and Great Lakes elevation data—from the upland topography to the nearshore and bathymetric ocean depths—is more essential today than ever before. Users across the Nation rely on accurate coastal elevation data to inform decisions in high-risk realms such as emergency planning, climate adaptation and resilience, economic investment, infrastructure development, and habitat protection. Elevation data are also critical inputs for modeling to prepare for and respond to hazards such as flooding, storm surge, and landslides. As coastal populations and coastal storm frequencies and intensities increase and as coastal environments degrade due to climate change and human use, the need for coastal elevation data will only grow.

The IWG-OCM NCMS lays out an aspirational 8-year plan to map U.S. coastal areas *routinely* through the judicious, efficient, and closely aligned collection of LiDAR bathymetry and topography, contingent on funding, agency commitment, and interagency/partner coordination. Partnerships are essential to the success of this geographically sequenced strategy. Partners meet annually to enhance coordination related to coastal LiDAR acquisition. The NCMS aims to improve interagency coordination on data management tasks (validation, processing, stewardship, dissemination, and archiving) in order to reduce costs, maximize efficiency, and avoid duplication of effort. The NCMS strategy lays out an approach to create a structure for cooperation on targeted methods, research, and technique development. New tools and improved technologies developed through this structure will facilitate interagency collaboration by obtaining the maximum value from shared coastal mapping data.

Currently, the NCMS adopts 3DEP-recommended topographic LiDAR standards and defines bathymetric LiDAR that will foster the collection of interoperable datasets by all IWG-OCM member agencies involved in LiDAR collection.

4.3.3.3 Water-Level Data

NOAA and select USGS tide gages provide coastal water-level data that serve as the basis for statistical analysis required to determine the water-level corresponding to the 1-percent-annual-chance flood in coastal areas. Conducting these analyses requires that the annual-peak water-level data be referenced to a single datum for the period of record and, ultimately, to land-surface and building elevations.

Though various models are available to convert water-level data from other datums to a national datum such as NAVD 88, developers of floodplain maps and other users principally concerned with elevation are best served when the water-level data are referenced to a national datum.

While USGS streamgages also produce and use water-level data (generally reported as river stage) in the process of estimating streamflows, the annual peak streamflow data, not the water level data, are the basis for the statistical analysis needed for mapping riverine floodplains. These data are often collected at significant distances from, and with no direct relation, to the landscape being mapped, and the follow-on hydraulic models are independently referenced to datums. Stage data in combination with associated observed discharges may be used for hydraulic model calibration requiring a common datum for gages on the same riverine watercourse. Thus, there is an indirect benefit to the flood mapping activity for the water levels at streamgages to be referenced to a single, common datum.

Substantial benefits for other floodplain management activities may also result from tying current operational, real-time USGS streamgages, particularly those in coastal areas, to national datums. For example, such ties could facilitate the creation and wider use of new flood-inundation maps and services under development by the USGS, the NOAA National Weather Service (NWS), U.S. Army Corps of Engineers (USACE), and many State and local agencies. Widespread adoption of flood-inundation mapping could provide a dynamic and persistent reminder of real-time flood conditions and potential flood threats on a block by block basis, aide emergency planning, flood response, and evacuation efforts, and, over the long-term, enhance public understanding and discourse about riverine flood risks.

4.3.3.4 Issue Analysis

Critical decisions made across the Nation every day depend on elevation data, ranging from immediate safety of life and property to long-term planning for infrastructure projects. The quality and timeliness of these decisions depend upon actionable information supported by accurate elevation data. The acquisition and storage of this data—in particular, high-accuracy, high-resolution topographic and bathymetric LiDAR—must be comprehensive, coordinated, cost-effective, and recurring.

Due to the investment of these data, the raw data or point cloud data should be leveraged and protected in order to reprocess the data for future requirements. For example, structure footprints can be derived from raw LiDAR data. Accurate footprints on the same geospatial platform as the DEM will eliminate a source of incorrect flood risk assessment.

Terrestrial LiDAR can be used to supplement aerial LiDAR collection for stream channel areas. Current aerial LiDAR does an inadequate job in confined areas and considerable effort is needed to correct hydraulic models, which introduces a potential for error. Bathymetric information is important for hydraulic analysis of perennial streams. If the underwater topography is unknown, an informed estimate is often applied, introducing another potential source of error.

Water-level data, both coastal and riverine, are fundamental to flood hazard identification. The utility of these data is greatly enhanced when gage datums are referenced to national datums.

4.3.3.5 Key Findings and Recommendations 4 and 5

The TMAC's key findings and a recommendation related to core data are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings Related to Recommendations 4 and 5

- Legacy FIRMs and FIS Reports that reference superseded geodetic datums are still in use, and new maps that reference NAD 83 and NAVD 88 will be superseded in the coming years as more accurate referencing datums are adopted by the NGS.
- It is important to require and store complete metadata for all mapping products. Original data such as point clouds should be retained for reprocessing.
- LiDAR data collection must include tying to the NSRS as part of the QA/QC procedures.
- Currently, the NCMS adopts 3DEP recommended topographic LiDAR standards and defines bathymetric LiDAR that will foster the collection of interoperable datasets by all IWG-OCM, member agencies involved in LiDAR collection, including FEMA.
- Substantial benefits for other flood-management activities may result from tying current operational, real-time USGS streamgages, particularly those in coastal areas, to national datums and the NSRS.

Recommendation 4

FEMA should work with Federal, state, local, and tribal partners to ensure topographic, geodetic, water-level, and bathymetry data for the flood mapping program is collected and maintained to Federal standards. Future FEMA topographic and bathymetric LiDAR acquisition should be consistent with 3DEP and Interagency Working Group on Ocean and Coastal Mapping standards, and all geospatial data for the flood mapping program should be referenced to current national datums and the National Spatial Reference System. Water level gage datums for active gages should be referenced to current national datums and the National Spatial Reference System, and to the extent practical, datums for inactive gages should be converted to meet these standards.

Discussion of Recommendation 4

Topography, also referred to as land surface elevations, along with bathymetry, or underwater elevations, and water level information are core data types that are critical in evaluating flood hazards. These data must be related to an accurate geodetic reference frame that ties them to the Earth's surface. Technologies exist today that can provide these data for the entirety of the United States, but not without substantial investment. It is important for FEMA to collaborate with other Federal agencies, States, and local agencies in funding, collecting, and maintaining these important core data and geospatial metadata. Data collected according to Federal standards and best practices will yield high-quality, cost-efficient mapping.

BW-12 Mandate **Pub. Law 112-141, Section 100215(c)**

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data; and
- (2) recommend to the Administrator mapping standards and guidelines for—
 - (B) data accuracy, data quality, data currency, and data eligibility;
- (5) recommend to the Administrator and other Federal agencies participating in the Council—
 - (A) methods for improving interagency and intergovernmental coordination on flood mapping and flood risk determination;

Recommendation 5

FEMA should document the horizontal and vertical accuracy of topographic data input to flood study models and the horizontal and vertical accuracy of topographic data used to delineate the boundaries of the flood themes. These data should be readily available to users, and clearly reported with products.

Discussion of Recommendation 5

The inventory of flood hazard studies and mapping has been created over decades under changing quality standards and a variety of both horizontal and vertical datums. Understanding the basic data upon which flood hazards have been delineated is fundamental to understanding the accuracy of the presentation. Communicating this basic information about the NFIP products is needed to assist users with comparisons and for future updates to improved datum.

Users, both technical and non-technical, must be informed and educated regarding data quality and limitations. Full documentation of data accuracy should be available both inside and outside of metadata for better recognition by all users. Documenting the accuracy of the topography aids in communicating uncertainty and can help users understand the limitations of the map display.

BW-12 Mandate **Pub. Law 112-141, Section 100215(c)**

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data; and
- (2) recommend to the Administrator mapping standards and guidelines for—
 - (A) flood insurance rate maps; and
 - (B) data accuracy, data quality, data currency, and data eligibility;

4.3.4 Riverine Hydrology and Hydraulics

FEMA flood mapping requires determining the potential magnitude and frequency of flood events along streams and rivers. Streamgages, where they are available, provide information on the rate of flow (discharge) as well as corresponding elevation at the gage. Estimation of the peak discharge during extreme events is determined from analysis of annual flood-peak flows, either observed or synthetic.

The quality of estimates depends on the length of the record; the precision, accuracy, and representativeness of the observations; and the suitability of the analytical tools and models to the study area.

4.3.4.1 Riverine Hydrology

The USGS has compiled the “Peak Streamflow for the Nation” (USGS, 2015c), which lists the dates and magnitudes of approximately 750,000 observed annual peak flows at more than 24,000 gaged locations. The data collected extends back, for some sites, to the mid-1800s, but for most sites, the data were collected during the past few decades within the 1900s—a span of time much shorter than the recurrence intervals for which the estimates are needed (e.g., the 1- and 0.2-percent-annual-chance flood).

Using observed peak flow data and working in cooperation with State and local agencies, the USGS has developed and published the flood-frequency distributions for approximately 14,000 locations (USGS, 2015e). Engineers conducting flood studies also use the original flood-peak data to compute their own estimates. Rainfall-runoff hydrology models are calibrated to match flows at gaged sites. It is estimated that at-site flood-frequencies are the basis of approximately 25 percent of FEMA current riverine flood studies.

Currently, flood-frequency analyses are based on the interagency guidelines titled *Guidelines for Determining Flood-Flow Frequency*, referred to as “Bulletin 17B” (IACWD, 1982). These guidelines are now undergoing revision for the first time since 1982 (see text box “Updated *Guidelines for Determining Flood-Flow Frequency*”). The use of the new methods envisioned in the draft guidelines could greatly improve flood-frequency estimates (Cohn et al., 1997; Griggs and Stedinger, 2007), but the development of the input data could involve extensive searches of public and private records and/or formidable hydrologic investigations, and require considerable skill in their formulation and coding.

To extend site-specific estimates to ungaged locations, the USGS develops regional regression equations that link the flood-frequency data to basin characteristics. Equations are available for every

Updated *Guidelines for Determining Flood-Flow Frequency*

The revised approach, expected to be published as Bulletin #17C in 2016 (USGS, forthcoming 2016), deals with lingering technical issues identified in Bulletin #17B (IACWD, 1982). Most importantly the revised guidelines facilitate the statistically efficient use of pre-instrumented and incomplete flood records, including observations of the absence of flooding over extensive periods before or after the instrumented record based on community information and nontechnical reports (e.g., newspapers, historical dairies, journals), select biological indices, and other “paleoflood” data. Other enhancements include improved regional estimates of flood-distribution skews; and automated, rather than subjective, censoring of low-peak floods that may otherwise overly influence determination of the relatively large 1-percent-annual-chance flood.

State and many urban areas.¹³ They are updated approximately every 10 years, on a State-by-State basis, as new data are collected and new statistical methodologies provide increased predictive power and precision. The equations are widely used and may be the basis of the hydrology for an additional 25 percent of FEMA riverine flood studies.

Analysis of Synthetic Flood Data

While the USGS streamgage network is extensive, neither it nor the USGS equations provide enough data for the most of the locations where flood-frequency estimates are needed, including the majority of locations where FEMA must provide flood maps. Rainfall-runoff models are used to estimate flood-peak flow rates for these locations. Rainfall-runoff models are generally classified as “design-storm” models or “continuous simulation models” and use a variety of algorithms and approaches to simulate the rainfall delivery, abstraction, infiltration, and runoff generation processes and streamflow routing. FEMA maintains a list of “approved” models at its website.¹⁴

Rainfall-runoff models require precipitation and either temperature or evapotranspiration data to drive them, plus data on stream networks, soil types and characteristics, and land use. These data are collected and compiled by a variety of agencies and many levels of government.

4.3.4.1.1 Issue Analysis

A key element of identifying riverine flood hazards is the estimate of discharges that have expected frequencies of occurrence (e.g., 1 percent, 10 percent). Streamgages provide data that are analyzed to provide flow estimates for flood studies.

4.3.4.1.2 Key Findings and Recommendation 6

The TMAC’s key findings and a recommendation related to riverine hydrology are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- About half of FEMA riverine flood studies depend on either direct analysis of USGS flood data or regional regression equations derived from them.
- Ultimately, the accuracy of the flood-frequency estimates depends primarily on the length and representativeness of the flood records; many flood records are too short to ensure accurate flood-frequency estimates of the 1-percent-annual-chance flood event.
- The release of the proposed flood-frequency guidelines in Bulletin 17C in 2016 will provide tools for improving flood-frequency estimates at many locations, but its use will require the development and coding of other nontraditional data from public and private documents and formidable field work in many cases.

¹³ <http://water.usgs.gov/osw/streamstats/ungaged.html>

¹⁴ <http://www.fema.gov/hydrologic-models-meeting-minimum-requirement-national-flood-insurance-program>.

Recommendation 6

FEMA should periodically review and consider use of new publicly available statistical models, such as the proposed Bulletin 17C, for flood-frequency determinations.

Discussion of Recommendation 6

The pending release of Bulletin 17C will provide better statistical tools and techniques that could greatly improve flood-frequency estimates on which FEMA flood maps are based. The USGS, the USACE, and the U.S. Bureau of Reclamation (USBR) are already adopting the tools and techniques in Bulletin 17C, and other agencies appear ready to follow.

However, the new tools will require training of FEMA personnel and contractor resources. In addition, the new tools can only process data that are available. Making the data available could involve considerable effort and significant expense, particularly if performed on a case-by-case basis. A better strategy would be to work with the USGS and other agencies to develop and share the information on a systematic and regional basis.

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- (2) recommend to the Administrator mapping standards and guidelines for—
 - (A) flood insurance rate maps; and
 - (B) data accuracy, data quality, data currency, and data eligibility;
- (5) recommend to the Administrator and other Federal agencies participating in the Council—
 - (A) methods for improving interagency and intergovernmental coordination on flood mapping and flood risk determination;

4.3.4.2 Riverine Hydraulics

Models are used to simulate the physical world to predict the expected area, depth, and velocity of flood events that are expected to occur at prescribed frequencies. Models are not a perfect replica of the physical world, and a variety of modeling approaches have been developed for application in different locations and geographies. Different models will produce different results, and it is extremely important in a regulatory environment to use appropriate models for simulation of flood events. Models used to simulate flood events and define regulatory tools (i.e., SFHA, BFE, floodway) must not only reasonably replicate the expected conditions but also meet the test of repeatability, general availability, and practicality of use. Quality assurance of model results must be ensured for credibility of the identified flood hazard. Confidence in the product, the identified flood hazard, begins with the choice of models and methodologies and includes a strong protocol for quality review.

One-Dimensional Unsteady and Two-Dimensional Models

One-dimensional (1-D), steady-state models have been the standard for riverine flood studies for decades. It has long been recognized that in some complex flow situations, the 1-D steady-state model does not adequately simulate the physical world. Rapid advancements in publically available models such as HEC-RAS 5.0, which offers unsteady 1-D unsteady and two-dimensional (2-D) modeling options, has made possible increased application of these models for regulatory flood studies. Refer to the text box titled “ASFP White Paper Conclusions” from the white paper *One-Dimensional Unsteady and Two-Dimensional Models: Issues for Regulatory Use* (ASFP/NAFSMA, n.d.).

Floodways

Floodways are a conceptual tool used to determine areas of a floodplain that may not be encroached upon without the consequence of increased flood depths in other locations. The specifications and procedure for calculating the extent (boundary) of a floodway were developed when the primary means of riverine flood hazard identification were 1-D steady-state mode models. Modern technology is faster and able to perform more complex computation and simulation options than when the floodway concept and calculation protocols were developed. Floodway specifications developed under limitations of 1-D steady flow are not applicable in unsteady and 2-D flow simulations.

Floodways are currently determined using the minimum criterion of “no more than 1 foot” rise in the 100-year flood elevations. This specification was selected in the mid-1950s as a criterion for governing reasonable and wise use of floodplains (Goddard, 1978). Under the current regulations, fill can be placed in the floodplain and the BFE increased by 1 foot, but current minimum NFIP regulations only require buildings be at the un-encroached BFE. For streams and other watercourses where FEMA has provided BFEs, but no floodway has been designated, the community must review floodplain development on a case-by-case basis to ensure that increases in water surface elevations do not occur, or identify the need to adopt a floodway if adequate information is available.

4.3.4.2.1 Issue Analysis

- **One-Dimensional Unsteady and Two-Dimensional Models** – FEMA has minimal or nonexistent guidance for use and QA review of these complex models. The FIRM DB and FIS Report options are ill suited to documenting these complex modelling approaches, yet FEMA accepts these models for riverine

Regulatory Floodway

A “regulatory floodway” is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the base flood without cumulatively increasing the water surface elevation more than a designated height. Communities must regulate development in these floodways to ensure that there are no increases in upstream flood elevation (FEMA, 2015g).

ASFPM White Paper Conclusions

Models used to define regulatory tools (SFHA, BFE, floodway) must not only reasonably replicate the expected conditions but must also meet the test of repeatability, general availability, and practicality of use. Use of unsteady 1-D models and 2-D models is likely to increase given their ability to better simulate complex flow patterns. It is important to use appropriate models for simulation of flood events. It is vital to initiate research, develop best practices, and create more robust modeling tools to appropriately and consistently use these models in stormwater and floodplains management. It is incumbent upon Federal and State agencies to clearly state which models they will accept under what conditions.

Federal and State agencies should articulate best practices, consequences, and considerations of using unsteady 1-D and 2-D models for regulatory use. In particular, FEMA needs to establish guidelines and QA protocols for review of the unsteady 1-D and 2-D models and for the development and review of floodway boundaries derived from such models, as well as reporting requirements appropriate for these modeling techniques. FEMA is called upon to take the lead in addressing the issues identified in this paper (*One-Dimensional Unsteady and Two-Dimensional Models: Issues for Regulatory Use* [ASFPM/NAFSMA, n.d.]).

studies; therefore, information and best practice guidance needs to be prepared to identify suitability of parameters for conditions.

The 1-D unsteady and 2-D models require considerably more effort to develop, calibrate, and maintain. Costs and maintenance of these complex models should be taken into consideration as these options may not be the best choice when less complex and less costly approaches produce acceptable results.

The use of unsteady and 2-D models is increasing, but there is no consistent set of QA/QC protocols. FEMA is a partner in selecting models and is responsible for checking the study results. Therefore, FEMA should be proactive in compiling best practices, comparative analyses, and parametric ranges.

Assembling a body of knowledge on best practices to help identify the appropriate locations and geographies for different models will help build consistency in model use and confidence in products. Gathering, evaluating, and disseminating this information is an important step towards having the tools to do a proper, adequate QA/QC of models used in flood studies and to reduce appeals that have to go to Scientific Resolution Panels.

- **Floodway** – The consequences of allowing floodplain encroachment up to a 1-foot rise in water surface elevation have not been fully explored or adequately documented. The current method of computing the “floodway” does not apply when modelling techniques more advanced than the traditional 1-D steady state models are used.

4.3.4.2.2 Key Findings and Recommendation 7 (Riverine)

The TMAC’s key findings and a recommendation related to riverine hydraulic models are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- FEMA has minimal or nonexistent guidance for the use and QA review of 1-D unsteady and 2-D models used to support riverine flood studies.
- The FIRM DB and FIS reporting options are ill suited to documenting these complex modelling approaches.
- There is insufficient information and best practice guidance from FEMA on parameter selection and applicability of these models for given conditions.
- Floodway specifications developed under limitations of 1-D steady flow are not applicable in unsteady and 2-D flow simulations.
- Current regulations allow fill to be placed in the riverine floodplains and the BFE increased by 1 foot, even though current minimum NFIP regulations allow construction to the lower, un-encroached BFE (elevation without the fill).

Recommendation 7 (riverine)

FEMA should develop guidelines, standards, and best practices for selection and use of riverine models appropriate for certain geographic, hydrologic, and hydraulic conditions.

- a) Provide guidance on when appropriate models would be 1-D vs 2-D, or steady state vs unsteady state,
- b) Support comparative analyses of the models and dissemination of appropriate parameter ranges; and
- c) Develop quality assurance protocols.

Discussion of Recommendation 7 (Riverine)

There are many acceptable riverine models and methodologies available to simulate flood hazards. Different models and methods can lead to different results; while there are technically justifiable reasons for these differences, multiple results can lead to controversy, challenges, and a lack of confidence in study products. Developing clear guidelines, standards, and best practices for model selection—and applying them consistently and transparently in riverine flood studies nationwide—will increase user confidence in the results.

Additionally, given limited resources, such guidelines, standards, and best practices help ensure that the models selected are appropriate for the level of study required, meet the users' needs, and clearly communicate accuracy, precision, and uncertainty of the results.

4.3.4.3 Riverine Event-Based Erosion

Event-driven riverine erosion is not well understood, and is not mapped by FEMA as part of the FIS process. However, the current FEMA practice of assuming clear water and rigid boundary conditions for riverine flood mapping neglects possible movement of watercourses during flood events, and can under-predict riverine flood hazards and flood risk. This is especially true for mountainous terrain and alluvial fans as was seen in the 2011 Vermont flooding (Hurricane Irene) and the 2013 Colorado flooding.

The TMAC did not investigate riverine event-based erosion during 2015 but will do so in the future. The TMAC will review the *Riverine Erosion Hazard Area Mapping Feasibility Study* (FEMA, 1999) and other studies and information developed by various States and other partners.

4.3.5 Coastal Hydrology and Hydraulics

FEMA flood mapping requires determining the potential magnitude and frequency of coastal flood events. Tide gages, high water marks and wave observations, if available, provide information that is used to validate storm surge and wave models. The models are then used to develop probabilistic estimates of coastal flood conditions. The quality of estimates depends on the length of the record; precision, accuracy,

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and representativeness of the observations; and the suitability of the analytical tools and models to the study area.

FEMA is completing the first comprehensive update of its coastal flood hazard studies and mapping since the 1980s. During the 1990s and 2000s, FEMA convened multiple panels of coastal science and engineering experts to review, update, and/or create guidelines and standards for the Atlantic/Gulf, Pacific, and Great Lakes coasts (FEMA, 2005a; 2007a; 2012a), including guidance on sheltered water environments (FEMA, 2005b). Coastal flood studies conducted on the Gulf Coast following Hurricanes Katrina and Rita also included expert review of FEMA's models and guidance, and the studies yielded valuable revisions to the guidance reflecting 21st century knowledge and technological advances. These investments are improving the accuracy, technical credibility, and reliability of the numerous flood studies that were completed recently or are underway along the Atlantic, Gulf, Pacific, and Great Lakes coasts.

While FEMA has made significant progress in updating its standards and procedures for coastal modeling and flood mapping, including leveraging geospatial technology, multiple areas remain in which further improvements are needed to enable the delivery of accurate and reliable flood hazard information. The analysis and recommendations in the following subsections rely heavily on the findings and reports developed by FEMA's earlier expert panels.

4.3.5.1 Coastal Surge Modeling

Although numerical models have advanced greatly since FEMA's last major overhaul of coastal surge modeling in the 1980s, the latest round of 2-D coastal storm surge and wave modeling has proven to be difficult, time-consuming, and expensive to use. The models are complex and require large amounts of data to take advantage of the complexity. The following aspects of modern coastal flood studies are all resource intensive:

- Achieving stable model meshes
- Validating models using historical storm data
- Defining appropriate distributions for key storm parameters
- Running models in "production" mode
- Performing statistical analyses of model outputs

4.3.5.1.1 Issue Analysis

One consequence of the complexity of the current 2-D coastal storm surge modeling has been to reduce the number of production run storms (using JPM-OS) to the minimum necessary to yield what are thought to be statistically valid 1-percent-annual-chance water surface elevations.

However, it is not clear whether production run storm sets are sufficient to define water surface elevations throughout the study area, especially in bays, sounds, tributaries and complex sheltered water bodies. Uncertainty in the results is not defined but likely increases as the number of modeled storms decreases.

The model that was used in most of the recent Atlantic and Gulf of Mexico studies, Advanced Circulation (ADCIRC), is among the best models available, but 1-percent-annual-chance (and other) stillwater elevations are as much a product of production run storm selection and statistical calculations as the model itself.

Accordingly, the ability to identify and evaluate ways to extend and validate the results of the complex models would be useful.

4.3.5.1.2 Key Findings and Recommendation 8

The TMAC’s key findings and a recommendation related to coastal surge modeling are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- Current 2-D coastal storm surge modeling is difficult, time-consuming, and expensive.
- Modelers often reduce the number of production run storms for efficiency, but it is unclear whether these storm sets are sufficient to define water surface elevations throughout the study area.
- The ability to identify and evaluate ways to extend and validate the results of the complex models, such as ADCIRC, would be useful.

Recommendation 8

FEMA should develop standards, guidelines, and best practices related to coastal 2-D storm surge modeling in order to expand the utility of the data and more efficiently perform coastal flood studies.

Discussion of Recommendation 8

The data development, modeling, and statistical analyses that comprise most of FEMA’s new coastal flood studies are highly resource intensive. Despite the substantial level of effort invested in these studies, questions remain concerning the statistical validity of the current modeling and statistical methods used to produce final 1-percent-annual-chance (and other) stillwater elevations. By implementing Recommendation 8, FEMA would be able to address these questions, improving study technical defensibility, and realize greater return on surge modeling investments. Among the technical approaches FEMA could consider as the basis of new standards and best practices are:

- Using less complex, but fast and efficient numerical models calibrated against the ADCIRC results
- Calculating storm surge response functions for certain areas
- Leveraging studies performed by other Federal agencies, such as the *North Atlantic Coast Comprehensive Study Report* (USACE, 2015)

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4.3.5.2 Coastal Event-Based Erosion

FEMA procedures for event-based erosion are limited and dated. Developed in 1988 (and codified in 44 CFR §§ 59.1 and 65.11), FEMA's guidelines call for applying the "540 sq ft (square-foot) rule" to assess survival of open-coast dunes during the base flood (FEMA, 2007a). Based on pre-storm cross-sectional area, engineers modify the topographic profile to remove or retreat the dune. A dune with a reservoir <540 sq ft is removed, and a dune with a reservoir of >540 sq ft is retreated. The modified profile is then used for hydraulic modeling and flood zone mapping. The 540 sq ft approach is only applicable to dunes on sand-dominated, open-ocean coasts. Event-based erosion is assessed and applied on a case-by-case basis for flood studies in other hydrodynamic, geologic, and/or geomorphic settings (e.g., sheltered shorelines, bluffs, mixed-sediment beaches). Although removing frontal dunes and erosion of other natural features could prove to be important factors in storm surge propagation, analyses of event-based erosion only occur after surge modeling (i.e., surge models do not currently use eroded profiles).

4.3.5.2.1 Issue Analysis

FEMA's event-based erosion guidance and procedures warrant review and potential modification in three areas:

- Sufficiency of the 540 sq ft criterion
- Approaches for considering erosion in non-open coast settings
- Timing of erosion analysis

With an additional 30 years of available pre- and post-storm profiles, coastal experts have repeatedly recommended that FEMA reevaluate the 540 sq ft criterion and revise regulations and guidance, as needed, to ensure that storm-related erosion hazards are effectively mapped and managed.

In areas beyond the open coast (e.g., sheltered shorelines, bluffs, mixed-sediment beaches), event-based erosion is assessed and applied on a case-by-case basis for flood studies. FEMA currently provides no formal guidelines, standards, or best practices for modelers to consult in these studies, which may render the studies vulnerable to technical and scientific challenges. Despite initial work by prior expert panels in the early 2000s to identify existing approaches, FEMA has yet to adopt event-based erosion methods for all shore types and settings.

In addition to potential changes to facets of FEMA's event-based erosion method, the timing of its application in the coastal FIS process also warrants review. As described earlier, modeling of event-based erosion is typically performed after stillwater elevations are generated, using coastal transect ground elevations usually derived from the same bathymetric and topographic DEM used to support the surge modeling and/or statistical analyses. Treating erosion and flooding as separate events is a simplification stemming from the limitations of the models used in older FEMA flood studies (i.e., in the 1970s through 1990s). In reality, these are not discrete, sequenced events—erosion and sediment transport occur with the rise and fall of floodwaters. The current process of applying erosion only after storm surge modeling could produce results that under- or overpredict the height and/or geographic distribution of stillwater elevations across the study area.

4.3.5.2.2 Key Findings and Recommendation 9

The TMAC's key findings and a recommendation related to coastal event-based erosion are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- Coastal experts recommend that FEMA reevaluate its 540 sq ft criterion (originally adopted in 1988), and revise regulations and guidance, as needed, to ensure that storm-related erosion hazards are effectively mapped and managed.
- FEMA does not have any formal guidelines, standards, or best practices to guide event-based erosion analyses in areas outside of open-coast, dune-dominated settings, which may render the parent coastal flood studies vulnerable to technical and scientific challenges.
- Erosion and sediment transport occur with the rise and fall of floodwaters. However, current FEMA FIS practice is to consider erosion only after storm surge modeling, despite the potential for the loss of dunes and other natural features to affect surge propagation.

Recommendation 9

FEMA should review and update existing coastal event-based erosion methods for open coasts, and develop erosion methods for other coastal geomorphic settings.

Discussion of Recommendation 9

Scientific review and revision, as warranted, of the 540 sq ft criterion would help ensure accurate identification of coastal flood and erosion hazard areas and facilitate community management and protection of dunes (including Primary Frontal Dunes, as required by NFIP regulations). The analysis of pre- and post-storm data necessary to address this issue would also permit FEMA to determine the appropriate dune reservoir volumes for events beyond the base flood, which is essential to comprehensive coastal risk assessments.

Expansion of FEMA's event-based erosion guidance to encompass other coastal settings beyond the open coast (e.g., sheltered waters, bluffs, mixed-sediment beaches) would provide consistent, technically sound guidance for all coastal studies, reducing the potential for technical challenges.

Because of concerns about the impacts of storm-related erosion on surge propagation, FEMA's erosion methods may warrant further revision to shift application of event-based erosion prior to surge modeling in the study process. As a first step, a sensitivity analysis (comparing surge model output using eroded- and

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non-eroded dunes in the DEM) would provide critical data for FEMA to assess whether such a change in methods and guidance would improve the accuracy and technical credibility of coastal flood studies.

4.3.5.3 Coastal Wave Modeling

One-dimensional wave models such as WHAFIS and RUNUP have been mainstays in FEMA coastal flood studies since the 1980s. Newer 1-D and 2-D wave models and approaches have been applied in recent years as FEMA has needed to develop guidance and procedures to improve coastal wave modeling, and to reflect the unique physical processes characterizing study areas such as the Pacific Coast and Great Lakes. Increasingly, 2-D nearshore wave models such as STWAVE and SWAN are being applied to FEMA coastal studies. Little to no information exists on how results from these newer models compare to those from FEMA's traditional 1-D models, including details on the models' key controlling variables and how each affects wave heights, wave runup, and flood elevations. The lack of such information has hindered the development of detailed standards and guidance on where (i.e., in what physical settings) the application of each model is technically appropriate.

4.3.5.3.1 Issue Analysis

Modeling coastal waves is complex and defining base flood conditions at the shoreline and across upland areas is difficult. Further complicating the situation, several wave models have been used during coastal flood studies. Different wave models can lead to different results at the same location, so proper selection of appropriate wave models is required.

The three principal issues related to waves and coastal flood studies are:

- **Nearshore wave conditions** – Nearshore wave models describe wave conditions from outside the surfzone to the shoreline. These models provide inputs to wave calculations on land. On the open coast, the computations are easier since the maximum water elevations and maximum wave conditions tend to coincide. However, in bays, sounds, tributaries, and other complex sheltered water bodies, the spatial and temporal variability in wave conditions during a storm can be great, and maximum water levels and wave conditions may not coincide. Current practice uses 2-D wave models to estimate input wave conditions at shoreline, but it is not certain that sufficient production runs are made to properly characterize wave conditions in complex shoreline environments.
- **Overland wave modeling** – Replacing FEMA's 1-D WHAFIS wave model with a 2-D wave model for overland wave calculations to determine coastal BFEs and flood hazard zones on land has been discussed. The 1-D wave model has faults, but through proper transect selection, it allows small obstructions to be represented in wave dissipation calculations. The 2-D wave models can better capture spatial variability in wave processes, but the grids are too large to represent small obstructions captured by the 1-D model. Shrinking 2-D model grids is not currently practical due to model time step and stability issues. Requiring use of 2-D wave models on land also makes applying for and securing map revisions more difficult for property owners.
- **Wave runup modeling** – Many different wave runup models have been used in FEMA coastal flood insurance studies. Some are based largely on laboratory tests, and are applicable over wide geographic areas provided actual wave and terrain conditions are consistent with model tests. Others are based largely on field observations and are tied to regional shoreline and wave characteristics.

Guidance on the selection and use of the various wave models is not well developed but is needed to assist study partners achieve technically sound and consistent studies.

4.3.5.3.2 Key Findings and Recommendation 7 (Coastal)

The TMAC's key findings and a recommendation related to coastal models are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- Coastal wave modeling is difficult, and there are trade-offs between the accuracy and uncertainty of wave results and the number of model runs needed to properly characterize wave conditions in sheltered water bodies.
- 1-D and 2-D models both have advantages and disadvantages.
- Many wave runup models have been used in FEMA coastal flood studies.
- There is currently a lack of guidance on the appropriate selection and implementation of coastal wave models in flood insurance studies.

Recommendation 7 (Coastal)

FEMA should develop guidelines, standards, and best practices for selection and use of coastal models appropriate for certain geographic, hydrologic, and hydraulic conditions.

- a) Provide guidance on when appropriate models would be 1-D vs 2-D,
- b) Support comparative analyses of the models and dissemination of appropriate parameter ranges, and
- c) Develop quality assurance protocols.

Discussion of Recommendation 7 (Coastal)

Many models and methodologies are available to simulate coastal flood hazards, but using different models and methodologies can lead to different results. Although there may be technically justifiable reasons for the differences, multiple results can lead to controversy, challenges, and a lack of confidence in study products. Developing clear guidelines, standards, and best practices for model selection and applying them consistently and transparently in coastal flood studies nationwide will increase user confidence in the results. Additionally, given limited resources, guidelines, standards, and best practices will help ensure that the selected models are appropriate for the required level of study, meet the user's need, and clearly communicate accuracy, precision, and uncertainty of the results.

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4.4 Flood Hazard Identification – Production Processes

Section 4.4 describes how FEMA identifies, maps, and regulates to the 1-percent-annual-chance floodplain boundary; the production of FIRMs, FIRM DBs, and FISs; FEMA's Guidelines and Standards; and flood map revisions. The TMAC's key findings and recommendations related to these topics are also presented.

4.4.1 Identifying, Mapping and Regulating to the 1-Percent-Annual-Chance Floodplain Boundary

As discussed in Section 4.3, FEMA uses engineering principles and mapping techniques to identify and map the area that will be inundated by the flood event with a 1 percent chance of being equaled or exceeded in a given year (probability of flooding). A hydrologic analysis is conducted to calculate the magnitude of this event, followed by a hydraulic analysis that determines the resulting elevations based on the characteristics of the flooding source. The elevations are then mapped on available topographic data to determine the SFHA. The resulting regulatory products are the FIRM, FIS Report, and FIRM DB, as discussed in Section 2.2.2.1. The SFHA identifies where flood insurance may be required to financially protect structures against flooding. FIRMs and the accompanying FIS Report also help establish minimum floodplain management and development requirements for communities.

Flood Insurance is required for all properties in the SFHA, or areas delineated on the FIRM as being subject to inundation by the base flood, where there is a federally backed mortgage. Flood insurance rates and minimum floodplain management and development requirements for riverine areas are established primarily by two types of studies: Approximate (Zone A) and Detailed (Zone AE). Zone A floodplains depict only the location of the SFHA, without BFEs or floodway, while Zone AE floodplains depict the location of the SFHA along with BFEs and floodway information (see Section 4.3). BFEs are provided at whole foot locations on older FIRMs or at each riverine cross section for FIRMs developed during Risk MAP.

Coastal high risk areas subject to inundation by the 1-percent-annual-chance flood event are generally depicted on FIRMs as Zone V and Zones VE, V1-30. Zone V areas include the additional hazards associated with storm-induced waves and do not depict BFEs or flood depths. Zones VE and V1-30 areas include additional hazards due to storm-induced velocity wave action and depict the calculated BFE. Table 2-1 and Table 2-2 contain descriptions of the high risk flood zones in riverine and coastal areas, respectively, where mandatory flood insurance is required.

FEMA's Guidelines and Standards (FEMA, 2014b) requires that all riverine studies include the 10-, 4-, 2-, 1-, 0.2- and 1-percent "plus" (allowing for uncertainties in estimating discharges) annual-chance recurrence intervals. Despite the availability of multiple recurrence interval profiles for riverine studies (current standards only require the calculation of the 1- and 0.2-percent-annual-chance floodplain and BFEs for coastal areas), flood insurance premiums and regulatory requirements for development are based solely on the 1-percent-annual-chance floodplain and BFE unless the local community regulates development to a higher standard.

As discussed in Section 4.1.2, NFIP insurance rates are determined on the basis of the flood zone (e.g., Zones A, AE, V, VE) and for some zones, rates are determined on the basis of the difference between the height of the lowest floor elevation in the structure and the identified BFE at the site.

This method of determining rates, while identifying the structures that will be affected by the 1-percent-annual-chance flood event, does not identify the structures that will be affected by more frequent flood events. Failing to identify all structures at risk of flooding, beyond the current standard 1-percent-annual-

chance flood event, may lead to over- or underestimating the risk and related insurance premium based on expected damage from more recurrent flood events or unique floodplain flooding characteristics. Additionally, the focus on the 1-percent-annual-chance floodplain may give a false sense of safety and discourage flood insurance purchase for buildings outside the 1-percent-annual-chance floodplain with a substantial flood risk from large flood events.

4.4.1.1 Issue Analysis

Flood risk is unique to the H&H characteristics of each flooding source as well as to the attributes of each structure located along the flooding source. FEMA's current insurance rates are based on limited study data prepared in the early 1970s that related a limited amount of building data to the flood depth data that were available at the time of the studies. The data were extrapolated as representative of the flooding condition and building stock attributes for all areas within the Nation. As discussed in Section 4.1.2.4, the NRC reviewed FEMA's method of setting full-risk rates for flood insurance and concluded that FEMA may want to consider an alternate approach to assessing risk, stating that "[m]odern technologies ... that enable the development and use of comprehensive risk assessment methods ... could improve NFIP estimates of flood loss" (NRC, 2015b, p. 51).

Although the TMAC did not examine in detail how FEMA relates flood hazard to frequency and expected damage to risk, the TMAC recommends identifying the 1-percent-annual-chance floodplain and associated BFE as the basis of insurance rates to a structure-specific flood frequency determination and associated flood elevations. The following information is provided as support for the recommendation.

Insurance premiums are set annually based on the expected losses for the NFIP for the upcoming year. The expected losses are distributed to each policy based on a number of factors, including whether the building was constructed pre- or post-FIRM, the flood zone designation for the area, first floor elevation data and other building attributes, and the 1-percent-annual-chance whole foot rating group, if available. This approach ensures that the premium collection matches the expected flood losses for the year for the entire NFIP policy base but does not account for the risk or premium based on that risk at each insured property.

Risk MAP has increased the number of Detailed Studies, increasing the amount of multiple recurrence interval flood profile data that are available. However, these additional datasets are not being used to better determine the extent of the flood hazard or risk to the structures. In addition, as noted in Section 4.2, approximately half of the flood studies are out-of-date, and a significant percentage of stream miles are unmapped.

FEMA Zone A studies are not required to use model-based water surface elevation data. A significant portion of FEMA's flood studies are based on USGS regression equations, which can easily be expanded at relatively low cost to develop additional flood profiles to generate the 1-percent-annual-chance discharge and hydraulic model. The multiple recurrence interval flood profile data that are already developed, as well as any future studies, can be used to augment the existing flood insurance premium background dataset.

Advances in data collection techniques have greatly increased the amount of building data that are available at the local, State, and national levels. Tax record data, including many critical building attributes, have become increasingly available in database or GIS format and are often distributable through web-based systems. Data sharing or data federation could greatly increase the amount of building data available to FEMA.

4.4.1.2 Key Findings and Recommendation 10

The TMAC’s key findings and a recommendation related to FEMA’s process for determining SFHAs are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- The current FEMA insurance rating approach, which groups buildings into whole foot rating categories based on the level of the lowest floor above or below the BFE, does not account for the risk associated with other flood events, which may lead to over- or underestimating the risk and related insurance premium based on expected damage from more frequent flood events or unique floodplain flooding characteristics.
- Risk MAP has increased the number of Detailed Studies, increasing the amount of multiple recurrence interval flood profile data that are available.
- Advances in data collection techniques have greatly increased the amount of building data that are available at the local, State, and national levels, and data sharing or data federation could greatly increase the amount of building data that are available to FEMA. This type of data can “enable the development and use of comprehensive risk assessments, which could improve NFIP estimates of flood loss” (NRC, 2015a, p. 51).

Recommendation 10

FEMA should transition from identifying the 1-percent-annual-chance floodplain and associated base flood elevation as the basis for insurance rating purposes to a structure-specific flood frequency determination and associated flood elevations.

Discussion of Recommendation 10

For areas in which multi-profile data exist, transitioning to frequency-based determinations would increase the detail and precision in the actuarial models used for premium rating. The increased level of precision may be useful for increasing policyholder confidence since the insurance rating would be based on more detailed data. Additionally, the development of multiple flood frequency data provides the foundation for structure-centric flood-frequency determination.

4.4.2 Risk MAP Project Process

FIRMs are produced through the Risk MAP project process, which involves the interrelated elements of outreach and coordination, survey and engineering studies, mapping and database generation, and regulatory compliance. Risk MAP studies are designed to have a timeline of 3 to 5 years, but the timeline

BW-12 Mandate from Section 100215(c)

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data; and
- (2) recommend to the Administrator mapping standards and guidelines for—
 - (A) flood insurance rate maps; and
 - (B) data accuracy, data quality, data currency, and data eligibility;

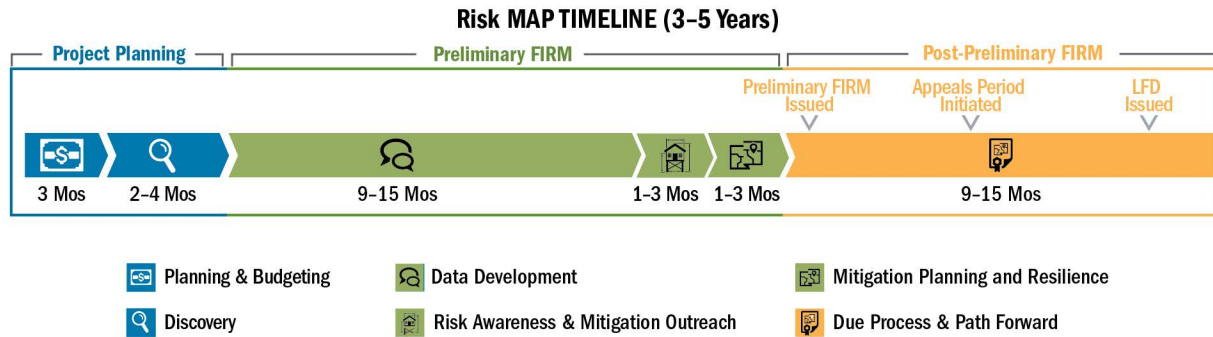


Figure 4-10: Risk MAP project phases and timeline

has increased to more than 5 years as a result of increased procedural, administrative, and funding requirements.

4.4.2.1 Production Timeline

The three phases of the Risk MAP project process are project planning, Preliminary FIRM, and Post-Preliminary FIRM. The phases are described below, and the ideal timeline for the phases is shown in Figure 4-10.

- Project planning** – Project planning begins after a community or mapping partner has identified an area in need of study and has begun planning and budgeting for the selected project. Once a study area is selected for Discovery, the project is reviewed to evaluate the need for a Risk MAP project. During the Discovery process, the identification of available data, increases in development, and other flood-related factors are considered along with current and historical flood-related data. The findings of the initial evaluation along with additional input from the community and other stakeholders is discussed during a Discovery meeting (see Section 4.1.1). The results of the Discovery process are provided in a Discovery Report.
- Preliminary FIRM** – After the Discovery process has been completed and FEMA has determined that a study is needed and has provided funding, a Risk MAP project is initiated through a Production and Technical Services Contract or a CTP grant agreement. If the project includes a Detailed Study, land surveys are collected and H&H studies are conducted to determine the SFHA and the BFE (data development phase). An optional Flood Risk Review meeting may be held to provide community officials the opportunity to review the results of the FIS and discuss the proposed map changes. Development of Risk MAP products, referred to as flood risk products, begins during this phase. A Resilience meeting is held in coordination with the release of Preliminary FIRMs as an opportunity to raise flood risk awareness and discuss actions to mitigate flood risk. More commonly, the Resilience meeting is held after Preliminary map issuance so that the Risk MAP products are complete.
- Post-Preliminary FIRM** – Delivery of the Preliminary FIRMs and FIS report to community officials and a series of review and public comment periods. Meetings are held with communities and often the public to review the changes to the FIRMs and provide an opportunity for feedback. After the community meeting, the maps go through an appeal process prior to finalizing the FIRMs and FIS and issuance of a Letter of Final Determination (LFD) indicating FEMA’s intent to issue the Effective FIRMs and FIS in 6 months. During the 6 months, communities FEMA adopt or amend their floodplain management

ordinance to reflect the new maps. Risk MAP products are finalized and a Resilience meeting is held to present the flood risk products and discuss mitigation options to reduce the flood risk.

The data development and sharing phase includes all of the data collection, surveying, and engineering studies to determine the flood hazard of each study within a Risk MAP project. This portion of the Risk MAP timeline is estimated as 9 to 15 months. Depending on the size and complexity of the studies within the watershed, this phase of the project can take much longer. In addition, if there are appeals received during the due process, the post-preliminary phase could take longer to resolve the appeals.

4.4.2.2 Key Decision Point Process

In May 2015, FEMA implemented a Key Decision Point (KDP) process for current and future flood studies for Risk MAP. The KDP process consists of six KDPs, each requiring elevating levels of approval from FEMA, and applies to all new and existing Risk MAP projects and Physical Map Revisions. The KDP process does not apply to LOMR projects. The intended purpose of the KDP process is for FEMA to be better able to respond to congressional and media inquiries, to increase transparency in the decision-making process, and to streamline communications between FEMA HQ and the 10 FEMA Regions.

An overview of each KDP decision, when the documentation is developed, when approvals are required before the Risk MAP project can proceed, and FEMA's review schedule are provided in Table 4-5.

Table 4-5: Key Decision Points and Decision Schedule

Key Decision Point		Documentation Begins	Must Occur Before	FEMA Decision Schedule
KDP 0	Is FEMA ready to initiate this Flood Study?	Projects selected	Discovery	Twentieth business day of each month
KDP 1	Is FEMA ready to continue this Flood Study?	After Discovery	Data Development	Twentieth business day of each month
KDP 2	Is FEMA ready to develop a Preliminary FIRM and FIS?	Following Flood Risk Review meetings	Preliminary FIRM development	Fifth and fifteenth business day of each month
KDP 3	Is FEMA ready to issue a Preliminary FIRM and FIS?	Resolution of QA/QC reviews	Preliminary FIRM and FIS distribution	Fifth and fifteenth business day of each month
KDP 4	Is FEMA ready to initiate an Appeal Period?	Following community meetings	Initiation of appeal period	Eight and eighteenth business day of each month
KDP 5	Is FEMA ready to issue the Letter of Final Determination?	All appeals have been resolved	Preparation of final FIRM and FIS	Eight and eighteenth business day of each month

Source: *Guidance for Flood Risk Analysis and Mapping: Key Decision Point (KDP) Process Guidance Document (FEMA, 2015)*

KDP data and supporting documentation are uploaded through the KDP SharePoint site on the Risk MAP portal by the mapping partner (PTS contractor or CTP) via a KDP documentation tool at key stages in the Risk MAP process. Once documentation of a key stage is developed, the project cannot move forward until approval to continue is provided from FEMA. For example, the issuance of Preliminary FIRM and FIS cannot continue until FEMA has verified that all QA/QC has been addressed and that the FIRM and FIS are a

technically credible product and that all meetings and other community engagement activities are documented. This is an intentional pause in the process for FEMA to decide if the project can continue.

Based on the review times and approval schedule of the FEMA Regions and HQ as shown in Table 4-5, the KDP process, can add up to 41 business days or approximately 2 months to the Risk MAP project timeline. In some circumstances, a request can be made for an expedited review to ensure that urgent emergency cases are expedited.

4.4.2.3 Mapping Information Platform

FEMA released the Mapping Information Platform (MIP) in June 2004 to enable the management, production, and sharing of flood hazard data and maps in the digital environment. This online portal allows FEMA and mapping partners to track the progress of flood studies and countywide FISs from project initiation through to an Effective FIRM. The MIP provides a management workflow for reporting and tracking budgets, schedules, and the progress of flood hazard identification and risk studies. Through a number of tasks with different roles and responsibilities for completing the tasks, the MIP moves projects through the study process and the required quality review steps. Through a number of service pack upgrades, the MIP has continued as the sole portal for flood hazard studies and mapping in the Risk MAP program, including regulatory products, non-regulatory products, and processing LOMCs.

The MIP was designed to accommodate the Map Mod countywide study workflow process and has not evolved to accommodate the current Risk MAP project workflow that includes the flood risk products and KDP process. It has a rigid workflow that cannot accommodate non-routine tasks, special projects, or more complex watershed-based Risk MAP projects. Workarounds have to be used to accommodate regional coastal studies that cannot be broken down by county or watershed. For example, to accommodate the flood risk products as part of the Risk MAP project, standard data development tasks are used in the MIP as shown in Table 4-6.

Table 4-6: MIP Workarounds to Accommodate Risk MAP Products

Risk MAP Products Task	MIP Data Development Task
• Develop Flood Risk Datasets (e.g., CSLF, depth grids, Areas of Mitigation Interest)	• Develop Hydrologic Analysis
• Develop Flood Risk Database	• Develop Hydraulic Analysis
• Develop Flood Risk Map	• Perform Flood Mapping
• Develop Flood Risk Report	• Perform Field Survey
• Risk Communication and Outreach	• Perform Alluvial Fan Analysis

MIP roles are assigned to various FEMA contractors and mapping partners, requiring significant coordination to continue moving projects through the process. Further, the MIP is not a sufficient tool for earned value reporting because mapping partners are required to manage and track the financial health of projects outside the MIP. The MIP design was based on an antiquated programming language and is therefore limited in its ability to accommodate changing requirements and standards. MIP access is slow and data storage is limited. These limitations often require the user to submit a MIP Help ticket, causing delays in the study process. Also see Section 4.6.

4.4.2.4 Issue Analysis

The Risk MAP project timeline has become increasingly difficult to complete in 3 to 5 years because of the increased coordination and engagement that has been mandated through various NFIP reforms. Increased engagement includes allowing communities to review technical approaches at the project outset, regular updates to Congress on study milestones, and more extensive notification of property owners on study impacts. In reality, Risk MAP studies are being completed in 5 to 7 years and in as long as 10 years. Many of FEMA's changes to requirements and procedures may appear to have small impacts on the workflow and schedule, but the changes have increased the total study time significantly.

FEMA has implemented procedural changes both formally and informally. The Mapping Information Portal (MIP) and the KDP process were announced, and FEMA provided training in a formal ramp-up period to implementation. Other changes such as the "cooling-off period," which is a 30-day delay following the appeal period before requesting the LFD, have been implemented less formally but are treated with the same level of authority as procedures that are issued formally.

The ideal Risk MAP project timeline from project planning to an Effective FIRM and FIS is 25 months (see Figure 4-10). The engineering analysis (conducted within the data development phase) is 11 to 19 months old when the FIRM reaches the Effective date. Given that the NVUE update cycle is 5 years from the Effective date, the engineering analysis can be as old as 6.5 years before FEMA performs the NVUE assessment to determine whether the study is still valid. Any additional increase in the study time due to administrative procedures increases the age of the engineering analysis and underlying data.

The MIP has made it difficult for mapping partners to implement projects that require unique processes or schedules because any project with deviations from the established workflow faces unanticipated consequences based on the rigidity of the MIP workflow. MIP workarounds require assistance from MIP Help or the Regional Service Center (RSC), both of which may require FEMA approval prior to taking action and both of which add time. Workarounds can also result in the MIP suspending the next step in the work, which can prevent the request for the approval MIP step from occurring. Additionally, the MIP is limited in its file storage capabilities and maintenance and enforcement of file structure. It is not uncommon for the MIP to have incomplete project data, blank files, improper file formats, duplicate data, and/or data stored in the wrong location.

4.4.2.5 Key Findings and Recommendation 11

The TMAC's key findings and a recommendation related to production process for flood mapping products are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- There is considerable concern about the length of time between identifying an area that is in need of updated assessment and producing a final product.
- Procedural changes to the Risk MAP process have extended the timeline of projects from 3 to 5 years to 5 to 7 years or longer.
- Flood studies are at least 9 to 15 months old before the flood maps are adopted by communities and become Effective. The NVUE process for addressing the validity of flood studies every 5 years considers

the age of the FIS to be the same as the Effective date of the FIRM. Due to the length of the regulatory adoption process and the FEMA-implemented procedural changes through the KDP process, the studies are approximately 1 year older than the Effective date of the FIRM.

- The MIP is too rigid for many of the projects in Risk MAP, and any project that requires any deviation from the standard workflow process requires the intervention of FEMA, either through MIP Help or the RSC.

Recommendation 11

FEMA should modify the current work flow production process and supporting management system, Mapping Information Platform, to reduce unnecessary delays created by redundant tasks and inflexibility of the system. The process and system are currently not designed to properly manage non-regulatory products or products that do not fit predefined footprints. FEMA should modify the system to enable flexibility in project scope and size, such as in the choice of watershed size, not limiting projects to only the hydrologic unit code 8 (HUC8).

Discussion of Recommendation 11

The engagement of and collaboration with the communities affected by a Risk MAP project throughout the study process are clearly beneficial to FEMA and its mapping partners. However, interaction should not be indiscriminately reduced due to internal administrative tasks and workflow processes that unnecessarily lengthen the process.

Eliminating redundant tasks and correcting the workflow to avoid unused and unneeded tasks will save time, be more efficient, and reduce costs. Specifically:

- Allowing greater flexibility in the process will allow adaptation to the particular project and avoid spending time on unnecessary tasks to “trick” the MIP into allowing the project to advance.
- The use of the HUC8 for the watershed footprint does not fit in all areas of the country. In highly populated areas, its use can make it impossible to work with dozens of communities and complete multiple studies in a timely manner. Allowing alternative watershed footprints will allow projects to be designed to an effective and appropriate scale.
- Although the KDP process has strengths, it does not integrate smoothly with other processes such as QA checks. The result is a stop/start stuttering that impedes projects from advancing efficiently. For example, delaying the preparation of *Federal Register* notices for KDP 4 can delay the project by 2 months.
- Providing an updated work flow production process and management system that provides adequate storage capabilities and enforces file storage protocols will better support the move to a database-driven environment (see Recommendation 16).

**BW-12 Mandate
from Section 100215(c)**

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data;

4.4.3 Guidelines and Standards for Flood Risk Analysis and Mapping

The processes of data collection, analysis, and reporting do not always proceed linearly. The planning for a study, local review, FEMA review, and final approval stages stretch over months or up to several years. When FEMA announces new procedural requirements, a significant number of studies are usually underway, each following existing guidelines. After announcing new procedural requirements, FEMA typically requires new procedural, administrative, and specifications to be implemented immediately and retroactively upon release. FEMA generally does not relax the requirements or provide relief from the increased cost even though the new requirements can result in rework, increasing the study cost and delaying the schedule.

4.4.3.1 Guidance Transformation and Maintenance

Prior to 2013, FEMA provided standards and guidance to its mapping partners through its G&S publications. In August 2013, FEMA finished extracting the standards in the G&S and published them as its "Policy for Flood Risk Analysis and Mapping" (FEMA, 2015i). The policy outlines all of FEMA's requirements for practitioners of the Risk MAP program and is generally referred to as the Guidelines and Standards. This term encompasses standards, guidance, documents, technical references, and related forms and templates. The new Guidelines and Standards are also published to FEMA's Knowledge Sharing Site (KSS), a web-based tool that allows users to search for Guidelines and Standards on specific topics. Since 2013, FEMA has also been working on organizing, formatting, and updating its guidance on Risk MAP projects and posting the guidance to the KSS. As of August 2015, the guidance transformation process was nearly two thirds complete. As guidance on a topic is transformed and incorporated into the KSS, the relevant sections and appendices of the legacy G&S are retired and archived.

The Guidelines and Standards is updated twice a year. At the beginning of each cycle, FEMA publishes a maintenance announcement outlining the planned changes. During each maintenance cycle, FEMA conducts a public review of draft standards. The review period lasts 1 month and generally starts 3 months prior to the completion of the maintenance cycle. Once the updated guidance and standards are approved, they are required to be used in all current flood studies and Risk MAP projects.

4.4.3.2 Issue Analysis

When rolling out new standards and guidance, FEMA should consider the budgetary impacts to mapping partners, including CTPs. Examples of how FEMA could better balance requiring new standards are:

- New products where none existed before
- The percentage of completion or reaching certain milestones of a study

These examples could provide a means of establishing the phasing of when new standards or procedural changes should be required or when Risk MAP projects should be exempt from new standards.

Unanticipated budgetary pitfalls, the need for additional review time for studies already underway, and the need for another round of public hearings and input are all considerations in the process of determining how and when to apply changes in procedure. FEMA should consider all impacts on existing projects to make better informed decisions and avoid retroactive changes when possible.

An appropriate roll-out plan may mean that complete implementation of procedural changes may take longer than desired. Modifying FEMA's standards and guidance roll out process will also mean that projects already nearing final stages when new procedures are announced may not comply with newer, higher

standards and requirements, but thoughtful application of phasing in such changes provides stability to the study process.

4.4.3.3 Key Findings and Recommendation 12

The TMAC’s key findings and a recommendation related to FEMA’s Guidelines and Standards are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- FEMA has undertaken a much needed update to the Guidelines and Standards. These Guidelines and Standards are now updated twice a year on an established maintenance cycle.
- Currently, new standards and guidance are retroactively applied to all current FIS and Risk MAP projects, and many of the updated standards result in considerable schedule delays and increases in cost due to the additional rework and changes that are required.

Recommendation 12

FEMA, in its update of guidance and standards, should determine the cost impact when new requirements are introduced and provide guidance to consistently address the cost impact to all partners.

Discussion of Recommendation 12

When new requirements are introduced, FEMA should evaluate the new process to determine its cost impact to the mapping partners. FEMA should provide guidance regarding the cost impact to CTP and other mapping partners.

4.4.4 Flood Map Revisions

A critical aspect of FEMA’s national flood mapping program is the periodic revising and updating of the maps to ensure that they accurately reflect the risks to the mapped communities. The impact of BW-12 reforms highlighted the importance of advance knowledge of proposed and imminent mapping changes and led directly to the expanded outreach and communication requirements in the Homeowners Flood Insurance Affordability Act. Members of Congress and all stakeholder groups, including consumers, want advance knowledge of the proposed and imminent changes to flood zones and to be assured that maps are current and accurate.

Establishing an open and transparent approach to remapping that maximizes the accessibility of advanced mapping and geographic technology would streamline FEMA’s flood mapping program, allowing it to better reflect current conditions while making it nimble and dynamic enough to facilitate interagency cooperation in data sharing.

Physical map revisions can take from 3 to 10 years, resulting in a product that is already outdated when it is released. In some instances, pertinent newer data that were developed during the production cycle is not

BW-12 Mandate from Section 100215(c)

- The Council shall —
- (2) recommend to the Administrator mapping standards and guidelines for—
 - (A) flood insurance rate maps; and
 - (B) data accuracy, data quality, data currency, and data eligibility;

incorporated in the map release, and it may be many years before updated information is incorporated and published. A LOMC process exists to provide for map changes outside the larger FISs conducted as part of Risk MAP, but the process does not provide a complete solution to the issues of timeliness and completeness of data.

4.4.4.1 Letters of Map Change (LOMC)

After a FIRM becomes Effective for regulatory and insurance purposes within a community, the conditions represented on the map do not remain static. In fact, the conditions represented on the map may already be out-of-date because of length of time between data collection and publication of the map. These may be out-of-date no matter how short the time frame is. Correcting this problem requires that FIRMs be easy to update. An updating process that is accessible would facilitate the presentation of the most current and accurate depiction of hazard and risk status.

Map changes that are on a relatively small scale result in LOMCs, which are documents that officially amend or revise information shown on the currently Effective FIRM. LOMC must be consulted for a full and up-to-date understanding of risk and hazard conditions within the mapped area.

Other factors that can necessitate the initiation of flood studies and publication of new maps through the LOMC process are:

- Availability of better technical data
- Documented change in physical conditions
- Addition or removal of flood structures
- Development in the watershed (not only within the 1-percent-annual-chance floodplain)
- Change in hydraulics (water velocity, depth, and surface elevation) and/or hydrology (volume of water)
- Sea level rise

4.4.4.2 Letters of Map Amendment (LOMA)

As discussed in Section 3.2, flood hazard studies and flood maps are estimates of complex H&H processes. Some flood maps are based on Detailed Studies using recent terrain and hydraulic data and mapping techniques, while others rely on a less detailed analysis of the flood hazard. The degree of accuracy and precision of flood hazard determinations and the production of mapping products at resolutions appropriate to capture the many variabilities of the flood extents and structures affected is costly and must be balanced with the resource constraints of each project and the needs of the users. With projects taking 5 to 7 years for completion, many of the physical flood conditions could continue to change or be updated during the FIS.

Flood hazard analysis and mapping studies are based on terrain data that are collected at varying resolutions but are not the result of individual structure surveys. Since studies and the resulting maps are conducted on miles of streams at a time, the individual spatial variations of specific geographic areas are not always captured, and the final resolution of the FIRM does not always capture the topographic and SFHA at individual structures. When the actual ground elevation is higher than the reported BFE for an area, the higher ground elevation should not be included in the mapped SFHA. Such inadvertent inclusion may be the result of an error in data collection, analysis, or depiction or may be related to the original scale of the FIS.

The level of detail included in the data collected to map a floodplain does not reflect gradual undulations of the Earth's surface that are smaller than the methodology used in the study can detect. In flatter areas, studies have generally been conducted to generate 2-foot contour intervals. Areas with greater topographic variation and relief have generated 10-foot contours. Therefore, a ground elevation of less than half a contour interval may be shown as "in" the SFHA while a comparison of the topography to the BFE shows that it should instead be "out."

The mapping correction procedure is contained in 44 CFR Part 70, "Procedure for Map Correction." Current FEMA policy for approval of applications for LOMAs requires submission of better technical data that shows the ground level above the reported BFE before an application can be approved. Terrestrial survey techniques can readily measure ground elevations to 0.01 foot. In most cases, the scale and level of accuracy of flood studies for FIRMs do not approach this small increment. While a BFE can be interpolated to the nearest 0.1 foot from a floodway data table or stream/river profile included in the FIS Report for a Detailed Study, the interpolation is a finer level of detail than what was provided in the original studies.

4.4.4.3 Letters of Map Revision (LOMR)

While a LOMA establishes a property's location in relation to the SFHA, changes to the characteristics of the flooding source require a LOMR to update the FIRM. While a LOMA is generally specific to a building, lot, or site, a LOMR generally encompasses a larger area. Changes to stormwater facilities, grading, and other engineered modifications that result in alterations of the vertical and/or horizontal extent of the SFHA will generate a request for a LOMR. Such changes typically involve hydrologic and/or hydraulic analyses, and the technical information must be submitted with the LOMR application. The required supporting data for LOMR are outlined in 44 CFR Part 65, "Identification and Mapping of Special Flood Hazard Areas," but the criteria for approval are expressed in FEMA policy and not in NFIP regulations or technical guidance documents.

4.4.4.4 Letters of Map Revision based on Fill (LOMR-F)

LOMR-F are a type of LOMR in which engineered fill has been placed on a site to raise the elevation above the BFE. As with LOMA, FEMA approval is based on showing a change of 0.5 foot above BFE but also requires that the community provide an acknowledgement that the applicant has met all of the floodplain management requirements, including the restriction on basements below the BFE into the fill.

4.4.4.5 Issue Analysis

Although conversion to a true digital database-driven process for creating and visualizing digital flood maps will resolve many of the issues associated with the determinations as to whether a structure is in or out of a regulated flood zone (see Section 4.4.4.1), there will still be several structures where the location of the SFHA is not certain due to small-scale distinctiveness of an area (i.e., the resolution of the final FIRM). When studies are conducted as part of Risk MAP, additional datasets are developed (e.g., depth, water surface, percent-annual-chance flood boundary, other raster datasets), creating information that could benefit property owners in their efforts to remove properties from the SFHA.

FEMA currently processes over 25,000 LOMA requests annually. Many of the newly included structures could be removed from the SFHA designation by processing mass LOMA during the final stages of the flood mapping process. While the cost to the property owner to request a LOMA is limited to the cost of the land survey, each LOMA represents considerable cost to FEMA. FEMA's direct costs of processing LOMA requests

is approximately \$7 million annually, but when adding the indirect costs associated with the FEMA Call Center, answering congressional inquiries and other written correspondence that is dominated by LOMA issues, the cost nearly doubles to \$12 to \$13 million.

When communities, States, or other Federal agencies collect LiDAR that is more accurate than the elevation data used for the flood studies and mapping, numerous properties could be removed from the SFHA. In these instances, the community usually starts requesting a new FIS and involves its congressional delegation. However, the current Risk MAP process is costly and performed on a watershed basis rather than a community or county basis, so prioritizing these FISs is difficult. The process should be changed to capitalize on the utility of the new LiDAR to remove several structures from the SFHA and providing for a mass LiDAR-based LOMA instead of multiple individual applications. The requirements and restrictions on the process would have to be developed so that critical factors such as fill would be needed.

Using a mass LOMA process would not be appropriate in all scenarios and would require additional community involvement, but it would be greatly beneficial in many areas. Much of the information needed to process a mass LiDAR-based LOMA is routinely collected and/or developed during an FIS, and the mapping partner would have most of the information readily available. For communities that have obtained new LiDAR that is more accurate than the LiDAR used during the original mapping process and also have GIS capabilities, being able to remove properties en masse would save both time and money.

FEMA has funded numerous pilot projects in recent years on mass LOMA, so implementing this recommendation should require little effort other than the development of standards and procedures. This small investment in time and effort by FEMA would result in a sizable benefit for property owners who are newly mapped into the SFHA but could easily be removed by using more detailed LiDAR and topographic evaluation.

Three Pilot Mass LOMA Projects

In 2012, the Risk Assessment, Mapping, and Planning Partners (RAMPP) team conducted a LiDAR LOMA pilot study for the San Antonio River Authority (SARA), Denton County, Texas, and Bexar County, Texas, under a FEMA Production and Technical Services contract to evaluate the feasibility of using LiDAR data to assess and remove multiple properties from an SFHA at one time. The pilot project involved developing methodologies for using LiDAR data to derive elevation data as a substitute for property owner-submitted elevation certificates. The study resulted in an 86 percent cost savings from the standard LOMA process, and FEMA concluded that the cost savings would increase if the process were adopted as a standard operating procedure.

In 2012, the Strategic Alliance for Risk Reduction (STARR) Team conducted a mass LiDAR LOMA project in Benton County and Sherburne County, Minnesota. Both counties had Effective FIRMs issued in 2011, LiDAR flown in 2011 that was not used in the creation of the Effective FIRM, digital parcel boundaries, digital building footprints, and personnel with a background in GIS. The purposes of the pilot were to (1) develop a mass LiDAR LOMA process, identify challenges and risks, and issue LOMA removal determinations, (2) develop/enhance Individualized Risk Reports, identify challenges and risks, and issue the reports, (3) train local governments on the mass LiDAR LOMA process and analyze their ability to perform the work, and (4) perform a cost analysis to determine

whether mass LiDAR LOMA is cost-effective.

In 2012, Baker AECOM conducted a LiDAR pilot for mass LOMAS in Collier County, Florida, during the mapping process. Determinations were made for 6,114 single structures for which requests would have been submitted through the standard LOMA procedures. Assuming an average unit cost of \$250 per request, the estimated cost savings was approximately \$1.5 million if LOMA determinations had been requested for all eligible properties. This pilot involved considerable outreach to local residents and coordination with FEMA, the National Flood Determination Association, and others.

4.4.4.6 Key Findings and Recommendation 13

The TMAC's key findings and a recommendation related to using LiDAR to make mass LOMA determinations are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- FISs are conducted on a watershed basis using available elevation data. In projects that are conducted on a large scale, sometimes the elevation data for the study areas do not reflect the slight undulations of land surface on all properties.
- The LOMA process provides property owners a way of amending the flood map for a property that was inadvertently mapped as being in the floodplain but is actually located above the BFE based on localized elevation data. While there is no review or processing fee for FEMA to review a LOMA request, the property owner is required to submit elevation information certified by a licensed land surveyor or registered Professional Engineer. The cost of acquiring this information is not insignificant to the property owner.
- More and more communities and regional areas are committing resources to update their elevation data (LiDAR), and as these datasets are being finalized, these communities are requesting map updates based on the new data. There is a need to process mass LOMA outside the Risk MAP process due to its scale and complexity.
- An opportunity exists during the Risk MAP process to capitalize on the additional data collected on flood depth, building footprints, and other community-supplied parcel information to remove certain structures from the floodplain as part of the mapping process.

Recommendation 13

FEMA should develop guidelines and procedures to integrate a mass LiDAR-based LOMA process into the National Flood Hazard and Risk Assessment Program. As part of this process, FEMA should also evaluate the feasibility of using parcel and building footprint data to identify eligible “out as shown” structures as an optional deliverable during the flood mapping process.

Discussion of Recommendation 13

Implementing this recommendation could greatly reduce both the burden on homeowners and the costs to FEMA for LOMC processing under the NFIP and result in a reduction in the number of congressional inquiries associated with structures newly mapped into the SFHA. Providing a way for communities to use

their own LiDAR data to make SFHA determinations would not only help provide a sense of ownership of the study results, encouraging the use of LiDAR to make SFHA determinations would also be an incentive to collect LiDAR data that could be leveraged for other studies.

One effect of this recommendation could be an increase in the number of LOMA requests that FEMA would receive. The added requests could prove costly to process if not anticipated and planned for accordingly.

Due to the potential impacts to the determination and lending industry, processing mass LiDAR-based LOMAs should be coordinated with these groups. Mapping partners and/or communities would also need to coordinate early and often with FEMA when processing any type of mass LOMAs.

**BW-12 Mandate
from Section 100215(c)**

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data; and
- (2) recommend to the Administrator mapping standards and guidelines for—
 - (A) flood insurance rate maps; and
 - (B) data accuracy, data quality, data currency, and data eligibility;

4.5 Flood Risk Assessment and Communication

Achieving risk awareness is dependent on performing accurate flood risk assessments and effectively communicating flood risk.

Without effective flood risk communication, individual, corporate and government behaviors and policies that put lives and property at risk will continue and the resources that are expended to identify the flood hazard and risk will not reduce the potential for loss of life and property damage from flooding.

Before effective flood risk communication can occur at the local level, the following factors should be considered:

- Availability of flood hazard and flood risk assessments
- Accuracy, precision, and uncertainty of flood hazard information and flood risk assessments
- Availability of structure level information for individual assessments

This section describes flood risk assessment and communication, and presents the TMAC's key findings and recommendations related to each of these topics.

4.5.1 Flood Risk Assessment

As discussed in Section 2.3.2.2, one dataset the FRD is the Flood Risk Assessment. The Flood Risk Assessment provides an analysis of potential financial consequences and other impacts associated with structures located in a SFHA. Typically, this analysis is performed using FEMA's Hazus program and requires up-to-date information on flood hazards, building asset data, and flood vulnerability functions. Hazus is a nationally applicable standardized methodology for estimating potential physical, economic, and social impacts of earthquakes, floods and hurricanes.

4.5.1.1 Issue Analysis

Currently, national Hazus results are provided to communities at a coarse national-scale (census block) using data from the 2000 census. Coarse scale risk assessment results are typically not sufficient for local planning and are not ideal for communicating flood risk to homeowners. Flood risk assessments by census block averages flood loss estimates across a large geographic area and a large numbers of structures with minimal localized data. When local structure-specific data are available, more accurate structure based flood risk assessments can be developed for individual structures.

A methodology for national flood risk assessment—with a capability for producing accurate, individual structure, flood risk estimates—should be pursued.

Local, State, and national building and tax record data, including many critical building attributes, have become increasingly available in GIS database format and distributable through web-based systems. Data sharing or data federation could greatly increase the amount of building data available to FEMA. Therefore, coordination with State and local partners would be required to achieve the objective of individual structure flood risks assessments on a national or large-area basis.

4.5.1.2 Key Findings and Recommendation 14

The TMAC's key findings and a recommendation related to structure-specific flood risk assessments are provided below and followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- Flood risk assessments with a capability for producing accurate, individual structure, flood risk estimates would more effectively communicate flood risk at the local level than a line on a map used to determine whether a structure is in or out of the SFHA.

Flood Risk Assessments

Credible flood risk assessments require three things:

- Accurate flood hazard identification
- Accurate characterization of manmade and natural assets subject to flooding
- Flood vulnerability functions, which accurately estimate economic loss based on hazard and asset information

- Developing a system that allows structure-specific risk assessment is within FEMA's resources and capabilities and could build on capabilities developed by its mapping partners, including the private sector.
- Local, State, and national building and tax record data, including many critical building attributes, have become increasingly available in GIS format and are currently being used in several Risk MAP projects. An updated methodology to accommodate structure specific risk assessments could support the areas where the structure specific data are readily available.
- Structure-based risk assessments will require coordination with various stakeholders to determine the needs of the users and to develop standards and data management processes.

Recommendation 14

FEMA, and its mapping partners including the private sector, should transition to a flood risk assessment focus that is structure specific. Where data are available, FEMA and its partners should contribute information and expertise consistent with their interests, capabilities, and resources towards this new focus:

- a) A necessary prerequisite for accurate flood risk assessments is detailed flood hazard identification, which must also be performed to advance mitigation strategies and support loss estimations for insurance rating purposes.
- b) FEMA should initiate dialogue with risk assessment stakeholders to identify potential structure-specific risk assessment products, displays, standards, and data management protocols that meet user needs.
- c) FEMA and its partners should develop guidelines, best practices, and approaches to implementing structure-specific risk assessments.

Discussion of Recommendation 14

The purpose of this recommendation is to develop an online mapping program capable of conducting structure-based risk assessments. Numerous State and local mapping partners have the data to analyze risk at the structure level. The data should be leveraged by FEMA to populate the new web-based mapping platform to provide this information to property owners and communities. The Flood Risk Information System (FRIS) used by North Carolina, Alabama, and Virginia is an excellent example of a flood mapping platform that provides structure-level risk information (FRIS, n.d.). See Figure 4-11.

This system provides the property owner with a wealth of information beyond “Am I in or out of the floodplain?” The FRIS provides information on flood depths at the property owner’s structure for various flood recurrence intervals and a dollar estimate of the damage that the flood event would cause to the structure. Being able to envision one’s home and personal property under water communicates the risk far more effectively than a line on a map. The percent chance of flooding is calculated for the structure for the current year, and 15 and 30 years out. These calculations help the property owner to move beyond the common misconceptions communicated by the term “100-year flood” and better understand their probability of experiencing flooding.

A better understanding of flood hazard and individual flood risk will result in property owners and local governments taking action to reduce the risk. The FRIS provides the property owner with an estimate of the benefits and costs of a range of common flood mitigation actions. Some of the mitigation actions evaluated include elevating the structure, relocating the structure, implementing dry and wet flood proofing, and elevating utilities.

BW-12 Mandate

Pub. Law 112-141, Section 100215(c)

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data; and
 - (B) performance metrics and milestones required to effectively and efficiently map flood risk areas in the United States;
- (3) recommend to the Administrator how to maintain, on an ongoing basis, flood insurance rate maps and flood risk identification;

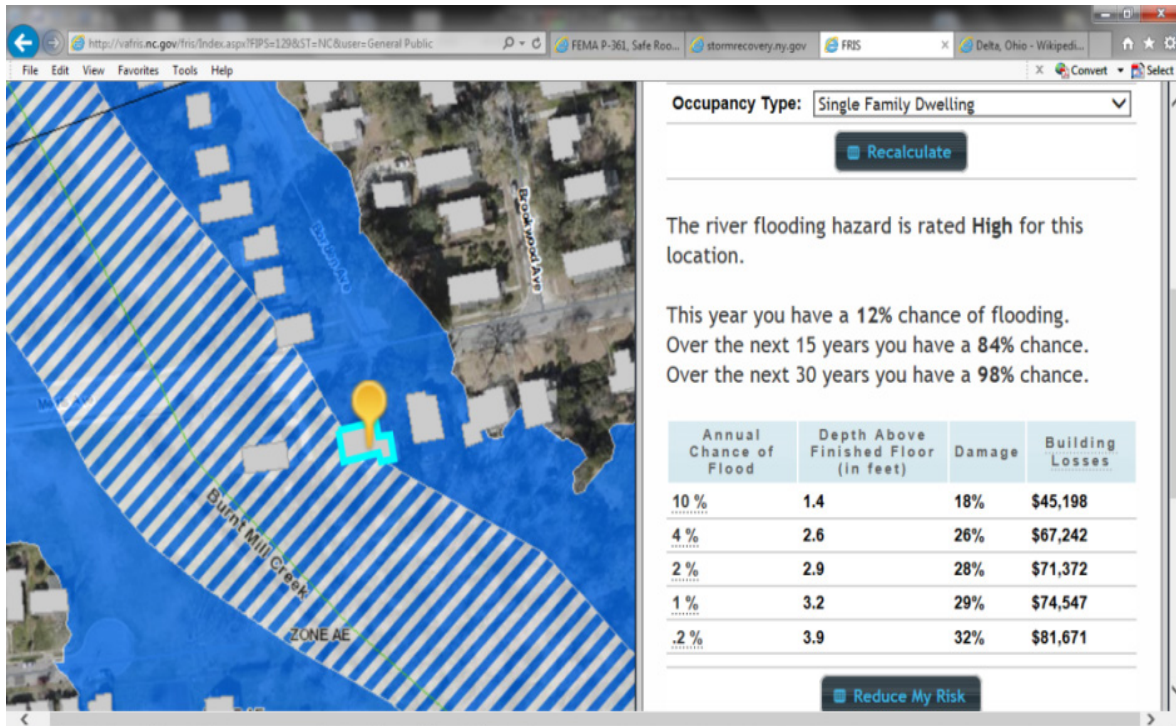


Figure 4-11: North Carolina’s FRIS provides risk information at the structure level

The FRIS compares the estimated cost of each mitigation action to the future losses avoided and generates a ratio of the cost to the benefit. These data can be used by the property owner to begin exploring possible mitigation action alternatives. In this regard, the NRC recently issued a report that concluded that the NFIP can strive for risk-based premiums to encourage investment in loss reduction measures while addressing affordability by implementing a combination of policy measures, including means-tested mitigation grants, mitigation loans, vouchers, and encouragement of higher premium reductions (NRC, 2015a).

Moving towards assessing flood risk at the individual structure level would also assist communities in developing local hazard mitigation plans and result in more accurate flood risk analyses in the community. Standardizing a structure-based risk assessment methodology would also make it easier for States to meet the requirement to provide an overview and analysis of potential losses to vulnerable structures based on estimates provided in local risk assessments (44 CFR 201.4(c)(2)(ii)).

Providing flood hazard and risk assessment at the structure level would greatly enhance the public’s understanding of flood risk, improve flood risk assessments in local hazard mitigation plans, and lead to better land use decisions at the local level. The increased level of precision of providing flood risk information for individual structures may also be useful for adding confidence to policy holders, given their insurance rating is based on more detailed, localized data.

FEMA should create an online tool to capture and display structure-level risk assessment data and use the Risk MAP program to encourage communities to provide/develop data to populate the online tool. As the result of Map Mod, highly populated areas were targeted for the development of detailed mapping (flood profiles containing multiple recurrence intervals). These areas also tend to have detailed data at the structure level (e.g., location, building foundation type, structure value). The Risk MAP Discovery process is one coordination point FEMA should use to seek and leverage this information from mapping partners to

populate the online risk assessment tool. Incentives should be developed in the CRS to reward communities for sharing/developing and maintaining the data.

4.5.2 Flood Risk Communication

Effective communication about flood hazard and risk is integral to flood risk management (Faulkner et al., 2011). The results of a study by the NRC in 2013 on implementing flood risk management strategies are as follows:

- Part of formulating flood risk management strategies is developing ways to communicate with the public about flood risk, but efforts to communicate information about flood risk face many challenges. For example, the meaning of the “100-year” floodplain is often misunderstood. Moreover, even if people are aware of risk, they do not always act to reduce it. People often assume that flood control structures such as levees are always effective and that they personally do not need to take additional actions to mitigate risk.
- Effectively communicating flood risk is an important FEMA goal and a key ingredient in the FEMA Risk MAP process and its engagement components. Risk MAP provides the opportunity for touch points throughout the process with community decision-makers, stakeholders, and the public when risks are discussed. Under the Risk MAP program, FEMA has begun to evolve new products that communicate flood risk more clearly by juxtaposing the flood hazard with the community-specific vulnerabilities. This evolution allows FEMA to underscore the benefits of risk identification and its role in informing mitigation planning and decision-making that leads to positive action by the community.
- To be effective, risk communication efforts:
 - Are delivered at the local level
 - Are tailored to individual households, communities, and other stakeholders
 - Are delivered from a credible and trusted source
 - Are long-term
 - Have consistent, clear, and non-conflicting content
 - Encourage and motivate some behavior
 - Account for the values of target audiences or communities
 - Use various modes of communication
 - Provide repeat messaging (NRC, 2013)

4.5.2.1 Issue Analysis

FEMA and other Federal, State, and local organizations that communicate flood risk should incorporate the risk communication principles outlined in the 2013 NRC study into their strategies. A single Federal message that uses consistent terminology, transparent data, and open discussion about flood risk is critical to informing the affected communities that, in turn, communicate and manage risk at the local level. FEMA should assume a leadership role in providing direction for research, development, and release of flood risk communication products and maps.

The TMAC supports the concepts and recommendation in the 2013 NRC study, but also believes FEMA needs to expand on its recommendations. As Faulkner et al. (2011) point out, for example, effective flood risk communication also involves complex information flows among many various professionals, governmental and non-governmental agencies, public utilities, the media, and the general public. Furthermore, the emergence of social media requires adopting new communication strategies.

The TMAC agrees that it will be important to frame and communicate messages to stakeholders so they understand flood risk in terms of their values and needs, thus enabling them to incorporate flood risk into their decision making process. Messages complemented with economic incentives may lead individuals to undertake cost-effective risk reduction measures.

4.5.2.2 Key Findings and Recommendation 15

The TMAC's key findings and a recommendation related to communicating flood risk are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- Transitioning to a structure-specific depiction of flood hazard and flood risk would greatly help FEMA with communicating flood hazard and flood risk beyond the "in-or-out" type of discussions, but a structure-specific depiction is only the technical portion of communicating flood risk.
- An open dialogue about flood risk beyond the requirements for flood insurance is needed.
- The public needs to understand flood risk in terms of their individual needs and priorities. If homeowners fully understand their risk, they will be in a better position to decide if they should allocate their limited resources to mitigating or reducing this risk.

Recommendation 15

FEMA should leverage opportunities to frame and communicate messages to stakeholders in communities so they understand the importance of addressing the flood risk today and consider long-term resilience strategies. Messages should be complemented by economic incentives such as low-interest loans and mitigation grants that lead community leaders and individuals to undertake cost-effective risk reduction measures.

Discussion of Recommendation 15

In communicating flood risk to residents and property owners, the message should focus on how flood risk affects them, their responsibilities, and ways they could reduce the risk to their lives and property. When faced with deciding whether to invest in flood loss reduction measures, property owners need information they can understand to be able to weigh their options.

Residents in hazard-prone areas often ignore the flood risk until after suffering losses from a disaster. Many discount the 100-year flood event as impossibly far away or unlikely, so discussion of even larger but less frequent events such as the 500-year flood may be even less psychologically effective in conveying the likelihood of a future disaster.

Following are actions FEMA could take to encourage residents to consider their risk more carefully:

- FEMA could consider stretching the time horizon in presenting information on the likelihood of a flood occurring by indicating, for example, that the chances of one or more 100-year floods occurring in a 25-year period is greater than 1 in 5.
- FEMA could better communicate the personal loss and property damage caused by flooding and encourage property owners to take actions such as investing in mitigation and purchasing insurance to reduce the flood risk to their households and assist them if they suffer damage from a future flood.
- Individuals are reluctant to invest in loss reduction measures because of the high upfront costs and budget constraints. FEMA mitigation grants and long-term loans could spread the cost of the measure over the life of the property to make these measures affordable. The grants and loans could promote individual and community safety and resilience and reduce taxpayer dollars spent on disaster response and recovery, as discussed in Section 4.1.1.6 (Mitigation).

BW-12 Mandate
Pub. Law 112-141, Section 100215(c)

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data; and
- (3) recommend to the Administrator how to maintain, on an ongoing basis, flood insurance rate maps and flood risk identification;

4.6 Data Distribution and Management

The current information environment in the United States is rooted in digital exchanges, with technological advances allowing ever simpler and faster data sharing and enhancement. The vast and varied array of floodplain data users—community officials, engineers, surveyors, emergency responders, property owners, flood insurance agents, realtors, and appraisers—rarely experience restricted computer access and/or limited digital information exchanges. Technical data users expect information to be readily available and accessible, and both technical and non-technical users increasingly rely on the Internet to learn more about flood hazards and flood risks on their own. Flood hazard and flood risk data should be readily available to both satisfy the critical needs of the technical world and serve as community information and outreach for everyone.

FEMA provides flood mapping and hazard information and data using a number of platforms and source data, but not all data are available in all formats or on all platforms. This leads to user confusion, data fragmentation, and inconsistencies between data sources. NFIP data need to be consistent, fully documented, and readily available. Flood hazard and flood risk data depend on spatial relationships, and the data must therefore be georeferenced for integration and display in the digital environment. Cost-effective and efficient dissemination of flood hazard and flood risk data necessitates the transition to a fully georeferenced, relational digital format for all data, nationwide.

This section describes current NFIP products, distribution mechanisms for the program data, and data management. Considerations related to moving toward a fully digital environment are presented, along with the TMAC’s key findings and recommendations related to these topics.

4.6.1 Current Program Data Distribution Mechanisms

FEMA's mechanisms for distributing NFIP-related data include the Map Service Center (MSC), MIP, FEMA GeoPortal, and Flood Risk Study Engineering Library (FRiSEL). The mechanisms are described in the following subsections.

4.6.1.1 Map Service Center

FEMA's MSC is the authoritative source of flood hazard information produced under the NFIP. MSC products include Effective regulatory maps, studies, and geodatabases that are used for official legal determinations under the NFIP, as well as regulatory products with different statuses, such as Preliminary, Pending, or Historical. The MSC also hosts flood risk products (non-regulatory products) if available for a given community. However, there are limitations on some of the flood risk products stored. For example, there is no central location (platform) for storing Hazus analyses.

Products may be downloaded for free from the MSC. Effective FIRM map panels may be selected from a list or via an interactive map interface. FIRM panels may be viewed and downloaded in whole or in part from the MSC. The FIRM panels show the date the panel became Effective; updates are not incorporated. However, through the MSC, LOMCs are listed for each panel. The user must download all relevant information and piece together the currently Effective data because LOMCs are not named or geocoded in a manner to easily identify which portions of the FIRM panel they affect.

4.6.1.2 Mapping Information Platform

The MIP, primarily directed at mapping contractors and requiring credentials to log in to access most resources, provides tools and technology for digital flood map production. FEMA mapping partners can create, validate, store, track, and update digital flood data using the MIP workflow process.

The NFHL is also available through the MIP. The NFHL is regularly updated to reflect LOMRs but not LOMAs LOMR-Fs. See Section 4.4.4 for information about flood map revisions.

The MIP provides links to display the NFHL in Google Earth as well as to access GIS web services for display in GIS mobile, desktop, and web applications. Data may not be downloaded when viewed from these services, and because it is often difficult to evaluate whether the base map specifications for horizontal control are consistent with 1:12,000-scale mapping, information from many of these viewers may not be considered authoritative.

FEMA provides two means to view the NFHL in Google Earth:

- "Stay Dry" – Provides a simplified, subset of the NFHL for display of basic flood hazard map information, including flood hazard zones and FIRM numbers and boundaries.
- FEMA NFHL – Provides for the display of flood hazard zones and labels; floodways; Coastal Barrier Resources System and otherwise protected area units; community boundaries and names; BFEs; cross sections, coastal transects, and their labels; hydraulic and flood control structures; flood profile baselines; coastal transect baselines; LiMWA action lines; river mile markers; and FIRM and LOMR boundaries and numbers. Additional reference layers include the status of NFHL data availability and point locations for LOMAs and LOMR-Fs.

The NFHL GIS web services that are available through the MIP may be viewed in mobile, desktop, and web-based GIS applications capable of displaying ArcGIS REST, OGC Web Mapping Services, and OGC Web Feature Services.

Figure 4-12 illustrates how the base map and display of the NFHL can affect the decisions made about the degree of flood hazard for a particular building. These images use the same NFHL source, but the cartographic base maps or the way in which the NFHL is displayed is different. Since a map can only be as accurate at the least accurate layer, when flood zone determinations are based on visual inspection of a paper or digital maps, the quality of the cartographic base map or the line work depicting the NFHL on the map determines the horizontal accuracy of the flood zone determination. In most cases, however, users do not have access to the information needed to assess the accuracy of the determination. Likewise, when flood zone determinations are made in a wholly digital environment, the horizontal, absolute, and relative accuracy of layers drive the overall accuracy of the flood zone determination, rather than the accuracy of the NFHL itself. The TMAC intends to take up this issue in FY16.

4.6.1.3 FEMA GeoPlatform

The NFHL is also available through FEMA's GeoPlatform, an ArcGIS Online portal containing a variety of FEMA-related products. The GeoPlatform allows users to view and download the NFHL, LOMAs, and LOMRs. TIF or PNG images of FIRM panels may also be downloaded by clicking a location on the map. FEMA considers the GeoPlatform an authoritative source of flood hazard determinations when NFHL data are overlaid on a base map that meets or exceeds specifications for horizontal control consistent with 1:12,000-scale mapping. USGS base map data and services are available that meet this standard.

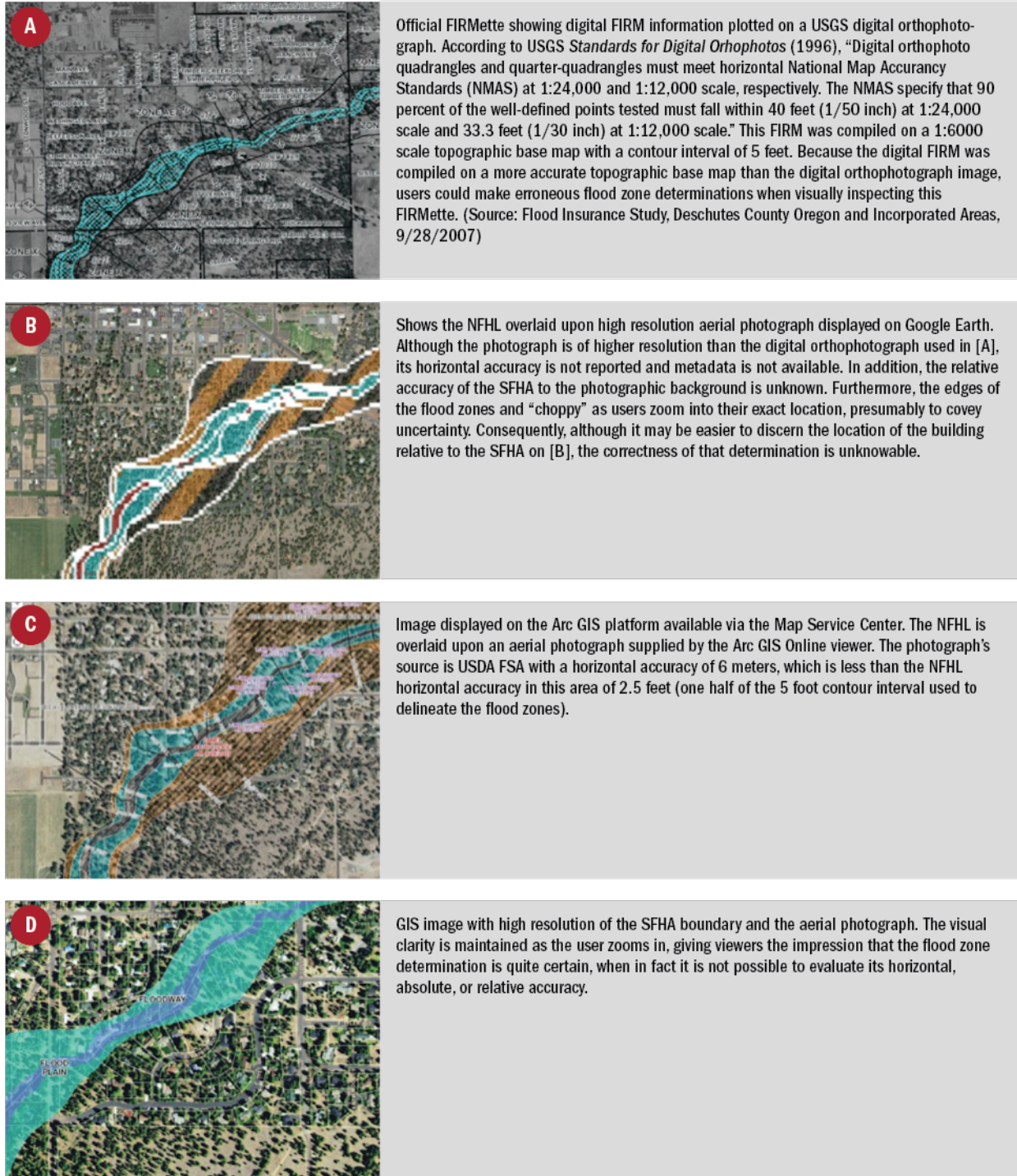
The web-based NFHL viewer available through the GeoPlatform is continuously updated as LOMRs become Effective. FEMA provides new releases of the NFHL dataset monthly.

Unlike the MSC, Preliminary and Historic products are not viewable on the GeoPlatform.

4.6.1.4 Flood Risk Study Engineering Library

Core data and H&H models are submitted to FEMA through the FRiSEL, which is an online search portal used to access engineering and FIS data uploaded to the MIP. The search is based on key words and search results are displayed 10 to a page, sorted by date, with the most recent upload listed first. The user must review the individual documents to ensure that they apply to desired flooding source and location. The information is not linked spatially to the stream or coastal reach.

Legacy data and models that had been archived as paper records are being scanned and currently are accessed through the FEMA Engineering Library managed by the Customer and Data Services Contractor. After the paper record scanning process has been completed, these records will be migrated to the FRiSEL. All digital data and models have been consolidated into the FRiSEL. Authenticated MIP users are able to search and download data through the FRiSEL. Users without download access to FRiSEL, or who are seeking older records not in the FRiSEL, must manually request records through the FEMA Engineering Library. Since this search and retrieval method requires third-party input and handling, searches are not instantaneous and can take days or weeks to fulfill.



Images A-D show the same general area in the City of Sisters, Deschutes County, Oregon.

Figure 4-12: Example of how different products and data display mechanisms affect the cartographic base map and the decisions that are made about the intersection of flood hazards and the built environment (FEMA, 2007b)

4.6.2 Data Management

The FEMA Geospatial Data Coordination Policy and accompanying Geospatial Data Coordination Implementation Guide established the principles for coordinating, communicating, documenting, and reporting existing and proposed geospatial data that are collected, produced, or manipulated under the FEMA Risk MAP program.

The goals of the policy are to help ensure FEMA will:

- Protect its investments in geospatial data by requiring data to be documented, comply to standards, and be easily accessible to the general public
- Maximize the use of partnerships, including Federal, State, tribal, and local partners, for the acquisition and production of geospatial data
- Minimize duplicative requests from Federal agencies to State and local data stewards and use existing data when possible
- Recognize the value of existing coordination efforts at the State and local levels
- Comply with all Federal requirements for coordination and reporting of geospatial activities.

Toward those goals, FEMA develops State Geospatial Coordination Standard Operating Procedures produced for each State and Territory that contain key contacts and identify the most recent GIS data (e.g., topography, political layers, streams) that should be used for developing FIRMs and other FEMA products.

Additionally, State GIS clearinghouses and local government data sources often discoverable through the National States Geographic Information Council (NSGIC) GIS Inventory¹⁵ are used for developing FIRMs and other FEMA products. Locally produced data have the most temporal relevancy and highest resolution to ensure users have the best available data. FEMA should continue to leverage State spatial data infrastructures and local data to support flood mapping.

To find available topographic data, FEMA uses the U.S. Interagency Elevation Inventory (USIEI), which is managed by NOAA and USGS and supported by FEMA, U.S. Department of Agriculture (USDA), and USACE. The USIEI provides a comprehensive listing of known topography data and its attribution. The USIEI supports 3DEP, which was developed to respond to growing needs for high-quality topographic data.

4.6.3 Issue Analysis

Professionals and the public are increasingly using technology to access information via the Internet and mobile applications to access rapid and efficient search engines and map viewers. Industry continues to develop tools to display integrated spatial data; many of these tools can be accessed via the Internet. Flood hazard and flood risk data should be managed and disseminated using industry standard protocols and web services to allow for ready integration with other data. Fully georeferenced, relational NFIP data can be integrated with other national datasets, helping to serve the needs of various users.

Currently NFIP data are fragmented across products and access points. Core data and models are not linked directly to stream or coastal reaches. Research is needed to identify the data and models for a particular area

¹⁵ <http://gisinventory.net>

of interest. For example, images of all LOMCs can be called up by case number, selected from a list displayed with the Effective map panel on the MSC, or accessed on the GeoPlatform. However, the user must know how to access multiple sources of data to have a complete Effective set of data because interfaces are disjointed and not intuitive.

Limited search engines and a lack of geospatial linkages limit the ability to retrieve information, raise concerns that complete and current information has been accessed, and are not efficient. Furthermore, flood hazard data for much of the nation are still in paper formats (or scanned images). The first step to efficiently manage the NFIP data is to complete the task of preparing fully georeferenced digital data for all flood hazards. Fully georeferenced, relational digital data facilitate rapid searching and dissemination of appropriately linked and coded current and historical data, resulting in time and cost savings. Employment of relational geodata bases allows for linking documentation and can effectively assist in the capture of technical rationale and management decisions, creating transparency for stakeholders at all levels.

Modern FEMA studies have multiple final deliverables: FISs, FIRM panels, digital FIRM DBs, Technical Support Data Notebook, NFHL, and various MIP uploads and QC submittals. Production of the individual products are completed from key common data and each require a significant amount of labor to create and are largely template based, repeated data. This process needs to be examined for efficiencies gained in a fully digital, relational database environment.

4.6.4 Key Findings and Recommendation 16

The TMAC's key findings and a recommendation related to distribution and management are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- Digital exchanges have already broadened the distribution of information throughout the NFIP. Detailed policy guidance is sent to flood insurance agents, and design professionals have the ability to submit applications for map changes online. However, more is possible. The TMAC sees a fully digital environment as a means of achieving the following goals:
 - Time- and cost-efficient generation and process management of flood hazard and risk data, models, assessments, and displays.
 - Effective use of efficient technologies for acquisition, storage, generation, display, and communication of data, models, displays, and risk.
 - Integrated flood risk management framework of hazard identification, risk assessment, mitigation, and monitoring.
- Flood hazard and risk assessment data are currently maintained on an array of platforms and formats. Transitioning to a fully georeferenced, relational digital format for all data would be a cost-efficient method providing easily accessible data to all floodplain data users: community officials, engineers, surveyors, emergency responders, property owners, flood insurance agents, realtors, and appraisers.
- The public and other agencies are increasingly using NFIP data for a variety of non-floodplain management purposes, and these users need data that are easily searchable and can be linked to other datasets. The data are currently stored across multiple platforms and lack common linkages that are

needed to meet the needs of the expanding user groups. The development of a fully digital environment would provide an opportunity for broader sharing of current and historical NFIP data to other stakeholders while expanding the services to meet local community needs by providing a mechanism for uploading community-supplied data, such as jurisdictional boundaries.

- Flood hazard and flood risk data should be managed and disseminated using industry standard protocols and web services to allow for ready integration with other data.

Recommendation 16

FEMA should transition from the current panel-based cartographic limitations of managing paper maps and studies to manage NFIP data to a database-derived, digital-display environment that are fully georeferenced and relational, enabling a single digital authoritative source of information and database-driven displays. Towards this transition, FEMA should:

- a) Prepare a multi-year transition plan to strategically transition all current cartographic and/or scanned image data to a fully georeferenced, enterprise relational database.
- b) Update required information for map revisions (MT-2 forms) and LOMC applications to ensure accurate geospatial references, sufficient data to populate databases, and linkages to existing Effective data.
- c) Adopt progressive data management approaches to disseminate information collected and produced during the study and revision process, including LOMCs.
- d) Ensure that the data management approach described in (c) is sufficiently flexible to allow efficient integration, upload, and dissemination of NFIP and stakeholder data (e.g., mitigation and insurance data that are created and maintained by other Federal agencies), and serve as the foundation for creating all digital display and mapping products.
- e) Provide a mechanism for communities to readily upload jurisdictional boundary data, consistent with requirements to participate in the NFIP, as revised, allowing other stakeholders access.

Discussion of Recommendation 16

The digital environment offers many advantages for keeping flood data current. LOMCs provided to communities as GIS data offer a direct means of incorporating the information into their own systems of flood mapping rather than having to scan the paper copies currently provided. The resulting database and displays should answer needs beyond the strict confines of NFIP, such as for local zoning, planning, and other State and local regulations related to, but not legislatively part of, the NFIP.

The timeliness of data and product availability are critical to the ability to manage flood hazards and flood risks. As one example, the ability to process an

BW-12 Mandate from Section 100215(c)

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data; and
- (2) recommend to the Administrator mapping standards and guidelines for—
 - (A) flood insurance rate maps; and
 - (B) data accuracy, data quality, data currency, and data eligibility;

online electronic LOMA (eLOMA) instantaneously does not include simultaneous community notice of the change to its FIRMs. Thus, the coordination of digital data availability and distribution directly affects community floodplain management and welfare.

While the possibilities for cost savings in data acquisition, analysis, dissemination, and storage are clear in the long term, the immediate costs to transition to a fully digital environment are far from negligible. States, local, and tribal communities can begin to prepare their documents and data to be integrated into a seamless national system if fully informed of the incremental steps required to reach this goal. FEMA should establish guidelines and provide appropriate technical assistance relating to sequencing/phasing in of processes and changes that will facilitate integration of data, QA review of the data and of the means of accessing the data, and determining how to preserve data in future transitions related to software and hardware.

4.7 Federal Partner Collaboration

Developing a FEMA FIS requires a variety of datasets, analytical methodologies, models, H&H studies, and other types of information. Although FEMA CTPs develop FISs and/or Risk MAP projects for specific States and communities, most of the underlying information is collected by Federal agencies. Unfortunately, the flood mapping process is so broad that those involved in map production are often unaware of the importance of some critical datasets, and, conversely, the agencies that provide information are often unaware of FEMA's need for specific data, notifications, or documentation. In addition, agencies generally produce information to meet their own objectives, and that data are subject to agency collection and sharing policies and legalities.

Various coordination councils and groups within the Federal establishment and across various thematic areas could be used more effectively to improve the flow of information needed for FISs. Improving the coordination and delivery of the information could improve the workflow, reduce costs, and reduce the time needed to develop the maps.

Section 4.7 summarizes and reviews recommendations provided by the National Academy of Public Administration (NAPA) report on interagency and intergovernmental coordination in flood mapping (NAPA, 2013), which describes the existing national datasets and other data coordination activities and organizations that FEMA could leverage, and presents the TMAC's key findings and recommendations related to these topics.

4.7.1 National Academy of Public Administration's Key Findings and Recommendations

FEMA was directed by BW-12 to contract with NAPA to prepare a report on "how FEMA should improve interagency and intergovernmental coordination on flood mapping, including a funding strategy" and how FEMA "can establish joint funding mechanisms with other Federal, State, and local governments to share the collection and utilization of data among all governmental users" (NAPA, n.d.-a). In 2013, NAPA formed a panel of experts to investigate these issues and in 2013, issued *FEMA Flood Mapping: Enhancing Coordination to Maximize Performance* (NAPA, 2013).

The panel found that while FEMA has made progress on coordination in flood mapping since the initiation of Risk MAP, FEMA should enhance these efforts. NAPA recommendations for improving coordination may be summarized as follows:

- Increase the leadership's attention to strategic goals and the communication of the goals
- Use employee performance policies and metrics consistently
- Deploy more user-friendly websites
- Transfer best practices among the 10 FEMA Regions
- Convey risk information to localities

Other recommendations relate to best practices in the establishment of funding strategies and joint funding mechanisms. The panel found that the FEMA's flood mapping efforts and other Federal Government mapping activities could be advanced by a Government-wide strategy in multi-purpose mapping capabilities. This strategy can be used to drive investments. The panel also recommended that the OMB work with FEMA and its major partners to use the budget crosscut required by BW-12 to drive more strategic operational and funding coordination.

NAPA (2013) provides the following recommendations on interagency and intergovernmental coordination:

- **Recommendation 6:** FEMA should assess and prioritize its participation in interagency and intergovernmental coordination bodies in support of Risk MAP to ensure that opportunities are not being missed, appropriate staff are participating, and the appropriate amount of resources are being expended. FEMA should also review the work of interagency and intergovernmental coordination bodies and consider proposing changes to these bodies in support of Risk MAP objectives (NAPA, 2013, p. 10).
- **Recommendation 7:** FEMA should identify interagency and intergovernmental partnerships that would benefit from formalizing a well-defined opportunity for coordination (NAPA, 2013, p. 11).
- **Recommendation 8:** FEMA should continue to explore and develop shared technologies to facilitate interagency coordination and avoid duplication of effort (NAPA, 2013, p. 11).
- **Recommendation 9:** FEMA should coordinate with other federal, state, and local agencies to leverage their unique experience and competencies to improve Risk MAP products and services and to understand how they could more broadly support other agencies' missions (NAPA, 2013, p. 11).
- **Recommendation 13:** The Office of Management and Budget (OMB) should work with the core group of Federal agencies that have flood mapping-related mission responsibilities to develop a government-wide strategy for advancing multi-purpose mapping capabilities that will increase the efficiency and effectiveness of flood mapping, among other benefits. This strategy should be used to guide investments. To implement this recommendation, OMB should:
 - Convene a meeting of FEMA and its partner agencies to obtain broad input on multiagency mapping priorities, appropriate categorization to ensure flood mapping focus is consistent, and to discuss possible approaches to an improved government wide strategic planning and funding process. The FIFM-TF [Federal Interagency Floodplain Management Task Force] or the federal participants in the TMAC might provide an appropriate venue for such a meeting and assist with the development of the strategy.
 - Work with FEMA and the TMAC to identify multi-purpose mapping capabilities that would do the most to advance the efficiency and effectiveness of flood mapping.
 - Link the strategic planning process to future iterations of the flood risk budget crosscut.
 - Name a senior level individual, preferably at the level of Program Associate Director or above, to lead the development of the strategy and the budget crosscut in order to ensure interagency focus and quality results (NAPA, 2013, p. 86).

- **Recommendation 15:** The Office of Management and Budget should use the 3DEP implementation plan for nationwide elevation data collection to guide the development of the President’s annual budget request. To implement this recommendation, OMB should:
 - Work with USGS and other agencies to define joint funding mechanisms to support the 3DEP implementation plan (NAPA, 2013, p. 87).

4.7.1.1 Issue Analysis

The NAPA recommendations involve FEMA (and the OMB), but a larger issue is the coordination of geospatial and H&H data across Federal, State, local, and tribal organizations. The challenge of coordinating acquisition, development, management of geospatial data has been documented in two GAO reports:

- *Geospatial Data: Progress Needed on Identifying Expenditures, Building and Utilizing a Data Infrastructure, and Reducing Duplicative Efforts*, GAO 15-193 (2015)
- *Geospatial Information: OMB and Agencies Can Reduce Duplication by Making Coordination a Priority*, GAO 14-226T (2013)

The NAPA recommendations are a good start, but more work needs to be done to develop workable mechanisms to facilitate the coordination and ultimate repurposing of program-specific data to support flood mapping.

FEMA has made progress on implementing the NAPA report recommendations. The coordination of H&H data is especially challenging because many agencies at all levels of Government regularly develop H&H models, but the potential gain in efficiencies could be substantial if these models were standardized, cataloged, and shared. The following could improve the efficiency of flood mapping studies:

- Using geospatial tools and embedding consistent labeling nomenclature to reference cross-sectional data and other hydraulic model features
- Making public the hydraulic models maintained by FEMA, USACE, NWS, and others and creating a portal to access these datasets

Collaboration with the following organizations could assist in the effort:

- Integrated Water Resources Science and Services (IWRSS) consortium (<http://www.hec.usace.army.mil/misc/IWRSS/>)
- National Science Foundation Consortium of Universities for the Advancement of Hydrologic Sciences, Inc. (CUAHSI) (<https://www.cuahsi.org>)
- Various intergovernmental coordination agencies, such as the Advisory Committee on Water Information (ACWI) and Subcommittee on Hydrology (<http://acwi.gov/hydrology/>)

4.7.1.2 Key Findings and Recommendation 17

The TMAC’s key findings and a recommendation related to interagency and intergovernmental coordination are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- NAPA (2013) provides several recommendations on interagency and intergovernmental coordination.
- Sharing geospatial and H&H data across Federal, State, local, and tribal organizations is an issue that transcends FEMA. Effectively using high-resolution data generated locally to complement national data sets is a massive coordination effort and difficult to manage nationwide.
- NAPA (2013) recommendations are a good start, but more work needs to be done to develop workable mechanisms to facilitate the coordination and ultimate repurposing of program-specific data to support flood mapping.

Recommendation 17

FEMA should consider National Academy of Public Administration recommendations on agency cooperation and federation (6, 7, 8, 9, 13, and 15) and use them to develop more detailed interagency and intergovernmental recommendations on data and program-related activities that can be more effectively leveraged in support of flood mapping.

Discussion of Recommendation 17

The TMAC may use the NAPA (2013) recommendations to develop more detailed intergovernmental and interagency coordination recommendations for the TMAC 2016 Annual Report, looking at the alignment of geospatial and H&H data being generated by specific agency programs across Federal agencies with flood mapping missions. Of the two, coordination and standardization of H&H data have received less attention and will prove the more difficult. However, interagency consortiums, such as IWRSS and CUAHSI, have the potential to lead the effort to make progress on the issue and improve the efficiency of flood mapping studies.

BW-12 Mandate

Pub. Law 112-141, Section 100215(c)

The Council shall —

- (5) recommend to the Administrator and other Federal agencies participating in the Council—
 - (A) methods for improving interagency and intergovernmental coordination on flood mapping and flood risk determination;

4.7.2 Leveraging Existing National Datasets and Coordination Bodies

Numerous national datasets could be leveraged to support more efficient flood mapping. Similarly, numerous existing coordination bodies at the Federal level could be leveraged to help manage and standardize data to support efficient flood mapping.

4.7.2.1 National Datasets

Traditional geospatial datasets are well known, consolidated, and relatively static and therefore generally have broad mobility and applicability. Broad recommendations about these datasets are included in Section 4.7.2.3. H&H datasets are dynamic, are often collected for specific purposes and model applications, are hard to work with (because of what they represent), and are fragmented across agencies and agency projects in terms of indexing and storage, and lack standardization. However, H&H datasets are critical to characterizing the flood hazard, mapping the floodplain, and assessing flood risk.

The source dataset and the primary source agencies for the major datasets, models, and methods that are needed to produce flood hazards maps are listed in Table 4-7. The data and other types of information

needed to support flood mapping are highly varied, and the sources are discrete and driven by disparate but reconcilable missions. Some sources focus on long-term planning and risk-based products while others provide real-time data event-based products.

Table 4-7: Types of Data Used in Flood Mapping, Source Datasets, and Source Agencies

Data Type	Source Datasets	Source Agencies
Meteorological	National Hydrologic Atlases (rainfall-depth-duration-frequency tables)	NOAA
Elevation (topography) and hydrography	3DEP Elevation Products	USGS (NGP), NOAA, FEMA, USACE, NASA, USDA, State, and local
	National Hydrography Database-Plus Watershed Boundary Dataset	USGS (NGP)
Mapping	Jurisdictional boundaries and roads	NOAA, Census, State and local
	Coastal Barrier Resources System Boundaries	USFWS
Hydraulic	National Inventory of Dams	USACE
	Water-surface models	FEMA, USACE, USGS, NRCS, TVA
	Flood-inundation maps	USACE, NOAA, USGS
	USGS annual peak flow time series	USGS
	USACE annual peak flow time series	USACE
	<ul style="list-style-type: none"> Flood-frequency computations USGS StreamStats 	USGS, USACE, USBR, NRC, FERC, FHWA, FEMA
Hydrological	<ul style="list-style-type: none"> Statewide flood-frequency regressions USGS StreamStats and NSS 	USGS
	Rainfall-runoff models	FEMA, USACE, USGS, TVA, USBR

3DEP = 3D Elevation Program
 FEMA = Federal Emergency Management Agency
 FERC = Federal Energy Regulatory Commission
 FHWA = Federal Highway Administration
 NASA = National Aeronautics and Space Administration
 NGP = National Geospatial-Intelligence Agency Program
 NOAA = National Oceanic and Atmospheric Administration
 NRC = National Research Council
 NRCS = Natural Resources Conservation Service

NRCS = Natural Resources Conservation Service
 NSS = National Streamflow Statistics
 TVA = Tennessee Valley Authority
 USACE = U.S. Army Corps of Engineers
 USBR = U.S. Bureau of Reclamation
 USDA = U.S. Department of Agriculture
 USFWS = U.S. Fish and Wildlife Service
 USGS = U.S. Geological Survey

The USGS NHD and Watershed Boundary Dataset (WBD) are used to portray surface water on The National Map (USGS, 2015d). The NHD represents the drainage network with features such as rivers, streams, canals, lakes, ponds, coastline, dams, and streamgages. The WBD represents drainage basins such as enclosed areas that are divided into eight categories based on size. Consistency across watershed studies is improved when national datasets are used. However, scale and resolution, particularly with the NHD, have proven to be problematic in flood mapping, and local hydrology data are often used over this national dataset.

Increasing the Availability of Flood Data for FEMA Mapping

USGS streamflow data play a pivotal role in FEMA flood mapping. For FEMA riverine flood hazard maps:

- Approximately 25 percent is based on direct analysis of USGS flood-peak data for gaged locations
- Approximately 25 percent is based on USGS regional regression equations that relate USGS flood frequencies of gaged streams to their basin characteristics to extend flood-frequency estimation to ungaged streams
- An unknown but significant percentage is based on rainfall-runoff models that are calibrated against USGS flood-peak data

The quality of a flood-frequency estimate depends on the length of the peak-flow record and the precision, accuracy, and representativeness of the flood observations. In turn, the precision and accuracy of a flood-record depend primarily on the stability of the stage-discharge rating (and by inference the stability of the stream channel) and the number and range of streamflow measurements used to construct the rating. Most ratings must be extended if flood data are to be obtained for major floods, but direct streamflow measurements made during floods (Turnipseed and Sauer, 2010) and forensic reconstructions immediately after floods (Benson and Dalrymple, 1967) can be used to minimize the extension and thereby improve the accuracy of the flood data.

The USGS has compiled the dates and magnitudes of approximately 750,000 flood-peak flows at more than 24,000 gaged streams. However, Bulletin #17B guidelines (USGS, 1981) suggest that 10 or more flood observations are needed to compute a flood frequency, but accurate estimates of large floods, such as the 1-percent-chance flood, require more observations. Only approximately two thirds of USGS flood records include 10 or more observations, approximately one third include more than 25 observations, and approximately 10 percent include 50 observations or more.

Determining Water Levels along the Coasts and Great Lakes

The NOAA National Water Level Observation Network (NWLON) is the foundation of a comprehensive system for observing, communicating, and assessing the impact of changing ocean and Great Lake water levels nationwide, including the Territories. NWLON consists of 210 long-term, continuously operating water level stations (tide/water level gages) and is considered the primary source of water-level data for commercial sector navigation, recreation, and coastal ecosystem management.

The NWLON also provides the national standards for tide and water level reference datums used in nautical charting, coastal engineering, international treaty regulation, and boundary determination. Originally established to support safe navigation through tide predictions and nautical charts, the gage network now contributes to NOAA's forecast models, which provide tsunami and storm surge warnings.

The NWLON provides historical as well as present-day water level information. For example, long-term records from the NWLON are used to compute local relative sea-level trends and to help understand the patterns of high-tide events and extreme water levels from storm events. Historical data from NOAA tide gages are used to verify storm surge modeling for FEMA coastal flood insurance studies and for developing return periods. Sea-level trend information is used to develop local relative sea level trends and future sea level projections.

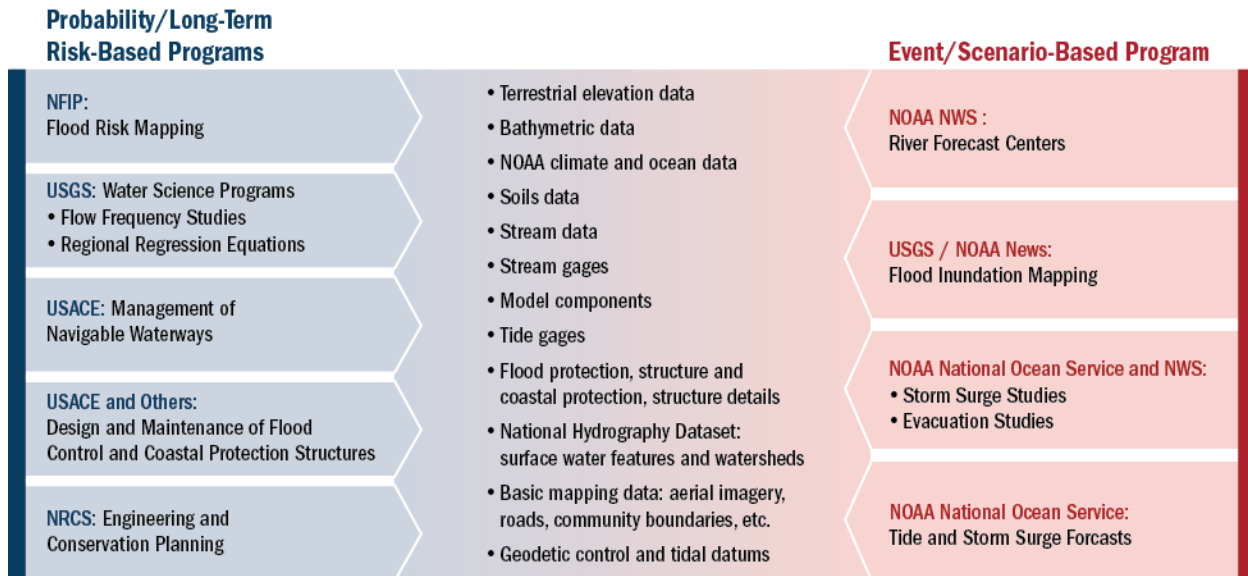


Figure 4-13: Overview of Federal water programs

In addition, activity is increasing to co-locate NWLON stations with NGS Continuously Operating Reference Systems (CORS) to accurately measure local rates of vertical land motion as well as local sea level change relative to the land. Both are important for future FEMA mapping and planning.

4.7.2.2 Coordination Bodies

Numerous Federal coordination entities acquire, promote, and maintain data relevant to flood mapping activities. Some are focused on geospatial coordination, and others are focused on H&H data (see Figure 4-13). Existing entities that could be leveraged include:

- **Federal Geographic Data Committee (FGDC)** – Promotes the coordinated development, use, sharing, and dissemination of geospatial data on a national basis. The FGDC Elevation subcommittee is charged with coordinating elevation data across the Federal Government through the 3DEP.
- **Advisory Committee on Water Information (ACWI)** – Represents the interests of water-information users and professionals in advising the Federal Government on activities and plans related to Federal water information programs and the effectiveness of these programs in meeting the Nation’s water information needs. ACWI members foster better communication between the Federal and non-Federal sectors on acquisition of water information, information sharing, and related technology transfer.
- **Silver Jackets** – Coordination forum facilitated by the USACE to address States’ flood risk management priorities.
- **National States Geographic Information Council (NSGIC)** – Committed to efficient and effective government through the prudent adoption of geospatial information technologies. Members of NSGIC include senior State GIS managers and coordinators.
- **Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM)** – Charged with working to improve coordination on planning, acquiring, documenting, managing, integrating, and disseminating mapping data and products in a manner that permits easy access to, and use by, the greatest range of users. IWG-OCM objectives include streamlining operations, reducing redundancies, improving

efficiencies, developing common standards, and stimulating innovation and technological development to meet the Integrated Ocean and Coastal Mapping vision of “Map once, use many times.” The IWG-OCM is mandated in the Ocean and Coastal Mapping Integration Act of 2009 (33 U.S.C. § 3504). Co-chaired by NOAA, USGS, and USACE, participating agencies include FEMA, U.S. Coast Guard, U.S. Navy, U.S. Fish and Wildlife Service (USFWS), National Aeronautics and Space Administration, Bureau of Ocean Energy Management, Environmental Protection Agency, and National Geospatial-Intelligence Agency Program. Increased FEMA involvement in coastal data acquisition (topobathymetric, acoustic) would be welcome to further improve flood and storm surge modeling, coastal resilience tools, and for other purposes.

4.7.2.3 Issue Analysis

National Datasets

Topographic and hydrologic data are essential to for flood mapping and LiDAR-derived products could great improve the availability, quality, and usefulness of such data. However, scale and resolution, particularly with the NHD, have proven to be problematic in flood mapping. 3DEP includes standards related to LiDAR data collection and processing and would substantially improve the both the availability and consistency of such data.

Increasing the Availability of Flood Data

TMAC identified several strategies for expanding and extending the availability of flood data. These include:

- Grow the USGS streamgauge network. Funding for the network is already highly leveraged and cost shared: State and local agencies provide approximately half of the total funding, the USGS provides approximately 30 percent, and other Federal agencies, particularly the USACE, provide the balance.
- Extend select flood records back in time by conducting paleoflood studies to ascertain the magnitude and timing of major historical floods. This strategy has significant potential in arid areas, particularly the Southwest, but is problematic in the humid East.
- Encourage the hundreds of State and local agencies that collect river stage data to make flow measurements and maintain accurate stage-discharge ratings, thus converting their river stage data into flow data. The resulting flood data could be furnished to the USGS or alternatively supplied through data portals now being developed as part of the Department of Interior open water-data initiative.¹⁶ The challenge with this strategy is that measuring flood flows is essential for quality flood data but is difficult and dangerous and will likely compete poorly with other urgent flood-related activities that State and local agencies must undertake during flood emergencies. Failure to measure and maintain ratings would increase the uncertainties associated with flood frequencies associated with such records.
- Expand the NOAA NWLON to fill existing gaps and harden existing gages to ensure data collection during extreme water level events to capture the entire event in time series. NOAA is working with the USGS in the Mid-Atlantic to coordinate USGS tide gage operations and data interoperability for USGS gages that are located in NOAA NWLON gaps. The agencies plan to expand this effort to the Northeast.

¹⁶ <http://acwi.gov/spatial/owdi/>

The gages will provide long-term water level data for multiple coastal applications, including flood information for FEMA.

- Continue to improve NOAA Atlas 14 (precipitation frequency estimates), add new precipitation data to the analysis, study trends to determine whether non-stationarity is occurring in some locations, and provide data in geospatial formats for easy incorporation into flood studies.

Levering Coordination Bodies

More effective coordination is needed in leveraging the existing national datasets. It is doubtful that any one agency or coordination group has the resources to undertake the task of improving coordination for flood mapping. A combination of existing bodies or a new body focused on improving flood mapping and risk communication may be required. Any entity assuming this responsibility would need to be able to cross cut the data types and user needs. For maximum effectiveness, coordination and discussion need to include the local level.

4.7.2.4 Key Findings and Recommendation 18

The TMAC's key findings and a recommendation related to leveraging datasets are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- H&H datasets are critical to characterizing the flood hazard, mapping the floodplain, and assessing flood risk, yet they are often hard to work with, fragmented across agencies in terms of indexing and storage, and lack standardization.
- While 10 or more flood observations are needed to compute a flood frequency, accurate estimates of large floods require more observations. Current datasets are inadequate for such analyses at many locations due to their relative short record length and scarcity. The TMAC has identified several potential strategies to help address the data shortage. Broadly stated, the strategies are to grow the USGS network, develop and use record extension techniques based on "paleoflood" and other historical information, upgrade and standardize State and local streamgage networks to acquire more flood information, expand the NOAA NWLON tide gage network, and update and modernize NOAA's Atlas 14 product.

Recommendation 18

FEMA should work with Federal, State, local, and tribal agencies, particularly the U.S. Geological Survey (USGS) and National Ocean Service, to ensure the availability of the accurate water level and streamflow data needed to map flood hazards. Additionally, FEMA should collaborate with USGS to enhance the National Hydrography Dataset to better meet the scale and resolution needed to support local floodplain mapping while ensuring a consistent national drainage network.

Discussion of Recommendation 18

Various national geospatial datasets needed for accurate flood mapping and continued coordination will both improve the quality of national datasets and prevent duplication of effort. Because H&H datasets are particularly challenging to assimilate nationally, improvements require streamflow data coordination bodies to work diligently across data types as well as across Federal, State, and local scales. This collaboration will ultimately take better advantage of river stage data already being collected and improve the characterization flood hazards, mapping floodplains, and assessing flood risk.

BW-12 Mandate **Pub. Law 112-141, Section 100215(c)**

The Council shall —

- (1) recommend to the Administrator how to improve in a cost-effective manner the —
 - (A) accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data; and
- (5) recommend to the Administrator and other Federal agencies participating in the Council—
 - (A) methods for improving interagency and intergovernmental coordination on flood mapping and flood risk determination;

4.8 Cooperating Technical Partners

FEMA's CTP Program has been in place for more than 15 years as a mechanism to formally establish partnerships between FEMA and a range of eligible State and local agencies to assist FEMA in carrying out the program goals from both Map Mod and the Risk MAP program. Through this time, little if anything has changed in terms of roles and responsibilities for these partners, and more importantly, little has been done to provide increased roles and responsibilities for long-standing CTPs that have continued to successfully deliver the program objectives year after year.

This section describes FEMA's CTP Program and presents key findings and recommendations related to this topic.

4.8.1 Overview of the CTP Program

FEMA's Risk MAP vision is to develop a more integrated process of identifying, assessing, communicating, and mitigating flood-related risks. CTPs are considered valued partners in assisting FEMA reach that goal. More than 231 CTPs participate in the CTP Program (see Figure 4-14). In FY15, \$41 million was made available to the CTP Program across the 10 FEMA Regions.

The CTP Program was developed in 1999 as an innovative approach for creating partnerships between FEMA and participating NFIP communities in good standing, regional agencies, State agencies, tribes, approved national non-profit associations, and universities that have expressed interest and have the capability to become more active participants in the FEMA national flood mapping program to support the NFIP.

Funding is made available to CTPs through a cooperative agreement and a detailed Mapping Activity Statement (MAS) that meets FEMA's priorities of mapping, program needs and related policies, and cost sharing and demonstrates the ability of the entity to perform the required activities. CTP Program activities vary year to year based on the program priorities and amount of funding each FEMA Region receives. Each fiscal year, FEMA issues a Notice of Funding Opportunity (NOFO) document to announce the availability of the CTP cooperative agreement funding opportunity for the following five categories:

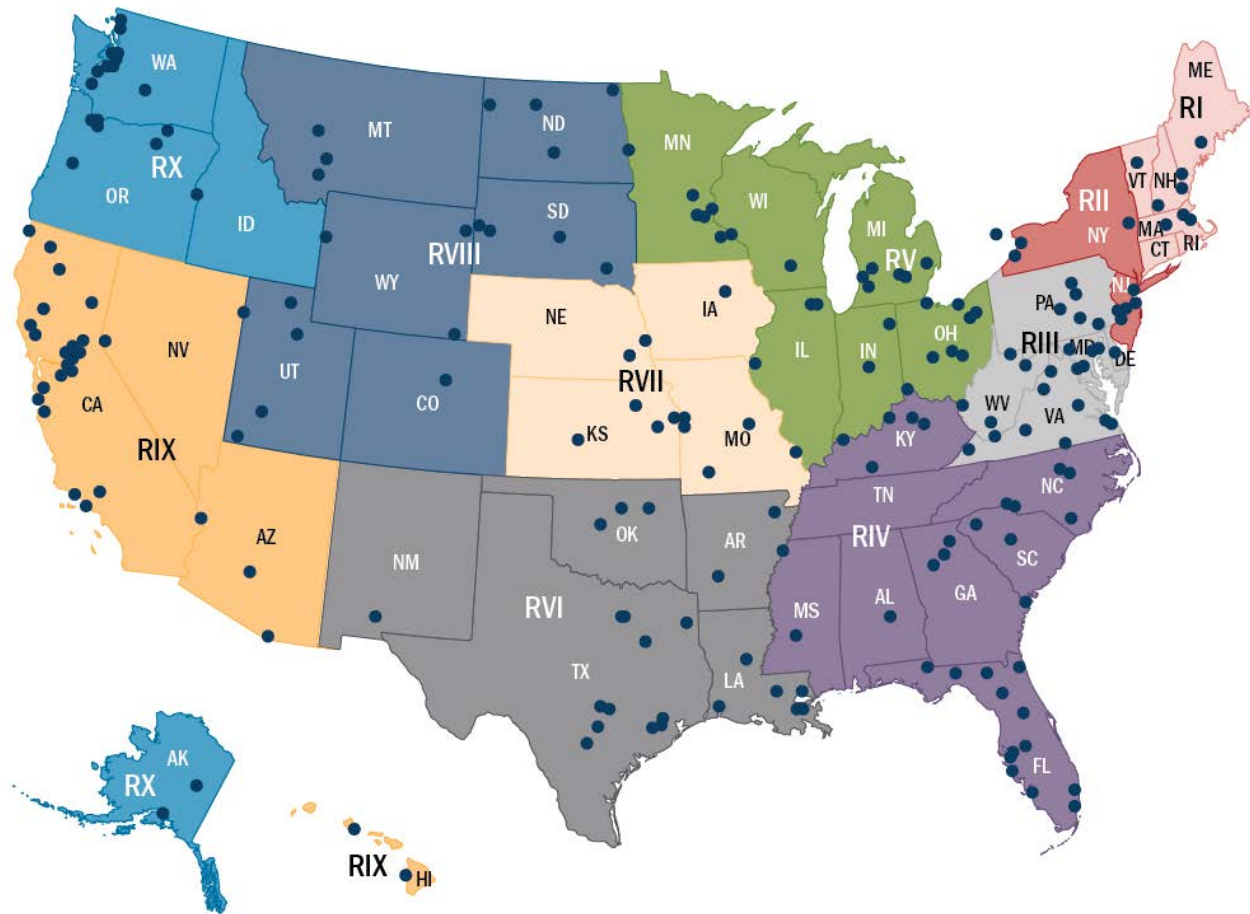


Figure 4-14: Participation in the CTP program: More than 231 CTPs as of 2015

1. Program Management
2. Community Engagement and Risk Communication
3. Technical Risk Analysis and Mapping
4. LOMR Delegation
5. Special Projects

FEMA has committed to do the following in support of the CTP program:

- Recognize the contributions made by States including universities, tribal nations, and regional and local governmental organizations by providing timely and accurate flood hazard information
- Maximize the use of partner contributions as a means of leveraging limited public funds to the fullest extent while maintaining essential NFIP standards
- Provide training, technical assistance, and mentoring to its CTPs to increase capability when feasible and appropriate

FEMA has allocated resources to support CTPs in the implementation of a successful program and in meeting their goals by providing training on the CTP Program and FEMA programs, participating in the CTPs' implementation of the MAS categories, and providing oversight to the CTPs.

In order for a community to become a CTP and be eligible to receive funding, the community must follow these steps:

1. Sign a Partnership Agreement to formalize the partnership between FEMA and the community.
2. Develop an MAS as an extension to the Partnership Agreement and to define the activities that will be accomplished for a particular project, including the community's responsible for the activities, how the activities will be funded, and the nature of the working relationship between FEMA and the CTP.
3. Sign a Cooperative Agreement, which is the award mechanism of how Federal funds are allocated to the CTP to perform the tasks in the MASs.
4. Optional: CTPs are encouraged to sign up for the CTP Collaboration Center, a site that promotes collaboration and dissemination of information.

The success of the CTP Program has demonstrated the value of delegating a range of activities to partner agencies that have a strong commitment and interest in implementing key aspects of the program. Depending on their capabilities, some CTPs depend on FEMA to carry out key tasks that range from requesting and managing funding from OMB on an annual basis to issuing and taking responsibility for the final mapping products. Ultimately, when a study is appealed, FEMA is responsible for responding to and resolving any appeals.

The level of involvement of each CTP varies, based on its capabilities and resources. The CTPs' level of participation and implementation of the national flood mapping program can range from limited project oversight of Risk MAP projects and/or outreach and communications support to a more significant role where a CTP is implementing the program on FEMA's behalf (e.g., LOMR delegation).

4.8.1.1 Current CTP Selection Process

Each FEMA Region is responsible for selecting projects put forth by its CTPs for award. CTP projects are selected based on FEMA's priorities and the availability of FEMA funds. FEMA considers the following four elements discussed below when prioritizing funding for and selecting CTPs for cooperative agreements.

- **Program Priorities** – FEMA assesses how well the proposed project aligns with national and Regional program policies, measures, and priorities (including risk, mapping needs, and available topographic data). CTPs need to coordinate with FEMA Regions and HQ to obtain information regarding Risk MAP goals and priorities. Applications should demonstrate how the CTP's proposed project will meet or exceed identified national and/or Regional program priorities and measures.
- **Past Performance** – FEMA uses assessments of the CTP's performance on completed or ongoing cooperative agreement projects when considering the CTP for additional project funding. Throughout an ongoing project and at the end of the period of performance for each completed MAS/Statement of Work or cooperative agreement, FEMA evaluates the performance of the CTP and the effectiveness of the partnership to determine eligibility for future activities.

If FEMA has determined that the partnership has proven insufficient to complete the established project or achieve the goals of the partnership, FEMA's funding of the activities may be terminated and/or future funding denied.

FEMA bases its evaluation of the partner’s demonstrated performance on the following criteria:

- Continued maintenance of the processes or systems in place to support mapping or data collection activities that contribute to flood hazard identification
 - Management and commitment to existing and continued support of technical risk analysis and mapping activities and other programs conducted with and by FEMA
 - Adherence to standards for timeliness and completeness of reports and map products submitted to the FEMA Regional office or FEMA HQ
 - Adherence to performance metrics
 - Demonstrated quality of product(s) submitted to FEMA
 - Demonstrated ability to cooperate and coordinate during all phases of the activities with the FEMA and designated FEMA contractors
- **Technical Capability and Capacity** – FEMA evaluates the demonstrated capability and capacity of the CTP to perform, implement, or contract the activities for which it is applying. For the purpose of these awards, “capability” means demonstrated experience in the performance of, or management through contracting of, similar activities. This evaluation may be completed through, but not limited to, a FEMA review of the flood risk analysis and mapping products previously prepared by the CTP and the existing processes or systems the CTP intends to use for program-related activities. If the work for any portion of an activity is subawarded or contracted, the CTP must have in-house staff with the technical capability to monitor the subawardee(s) or contractor(s) and approve the product(s) developed by the subawardee(s) or contractor(s).
 - **Partner Contributions** – FEMA does not usually require a financial matching requirement under the CTP Program, but in order to support the Risk MAP vision and collaboration with stakeholders, FEMA prioritizes funding for CTPs that have a strong record of working effectively with FEMA on flood mapping activities and demonstrate their ability to leverage funding received from FEMA through partner contributions. For the purpose of these awards, “partner contributions” refers to the amount of cost share or leveraged data that allows FEMA to maximize limited public funds to the fullest extent possible in support of national and Regional program priorities and objectives.

4.8.1.2 Leveraging Partnerships

One of the core foundations of the NFIP is engagement with communities on local flood hazards and related risks. CTPs play a vital role in communicating and supporting local communities that benefit from sharing information and data, receiving feedback on FIS products, and acting a liaison with various stakeholders and partner to address community feedback. CTPs establish close relationships with local communities that facilitate one of the most important pieces of the flood insurance studies: local base data and engineering studies. Leveraging base data and existing engineering studies saves the NFIP money and time and aids in community ownership of FIS products. Additional aspects to CTP partnerships with local communities are as follows:

FEMA’s mission is to “support, our citizens and first responders to ensure that as a nation we work together to build, sustain and improve our capability to prepare for, protect against, respond to, recover and mitigate all hazards.”

- CTPs are the boots-on-the-ground to help FEMA get closer to the communities to support FEMA's mission and to provide citizens with direct support to mitigate hazards.
- CTPs are effective when they can leverage local relationships to promote better communication and understanding of flood risk and identification of actions that can reduce that risk.
- CTPs are in a strategic position to work with their local community officials and other agencies to collect and leverage data and cost-sharing opportunities.
- CTPs play a strong role in FEMA's mission to encourage local investment and ownership of proactive mitigation.

CTPs help break down the divide between flood insurance mapping and real, effective mitigation strategies. Because they work closely with FEMA Regional offices and within the Federal Insurance and Mitigation Administration., CTPs provide additional knowledge about mitigation activities that are discussed with communities as part of an FIS or through compliance queries from a community official.

4.8.1.3 Evaluating CTP Performance

FEMA developed Program Performance Reporting Requirements as part of the requirements for receiving a CTP grant. CTPs must also meet certain performance progress standards based on the anticipated and actual cost and schedule of a particular project, as documented in their MASs.

The MIP was developed in part to track the earned value of FISs, which represents the performance standards a mapping partner must adhere to. Earned value is automatically calculated by the MIP by using the actual cost and schedule of work performed, or "actuals," and comparing them to the expected cost and schedule of work performed, or "baseline."

FEMA uses the Cost Performance Index (CPI) and the Schedule Performance Index (SPI) in the MIP to monitor CTP performance and to determine future funding eligibility. CTPs must adhere to the performance requirements by maintaining a 0.92 score for both CPI and SPI. The CTP is required to report on the earned value of projects that are in the MIP on a monthly basis and must give explanations for variances outside the tolerance defined above.

FEMA implements a Corrective Action Plan (CAP) when a CTP is outside the tolerance. A CAP must define the reason for the variance and the intended resolution. FEMA Regional offices must coordinate with FEMA HQ when CAPs are developed.

CTPs leverage their capabilities beyond developing FISs in ways that add value to the NFIP and risk reduction but are not currently measured using existing metrics. Examples of how CTPs are measured for performance are:

- Risk MAP population deployed versus planned deployment
- Community engagement estimated the number of hours planned versus executed, similar to Community Assistance Contacts (CACs) in the Community Assistance Program – State Support Services Element (CAP-SSSE)
- Local community participation in the mapping process, quantified by the population represented by community officials with face-to-face contact during Risk MAP community engagement opportunities.

When FEMA has determined that a CTP is not performing to an acceptable level, the CTP may be classified as “high risk” as defined in 44 CFR § 13.12(a). Such a classification includes special conditions or restrictions as a condition of the award. As defined in 44 CFR § 13.12(b), these special conditions or restrictions may include:

- Payment on a reimbursement basis
- Withholding authority to proceed to the next phase until receipt of evidence of acceptable performance within a given funding period
- Requiring additional, more detailed financial reports
- Additional project monitoring
- Requiring the grantee or subgrantee to obtain technical or management assistance
- Establishing additional prior approvals

If a selected CTP is identified as “high risk,” FEMA will notify the CTP of any special conditions or restrictions placed on the award as outlined in 44 CFR § 13.12(c).

Examples of State and Local CTPs that Have Added Value

State of North Carolina: The State of North Carolina’s CTP program developed the iRISK tool so that users can educate themselves about their risk and make informed decisions that will help save lives, decrease property damage, and improve resiliency to natural disasters.

Harris County Flood Control District (TX): Harris County Flood Control District has developed an innovative Model and Map Management System (M₃) designed to distribute FEMA effective models to the general public, track ongoing changes to the models resulting from development projects, and facilitate communication between FEMA, Harris County Flood Control District, Local Floodplain Administrators, and the community.

Colorado Water Conservation Board (CWCB): CWCB has been proactive in preparing new and revised maps to show the effects of increased flood hydrology following large-scale wildfire events, development and growth in previously unstudied areas, and changes in engineering and mapping technology. Additionally, the CWCB has published a Statewide Floodplain and Stormwater Criteria Manual that provides much needed technical guidance for flood-related studies in Colorado.

State of Alabama: The State of Alabama’s CTP program is developing its FRIS, a web-based interface that includes the digital FIRMs, FIS Reports, and various flood risk datasets. In cooperation with FEMA, Alabama also trains communities and other stakeholders on how to incorporate all of the flood risk datasets into existing GIS platforms.

4.8.2 Issue Analysis

A key discussion item for the TMAC was the need to further the CTP Program to leverage the capabilities and experience of successful, high performing CTPs and allow for the delegation of more responsibilities, enabling them to more effectively carry out Risk MAP program objectives. These advances in the CTP Program will help strengthen the overall program, promote local ownership of flood risk information, and allow for the development of more effective flood risk communication tools at the State and local levels.

Historically, FEMA has seen varied success with CTPs and their ability to effectively deliver what is outlined in their MASs. Since the inception of the CTP program, beneficial partnerships have been created that have provided significant value to both FEMA and these partner communities. However, a number of partnerships have experienced limited success in executing their MASs. Based on this experience, FEMA would benefit

from a more flexible program that allows for increasing responsibility and autonomy for programs with a successful, proven track record.

State, regional, and local agencies make a commitment through program development and staffing to support CTP activities and implement FEMA's programs such as Risk MAP. Through this commitment, these partners have developed expertise in preparing FEMA regulatory and non-regulatory products. This expertise can only be maintained through some baseline, consistent funding stream. Prior to 2010, Congress mandated that a percentage of mapping funds be allocated to CTPs. Although the funding is no longer mandated, FEMA has maintained support of CTPs nationally.

4.8.3 Key Findings and Recommendations 19, 20, and 21

The TMAC's key findings and recommendations related to CTPs are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings Related to Recommendation 19

- FEMA recognizes CTPs as valued partners in carrying out its Risk MAP vision.
- Because of their role at the State and local levels, CTPs are in a unique position to encourage local partnerships in collecting and leveraging data and identifying cost-sharing opportunities.
- Local partnerships and contributions to projects encourage local ownership of the products and a better understanding of the flood hazards and risk.
- During Map Mod and Risk MAP, FEMA successfully identified several CTPs that could not only serve as qualified mapping partners but worked to increase partnering and cost-sharing at the State and local levels.
- Many CTPs have demonstrated capabilities beyond the technical aspects of flood mapping and have taken on additional activities, such as LOMR delegation.
- The establishment of the CTP Program and the growing list of successful partner programs clearly demonstrate the need for continuation of the program.

Recommendation 19

FEMA should develop and implement a suite of strategies to incentivize communities, non-government organizations, and private sector stakeholders to increase partnering and subsequent contributions for flood hazard and risk updates and maintenance.

BW-12 Mandate

Pub. Law 112-141, Section 100215(c)

The Council shall —

- (3) recommend to the Administrator how to maintain, on an ongoing basis, flood insurance rate maps and flood risk identification;
- (4) recommend procedures for delegating mapping

Discussion of Recommendation 19

activities to State and local mapping partners;

The contributions of CTPs that have demonstrated successful implementation of the program and have proven capability to have increased responsibilities in implementing FEMA’s vision should be better leveraged so that CTPs are better positioned to:

- Strengthen the program overall
- Promote local ownership of flood risks
- Communicate the flood hazards and related risks
- Contribute to program planning and priorities

Key Findings Related to Recommendation 20

- The success of the CTP Program has demonstrated the value of delegating a range of activities to partner entities that have a strong commitment and interest in implementing key aspects of the program.
- CTPs are most effective when they can leverage local relationships to promote better communication and understanding of flood risk and identification of mitigation actions.
- As the flood mapping program has evolved, many CTPs have built on their long-term relationships with local communities and property owners to better identify mitigation needs and break down the divide between flood mapping and effective mitigation strategies.
- CTPs are required to meet certain performance standards based on anticipated and actual cost and schedule of projects; however, this is only a small measure of the value of CTPs. Many CTPs have demonstrated capabilities and taken on additional activities that add value to the NFIP, risk reduction efforts, and community engagement.
- The broad range of participation and success from the various CTPs demonstrates the clear need for the program to evolve from its current “one size fits all” model to a tiered structure with increasing levels of responsibility associated with successfully proven programs that continue to demonstrate the commitment to the program.
- Development of a tiered structure for the CTP Program can assist FEMA in realizing greater return on its investment and help drive more action at the local/partner level through an increased ownership stake in the program.

Recommendation 20

FEMA should work with CTPs to develop a suite of measures that communicate project management success, competencies, and capabilities of CTPs. Where CTPs demonstrate appropriate levels of competencies, capabilities, and strong past performance, FEMA should further entrust additional hazard identification and risk assessment responsibilities to CTPs.

Discussion of Recommendation 20

BW-12 Mandate

Pub. Law 112-141, Section 100215(c)

The Council shall —

FEMA would benefit from a more flexible program that allows for increasing responsibility and autonomy for mapping partner-level CTPs with a successful, proven track record. Many CTPs are already providing additional value-added activities to local communities and property owners. This could easily be expanded to further FEMA's vision for delivering quality data that increases public awareness and leads to action that reduces risk to life and property.

- (3) recommend to the Administrator how to maintain, on an ongoing basis, flood insurance rate maps and flood risk identification;
- (4) recommend procedures for delegating mapping activities to State and local mapping partners;

For the communities that are newer or have demonstrated challenges with effectively carrying out the CTP Program, FEMA can maintain the existing framework and structure to ensure effective monitoring and oversight of the Federal dollars committed to the program.

Regardless of the level of participation or success of an individual CTP, FEMA must still be able to demonstrate both progress and value for the grant money that is provided. Ideally, FEMA would use a larger percentage of its monitoring and oversight efforts on CTPs that have less experience or are underperforming and provide more flexibility and autonomy to higher performing CTPs that have a proven track record.

Key Findings Related to Recommendation 21

- Over the last 15 years, FEMA has partnered with many CTPs and benefited from many best practices and lessons learned and shared by CTPs.
- While CTPs have provided FEMA with lessons learned and helped to refine the mapping and risk assessment process, consistent, bidirectional, programmatic collaboration between FEMA and CTPs has not been present.
- Allowing CTPs to have a collaborative role in the decision-making progress for programmatic changes will ensure that changes are informed by key implementation challenges prior to adoption.

Recommendation 21

To ensure strong collaboration, communication, and coordination between FEMA and its CTP mapping partners, FEMA should establish a National Flood Hazard and Risk Management Coordination Committee. The role of the committee should be focused around the ongoing implementation of the 5-year Flood Hazard Mapping and Risk Assessment Plan. FEMA should add other members to the committee that have a direct bearing on the implementation of the plan.

Discussion of Recommendation 21

**BW-12 Mandate
Pub. Law 112-141, Section 100215(c)**

- The Council shall —
- (3) recommend to the Administrator how to maintain, on an ongoing basis, flood insurance rate maps and flood risk identification;
 - (4) recommend procedures for delegating mapping

FEMA would benefit from establishing a National Flood Hazard and Risk Management Coordination Committee that includes CTP mapping partners. As the flood mapping program has evolved over the years from Map Mod and Risk MAP, CTPs have been valuable partners and have shared numerous best practices and lessons learned that FEMA has used to refine the guidance and standards. Until recently, CTPs were not able to participate in the guidelines and standards update process, and currently no process exists for CTPs to be engaged in the planning and implementation of the overall program.

activities to State and local mapping partners;

Establishing a National Flood Hazard and Risk Management Coordination Committee would benefit FEMA and the national flood mapping program by providing a process to fully evaluate programmatic changes. Allowing CTPs to serve on this committee would not only provide a voice for valued CTP mapping partners, it would also help FEMA identify challenges to programmatic changes and develop solutions prior to implementation.

4.9 Maintenance and Funding

Funding levels supporting the national flood mapping program operations, flood hazard analysis and mapping, and risk assessments have not been stable. Funding has been inconsistent and inadequate for short- and long-term programmatic operations and for the updating and maintenance of flood hazard and risk data, models, assessments, maps, and displays nationwide.

This section describes FEMA's current funding mechanisms for the national flood mapping program, past and present funding levels, the cost of flood hazard identification and flood risk product components, and the key findings and recommendation related to these issues.

4.9.1 Funding the National Flood Mapping Program

The following subsections describe the national flood mapping program funding mechanisms, funding levels, and the cost associated with producing flood hazard identification products and flood risk products.

4.9.1.1 Current Funding Mechanisms

Over the years, funding to support the national flood mapping program has come from a combination of policy fees and direct appropriations. Policy fees represent a flat fee charged on every flood insurance policy nationwide. Policy fees are used to provide a stable funding baseline for the program.

However, fee-based funding has provided only a portion of the funding that is required to support the program and as a result, additional direct appropriations, which have varied widely over the past 10 years, have been used to help support the program. From FY04 to FY08, policy fees accounted for an average of \$56 million per year in funding. This amount has more than doubled since 2008, with FY15 policy fees accounting for over \$121 million. Direct appropriations have varied widely from FY04 through FY15, with a high of \$249 million in FY04 and a low of \$90 million in FY13 (FY15 appropriations are \$100 million). Consequently, the policy fee has gone from accounting for less than 25 percent of program funding prior to FY09 to more than 50 percent of the total funding in FY12 to FY15.

Currently, most FEMA Regions do not require CTPs to provide a financial match for participation in the CTP Program. However, CTPs that offer funding matches are typically given priority for FEMA funding. Leverage,

otherwise known as in-kind services, can also be applied as a funding match. See FEMA’s *CTP Blue Book* (2011) for more information.

4.9.1.2 Flood Mapping Program Funding Levels

Past Funding

Since the inception of the NFIP, approximately \$7 billion (adjusted to 2012 dollars) has been invested in the national flood mapping program. Figure 4-15 shows that the total annual investment in the flood mapping program has varied widely since 2004. There has been a significant decrease in funding levels for the Risk MAP program since 2012, where the funding decreased from \$325 million from its inception to a low of \$208 million in 2013. The current funding level for 2015 is \$221 million.

Present Funding

In FY14, approximately \$215 million was allocated to the FEMA Risk MAP program; 56 percent is used for map production and the remainder is used for program areas such as customer support, program management, LOMC processing, risk assessment and mitigation planning, salaries and benefits, travel, and training (see Figure 4-16).

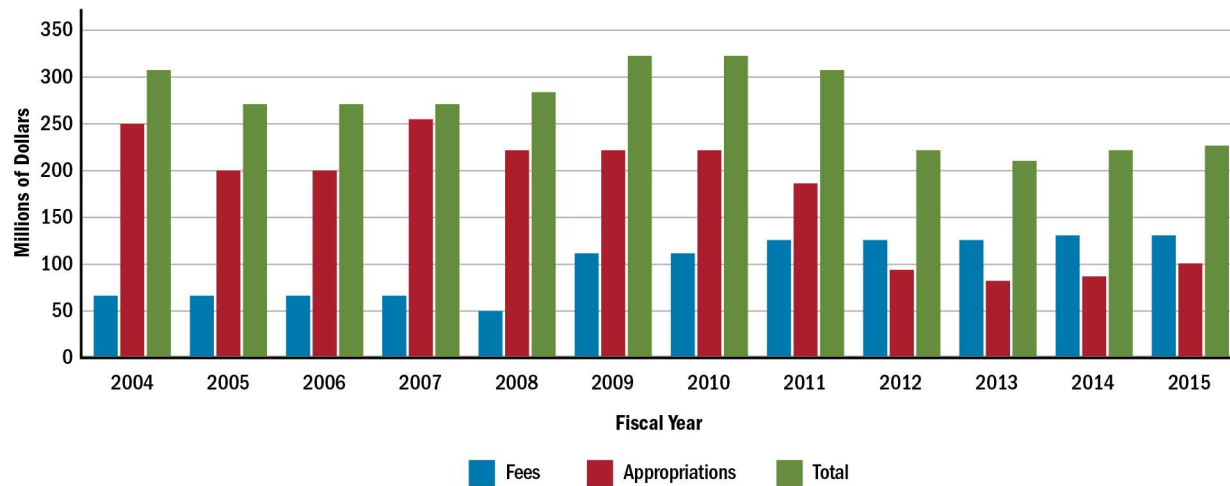


Figure 4-15: Annual investment in the national flood mapping program, 2004 to 2015¹⁷

¹⁷ Michael Godesky, P.E., Physical Scientist, FEMA, personal communication, September 22, 2015.

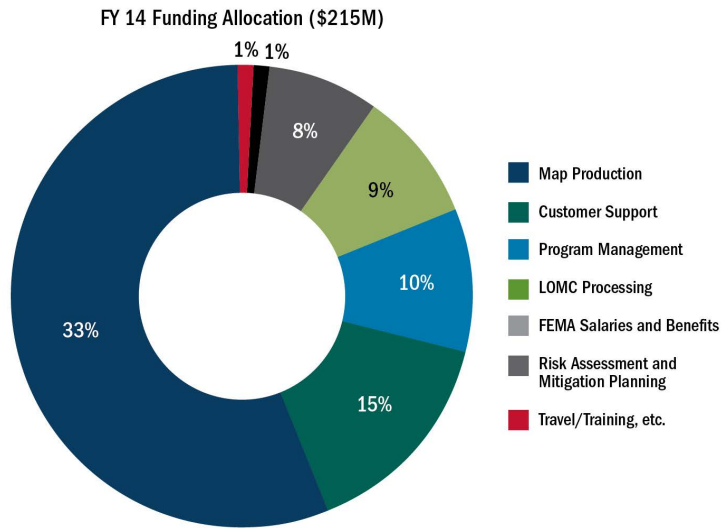


Figure 4-16: FY14 funding allocation (\$216 million)

4.9.1.3 Cost of Flood Hazard Identification Products

One of the core responsibilities of FEMA’s Risk Analysis Division is updating and maintaining the flood hazard information depicted on its regulatory products, including the FIRM, FIRM DB, and FIS. The six typical components of an FIS are base data, field survey, hydrologic data, hydraulic data, flood mapping, and the FIS Report. Each component consists of one or more elements. Table 4-8 provides a brief description and the typical cost of developing and acquiring the typical components of an FIS.

Table 4-8: Cost of the Components of an FIS

FIS Component	Description	Element	Typical Cost	
			Unit	Amount
Base Data	Obtaining and preparing digital base map data, imagery, and the topographic data needed to support base map production, engineering analysis, and mapping, and certifying that all data meet the minimum standards and specifications that FEMA requires for FIRM production.	Orthophotos	Square mile	\$20 – \$100
		Topographic data development (LiDAR)	Square mile	\$250 – \$1,000
		Base map	Project	\$5,000 – \$20,000
Field Survey	Obtaining channel cross sections, obtaining the physical dimensions of hydraulic and flood control structures, and identifying or establishing Elevation Reference Marks.	Field survey	Linear mile	\$3,000 – \$4,000
Hydrologic Data	Establishing discharge frequency relations along stream reaches to quantify the volumetric flow rate. Hydrologic analyses are stochastic, using streamgage record data, or deterministic, using a rainfall-runoff model.	Detailed riverine analysis	Linear mile	\$1,000 – \$3,500
		Limited detail riverine analysis	Linear mile	\$1,000 – \$1,500
		Approximate Study	Linear mile	\$150 – \$250
		Coastal grid development	Node	\$0.70 – \$1.00
Hydraulics Data	Determining the elevations associated with the water-surface of the flood frequencies that are investigated and determining the extent to which the floodwaters for the events inundate otherwise dry land.	Detailed riverine	Linear mile	\$4,500 – \$8,500
		Limited detail riverine	Linear mile	\$1,500 – \$2,500
		Approximate Study	Square mile	\$200 – \$300
		Coastal wave height/runup/erosion	Coastal mile	\$3,500 – \$12,000
Flood Mapping	Using topographic data to delineate annual chance floodplain boundaries and any other applicable elements for which H&H analyses were performed. Merging effective flood hazard mapping information to create digital floodplain data into a single, updated FIRM in conformance with FEMA specifications.	Detailed riverine mapping	Linear mile	\$1,500 – \$2,500
		Limited detail riverine mapping	Linear mile	\$1,000 – \$2,000
		Approximate Study	Linear mile	\$150 – \$200
		Coastal mapping	Linear mile	\$3,000 – \$4,000

FIS Component	Description	Element	Typical Cost	
			Unit	Amount
FIS Report	Updating data on the existence and severity of flood hazards in the study area. FIS Reports are used to establish actuarial flood insurance rates and help communities manage floodplains.	Areas studies Engineering methods Mapping methods Flood profiles	Study	\$10,000 – \$20,000

4.9.1.4 Cost of Flood Risk Products

As discussed in Section 2.3.2.3, the Risk MAP program produces flood risk products (non-regulatory products) as part of a Risk MAP project, and the flood risk products are the FRR, FRM, and FRD. The FRD consists of several datasets.

Table 4-9 summarizes the flood risk products and their approximate cost.

4.9.1.5 Additional Factors that Affect Cost

In addition to the cost of developing and producing the range of flood hazard and flood risk products outlined in Tables 4-8 and 4-9, the other contributing factors that affect the cost of producing flood hazard and flood risk products are the KDP process and coordination with Risk MAP partners.

- **KDP process** – KDPs (see Section 4.4.2.2) are an important part of the FIS process because they document the decision to continue the study at project milestones. The KDP process requires sufficient communication with and outreach to the community, the FEMA Region, and FEMA HQ in order to achieve approval at each KDP milestone.

The KDP process provides a formal approach to improve FEMA’s ability to manage the limited funding availability. Using KDP milestones ensures that funding is not allocated to studies that do not merit completing all of the study steps. Additional study delays can occur for studies that receive approval to progress past KDP 1 or KDP 2 but for which funding is not already available to execute the next phase of the project. At that point, the study must wait for FEMA’s funding request to Congress to be eligible to receive funding for KDP 3 in the following Federal fiscal year. Compared to a study funded through completion, the KDP process effectively adds from 6 months to 1 year to the study process. For KDP 2 approvals that occur after the congressional funding request has been made for the current fiscal year, the requested funding is delayed until the subsequent Federal fiscal year, extending the study timeline by up to 2 years.

While the KDPs are not a significant task in terms of cost, they can affect the FIS schedule and therefore the budget. KDPs cannot be calculated as a unit cost and the time required to advance each KDP cannot be predicted, but they should be considered during project planning and prioritization.

- **Coordination with Risk MAP Partners** – Frequent coordination with FEMA’s Risk MAP partners is important to the FIS process from Discovery to final issuance of the FIRMs. However, the coordination can affect the study schedule and therefore the FIS budget if not all partners come together quickly. Partner coordination is another FIS activity that cannot be calculated as a unit cost as it can vary widely based on specific project challenges, and funding the activity should be considered during project planning and prioritization.

Table 4-9: Flood Risk Products and Cost

Dataset or Product		Development	Cost	
			Unit	Amount
Flood Risk Dataset	Depth Grid	Computed by subtracting the terrain being used for the hydraulic analysis from the water surface grid	Linear mile	\$120 – \$180
	Water Surface Grid	Computed by interpolating between known water surface elevations at cross sections	Linear mile	\$120 – \$180
	Probability Grid	Computed by using multiple water surface elevation results and interpolating the percent annual chance of flooding at each grid cell based on those inputs coupled with the ground elevation	Linear mile	\$10
	Risk Assessment	Estimates physical, economic, and social impacts of disasters using GIS technology	Hazus level	Varies based on the Hazus level and data available
	Building Footprints⁽¹⁾	Compiled using techniques, such as LiDAR analysis and computation and manual digitization from referencing aerial imagery.	Per 1,000 buildings	\$400 – \$750
	Changes Since Last FIRM	Compiled using intersections between an Effective and Preliminary FIS. Output is attributed appropriately to identify the changes within the mapped boundaries	Linear mile	\$80 – \$100
	Areas of Mitigation Interest	N/A	Community	\$1,400 – \$2,200
Flood Risk Map	N/A	Manually compiled using the output features from a risk analysis	Project	\$10,000 – \$20,000
Flood Risk Report	N/A	Manually compiled using the results and tables that are computed from the Flood Risk Database	Project	\$10,000 – \$20,000

N/A = not applicable

⁽¹⁾ Building footprints are not currently a flood risk dataset required by FEMA; however, this information is included to showcase the approximate cost of acquiring this dataset

4.9.2 Issue Analysis

Because of the ever-changing development landscape, from urbanization to roadway/bridge improvements and new subdivisions, streams are continuously subjected to changes from the infrastructure that can affect the validity of the original stream study. In addition, as development creeps into rural areas, streams that did not previously pose a flooding threat will become areas of concern and need at least an initial FIS. Failure to update or revalidate the expiring inventory provides the public with an incorrect view of flood vulnerability. Routine validation of existing studies and proactive studies of new flooding sources due to development patterns will reduce the potential for loss of life and property.

As described in Section 4.2.1.1 (Maintenance of Existing FIS Areas), FEMA maintains the CNMS that is used to manage FEMA's flood hazard mapping inventory, including validation status of FIS and flood hazard mapping needs nationwide, with the exception of coastal study areas. The system identifies and tracks the lifecycle of flood studies and mapping requests to determine which FIS areas have been completed with up-to-date engineering methodology and which studies may warrant additional analysis.

FEMA's target is to progress toward a full maintenance phase of the existing inventory of mapped stream miles (paper and digital) in which each stream is assessed within a 5-year cycle and 80 percent of the miles are identified as valid. As of September 30, 2015 (FY15 Q4), the CNMS database indicated the total number of mapped miles in FEMA's inventory is approximately 1.13 million. In FY14 and FY15, a total of 10 to 15 percent of the Nation's stream miles "expired" or reached their 5-year "shelf life." The expired miles (over 150,000 stream miles) require reassessment to determine whether they are still valid.

The reassessment rate of expired miles at the end of FY15 was approximately 50 percent across the Nation, resulting in a decrease in the percentage of the total inventory of valid miles (NVUE-compliant) from 49.2 percent in FY14 Q4 to 42.0 percent in FY15 Q4, when 37,419 miles shifted from valid to unverified. As of September 30, 2015, a total of 235,924 miles were unverified (see Table 4-10), and the status of 419,010 miles was unknown.

Table 4-10: Current Inventory of Unverified Miles Based on Level of Detail

Unverified Streams	Detail (miles)	Approximate (miles)	Total Miles
Modernized Inventory	62,502	114,208	176,710
Paper Maps	4,071	55,143	59,214
Total Miles	66,573	169,351	235,924

FEMA FY15 Q4 CNMS Results

The 42 percent of valid miles does not account for the 75,665 miles of new study initiated in FY15. However, this is only 7 percent of the total inventory of miles where FEMA funded an update to an existing study. For FEMA to achieve its 80 percent target of valid miles, FEMA would need to fund an additional 350,000 miles of study. It is apparent that at the rate valid miles are expiring and becoming unverified, FEMA's inventory of valid miles will continue to decrease.

Figure 4-17 depicts the status of unknown and unverified miles in the Nation as of September 30, 2015 (FY15 Q4).

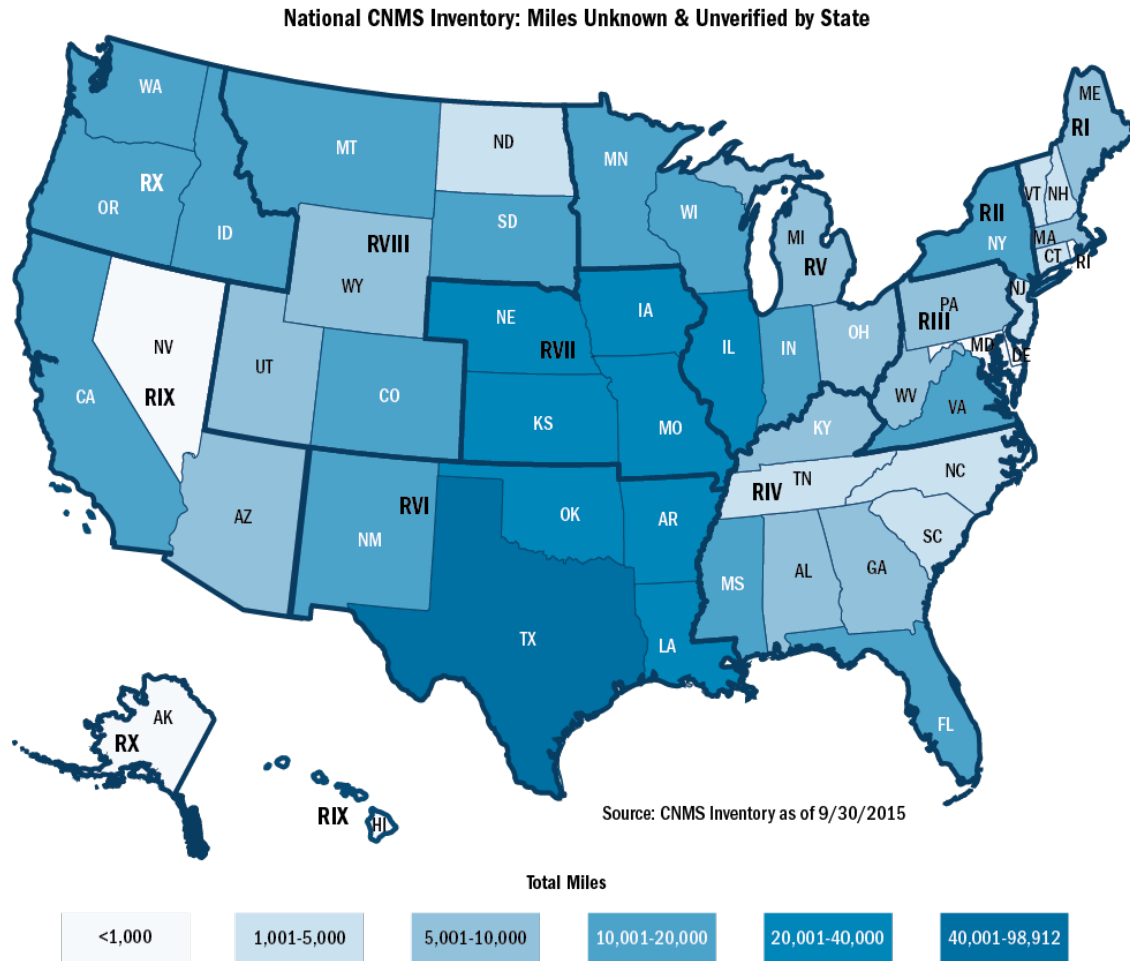


Figure 4-17: States with unverified or unknown miles in CNMS

The NRC report entitled *Mapping the Zone Report* (NRC, 2009) summarized the results of a BCA carried out by FEMA (FEMA, 1997b) and the State of North Carolina (NCFMP, 2008) on the benefits and costs of accurate flood mapping. The NCFMP analysis selected three types of benefits for its analysis:

- Expected annual flood losses avoided to new buildings and infrastructure through accurate identification of flood elevations and/or areal extent of the floodplain
- Expected annual flood insurance premiums to be collected by the NFIP for properties newly designated within the SFHA on more accurate maps
- Expected annual flood insurance premium savings to policy holders who, as a result of more accurate maps, are placed in lower-rate zones or removed from the mandatory purchase requirements of the NFIP

Table 4-11 contains the results of the three primary types of flood studies and their benefit-cost ratio. The Approximate Study level of analysis, which does not include BFEs, resulted in a Benefit-Cost Ratio of 0.86 and indicated that this level of study results in a net cost to the State. The limited detail, detail, and combination study types resulted in a net benefit to the State where the benefit increased as the level of detail of the study method increased.

Table 4-11: Benefit-Cost Analysis of Three Types of Flood Studies

Study Method	Unit Cost per Mile	Total Discounted Benefits (million \$)	Total Discounted Costs (million \$)	Benefit-Cost Ratio
Approximate Study (No-BFE)	\$1,423	\$335.4	\$391.4	0.86
Limited Detail	\$1,908	\$582.3	\$404.6	1.44
Detail	\$6,539	\$922.1	\$519.2	1.78
Combination*	\$2,419	\$933.2	\$417.2	2.24

Source: NRC (2009)

*The combination study method was a combination of study methods used by North Carolina.

Considering the benefit-cost of the different study methods identified in Table 4-11, performing a Detailed Study on the 350,000 miles needed to reach 80 percent valid would cost \$2.3 billion, but this estimate does not account for the 26,513 miles of coastal studies that are currently mapped or the 41,276 miles of coastline in the United States.

The Association of State Floodplain Managers (ASFPM) estimates that updating the inventory (including coastal miles) would cost from \$4.5 to \$7.5 billion (ASFPM, 2013). This estimate does not include the funding needed to meet the ongoing maintenance goals of the mapped inventory. The same report estimates annual maintenance of the mapped inventory would cost up to \$275 million annually, combining this cost with the average annual policy fees (approx. \$119 million over the last 5 years) would require a total national flood mapping program budget of nearly \$400 million on an annual basis.

While FEMA has made progress on fully mapping the Nation and funding has increased since 2000, present funding levels are not sufficient to update the current inventory of mapped miles and keep pace with the number of miles requiring new study every year.

4.9.3 Key Findings and Recommendation 22

The TMAC’s key findings and recommendations related to maintenance and funding of FEMA’s flood hazard and risk products are provided below and are followed by a discussion of the recommendation, benefits, and potential issues related to implementing the recommendation, as applicable.

Key Findings

- There has been a significant decrease in funding levels for the Risk MAP program since 2012, when the funding decreased from \$325 million at its inception to a low of \$208 million in 2013. The current funding level for 2015 is \$221 million.
- Present funding levels are not sufficient to keep pace with the number of miles requiring new study on an annual basis.
- Funding has been inconsistent and inadequate for short- and long-term programmatic operations and for the updating and maintenance of flood hazard and risk data, models, assessments, maps, and displays nationwide.
- ASFPM estimates that between \$4.5 and \$7.5 billion is required to update the current mapping inventory (including coastal flood studies) nationwide. ASFPM also estimates that the annual maintenance of the

mapped inventory would cost up to \$275 million annually, combining this cost with the average annual policy fees (approximately \$119 million over the last 5 years) would require a total national flood mapping program budget of nearly \$400 million on an annual basis.

- FEMA funded less than 7 percent of the total inventory of miles to update to an existing study. For FEMA to achieve its 80 percent target of valid miles, an additional 350,000 miles of study would need to be funded. This would cost an estimated \$2.3 billion.
- ASFPM estimates that updating the inventory (including coastal miles) would cost from \$4.5 to \$7.5 billion (ASFPM, 2013). This estimate does not include the funding needed to meet the ongoing maintenance goals of the mapped inventory. The same report estimates that annual maintenance of the mapped inventory would cost up to \$275 million annually. Combining this cost with the average annual policy fees (approximately \$119 million over the last 5 years) would require a total national flood mapping program budget of nearly \$400 million on an annual basis.

Recommendation 22

FEMA should define the financial requirements to implement the TMAC’s recommendations and to maintain its investment in the flood study inventory.

Discussion of Recommendation 22

The financial requirements to implement the recommendations of the *TMAC 2015 Annual Report* should be evaluated and considered when developing the short- and long-term implementation plan and evaluated against maintaining high quality flood hazard data (riverine and coastal).

FEMA should consider the cost of updating the mapping inventory to achieve its goal of 80 percent NVUE-compliance and the cost of maintaining the inventory once in a full maintenance phase of the program. As stated previously, ASFPM estimates the update alone could cost as much as \$7.5 billion. With the current financial state of the NFIP, which includes the continuing effect of the debt from post-disaster costs from events such as Hurricane Katrina and Hurricane Sandy, new ways of providing additional funding to the NFIP must be considered. For example, some flood insurance policy fees could be amended to pay for NFIP operations and engineering/mapping maintenance. ASFPM’s report, *Flood Mapping for the Nation*, explains that approximately \$400 million per year is needed to fund the program support and maintenance of the FISs and associated products (ASFPM, 2013). With annual Federal funding ranging from \$208 million to \$221 million in recent years, the NFIP is in jeopardy of not being able to maintain the engineering and mapping products that have been developed.

BW-12 Mandate

Pub. Law 112-141, Section 100215(c)

The Council shall —

- (3) recommend to the Administrator how to maintain, on an ongoing basis, flood insurance rate maps and flood risk identification;
- (5) recommend to the Administrator and other Federal agencies participating in the Council –
 - (B) a funding strategy to leverage and coordinate budgets and expenditures across Federal agencies; and

5. Glossary

Definitions are from FEMA (2015b) unless otherwise noted.

0.2-percent-annual-chance flood – Flood with a 0.2 percent chance of being equaled or exceeded in any given year.

1-percent-annual-chance flood – Flood with a 1 percent chance of being equaled or exceeded in any given year.

2-percent-annual-chance flood – Flood with a 2 percent chance of being equaled or exceeded in any given year.

4-percent-annual-chance-flood – Flood with a 4 percent chance of being equaled or exceeded in any given year.

10-percent-annual-chance flood – Flood with a 10 percent chance of being equaled or exceeded in any given year.

Aleatory Uncertainty – Variability in the physical world; uncertainty arising from variations inherent in the behavior of natural phenomena that are viewed as random rather than systematic.

Approved model – Numerical computer model accepted by the Federal Emergency Management Agency (FEMA) for use in performing new or revised hydrologic or hydraulic analyses for National Flood Insurance Program (NFIP) purposes. All accepted models must meet the requirements set forth in Subparagraph 65.6(a)(6) of the NFIP regulations.

Approximate Study – A Flood Insurance Study (FIS) that results in the delineation of floodplain boundaries for the 1-percent-annual-chance (100-year) flood but does not include the determination of base flood elevations (BFEs) or flood depths.

Base flood – Flood with a 1 percent chance of being equaled or exceeded in any given year.

Base flood elevation (BFE) – The elevation of a flood with a 1 percent chance of being equaled or exceeded in any given year.

Base map – The planimetric, or horizontal representation, of map features that show georeferenced locations and contain attribute information (i.e., names) about the items. A base map does not include topographic or elevation data (FEMA, 2014a).

Biggert-Waters Flood Insurance Reform Act of 2012 (BW-12) – Legislation that was later revised by the Homeowner Flood Insurance Affordability Act of 2014 requiring FEMA and other agencies to make a number of changes to the way the NFIP is run. Key provisions of the legislation required the program to raise rates to reflect true flood risk and make the program more financially stable. The legislation also authorized the Technical Mapping Advisory Council to re-convene.

Climate-Informed Science Approach – The use of data and methods informed by best-available, actionable climate science.

Coastal Barrier Resources System (CBRS) – A system of protected coastal areas, including the Great Lakes. The areas within the CBRS are defined as having depositional geologic features consisting of unconsolidated sedimentary materials; being subject to wave, tidal, and wind energies; and protecting landward aquatic habitats from direct wave attack.

Coastal Flooding – Flooding that occurs along the Great Lakes, the Atlantic and Pacific Oceans, and the Gulf of Mexico.

Coastal high hazard area – An area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high-velocity wave actions from storms or seismic sources.

Code of Federal Regulations (CFR) – The codification of the general and permanent rules published in the *Federal Register* by the Executive Departments and agencies of the Federal Government. NFIP are printed in 44 CFR Parts 59–77.

Community – Any State or area or political subdivision thereof, or any Indian tribe or authorized tribal organization, or Alaska Native village or authorized native organization, that has the authority to adopt and enforce floodplain management regulations for the areas within its jurisdiction.

Community Rating System (CRS) – A FEMA initiative, established under the NFIP, to recognize and reward communities that have implemented floodplain management measures beyond the minimum required by NFIP regulations. Under the CRS, those communities that choose to participate voluntarily may reduce the flood insurance premium rates for property owners in the community by taking these additional actions.

Cooperating Technical Partners (CTP) Program – A FEMA program to create partnerships between FEMA and participating NFIP communities, regional agencies, and State agencies that have the interest and capability to become more active participants in the FEMA national flood mapping program.

Detailed Flood Study – An FIS using detailed structure survey data that, at a minimum, results in the delineation of floodplain boundaries for the 1-percent-annual-chance (100-year) flood and the determination of BFEs or flood depths. Detailed Flood Studies in riverine areas include floodplain boundaries and profiles for the 0.2-, 1-, 2-, 4-, and 10-percent-annual-chance-flood and detailed flood studies in coastal areas include floodplain boundaries and transects for the 1-percent-annual-chance-flood.

Epistemic Uncertainty (Knowledge Uncertainty) – Uncertainty arising from imprecision in analysis methods and data. Arises from a lack of understanding of events and processes, or from a lack of data; such lack of knowledge is reducible with additional measurements, observations, and scientific analysis.

Flood – A general and temporary condition of partial or complete inundation of 2 or more acres of normally dry land area or of two or more properties (at least one of which is the policyholder's property) from one of the following:

- Overflow of inland or tidal waters
- Unusual and rapid accumulation or runoff of surface waters from any source
- Mudflow

Flood hazard – Flood conditions (e.g., depth, wind, velocity, duration, waves, erosion, debris) that have the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss (adapted from FEMA, 1997a).

Flood Insurance Rate Map (FIRM) – The insurance and floodplain management map produced by FEMA that identifies, based on detailed or approximate analyses, the areas subject to flooding during a 1-percent-annual-chance (100-year) flood event in a community. Flood insurance risk zones, which are used to compute actuarial flood insurance rates, also are shown. In areas studied by detailed analyses, the FIRM shows BFEs to reflect the elevations of the 1-percent-annual-chance flood. For many communities, when detailed analyses are performed, the FIRM also may show areas inundated by 0.2-percent-annual-chance (500-year) flood and regulatory floodway areas.

Flood Insurance Study (FIS) – A compilation and presentation of flood hazard data for specific watercourses, lakes, and coastal flood hazard areas within a community. When a flood study is completed for the NFIP, the information and maps are assembled into an FIS.

Flood Insurance Study Report (FIS Report) – The FIS Report contains detailed information of the FIS, including flood elevation data in flood profiles and data tables.

Flood Insurance Rate Map Database (FIRM DB) – The FIRM DB stores the digital GIS data used in the FIRM production process, as well as tabular information inside the FIS Report. The FIRM DB provides a standard, systematic method for FEMA to distribute comprehensive details of flood hazard identification studies to the public and others in digital format.

Floodplain – Any land area that is susceptible to being inundated by water from any source.

Floodplain management – The operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to, emergency preparedness plans, flood control works, and floodplain management regulations (FEMA, 2015d).

Flood profile – A graph showing the relationship of water-surface elevation to location, with the latter generally expressed as distance above the mouth for a stream of water flowing in an open channel.

Flood risk – Expected flood losses, based on the likelihood and severity of flooding, the natural and manmade assets at risk, and the consequences to those assets (modified from Schwab et al., 1998, p. 329).

Floodway – See Regulatory Floodway.

Geographic Information System (GIS) – A system of computer hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling, and display of spatially referenced data for solving complex planning and management problems.

Hazard – An event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, and other types of loss or harm.

Hazus – A nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods and hurricanes. Hazus uses GIS technology to estimate physical, economic, and social impacts of disasters (FEMA, 2015j).

Horizontal datum – North American Datum 83 or 27 (NAD 83 or NAD 27).

Hydraulic analysis – An engineering analysis of a flooding source carried out to provide estimates of the depths of floods of selected recurrence intervals.

Hydrograph – A graph showing the rate of flow (discharge) versus time past a specific point on a river, or other channel or conduit carrying flow.

Hydrologic analysis – An engineering analysis of a flooding source carried out to establish peak flood discharges and their frequencies of occurrence.

Hydrology – The science encompassing the behavior of water as it occurs in the atmosphere, on the surface of the ground, and underground.

Letter of Final Determination (LFD) – The letter in which FEMA announces its final determination regarding the flood hazard information, including (when appropriate) proposed and proposed modified BFEs, presented on a new or revised FIRM and FIS Report for a particular community. In the LFD, FEMA begins the compliance period and establishes the Effective date for the new or revised FIRM and FIS Report.

Letter of Map Amendment (LOMA) – An official determination by FEMA that a property has been inadvertently included in an SFHA as shown on an Effective FIRM and is not subject to inundation by the 1-percent-annual-chance flood. Generally, the property is located on natural high ground at or above the BFE or on fill placed prior to the Effective date of the first NFIP map designating the property as within an SFHA. Limitations of map scale and development of topographic data more accurately reflecting the existing ground elevations at the time the maps were prepared are the two most common bases for LOMA requests.

Letter of Map Change (LOMC) – A collective term used to describe official amendments and revisions to NFIP maps that are accomplished by a cost-effective administrative procedure and disseminated by letter.

Letter of Map Change Revalidation (LOMC-VALID) Letter – A letter issued by FEMA, immediately before the Effective date of a revised FIRM, to notify community officials about LOMAs, Letters of Map Revision Based on Fill (LOMR-Fs), and Letters of Map Revision (LOMRs) that will remain in effect after the FIRM is published.

Letter of Map Revision (LOMR) – FEMA’s modification to an Effective FIRM. LOMRs are generally based on the implementation of physical measures that affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway, the BFEs, or the SFHA. The LOMR officially revises the FIRM and sometimes the FIS.

Letter of Map Revision Based on Fill (LOMR-F) – An LOMC issued by FEMA when FEMA determines that a legally defined parcel of land or structure has been elevated above the BFE based on the placement of earthen fill after the date of the first NFIP map.

Levee – A manmade structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

Light Detection and Ranging (LiDAR) System – An airborne laser system, flown aboard rotary or fixed-wing aircraft, that is used to acquire x, y, and z coordinates of terrain and terrain features that are both manmade and naturally occurring. LiDAR systems consist of an airborne Global Positioning System (GPS) with attendant base station(s), Inertial Measuring Unit, and light-emitting scanning laser.

Limit of Moderate Wave Action (LiMWA) – The inland limit of the coastal area expected to receive 1.5-foot or greater breaking waves during the 1-percent-annual-chance flood event.

Mapping Information Platform (MIP) – The geospatial system that provides easy access to flood hazard information to enable the management, production, and sharing of flood hazard data and maps in a digital environment.

Map Service Center (MSC) – The official public source for flood hazard mapping produced in support of the NFIP. The MSC can be used to find official flood maps, access a range of other flood hazard products, and take advantage of tools for better understanding flood risk (FEMA, n.d.-a).

Mapping Activity Statement (MAS) – An agreement signed by FEMA and a participant (community, regional agency, or State agency) in the CTP Program under which the participant will complete specific mapping activities.

Mitigation – A sustained action taken to reduce or eliminate long-term risk to people and property from flood hazards and their effects. Mitigation distinguishes actions that have a long-term impact from those are more closely associated with preparedness for, immediate response to, and short-term recovery from specific events.

- National Academy of Public Administration (NAPA)** – An independent, non-profit, and non-partisan organization established in 1967 to assist government leaders in building more effective, efficient, accountable, and transparent organizations (NAPA, n.d.-b).
- National Flood Hazard Layer (NFHL)** – A digital database that contains flood hazard mapping data from FEMA’s NFIP. The map data are derived from digital FIRM DBs and LOMRs (FEMA, 2015m).
- National Flood Insurance Program (NFIP)** – Federal program under which flood-prone areas are identified and flood insurance is made available to the owners of the property in participating communities.
- National flood mapping program** – An ongoing program under which the FEMA Administrator shall review, update, and maintain NFIP rate maps in accordance with 42 U.S.C. § 4101b.
- National Hydrography Dataset (NHD)** – The surface water component of The National Map that represents the drainage network with features such as rivers, streams, canals, lakes, ponds, coastline, dams, and streamgages (USGS, 2015b).
- National States Geographic Information Council (NSGIC)** – An organization committed to efficient and effective government through the prudent adoption of geospatial information technologies (NSGIC, 2015).
- Non-regulatory** – Unlike regulatory flood hazard products (e.g., FIRM, FIS Report, FIRM DB), non-regulatory products are not intended to be used as the basis for official actions required under the NFIP, such as determining mandatory insurance purchase requirements for a property. Non-regulatory flood risk products work alongside regulatory products and can be adopted by local communities wishing to regulate floodplain development to a higher standard.
- Orthometric height** – Colloquially referred to as “height above mean sea level,” the distance between the geoid and a selected point along the (curved) plumb line, often on the Earth’s surface (National Geodetic Survey, 2011).
- Planimetric map** – A map representing only horizontal positions of features on the Earth’s surface which reveal geographic objects, natural and cultural physical features, and entities without topographic properties.
- Polygon** – A two-dimensional figure with three or more sides intersecting at a like number of points. (In GIS, a polygon is an area.)
- Regulatory Floodway** – A floodplain management tool that is the regulatory area defined as the channel of a stream, plus any adjacent floodplain areas that must be kept free of encroachment so that the base flood discharge can be conveyed without increasing the BFEs more than a specified amount. The regulatory floodway is not an insurance rating factor.
- Special Flood Hazard Area (SFHA)** – Area delineated on an NFIP map as being subject to inundation by the base flood. SFHAs are determined using statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with a community; floodplain topographic surveys; and hydrologic and hydraulic analyses.
- Structure** – For floodplain management purposes, a walled and roofed building, including a gas or liquid storage tank that is principally above ground, as well as a manufactured home. For flood insurance purposes, a walled and roofed building, other than a gas or liquid storage tank, that is principally above ground and affixed to a permanent site, as well as a manufactured home on a permanent foundation.
- Technical Mapping Advisory Council (TMAC)** – A Federal advisory committee established to review and make recommendations to FEMA on matters related to the national flood mapping program; authorized by BW-12.

Vertical Datum – National Geodetic Vertical Datum of 1929 (NGVD 29) or North American Vertical Datum of 1988 (NAVD 88) for which the property elevations are referenced. If the datum being referenced is different than the datum used to produce the Effective FIRM, provide the datum conversion.

Watershed – An area of land that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge (USGS, 2015f).

Zone A – The flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or depths are shown within this zone.

Zone AE – The flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH – The flood insurance rate zone that corresponds to the 100-year shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs are derived from detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AR – The flood insurance rate zone used to depict areas protected from flood hazards by flood control structures, such as a levee, that are being restored. FEMA will consider using the Zone AR designation for a community if the flood protection system has been deemed restorable by a Federal agency in consultation with a local project sponsor, a minimum level of flood protection is still provided to the community by the system, and restoration of the flood protection system is scheduled to begin within a designated time period and in accordance with a progress plan negotiated between the community and FEMA. Mandatory purchase requirements for flood insurance will apply in Zone AR, but the rate will not exceed the rate for unnumbered A zones if the structure is built in compliance with Zone AR floodplain management regulations. For floodplain management in Zone AR areas, elevation is not required for improvements to existing structures. However, for new construction, the structure must be elevated (or floodproofed for non-residential structures) such that the lowest floor, including the basement, is a maximum of 3 feet above the highest adjacent existing grade if the depth of the BFE does not exceed 5 feet at the proposed development site. For infill sites, rehabilitation of existing structures, or redevelopment of previously developed areas, there is a 3-foot elevation requirement regardless of the depth of the BFE at the project site. The Zone AR designation will be removed and the restored flood control system shown as providing protection from the 1-percent-annual-chance flood on the NFIP map upon completion of the restoration project and submittal of all the necessary data to FEMA.

Zone AO – The flood insurance rate zone that corresponds to the 100-year shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses. The highest top of curb elevation adjacent to the lowest adjacent grade (LAG) must be submitted if the request lies within this zone.

Zone Agg – The flood insurance rate zone that corresponds to areas of the 100-year floodplain what will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No BFEs or depths are shown within this zone.

Zone D – The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined but possible.

Zone E – An area of flood-related erosion hazards, defined by the NFIP, but as yet unused on FIRMs.

Zone V – The flood insurance rate zone that corresponds to the 100-year costal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed

for such areas, no BFEs are shown within this zone. Mandatory flood insurance purchase requirements apply.

Zone VE, V1-30 – The flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

Zone X (shaded), Zone B – The flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, and areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from 100-year flood by levees. No BFEs or depths are shown within this zone.

Zone X (unshaded), Zone C – Areas determined to be outside the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains. Flood insurance is not federally mandated, but lenders can require the purchase of flood insurance in these areas. No minimum Federal floodplain management standards apply.

6. Acronyms and Abbreviations

1-D	one-dimensional
2-D	two-dimensional
3DEP	3D Elevation Program
ACWI	Advisory Committee on Water Information
ADCIRC	Advanced Circulation
ADFO	Alternate Designated Federal Officer
ASFPM	Association of State Floodplain Managers
BCA	Benefit-Cost Analysis
BFE	base flood elevation
BW-12	Biggert-Waters Flood Insurance Reform Act of 2012
CAP	Corrective Action Plan
CAZ	Coastal A Zone
CBRS	Coastal Barrier Resources System
CFR	Code of Federal Regulations
CNMS	Coordinated Needs Management Strategy
CORS	Continuously Operating Reference Systems
CPI	Cost Performance Index
CRS	Community Rating System
CSLF	Changes Since Last FIRM
CTP	Cooperating Technical Partner
CUAHSI	Consortium of Universities for the Advancement of Hydrologic Sciences, Inc.
DEM	digital elevation model
DFO	Designated Federal Officer
DHS	Department of Homeland Security
eLOMA	electronic LOMA
FACA	Federal Advisory Committee Act
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FGDC	Federal Geographic Data Committee
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Maps
FIRM DB	FIRM Database
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FOIA	Freedom of Information Act
FRD	Flood Risk Database
FRIS	Flood Risk Information System
FRiSEL	Flood Risk Study Engineering Library
FRM	Flood Risk MAP

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FRR	Flood Risk Report
FY	Fiscal Year
G&S	<i>Guidelines and Specifications for Flood Hazard Mapping Partners</i>
GAO	Government Accountability Office
GIS	Geographic Information System
GRAV-D	Gravity for the Re-Definition of the American Vertical Datum
H&H	hydrologic and hydraulic
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HFIAA	Homeowner Flood Insurance Affordability Act of 2014
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HQ	Headquarters
HUC8	hydrologic unit code 8
IACWD	Interagency Advisory Committee on Water Data
ID	identification
IFSAR	interferometric synthetic aperture radar
IWG-OCM	Interagency Working Group on Ocean and Coastal Mapping
IWRSS	Integrated Water Resources Science and Services
KDP	Key Decision Point
KSS	Knowledge Sharing Site
LAG	Lowest Adjacent Grade
LFD	Letter of Final Determination
LiDAR	Light Detection and Ranging
LiMWA	Limit of Moderate Wave Action
LOMA	Letter of Map Amendment
LOMC	Letter of Map Change
LOMR	Letter of Map Revision
LOMR-F	Letter of Map Revision based on Fill
Map Mod	Flood Map Modernization Initiative
MAS	Mapping Activity Statement
MHIP	Multi-Hazards Information Portal
MIP	Mapping Information Platform
MSC	Map Service Center
NAD 83	North American Datum of 1983
NAPA	National Academy of Public Administration
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NAVD 88	North American Vertical Datum of 1988
NCMS	National Coastal Mapping Strategy
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program

NGP	National Geospatial-Intelligence Agency Program
NGS	National Geodetic Survey
NGVD 29	National Geodetic Vertical Datum of 1929
NHD	National Hydrography Dataset
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NSGIC	National States Geographic Information Council
NSRS	National Spatial Reference System
NSS	National Streamflow Statistics
NVUE	New, Validated and/or Updated Engineering
NWLON	National Water Level Observation Network (NOAA)
NWS	National Weather Service
OGC	Open Geospatial Consortium
OMB	Office of Management and Budget
PDM	Pre-Disaster Mitigation
PELV	surface elevation–probability functions
QA/QC	quality assurance/quality control
R&D	Research and Development
REST	Representational State Transfer
Risk MAP	Risk Mapping, Assessment and Planning
RSC	Regional Service Center
sq ft	square-foot
SFHA	Special Flood Hazard Area
SLR	sea level rise
SME	subject matter expert
SOP	Standard Operating Procedure
SPI	Schedule Performance Index
TMAC	Technical Mapping Advisory Council
TVA	Tennessee Valley Authority
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USIEI	U.S. Interagency Elevation Inventory
USGS	U.S. Geological Survey
WBD	Watershed Boundary Dataset

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Appendix A

TMAC Charter

The TMAC Charter in Appendix A is the renewed charter, effective July 29, 2015.
The original TMAC Charter was effective July 29, 2013.

Department of Homeland Security Federal Emergency Management Agency Technical Mapping Advisory Council

1. Committee's Official Designation:

Technical Mapping Advisory Council

2. Authority:

Pursuant to section 100215 of the Biggert-Waters Flood Insurance Reform Act of 2012, Public Law 112-141, 126 Stat. 924, 42 U.S.C. § 4101a ("the Act"), this charter establishes the Technical Mapping Advisory Council (TMAC or Council). This committee is established in accordance with and operates under the provisions of *the Federal Advisory Committee Act (FACA)* (Title 5, United States Code, Appendix).

3. Objectives and Scope of Activities:

The TMAC advises the Administrator of the Federal Emergency Management Agency (FEMA) on certain aspects of FEMA's flood Risk MAPping activities.

The TMAC recommends to the Administrator:

- A. How to improve in a cost-effective manner the:
 - 1. Accuracy, general quality, ease of use, and distribution and dissemination of flood insurance rate maps and risk data; and
 - 2. Performance metrics and milestones required to effectively and efficiently map flood risk areas in the United States.
- B. Mapping standards and guidelines for:
 - 1. Flood Insurance Rate Maps (FIRMs); and
 - 2. Data accuracy, data quality, data currency, and data eligibility;
- C. How to maintain, on an ongoing basis, FIRMs and flood risk identification; and
- D. Procedures for delegating mapping activities to State and local mapping partners.

The TMAC recommends to the Administrator and other Federal agencies participating in the Council:

- A. Methods for improving interagency and intergovernmental coordination on flood mapping and flood risk determination; and
- B. A funding strategy to leverage and coordinate budgets and expenditures across Federal agencies.

The TMAC submits an annual report to the Administrator that contains a description of the activities of the Council, an evaluation of the status and performance of FIRMs and mapping activities to revise and update FIRMs as required by the Act, and a summary of the activities of the Council. In addition, the TMAC must prepare written recommendations in a future conditions risk assessment and modeling report and submit the recommendations to the Administrator. Further, the Homeowner Flood Insurance Affordability Act (HFIAA) of 2014 requires additional flood mapping review requirements for the TMAC.

4. Description of Duties:

The duties of the TMAC are solely advisory in nature.

5. Official to Whom the Committee Reports:

The TMAC provides advice and recommendations to the Administrator of FEMA.

6. Support:

FEMA shall be responsible for providing financial and administrative support to the Council. Within FEMA, the Risk Analysis Division of the Federal Insurance and Mitigation Administration provides this support.

7. Estimated Annual Operating Costs and Staff Years:

The estimated annual operating cost associated with supporting TMAC's functions is estimated to be \$1,100,000 for FY2015 and \$800,000 for FY2016. This includes surge support for all direct and indirect expenses and 2.0 FTE of staff support. Adequate staffing within the annual operating cost estimate is required to support the TMAC.

8. Designated Federal Officer:

A full-time or permanent part-time employee of FEMA is appointed by the Administrator as the TMAC Designated Federal Officer (DFO). The DFO or an Alternate DFO approves or calls TMAC meetings, approves meeting agendas, attends all committee and subcommittee meetings, adjourns any meeting when the DFO determines adjournment to be in the public interest, and chairs meetings when requested in the absence of the Chair.

9. Estimated Number and Frequency of Meetings:

Meetings of the TMAC may be held with the approval of the DFO. The Council shall meet a minimum of two times each year at the request of the Chairperson or a majority of its members, and may take action by a vote of the majority of the members.

Council meetings are open to the public unless a determination is made by the appropriate DHS official in accordance with DHS policy and directives that the meeting should be closed in accordance with Title 5, United States Code, subsection (c) of section 552b.

10. Duration:

Continuing

11. Termination:

This charter is in effect for two years from the date it is filed with Congress unless sooner terminated. The charter may be renewed at the end of this two-year period in accordance with section 14 of FACA.

12. Member Composition:

Members of the Council are defined by Section 100215(b)(1), and include four designated members and sixteen appointed members.

The four designated members of the Council serve as Regular Government Employees and consist of:

- The FEMA Administrator or the designee thereof;
- The Secretary of the Interior or the designee thereof;
- The Secretary of Agriculture or the designee thereof; and
- The Under Secretary of Commerce for Oceans and Atmosphere or the designee thereof.

The sixteen additional members of the Council are appointed by the Administrator or designee. These members are appointed based on their demonstrated knowledge and competence regarding surveying, cartography, remote sensing, geographic information systems, or the technical aspects of preparing and using FIRMs.

To the maximum extent practicable, the membership of the Council will have a balance of Federal, State, local, tribal and private members, and include geographic diversity including representation from areas with coastline on the Gulf of Mexico and other States containing areas identified by the Administrator as at high risk for flooding or as areas having special flood hazard areas.

These members are selected from among the following professional associations or organizations:

- a. One member of a recognized professional surveying association or organization;
- b. One member of a recognized professional mapping association or organization;
- c. One member of a recognized professional engineering association or organization;
- d. One member of a recognized professional association or organization representing flood hazard determination firms;
- e. One representative of the United States Geological Survey;
- f. One representative of a recognized professional association or organization representing State geographic information;
- g. One representative of State national flood insurance coordination offices;
- h. One representative of the Corps of Engineers;
- i. One member of a recognized regional flood and storm water management organization;
- j. Two representatives of different State government agencies that have entered into cooperating technical partnerships with the Administrator and have demonstrated the capability to produce FIRMs;
- k. Two representatives of different local government agencies that have entered into cooperating technical partnerships with the Administrator and have demonstrated the capability to produce flood insurance maps;
- l. One member of a recognized floodplain management association or organization;
- m. One member of a recognized risk management association or organization; and
- n. One State mitigation officer.

The non-Federal members in a., b., c., d., i., l., m., and n. serve as Special Government Employees as defined in Title 18, United States Code, section 202(a). The members in e., and h., serve as Regular Government Employees. The non-Federal members in f., g., j., and k. serve as representatives of their respective

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associations or organizations and are not Special Government Employees as defined in Title 18 of United States Code, section 202(a).

The sixteen appointed members serve terms of office of two years. However, up to half (eight) of those initially appointed to the Council may serve one-year terms to allow for staggered turnover. Appointments may be renewed by the FEMA Administrator for an additional one- or two-year period. A member appointed to fill an unexpired term shall serve the remainder of that term and may be reappointed for an additional one- or two-year term. The Administrator has the authority to extend reappoints for an additional one- or two-year period as deemed necessary. In the event the Council terminates, all appointments to the Council will terminate.

13. Officers:

The Council membership shall elect any one member to serve as Chairperson of the Council. The Chairperson shall preside over Council meetings in addition to specific responsibilities authorized under the Act.

14. Subcommittees:

The DFO may establish subcommittees for any purpose consistent with this charter. Such subcommittees may not work independently of the chartered committee and must present their work to the TMAC for full deliberation and discussion. Subcommittees have no authority to make decisions on behalf of the TMAC and may not report directly to the Federal government or any other entity.

15. Recordkeeping:

The records of the TMAC, formally and informally established subcommittees, or other subgroups of the Council, shall be maintained and handled in accordance with General Records Schedule 26, Item 2 or other approved agency records disposition schedule.

16. Filing Date:

July 20, 2015
Department Approval Date

July 29, 2015
CMS Consultation Date

July 29, 2015
Date Filed with Congress

Appendix B

FEMA TMAC Bylaws

The FEMA TMAC Bylaws in Appendix B are the updated bylaws, effective April 29, 2015.
The original FEMA TMAC Bylaws were effective July 29, 2013.

**Federal Emergency Management Agency
Technical Mapping Advisory Council
Bylaws**

ARTICLE I AUTHORITY

As required by the *Biggert-Waters Flood Insurance Reform Act of 2012* (BW-12), codified at 42 United States Code Section 4101a, the Federal Emergency Management Agency (FEMA) Technical Mapping Advisory Council (TMAC) is established. The TMAC shall operate in accordance with the provisions of the *Federal Advisory Committee Act* (FACA), as amended (Title 5, U.S.C., Appendix).

ARTICLE II PURPOSE

The TMAC provides advice and recommendations to the Administrator of FEMA to improve the preparation of flood insurance rate maps (FIRM). Among its specified statutory responsibilities, TMAC will examine performance metrics, standards and guidelines, map maintenance, delegation of mapping activities to State and local mapping partners, interagency coordination and leveraging, and other requirements mandated by the authorizing BW-12 legislation. In addition, TMAC provides advice and recommendations to the FEMA Administrator on future risks from climate change, rising sea levels, and FIRM development, as mandated by BW-12. Further, the *Homeowner Flood Insurance Affordability Act* (HFIAA) of 2014 requires additional flood mapping review requirements for the TMAC.

ARTICLE III MEMBERSHIP AND MEMBER RESPONSIBILITIES

Section 1. Composition.

Members of the Council include designated members and additional members appointed by the FEMA Administrator or his designee. See 42 U.S.C. § 4101a.

The designated members of the Council are:

- The FEMA Administrator or the designee thereof;
- The Secretary of the Interior or the designee thereof;
- The Secretary of Agriculture or the designee thereof; and,
- The Under Secretary of Commerce for Oceans and Atmosphere or the designee thereof.

The appointed members may be selected from among the following professional associations or organizations:

- A member of a recognized professional surveying association or organization;
- A member of a recognized professional mapping association or organization;

- A member of a recognized professional engineering association or organization;
- A member of a recognized professional association or organization representing flood hazard determination firms;
- A representative of the United States Geological Survey;
- A representative of a recognized professional association or organization representing State geographic information;
- A representative of State national flood insurance coordination offices;
- A representative of the Corps of Engineers;
- A member of a recognized regional flood and storm water management organization;
- Two representatives of different State government agencies that have entered into cooperating technical partnerships with the Administrator and have demonstrated the capability to produce FIRMs;
- Two representatives of different local government agencies that have entered into cooperating technical partnerships with the Administrator and have demonstrated the capability to produce flood insurance maps;
- A member of a recognized floodplain management association or organization;
- A member of a recognized risk management association or organization;
- A State mitigation officer.

Subject Matter Experts/Technical Advisors: The TMAC may hear from subject matter experts/technical advisors (“SMEs”) who will be asked to provide specialized information or assistance as appropriate and approved by the Designated Federal Officer (DFO). Individual TMAC members may request SMEs, by expertise or skillset, to appear before the TMAC, as needed. Member requests will be made to the Chair for consideration and consultation with the TMAC Designated Federal Officer (DFO). FEMA will not compensate SMEs for their services but they may be reimbursed for travel and lodging expenses.

Section 2. Appointment.

With the exception of the Secretary of the Interior, Secretary of Agriculture, and Under Secretary of Commerce for Oceans and Atmosphere, members of TMAC are appointed by and serve at the pleasure of the FEMA Administrator in an advisory role. Membership is voluntary and members are not compensated for their services. Appointments are personal to the member and cannot be transferred to another individual. Members may not designate someone to attend in their

stead, participate in discussions, or vote. In compliance with FACA, members, while engaged in the performance of their duties away from their home or regular places of business, may be allowed travel expenses, including per diem in lieu of subsistence, as authorized by section 5703 of title 5, United States Code.

Section 3. Terms of Office.

Members of the TMAC may serve terms of office of two years; however, up to half of those initially appointed TMAC members may be appointed to serve one-year terms to allow for staggered turnover. The FEMA Administrator or his designee may reappoint serving members for additional terms. When the TMAC terminates, all appointments to the TMAC shall terminate.

Section 4. Certification of Non-Lobbyist Status.

All members of the TMAC must annually self-certify that they are not registered lobbyists under the *Lobbying Disclosure Act*, Title 2 U.S.C., Section 1603, and must advise the Department of Homeland Security (DHS) through the Federal Emergency Management Agency if they register as a lobbyist while serving on the TMAC. Members who register as a lobbyist after their appointment or re-appointment will be replaced on the Council.

Section 5. Members' Responsibilities.

Because the TMAC's membership is constructed to balance as many perspectives on floodplain mapping and future risk assessment as possible, member attendance and participation at meetings is vital to the TMAC's mission. Members are expected to personally attend and participate in Council, subcommittee meetings, and conference calls. Members will also be expected to provide written input to any final reports or deliverables.

The DFO or Chair may recommend to the FEMA Administrator that any appointed member unable to fulfill their responsibility be replaced on the Council or subcommittee. Members of the TMAC may be recommended for removal for reasons such as, but not limited to:

- a) Missing two consecutive meetings, including teleconference calls;
- b) Registering as a lobbyist after appointment; or,
- c) Engaging in activities that are illegal or violate the restrictions on members' activities as outlined below.

Section 6. Restriction on Members' Activities.

- a) Members may not use their access to the Federal Government as a member of this Council for the purpose of soliciting business or otherwise seeking economic advantage for themselves or their companies. Members may not use any non-public information obtained in the course of their duties as a member

for personal gain or for that of their company or employer. Members must hold any non-public information in confidence.

- b) The Council as a whole may advise FEMA on legislation or recommend legislative action. In their capacities as members of the TMAC, individual members may not petition or lobby Congress for or against particular legislation or encourage others to do so.
- c) Members of the TMAC are advisors to the agency and have no authority to speak for the Council, FEMA, or for the Department outside the Council structure.
- d) Members may not testify before Congress in their capacity as a member of the TMAC. If requested to testify before Congress, members of the TMAC:
 - 1. Cannot represent or speak for the Council, DHS, any agency, or the Administration in their testimony;
 - 2. Cannot provide information or comment on Council recommendations that are not yet publicly available;
 - 3. May state they are a member of the Council; and,
 - 4. May speak to their personal observations as to their service on the Council.
- e) If speaking outside the Council structure at other forums or meetings, the restrictions in Section (d) also apply.

ARTICLE IV OFFICIALS

Section 1. TMAC Leadership.

TMAC members will elect a Chair through a nomination and formal vote. (The FEMA Administrator, or his designee, shall serve in this capacity until a Chair is elected.) The Chair will be responsible for appointing one or more Vice Chairs. The Chair and Vice Chairs will serve for either a one or two year term, based on their initial appointment. Appointments may be renewed for an additional one-year term. No Chair or Vice Chair shall serve longer than three years. The Chair will select chairs for any subcommittee established. Only voting members can serve as subcommittee chairs.

Chair Responsibilities:

- a) Appoints officers to assist in carrying out the duties of the TMAC;
- b) Works with the DFO to develop meeting agendas;
- c) Sets and maintains a schedule for TMAC activities (e.g., report development);
- d) Works with the TMAC membership to develop the draft annual report;

- e) Signs the final reports addressed to the FEMA Administrator;
- f) Coordinates with the DFO to form subcommittees with assigned areas of consideration;
- g) Selects subcommittee chairs and vice chairs;
- h) Resolves member conflicts.

Vice Chair Responsibilities:

- a) Works with subcommittee chairs to ensure work is being completed;
- b) Coordinates member engagement;
- c) Assists Chair in conducting review of meeting minutes and recommendation reports;
- d) Elevates any unresolved issues to the Chair;
- e) Serves as Chair in absence of the Chair.

Subcommittee Chair Responsibilities:

- a) Works with the DFO to develop subcommittee meeting agendas;
- b) Facilitates subcommittee discussions;
- c) Reports to the Chair and Vice Chair; and
- d) Reports out subcommittee work at quarterly TMAC meetings.

Section 2. Designated Federal Officer.

The DFO serves as FEMA's agent for all matters related to the TMAC and is appointed by the FEMA Administrator. In accordance with the provisions of the FACA, the DFO must:

- a) Approve or call meetings of the Council and its subcommittees;
- b) Approve agendas for Council and subcommittee meetings;
- c) Attend all meetings;
- d) Adjourn meetings when such adjournment is in the public interest; and,
- e) Chair meetings of the Council when directed to do so by the FEMA Administrator.

In addition, the DFO is responsible for assuring administrative support functions are performed, including the following:

- a) Notifying members of the time and place of each meeting;
- b) Tracking all recommendations of the Council;
- c) Maintaining the record of members' attendance;

- d) Preparing the minutes of all meetings of the Council's deliberations, including subcommittee and working group activities;
- e) Attending to official correspondence;
- f) Maintaining official records and filing all papers and submissions prepared for or by the Council, including those items generated by subcommittees and working groups;
- g) Reviewing and updating information on Council activities in the Shared Management System (i.e., FACA database) on a monthly basis;
- h) Acting as the Council's agent to collect, validate and pay all vouchers for pre-approved expenditures; and
- i) Preparing and handling all reports, including the annual report as required by FACA.

ARTICLE V MEETING PROCEDURES

Section 1. Meeting Schedule and Call of Meetings.

TMAC will meet in plenary sessions approximately once or twice per quarter, with additional virtual meetings as needed, at the discretion of the DFO. The Council may hold hearings, receive evidence and assistance, provide information, and conduct research, as it considers appropriate, subject to resources being made available. With respect to the meetings, it is anticipated that some may be held via teleconference, with public call-in lines. TMAC meetings will be open to the public unless a determination is made by the appropriate FEMA official that the meeting should be closed in accordance with subsection (c) of section 552b of title 5, U.S.C.

Section 2. Agenda.

Meeting agendas are developed by the DFO in coordination with the TMAC chair. In accordance with the responsibilities under FACA, the DFO approves the agenda for all Council and subcommittee meetings, distributes the agenda to members prior to the meeting, and publishes the agenda in the Federal Register.

FEMA will publish the meeting notice and agenda in the Federal Register at least 15 calendar days prior to each TMAC meeting or official public conference call. Once published in the Federal Register, the agenda items cannot be changed prior to or during a meeting.

Section 3. Quorum.

A quorum of the TMAC is the presence of fifty percent plus one of the Council members currently appointed. In the event a quorum is not present, the TMAC may conduct business that does not require a vote or decision among members. Votes will be deferred until such time as a quorum is present.

Section 4. Voting Procedures.

When a decision or recommendation of the TMAC is required, the Chair will request a motion for a vote. A motion is considered to have been adopted if agreed to by a simple majority of a quorum of TMAC members. Members vote on draft reports and recommendations in open meetings through a resolution recorded in the meeting minutes. Only members present at the meeting—either in person or by teleconference—may vote on an item under consideration. No proxy votes or votes by email will be allowed.

Section 5. Minutes.

The DFO will prepare the minutes of each meeting and distribute copies to each Council member. Minutes of open meetings will be available to the public on the TMAC website at <http://www.fema.gov/TMAC>. The minutes will include a record of:

- a) The time, date, and place of the meeting;
- b) A list of all attendees including Council members, staff, agency employees and members of the public who presented or oral or written statements;
- c) An accurate description of each matter discussed and the resolution, if any, made by the Council;
- d) Copies of reports or other documents received, issued, or approved by the Council; and
- e) An accurate description of public participation, including oral and written statements provided.

The DFO ensures that the Chair certifies the minutes within 90 calendar days of the meeting to which they relate and prior to the next TMAC meeting.

Minutes of closed meetings will also be available to the public upon request subject to the withholding of matters about which public disclosure would be harmful to the interests of the Government, industry, or others, and which are exempt from disclosure under the *Freedom of Information Act* (FOIA) (5 U.S.C., section 552).

Section 6. Open Meetings.

TMAC meetings shall be open and announced to the public in a notice published in the Federal Register at least fifteen calendar days before the meeting. Members of the public may attend any meeting or portion of a meeting that is not closed to the public and, at the determination of the Chair and DFO, may offer oral comment at such meeting. Meetings will include a period for oral comments unless it is clearly inappropriate to do so. Members of the public may submit written statements to the TMAC at any time. All materials provided to the

Council shall be available to the public when they are provided to the members. Such materials, including any submissions by members of the public, are part of the meeting record.

Section 7. Closed Meetings.

All or parts of TMAC meetings may be closed in limited circumstances and in accordance with applicable law. No meeting may be partially or fully closed unless the component head issues a written determination that there is justification for closure under the provisions of subsection (c) of 5 United States Code 552b, the *Government in the Sunshine Act*. Where the DFO has determined in advance that discussions during a Council meeting will involve matters about which public disclosure would be harmful to the interests of the government, industry, or others, an advance notice of a closed meeting, citing the applicable exemptions of the *Government in the Sunshine Act*, will be published in the Federal Register.

The notice may announce the closing of all or just part of a meeting. If, during the course of an open meeting, matters inappropriate for public disclosure arise during discussions, the DFO or Chair will order such discussion to cease and will schedule it for a future meeting of the Council that will be approved for closure. No meeting or portion of a meeting may be closed without prior approval and notice published in the Federal Register at least 15 calendar days in advance. Closed meetings can only be attended by DFO, Council members, and necessary agency staff members. Presenters must leave immediately after giving their presentations and answering any questions.

Section 8. Other Meetings, No Public Notice Required.

Public notice is not required for meetings of administrative or preparatory work. Administrative work is a meeting of two or more TMAC or subcommittee members convened solely to discuss administrative matters or to receive administrative information from a Federal officer or agency. Preparatory work is a meeting of two or more TMAC or subcommittee members convened solely to gather information, conduct research, or analyze relevant issues and facts in preparation for a TMAC meeting or to draft position papers for consideration by the TMAC.

ARTICLE VI EXPENSES AND REIMBURSEMENTS

Expenses related to the operation of the TMAC will be paid by the Federal Insurance and Mitigation Administration. Expenditures of any kind must be approved in advance by the DFO. All such expense reports will be sent to the DFO for action and reimbursement. The DFO will be responsible for handling the payment of expenses. Members are responsible for submitting expense reports by the deadlines set by the DFO or they may not be reimbursed. The DFO will be responsible for developing the procedures for expense reimbursement.

ARTICLE VII ADMINISTRATION

The Federal Insurance and Mitigation Administration shall be responsible for providing financial and administrative support to the TMAC subject to the availability of appropriations.

ARTICLE VIII SUBCOMMITTEES

Section 1. Establishment of subcommittees.

The DFO may establish standing subcommittees with an overarching mission to work on specific focus areas and provide advice to the TMAC on a continuing basis. The DFO may also establish ad-hoc subcommittees to work and report on specific focus areas. The number, designation, mission, scope, and membership of subcommittees are determined by the DFO in consultation with the Chair and Vice Chairs. The Chair may also request of the DFO to establish (or reorganize) a subcommittee. The creation and operation of the subcommittees must be approved by the DFO on behalf of FEMA.

Subcommittee Members: TMAC subcommittees may consist of TMAC members and non-TMAC members as limited below. TMAC members will be named to serve on a specific subcommittee and may contribute to others as requested. It is mandatory that each TMAC member participate on at least one subcommittee and be a full and active participant in subcommittee deliberations.

Subcommittees will not function independently of the TMAC or provide advice or recommendations directly to FEMA. Subcommittees (standing and ad-hoc) must present all advice, recommendations, and reports to the full TMAC during a public meeting or teleconference for discussion, deliberation, and final approval. Each Subcommittee must be comprised of a majority of TMAC members.

In general, the requirements of FACA do not apply to subcommittees of advisory committees that report a parent advisory committee and not directly to a Federal officer or agency. However, minutes must be maintained for the public record and the DFO and/or ADFO must participate in all subcommittee proceedings.

Section 2. Membership.

Subcommittee membership should be balanced in relation to the subcommittee's mission and focus areas. The DFO and the Chair, with input from Council members, identify and determine the membership for the subcommittee, including a chair (and vice chair if deemed necessary). As noted above, each Subcommittee must be comprised of a majority of TMAC members.

Subcommittee chairs may request the DFO to invite non-TMAC individuals to serve on the subcommittee, as necessary. Only TMAC members may serve as the chair or vice chair of a subcommittee (standing or ad-hoc). The subcommittee chair can also advise the DFO that briefings from external subject matter experts are needed to provide pertinent and vital information not available among the

current TMAC membership or from Federal staff. All such requests shall be made to the DFO who will facilitate the process to obtain subject matter expertise.

Section 3 Subcommittee Quorum

A Subcommittee quorum consists of: (1) the presence (either in person or by teleconference) of fifty percent plus one of TMAC members currently appointed to the Subcommittee; and (2) TMAC members make up more than half of the Subcommittee members present. In the event a Subcommittee quorum is not present, the Subcommittee may conduct business that does not require a vote or decision among members. Votes will be deferred until such time as a quorum is present.

Section 4 Subcommittee Voting Procedures

When a decision or recommendation of the Subcommittee is required, and a Subcommittee Quorum as defined above is present, the Subcommittee Chair will request a motion for a vote. A motion is considered to have been adopted if agreed to by a simple majority of the TMAC Subcommittee members present. Members vote on draft reports and recommendations that will be presented to the full TMAC. Only members present at the meeting—either in person or by teleconference—may vote on an item under consideration. No proxy votes or votes by email will be allowed.

Section 5. Focus Areas

Focus Areas are identified areas of consideration for the Council to review, either via subcommittee or by the TMAC through discussion as an entire body. The DFO will determine focus areas in consultation with the TMAC Chair. The DFO will then work with the Chair and Vice Chair to identify whether the focus area should be assigned to a standing subcommittee, an ad hoc subcommittee; or submitted to the TMAC for discussion and review.

Section 6. Workload and meetings.

Subcommittees may have more than one focus area to address. Subcommittee chairs will recommend the appropriate number of conference calls necessary to address focus areas, working in coordination with the DFO.

The subcommittee chair determines what materials are needed to prepare a response and develop a report to the TMAC. The DFO will supply the requested materials to the TMAC subcommittee upon request and resource availability.

ARTICLE IX RECOMMENDATIONS AND REPORTING

P.L. 112-141 directs TMAC to submit an annual report to the Administrator that contains a description of the activities of the Council; an evaluation of the status and performance of flood insurance rate maps and mapping activities to revise and update flood insurance rate maps; and a summary of recommendations made by the Council to the Administrator.


Once the TMAC achieves consensus on a report and recommendations, the TMAC Chair is responsible for providing a final version of the report to the FEMA Administrator. The final report and any accompanying memoranda will be posted on the TMAC website.

ARTICLE X RECORDKEEPING

The DFO maintains all records of the advisory Council in accordance with FACA and FEMA policies and procedures. All documents, reports, or other materials presented to, or prepared by or for the Council, constitute official government records and are available to the public upon request.

ARTICLE XI BYLAWS APPROVAL AND AMENDMENTS

The DFO may amend these bylaws at any time, and the amendments shall become effective immediately upon approval.



Mark Crowell
Designated Federal Officer

Date approved: 4/29/15

Appendix C

2014-2015 TMAC Meetings

Table C-1: 2014–2015 TMAC Meetings

Meeting Date	Location	Business Purpose
September 10, 2014	Virtual (closed to the public)	The TMAC conducted an administrative meeting to kick off future efforts by informing the TMAC members of requirements under authorizing legislation, member roles and responsibilities, legal and ethical statutes governing member activities, and next steps for the first in-person meeting.
September 30-October 1, 2014	USGS, Reston, Virginia	The TMAC voted, elected, and announced their Chair, Mr. John Dorman. TMAC members also discussed legislative requirements and received subject matter expert (SME) briefings that helped establish the TMAC’s baseline understanding of the current status of the mapping program.
December 4-5, 2014	FEMA, Arlington, Virginia	The TMAC deliberated and voted upon its vision, mission and guiding principles and received SME briefings such as overall flood management process and components, data acquisition, maintenance, and dissemination, and future conditions risk to insurance rating.
March 10-11, 2015	USGS, Reston, Virginia	The TMAC deliberated and voted upon topics to be included in the 2015 Annual Report and the Future Conditions Report. TMAC members also received SME briefings such as how FEMA uses flood risk to calculate insurance ratings, floodplain management and the Flood Insurance Advocate, and State and local cooperating technical partner methods.
May 12-13, 2015	USGS, Reston, Virginia	The TMAC deliberated and voted to adopt outlines / table of contents for the 2015 Annual Report and the Future Conditions Report.
June 23-24, 2015	NOAA, Silver Spring, Maryland	The TMAC deliberated and voted upon the annotated outlines for the 2015 Annual Report and the Future Conditions Report. TMAC members also received SME briefings such as progress on the FEMA Flood Insurance Reform Flood Mapping Integrated Project Team and a tribal perspective.
August 4-5, 2015	USGS, Reston, Virginia	The TMAC deliberated on draft recommendations and narratives for potential infusion in the 2015 Annual Report and the Future Conditions Report.
September 9, 2015	Virtual	The TMAC reviewed, commented, and deliberated on draft recommendations and narratives for incorporation into the 2015 Annual Report and the Future Conditions Report.
September 29, 2015	Virtual	The TMAC reviewed, commented, and deliberated draft recommendations and narratives for incorporation into the 2015 Annual Report and the Future Conditions Report.
October 20-21, 2015	USGS, Reston, Virginia	The TMAC reviewed, commented, and deliberated draft recommendations and narratives for incorporation into the 2015 Annual Report and the Future Conditions Report.

Appendix D

Annual Report Subcommittee Meetings

Table D-1: Flood Hazard and Risk Generation Subcommittee Meetings

Meeting Date	Business Purpose
January 28, 2015	Subcommittee Kickoff
February 17, 2015	Discuss report section draft
February 25, 2015	To discuss report topics
March 3, 2015	To receive a SME briefing on NFIP Coastal Analysis and Mapping Overview.

Table D-2: Operations, Coordination, and Leveraging Subcommittee Meetings

Meeting Date	Business Purpose
January 30, 2015	To discuss the 2015 Report needs
February 19, 2015	To discuss the 2015 Report needs
March 6, 2015	To discuss flood determination
March 10, 2015	To discuss the report Table of Contents

Table D-3: Annual Report Subcommittee Meetings

Meeting Date	Business Purpose
March 10, 2015	To discuss the Annual Report Table of Contents
April 8, 2015	To receive an SME briefing on quality assurance for FEMA coastal flood risk studies
April 27, 2015	To receive a SME briefing on LIDAR technology
May 1, 2015	To receive an SME briefing on how FEMA uses flood map data to make flood determinations
May 7, 2015	To prepare for the May 12-13, 2015, TMAC meeting

Appendix E

Subject Matter Expert Presentations

Table E-1: Subject-Matter Expert Presentations

Date	Presenter	Presented to	Title
September 30, 2014	Mr. David Bascom Program Specialist, Risk Analysis Division, FEMA	TMAC	TMAC Priorities, Duties, and Reports
September 30, 2014	Mr. Joshua Smith Program Specialist, Business Analysis Branch, FEMA Ms. Kelly Bronowicz Program Specialist, Data and Dissemination Management Branch, FEMA Mr. Luis Rodriguez, P.E. Branch Chief, Engineering Management Branch, Federal Insurance and Mitigation Administration, FEMA	TMAC	Performance Metrics and Milestones Required to Effectively and Efficiently Map Flood Risk Areas
September 30, 2014	Mr. Michael Godesky Physical Scientist, FEMA	TMAC	FIRM Accuracy, Quality, Ease of Use, Distribution, and Dissemination
September 30, 2014	Mr. Paul Rooney Mapping Technology Specialist, FEMA	TMAC	Data Accuracy, Data Quality, Data Currency, and Data Eligibility
October 1, 2014	Mr. Mark Crowell Physical Scientist, FEMA Mr. Andy Neal Actuary, Risk Insurance Division, FEMA Ms. Rachel Sears Senior Policy Advisor, FEMA	TMAC	Future Conditions Risk Assessment and Modeling
October 1, 2014	Mr. Rick Sacbabit, P.E. Program Specialist, FEMA	TMAC	Maintaining, on an Ongoing Basis, Flood Insurance Rate Maps and Flood Risk Identification
October 1, 2014	Ms. Laura Algeo, P.E., CFM Senior Civil Engineer, FEMA Region IV	TMAC	Delegating Mapping Activities to State and Local Mapping Partners
December 4, 2014	Mr. Andy Read, CFM, EIT Program Specialist, FEMA	TMAC	Risk MAP: Flood Map Production
December 4, 2014	Ms. Vicki Lukas Chief, Topographic Data Services, USGS	TMAC	Data Acquisitions; Maintenance and Dissemination
December 4, 2014	Mr. Amar Nayegandhi, CP, CMS (RS), GISP Director of Remote Sensing, Dewberry	TMAC	Data Acquisitions; Maintenance and Dissemination
December 4, 2014	Mr. Jerad Bales Chief Scientist for Water, USGS	TMAC	Information for Understanding Current and Future Streamflow Conditions

December 2015

Date	Presenter	Presented to	Title
December 4, 2014	Mr. Douglas Marcy Coastal Hazards Specialist, National Oceanic and Atmospheric Administration Mr. Steve Gill Chief Scientist, Center for Operational Products and Services, NOAA Mr. Adam Parris Division Chief, Climate Assessment and Services Division, NOAA	TMAC	NOAA Sea Level Change Measurement and Future Sea Level Rise Scenarios
December 4, 2014	Mr. Paul Kovacs Executive Director, Institute for Catastrophic Loss Reduction, Western University	TMAC	Risk to Insurance Rating
December 4, 2014	Mr. Richard Fogleman Technical Director, Geographic Information Systems, AECOM	TMAC	Database, Mapping, and Digital Display
December 4, 2014	Mr. Eric Berman, GISP Hazus Program Manager, FEMA	TMAC	Risk Assessment and Mapping
December 4, 2014	Mr. David Key, PE, CFM Director, Water Resources, GIS and Applications, ESP Associates, P.A.	TMAC	Risk Assessment Processes
December 4, 2014	Ms. Tucker Mahoney Coastal Program Specialist, FEMA	TMAC	Key Decision Points
December 5, 2014	Dr. Ty Wamsley Division Chief, Flood & Storm Protection Division, US Army Engineer Research & Development Center, Coastal & Hydraulics Laboratory, ERDC	TMAC	USACE R&D: Development of Tools for the Future of Flood Inundation Prediction
December 5, 2014	Ms. Erin Cobb, CFM Program Specialist, FEMA	TMAC	Current and Future Possibilities: Delegation
December 5, 2014	Mr. Chad Berginnis Executive Director, Association of State Floodplain Managers (ASFPM)	TMAC	Current and Future Possibilities: Delegation
December 5, 2014	Ms. Sally Ann McConkey, P.E., CFM, D. WRE Illinois State Water Survey Prairie Research Institute, University of Illinois	TMAC	Examples of Next Generation Flood Risk Management
December 5, 2014	Ms. Carrie Grassi Deputy Director for Planning, New York City Mayor's Office of Recovery and Resiliency	TMAC	New York City Resiliency Briefing

December 2015

Date	Presenter	Presented to	Title
December 5, 2014	Mr. Ken Ashe, P.E., PMP, CFM Assistant Director, North Carolina Floodplain Mapping Program	TMAC	Examples of Next Generation Flood Risk Management
February 27, 2015	Mr. Ed Curtis, P.E., CFM FEMA Region IX Mr. Darryl Hatheway, CFM Baker AECOM	Future Conditions Subcommittee	FEMA West Coast Sea Level Rise Pilot Study
February 27, 2015	Ms. Heidi Moritz, P.E. Coastal Engineer, Climate Preparedness and Resilience Community of Practice, USACE	Future Conditions Subcommittee	Tiered Approach to the Assessment of Sea Level Change at USACE Projects and the Development of Adaptation Measures for the Future
February 27, 2015	Dr. Brian K. Batten, CFM Senior Coastal Scientist/ Project Manager, Coastal and Resiliency Services, Dewberry	Future Conditions Subcommittee	Case Studies of SLR and Floodplain Mapping
March 3, 2015	Mr. Jonathan Westcott, P.E. Coastal Hazards Specialist, Federal Emergency Management Agency	Flood Hazard Subcommittee Operations, Coordination and Leveraging Subcommittee	NFIP Coastal Analyses and Mapping Overview for the TMAC Subcommittee Meeting
March 10, 2015	Mr. Andy Neal Actuary, Risk Insurance Division, FEMA	TMAC	Flood Risk to Insurance Rating
March 10, 2015	Mr. David Stearrett Interim Flood Insurance Advocate, FEMA	TMAC	Floodplain Management and the Federal Flood Risk Management Standard
March 10, 2015	Mr. Michael Talbott, P.E., D.WRE Executive Director, Harris County Flood Control District	TMAC	Cooperating Technical Partners (CTP) Presentation
March 10, 2015	Ms. Leslie Durham, P.E. Floodplain Management Branch Chief, Office of Water Resources, Alabama Department of Economic and Community Affairs	TMAC	National Flood Mapping Program: A State CTP Perspective
March 10, 2015	Mr. David Mallory, P.E., CFM Program Manager, Floodplain Management Program, Urban Drainage and Flood Control District, Denver, CO	TMAC	Cooperating Technical Partnership Presentation, Urban Drainage and Flood Control District
March 20, 2015	Dr. Timothy Cohn Hydrologist, USGS Office of Surface Water	Future Conditions Subcommittee	Effects of Climate Change on Riverine Hydrology

December 2015

Date	Presenter	Presented to	Title
March 20, 2015	Dr. Martyn Clark Scientist III, Hydrometeorological Applications Program at the National Center for Atmospheric Research (NCAR)	Future Conditions Subcommittee	Effects of Climate Change on Riverine Hydrology
March 26, 2015	Dr. Philip Orton Research Assistant Professor, Stevens Institute of Technology	Future Conditions Subcommittee	Hydrodynamic Modeling of Future Coastal Flood Hazards for New York City
April 3, 2015	Dr. Robert Kopp Earth System Science & Policy Research Group, Rutgers University	Future Conditions Subcommittee	Uncertainties and risks of regional sea- level change
April 8, 2015	Mr. Stephen R. Kalaf, CFM Special Mapping and Quality Services Department Manager, Dewberry LLC	Annual Report Subcommittee	Quality Management in Risk MAP
April 27, 2015	Mr. Michael Bremer, CFM NFDA Director, Technical Mapping Committee Chair, Director of Operations CoreLogic Flood Services	Annual Report Subcommittee	Use of FEMA Flood Map Data to Make Flood Determinations
April 27, 2015	Mr. Jason Stoker Physical Scientist and Elevation Products and Services Manager, USGS National Geospatial Program	Annual Report Subcommittee	LIDAR Technology
May 12, 2015	Mr. Paul Rooney Program Specialist, FEMA	TMAC	Database-Driven/ All Digital Display – Status/ Transition
May 12, 2015	Mr. Michael Bremer, CFM NFDA Director, Technical Mapping Committee Chair, Director of Operations CoreLogic Flood Services	TMAC	Lending and Insurance Perspective
May 13, 2015	Mr. Michael DePue, P.E., CFM Principal Technical Professional, STARR II, Atkins Global	TMAC	Map Generation: Workflow Process
June 23, 2015	Ms. March Runner Tribal Administrator, Loudon Tribal Council	TMAC	Tribal Perspective
June 23, 2015	Mr. David Bascom Program Specialist, FEMA Mr. Paul Rooney Program Specialist, FEMA	TMAC	FEMA Flood Insurance Reform Flood Mapping Program Integrated Project Team Progress

