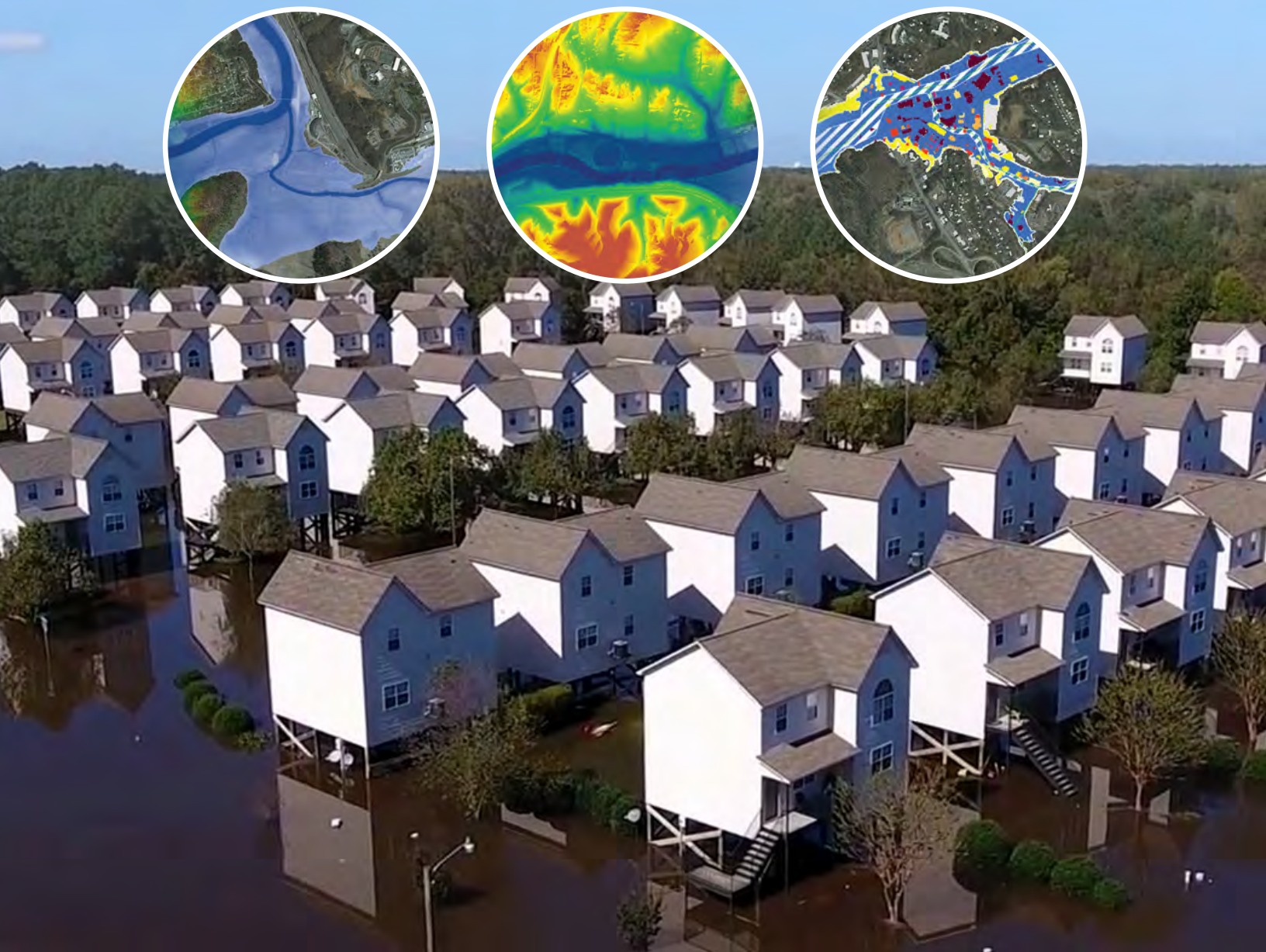
TMAC

TECHNICAL MAPPING ADVISORY COUNCIL

Annual Report

December 2017



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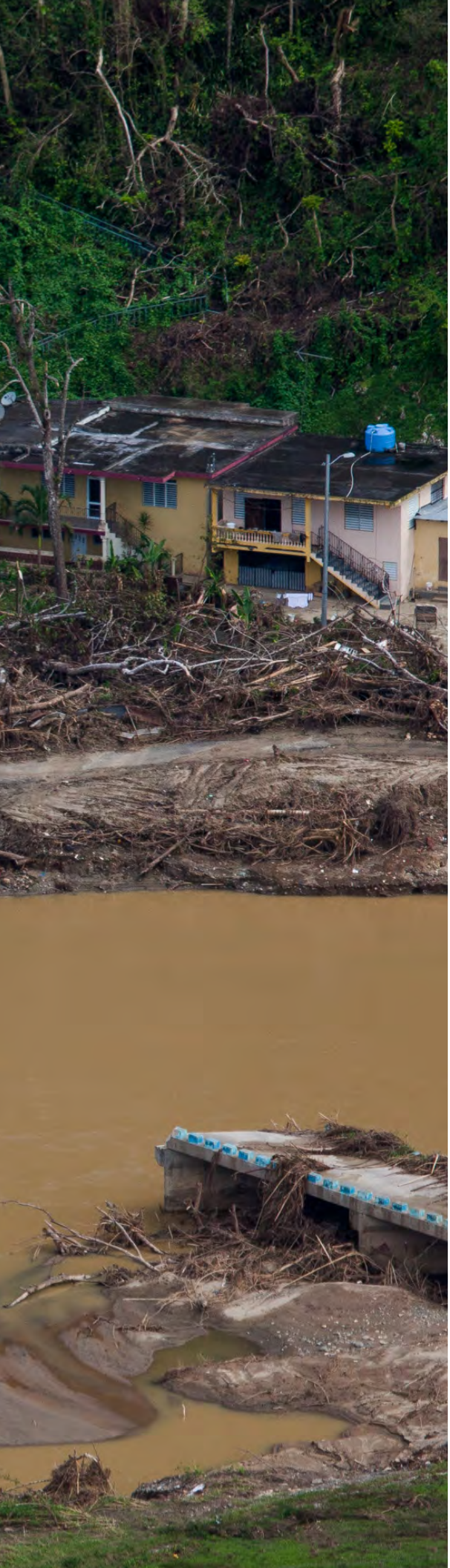

Executive Summary

As 2017 comes to an end and the Nation continues to suffer from the unprecedented impacts of Hurricane Harvey, Hurricane Irma, and Hurricane Maria, the importance of reaching the National Preparedness Goal has never been clearer—to become "a secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to and recover from the threats and hazards that pose the greatest risk."

In 2017, the Technical Mapping Advisory Council (TMAC) entered its third year as a Federal Advisory Council recommending ways to improve flood hazard and risk information to help achieve the National Preparedness Goal. For the TMAC, the key to becoming more resilient to flooding is the National Flood Mapping Program, which identifies areas that are at risk of flooding and determines level of risk. Decision makers use the hazard and risk information to manage development in floodplains, mitigate flood risk, communicate flood risk to the public, and administer flood insurance.

In 2015, the TMAC delivered its initial recommendations on improving the National Flood Mapping Program[1] and ensuring that the Federal Emergency Management Agency (FEMA) uses the best available climate science and methodology to address the impacts of sea level rise (SLR) and future development on flood risk.[2] In 2016, the TMAC delivered a review of the National Flood Insurance Program (NFIP),[3] a response to FEMA's request to prioritize the TMAC's recommendations, and new recommendations and implementation actions (IAs).[4]

In 2017, FEMA asked the TMAC to address floodplain management, residual risk, and future conditions, three key topics in the evolution of the National Flood Mapping Program and the future of flood mapping for the NFIP (see Table ES-1).

1 TMAC, *TMAC Annual Report* (2015), https://www.fema.gov/media-library/assets/documents/111853.
2 TMAC, *Future Conditions Risk Assessment and Modeling* (2015), https://www.fema.gov/media-library/assets/documents/111853.
3 TMAC, *National Flood Mapping Program Review* (2016) https://www.fema.gov/media-library-data/1474555532007-c063547f6f48026feb68c4bcfc41169d/TMAC_2016_National_Flood_Mapping_Program_Review_Updated.pdf.
4 TMAC, *TMAC 2016 Annual Report* (2016), https://www.fema.gov/media-library-data/1492803841077-57e4653a1b2de856e14672e56d6f0e64/TMAC_2016_Annual_Report_(508).pdf.

Table ES-1: FEMA's 2017 Tasks for TMAC

TOPIC	ISSUE	TMAC TASK
Floodplain Management	Floodplain management and mitigation impacts of transitioning away from the 1-percent-annual-chance flood hazard.	As FEMA moves away from mapping the 1-percent-annual-chance flood hazard and evolves the National Flood Mapping Program to provide structure-specific risk, what are the cascading impacts, issues, and opportunities that FEMA should consider from a floodplain management and mitigation perspective? What mapping tools will be needed to support floodplain management? Is the floodway concept still relevant? If we no longer mapped the floodway, how would floodplain management standards be enforced?
Residual Risk	The National Flood Mapping Program must purposely and strategically enhance, replace, and add flood hazard mapping products in the coming years to support a redesign of the flood risk rating structure for the NFIP and to enhance understanding of risk at a more granular level. The most significant gaps are currently in areas affected by levees, dams, and other embankments, as well as areas subject to event-driven erosion.	As FEMA takes on the challenge of delivering flood hazard data that support more robust flood risk rating, how can FEMA more effectively deliver, display, and communicate the hazards that drive credible risk assessments in the following areas? • Residual risk impacted by dams, levees, or other manmade structures • Areas of changing risk due to event-driven coastal erosion What related work of other Federal or State agencies and the private sector should be considered or should inform FEMA's approaches?
Future Conditions	TMAC's 2015 *Future Conditions Risk Assessment and Modeling* report (Future Conditions report) raised significant issues and opportunities. Many players exist in the development and dissemination of future conditions information, including Federal agencies, non-governmental organizations, States, and others. Perspective on the role of all players in the field of future conditions and gaps that remain in the development and dissemination of this information to stakeholders of the NFIP is needed.	Given the current datasets and tools currently being produced by various Federal agencies and non-Federal entities, what additional tools, data, and resources can FEMA provide with respect to future conditions that would be useful to our customers and stakeholders?

Source: Roy Wright, FEMA 2017 TMAC Tasking Memo

The TMAC responded by developing recommendations and implementation actions intended to further strengthen FEMA's evolving National Flood Mapping Program, reduce risk, and help keep the Nation safe (see Table ES-2).

Table ES-2: 2017 Recommendations and Implementation Actions

TOPIC	RECOMMENDATION
Floodplain Management	**TMAC Recommendation Annual Report (AR) 25** As FEMA transitions away from the 1-percent-annual-chance line, a risk score for existing and proposed structures should be developed. Each structure should be assigned a current conditions risk score and a future conditions risk score. **Implementation Action 25.1** FEMA should perform pilot projects utilizing risk scores to determine the best data and methods to accurately calculate structure-specific risk for floodplain management for existing and new structures.
	TMAC Recommendation AR 26 FEMA should coordinate with floodplain managers and mitigation planners to identify and test data and tools needed to support floodplain management and mitigation as it moves away from the 1-percent-annual-chance line. **Implementation Action 26.1** FEMA should perform pilot projects to understand the implications and opportunities for floodplain management in regard to moving to risk scores and determine other relevant data. **Implementation Action 26.2** FEMA should perform pilot projects to determine possible alternatives or modifications to the floodway concept.
	TMAC Recommendation AR 27 FEMA should develop, in coordination with stakeholders, a transition plan for moving away from the 1-percent-annual-chance flood line.
Residual Risk	**TMAC Recommendation AR 28** FEMA should develop a series of mapping prototype products aimed at more effectively communicating residual flood risk related to levees, dams, and event-driven coastal erosion. Products developed should incorporate end user and stakeholder testing, and FEMA should develop standards for routine production and presentation, if applicable. **Implementation Action 28.1** FEMA should conduct pilot projects with communities and other stakeholders to evaluate how effective the prototypes are at communicating residual risk. **Implementation Action 28.2** Once prototypes are developed and evaluated, FEMA should leverage the existing flood study process and other community engagement touchpoints to communicate residual risk. **Implementation Action 28.3** FEMA should refine existing non-regulatory products and develop new non-regulatory products to clarify coastal flood risks in the vicinity of erodible features, and highlight the spatial areas affected by event-driven coastal erosion and Primary Frontal Dune delineation. Possible products include: • Delineation of model results in the vicinity of the eroded Primary Frontal Dune • Representation of the regulatory flood zones in the absence of an erodible dune feature

TOPIC	RECOMMENDATION
Future Conditions	**TMAC Recommendation AR 29** FEMA should initiate stakeholder needs assessments to identify end users' highest priority needs for future conditions products and services that support its current flood-related program and its evolution over time. **Implementation Action 29.1** FEMA should engage a broad array of Federal, State, Tribal, and community-level stakeholders; private-sector stakeholders; and partners throughout the design, planning, execution, and interpretation of the Needs Assessment. **Implementation Action 29.2** FEMA should ensure that the Needs Assessment collects information on users' intended applications and addresses key analytical variables, such as relevant timeframe(s), spatial resolution, level of study, future conditions scenarios (e.g., land use, erosion, sea level rise), product type, uncertainty, and visualization preferences. **Implementation Action 29.3** FEMA should integrate an ongoing future conditions needs gathering step as part of the standard flood study process and during other local community engagement touchpoints, and use information gained to adapt FEMA's products to respond to evolving user needs and advancements in science and technology.

The TMAC's 2017 recommendations fit in context with the TMAC's recommendations and goals, which are listed in Figure ES-1.

See Table ES-3 for a complete list of the *TMAC's Recommendations and Implementation Actions*, 2015–2017. The list conforms with FEMA's request to associate IAs with the recommendations they are associated with and to renumber the IAs accordingly to enable easier reference and tracking. Former and new numbering systems for all previously identified IAs and sub-recommendations are provided in Table ES-3.

GOAL 1: ACCURATE DATA, MODELS, AND RISK ASSESSMENTS

AR 2
Develop National program 5-year plan.

AR 3
Develop National program goals and metrics.

AR 4
Work with partners to ensure topo data is collected to Federal standards.

AR 5
Document HV accuracy of topo data.

AR 6
Review updated statistical models (Bulletin 17C).

AR 7
Develop guidance for selection and use of riverine and coastal models.

AR 8
Develop guidance related to coastal 2D storm surge modeling.

AR 9
Update coastal event-based erosion methods.

FC 1
Provide future conditions flood risk products using standardized timeframes.

FC 2
Identify and quantify accuracy and uncertainty of data.

FC 3
Provide flood hazard products for coastal areas that includes erosion and SLR using scenario approach.

FC 4
Provide flood hazard products for riverine areas that includes future conditions.

FC 5
Generate future conditions data to frame and communicate messages.

FC 6
Perform demonstration projects.

FC 7
Future conditions should be consistent with existing conditions analysis and future conditions scenarios.

PR 1
FEMA should adopt TMAC's 2015 recommendations that relate to the National Flood Mapping Program's technical credibility from the TMAC 2015 Annual Report.

PR 2
FEMA should adopt the future conditions recommendations from the 2015 TMAC Future Conditions Risk Assessment and Modeling report.

PR 3
FEMA should complete the implementation of the statutory requirements of the National Flood Mapping Program.

PR 4
FEMA should continue to enhance communication and transparency with program stakeholders by, for example, including organizational and contact information on the Internet.

GOAL 1 (continued)

PR 5
FEMA should investigate offering multi-year program management grant periods (versus annual) to Cooperating Technical Partnerships (CTPs).

PR 6
FEMA should facilitate, partner, and leverage current high resolution topographic data (e.g., Light Detection and Ranging [LiDAR] data, other new and emerging technologies).

PR 7
FEMA should work with Congress and MAPPING partners to examine ways to shorten the study process, including the time added to the mapping process by QRs, KDPs, and legislated due process, as identified in Recommendation 11 in the *TMAC 2015 Annual Report*.

PR 8
FEMA should move to a database-derived display, as outlined in the TMAC 2015 Annual Report Recommendation 16.

PR 9
FEMA should work to identify residual risk areas behind levees, and other flood control structures and downstream of dams.

PR 10
For non-accredited levees, FEMA should replace the Zone D designation in levee-protected areas with risk zones that are more appropriate for the level of risk.

PR 11
FEMA should evaluate the current metrics to better measure the efficient production, valid inventory, and stakeholder acceptance of the National Flood Mapping Program.

PR 12
FEMA should have an inventory metric that reports quantity, quality, and time aspects on national, regional, tribal, state, and watershed levels.

PR 13
FEMA should have a metric that shows progress towards meeting a digital platform goal by area of the nation to complement FEMA's current population metrics. This metric could include the total area of the country, as well as progress towards Goal 3 and Recommendation 16 in the TMAC 2015 Annual Report.

PR 14
FEMA should evaluate the benefits and costs and its value to the nation as a result of different levels of funding to the National Flood Mapping Program.

AR 23 (2016 Annual Report)
FEMA should develop, in conjunction with others in the public and private sectors, flood risk-rated insurance premiums for all structures within and outside the identified Special Flood Hazard Area. These premiums should be based on the nature and severity of the flood hazard, and structure elevation and other characteristics, as well as structure damage functions and vulnerability.

AR 24 (2016 Annual Report)
FEMA should communicate to the property owner and the relevant interested parties on the cost of risk-rated insurance today and over time for new and existing structures to make the risk transparent. The data should include the benefits and cost that mitigation measures will have on these premiums.

Figure ES-1: TMAC Goals and Recommendations 2015-2016

GOAL 2: TIME AND COST-EFFICIENT GENERATION OF DATA

AR 11
Update MIP to add greater flexibility.

AR 12
Determine cost impact due to new program requirements.

AR 13
Integrate process for mass LiDAR-based LOMA.

GOAL 3: UTILIZATION OF COST-EFFICIENT TECHNOLOGIES

AR 16
Transition to database-derived, digital display environment.

GOAL 4: INTEGRATED FLOOD RISK MANAGEMENT FRAMEWORK

AR 10
Transition to structure-specific flood frequency .determination.

AR 14
Transition to structure-specific risk assessment.

GOAL 5: AWARENESS OF FLOOD HAZARD AND RISK DATA

AR 1
Implement process to assess needs of users.

AR 15
Communicate messages that consider long-term resilience strategies.

GOAL 6: ADDED VALUE PARTNERING AND LEVERAGING

AR 17
Consider NAPA recommendations on agency cooperation and federation.

AR 18
Partner to ensure availability of accurate water level and stream flow data and enhance the NHD.

AR 19
Implement strategies to incentivize stakeholders to increase partnerships.

AR 20
Develop measures to evaluate CTP capabilities and competencies and increase responsibilities.

AR 21
Establish National Flood Hazard Risk Management Coordination Committee.

GOAL 7: PERMANENT, SUBSTANTIAL PROGRAM FUNDING

AR 22
Define financial needs to implement recommendations.

KEY

Recommendation Sources:

AR	TMAC Annual Report (2015) or TMAC 2016 Annual Report
FC	TMAC Future Conditions Risk Assessment and Modeling (2015)
PR	TMAC National Flood Mapping Program Review (2016)

Acronyms:

CTP	Cooperating Technical Partner
FEMA	Federal Emergency Management Agency –
GIS	Geographic Information Systems
KDP	Key Decision Point
LiDAR	Light Detection and Ranging
NAPA	National Academy of Public Administration
NFIP	National Flood Insurance Program
NHD	National Hydrography Dataset
QR	quality review
Risk MAP	Risk Mapping, Assessment, and Planning
SLR	sea level rise
TMAC	Technical Mapping Advisory Council

Transformation of Mapping

INITIATIVES

Structure-Based Risk Assessments

BENEFIT: Transform the NFIP to protect current and future generations

National Program 5 Year Plan

BENEFIT: Increase transparency and leveraging of Federal funds

Future Conditions

BENEFIT: Stop building future problems

Table ES-3: TMAC Recommendations and Implementation Actions 2015-2017

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 1 (2015)	FEMA should establish and implement a process to assess the present and anticipated flood hazard and flood risk products to meet the needs of 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. **Former Numbering IA16 2.1 (New Numbering AR 1.1)** FEMA should construct and implement, and measure the effectiveness of public communication strategies that reflect how individuals acquire and process information on low-probability, high-consequence events. The strategies would include: • Using a variety of media to illustrate and communicate flood hazard and risk information to different audiences and generational groups; • Illustrating location-specific inundation levels by working with private-sector mapping companies and other partners to integrate street-level photos with overlays of flood levels at multiple return intervals into FEMA's mapping platform; • Working with real estate listing services to display flood hazard and risk information data for their customers; and • Displaying historical flood information, including flood boundaries and depths, where available.
AR 2 (2015)	FEMA should develop a national five-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 five-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. **Former Numbering IA16 1.1 (New Numbering AR 2.1)** FEMA should publish the State Geographic Information System (GIS) Standard Operating Procedures on a graphical web interface so that sources of local geospatial information are readily available to everyone. **Former Numbering IA16 3.1 (New Numbering AR 2.2)** FEMA should develop, with input from stakeholders, a list of factors to be used for prioritizing flood hazard and risk assessment studies across the country.
AR 3 (2015)	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. **Former Numbering IA16 3.2 (New Numbering AR 3.1)** FEMA should merge the Coordinated Needs Management Strategy (CNMS) and Risk Mapping, Assessment, and Planning (Risk MAP) Progress websites so users can see in one place what needs updating and what is being updated. **Former Numbering IA16 3.3 (New Numbering AR 3.2)** FEMA should evaluate whether adding the number or density of Light Detection and Ranging (LiDAR)-based Letters of Map Amendment (LOMAs) to Secondary Element contributes to the CNMS metric effectiveness.

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 4 (2015)	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 3D Elevation Program (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.
AR 5 (2015)	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.
AR 6 (2015)	FEMA should periodically review and consider use of new publicly available statistical models, such as the proposed Guidelines for Determining Flood Flow Frequency, Bulletin 17C, for flood-frequency determinations.
AR 7 (2015)	**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. **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.
AR 8 (2015)	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.
AR 9 (2015)	FEMA should review and update existing coastal event-based erosion methods for open coasts, and develop erosion methods for other coastal geomorphic settings.
AR 10 (2015)	FEMA should transition from identifying the 1-percent-annual-chance floodplain and associated Base Flood Elevation (BFE) as the basis for insurance rating purposes to a structure-specific flood frequency determination and associated flood elevations. **Former Numbering IA16 1.2 (New Numbering AR 10.1)** FEMA should develop a strategy for obtaining the building footprints and relevant building elevations of properties throughout the Nation to be used in determining structure-based flood risk. **Former Numbering IA16 6.1 (New Numbering AR 10.2)** FEMA and its partners should identify data needs and standards for developing and maintaining accurate, location-specific flood frequency information, including associated flood conditions (e.g., velocity, waves, erosion, duration), for both present and future flood conditions. **Former Numbering IA16 6.4 (New Numbering AR 10.3)** FEMA should perform a demonstration(s) to learn from and document data requirements, processes, and standards necessary for nationwide implementation for structure-based risk assessment.

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 11 (2015)	FEMA should modify the current workflow production process and supporting management system, the Mapping Information Platform (MIP), to reduce unnecessary delays created by redundant tasks and the inflexibility of the system. The process and system are not currently 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). **Former Numbering IA16 4.1 (New Numbering AR 11.1)** FEMA should develop a process for reviewing various aspects of the Flood Insurance Study (FIS) workflow and procedures to ensure that: • Workflow efficiencies and cost-effectiveness, including during the Key Decision Point (KDP) process, are encouraged; • Complementary reporting systems are integrated; • Revisions to the FIS workflow and procedures incorporate a dynamic, digital display environment system; • All internal paperwork required for publishing the notice in the Federal Register is reviewed; • Best Management Practices are incorporated; and • Guidance from FEMA Headquarters (HQ) and/or Regional offices is documented and shared. **Former Numbering IA16 4.2 (New Numbering AR 11.2)** FEMA should take into consideration the following items at the next review of the MIPsystem: • Integrate the MIP and KDP process into one system. • Provide mapping partners more visibility on Data Validation Tasks (i.e., who is responsible for these tasks at the Regional office) and ensure more proactive coordination is implemented before and after the data validation tasks. • The MIP should take into account the uniqueness of Cooperating Technical Partners (CTPs) and enable more flexibility in all areas of the flood production process, including product upload, geographic areas, metadata requirements, and Quality Assurance/Quality Control (QA/QC) reviews. • Transition the MIP to a geodatabase system, similar to the CNMS, in which information is saved geospatially and used to run customized queries and reporting for Regional offices, mapping partners, and CTPs. • Enhance functionality to create auto-generation of template correspondence (e.g., Summary of Map Actions [SOMA] letters). • Provide greater flexibility in user controls. • Provide additional user access to related information. • Add risk product workflows. • Integrate an efficient solution to seamless mapping or HUC or State geographic areas. **Former Numbering IA16 4.3 (New Numbering AR 11.3)** FEMA Regions should clearly document and communicate MIP workflow validation and QA/QC procedures, correspondence protocols and approvals, documentation requirements, and other Region-specific guidance expectations of the flood study process. Additionally, FEMA Regions should regularly update partners with staff changes and roles and responsibilities for the Regional staff. **Former Numbering IA16 4.4 (New Numbering AR 11.4)** FEMA HQ should develop additional guidance and training for mapping partners related to the Code of Federal Regulations (CFR) requirements for due process and Federal Register notifications. Regions should also be encouraged to create addendums that communicate their specific requests and internal timelines for their coordination activities with Production Technical Services (PTS) contractors and CTPs. **Former Numbering IA16 4.5 (New Numbering IA 11.5)** The TMAC recommends that FEMA work with the Customer and Data Services (CDS) contractor to evaluate the ability to migrate the MIP into a relational database system that can access data from other components of the flood insurance study program, such as a revised version of the Flood Insurance Rate Map (FIRM) database. Further efficiencies in reporting, data integration, and archival processes can occur if both a MIP database and FIRM database systems can relate to one another.
AR 12 (2015)	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 for all partners.
AR 13 (2015)	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.

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 14 (2015)	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 toward 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. **Former Numbering IA16 6.2 (New Numbering AR 14.1)** FEMA and its partners should identify data needs and standards for developing and maintaining accurate structure characteristics needed for risk estimation. Included in this should be a review of building characteristics data in existing flood risk estimation models, projects, programs, and databases. **Former Numbering IA16 6.3 (New Numbering AR 14.2)** FEMA and its partners should review and, if needed, modify flood damage functions to better capture structure-specific damage resulting from various flood hazards.
AR 15 (2015)	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.

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 16 (2015)	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 is 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 application forms) and Letter of Map Change (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[OFA]), 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. **Former Numbering IA16 5.1 (New Numbering AR 16.1)** FEMA should implement the following features into a future, dynamic, database-derived, digital display environment to manage the update, maintenance, and dissemination of all flood hazards and risk data across the country: • Data are geospatial and captured in a relational geodatabase. • Data can be dynamically queried and displayed (point and click). • Develop a new website that features user-specific inputs, and where data provide one access point for multiple sources of flood hazard data and risk assessment information. • Products are developed on-the-fly using dynamic data calling features. • The new website and database support scalability, based on data availability, population, flood frequency and population impacted, and flood insurance penetration. **Former Numbering IA16 5.2 (New Numbering AR 16.2)** FEMA should perform a demonstration(s) to learn from and document data requirements, processes, and standards necessary for nationwide implementation of a geodatabase-derived, digital display environment. **Former Numbering IA16 5.3 (New Numbering AR 16.3)** FEMA should utilize the National Flood Hazard Risk Management Coordination Committee to implement the TMAC's vision, including the new database-derived, digital display environment.
AR 17 (2015)	FEMA should consider National Academy of Public Administration (NAPA) 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.
AR 18 (2015)	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.
AR 19 (2015)	FEMA should develop and implement a suite of strategies to incentivize communities, nongovernment organizations, and private sector stakeholders to increase partnering and subsequent contributions for flood hazard and risk updates and maintenance. **Former Numbering IA16 7.2 (New Numbering AR 19.1)** FEMA should investigate opportunities and obstacles to implementing multi-year funding cooperative agreements that complement the five-year CTP Plan. **Former Numbering IA16 7.3 (New Numbering AR 19.2)** FEMA should facilitate and fund demonstration projects for CTPs to incentivize program innovation and efficiencies.

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 20 (2015)	FEMA should work with CTPs to develop a suite of measures that communicate the project management successes, 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. **Former Numbering IA16 7.1 (New Numbering AR 20.1)** FEMA should evaluate the LOMC Review Partnership pilot program and develop clear program requirements, responsibilities, and performance metrics. This information should be used to formally establish the LOMC Review Partnership program, and increase the number of designated communities, where appropriate.
AR 21 (2015)	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 five-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.
AR 22 (2015)	FEMA should define the financial requirements to implement the TMAC's recommendations and to maintain its investment in the flood study inventory.
AR 23 (2016)	FEMA should develop, in conjunction with others in the public and private sectors, flood risk-rated insurance premiums for all structures within and outside the identified Special Flood Hazard Area (SFHA). These premiums should be based on the nature and severity of the flood hazard, structure elevation, and other characteristics, as well as structure damage functions and vulnerability.
AR 24 (2016)	FEMA should communicate to the property owner and other interested parties the cost of risk-rated insurance today and over time for new and existing structures to make the risk transparent. These data should include the benefits and cost that mitigation measures will have on these premiums.
AR 25 (2017)	As FEMA transitions away from the 1-percent-annual-chance line, a risk score for existing and proposed structures should be developed. Each structure should be assigned a current conditions risk score and a future conditions risk score. **AR 25.1** FEMA should perform pilot projects utilizing risk scores to determine the best data and methods to accurately calculate structure-specific risk for floodplain management for existing and new structures.
AR 26 (2017)	FEMA should coordinate with floodplain managers and mitigation planners to identify and test data and tools needed to support floodplain management and mitigation as it moves away from the 1-percent-annual-chance line. **AR 26.1** FEMA should perform pilot projects to understand the implications and opportunities for floodplain management in regard to moving to risk scores and determine other relevant data. **AR 26.2** FEMA should perform pilot projects to determine possible alternatives or modifications to the floodway concept.
AR 27 (2017)	FEMA should develop, in coordination with stakeholders, a transition plan for moving away from the 1-percent-annual-chance flood line.
AR 28 (2017)	FEMA should develop a series of mapping prototype products aimed at more effectively communicating residual flood risk related to levees, dams, and event-driven coastal erosion. Products developed should incorporate end user and stakeholder testing, and FEMA should develop standards for routine production and presentation, if applicable. **AR 28.1** FEMA should conduct pilot projects with communities and other stakeholders to evaluate how effective the prototypes are at communicating residual risk. **AR 28.2** Once prototypes are developed and evaluated, FEMA should leverage the existing flood study process and other community engagement touchpoints to communicate residual risk. **AR 28.3** FEMA should refine existing non-regulatory products and develop new non-regulatory products to clarify coastal flood risks in the vicinity of erodible features, and highlight the spatial areas affected by event-driven coastal erosion and Primary Frontal Dune (PFD) delineation. Possible products include: • Delineation of model results in the vicinity of the eroded PFD • Representation of the regulatory flood zones in the absence of an erodible dune feature

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 29 (2017)	FEMA should initiate stakeholder needs assessments to identify end users' highest priority needs for future conditions products and services that support its current flood-related program and the evolution over time. **AR 29.1** FEMA should engage a broad array of Federal, State, Tribal, and community-level stakeholders; private-sector stakeholders; and partners throughout the design, planning, execution, and interpretation of the Needs Assessment. **AR 29.2** FEMA should ensure that the Needs Assessment collects information on users' intended applications and addresses key analytical variables, such as relevant timeframe(s), spatial resolution, level of study, future conditions scenarios (e.g., land use, erosion, sea level rise), product type, uncertainty, and visualization preferences. **AR 29.3** FEMA should integrate an ongoing future conditions needs gathering step as part of the standard flood study process and during other local community engagement touchpoints, and use the information gained to adapt FEMA's products to respond to evolving user needs and advancements in science and technology.
FC 1 (2015)	Provide future conditions flood risk products, tools, and information for coastal, Great Lakes, and riverine areas. The projected future conditions should use standardized timeframes and methodologies wherever possible to encourage consistency and should be adapted as actionable science evolves. **Former Numbering 3-4 (New Numbering FC 1.1)** FEMA should define a future population metric that uses a standard future population database along with various budget scenarios for keeping the data current to predict the percent of the population covered at various points in the future. **Former Numbering 3-5 (New Numbering FC 1.2)** FEMA should take into account future development (excluding proposed flood control structures for the base condition/scenario) for future conditions mapping. An additional scenario can be generated that does include future flood control structures. **Former Numbering 3-6 (New Numbering FC 1.3)** FEMA should use population growth as an indicator of areas with increased potential flood risk. **Former Numbering 4-4 (New Numbering FC 1.4)** FEMA should develop guidance for how local zoning and land use planning can be used to identify where and how land use will change in the future, and incorporate that into local hazard and risk modeling. **Former Numbering 4-11 (New Numbering FC 1.5)** FEMA should develop a policy and standards on how to consider and determine erosion zones that are outside of the SFHA as they ultimately affect flooding and environmental conditions within the SFHA. **Former Numbering 5-2 (New Numbering FC 1.6)** FEMA should use a scenario approach for future conditions flood hazards calculation and mapping that will allow users to evaluate the robustness of proposed solutions to a range of plausible future conditions, including uncertain land use and climate change impacts.
FC 2 (2015)	Identify and quantify accuracy and uncertainty of data and analyses used to produce future conditions flood risk products, tools, and information. **Former Numbering 3-2 (New Numbering FC 2.1)** FEMA should use future risk assessments to take into account the likelihood of events occurring and their impacts, as well as the associated uncertainties surrounding these estimates. **Former Numbering 3-7 (New Numbering FC 2.2)** FEMA should publish multiple future conditions flood elevation layers that incorporate uncertainty so as to provide a basis for building designs that lower flood risk.

RECOMMENDATION / IMPLEMENTATION ACTION	
FC 3 (2015)	Provide flood hazard products and information for coastal and Great Lakes areas that include the future effects of long-term erosion and sea/lake level rise. Major elements are: • Provide guidance and standards for the development of future conditions coastal flood risk products; • Incorporate local relative sea/lake level rise scenarios and long-term coastal erosion into coastal flood hazard analyses; and • Consider the range of potential future natural and man-made coastal changes, such as inundation and coastal erosion. **Former Numbering 4-1 (New Numbering FC 3.1)** FEMA should use a scenario approach when considering shoreline location for the estimation of future conditions flood hazards. At least two scenarios should be evaluated; one in which the shoreline is held at its present location, and another in which the shoreline is eroded according to the best available shoreline erosion data. **Former Numbering 4-6 (New Numbering FC 3.2)** FEMA should develop guidance for incorporating future conditions into coastal inundation and wave analyses. **Former Numbering 4-8 (New Numbering FC 3.3)** FEMA should develop consistent methods and models for long-term coastal erosion hazard mapping. **Former Numbering 5-4 (New Numbering FC 3.4)** FEMA should use Parris, et. al., 2012, or similar global mean sea level scenarios, adjusted to reflect local conditions, including any regional effects (Local Relative Sea Level) to determine future coastal flood hazard estimates. Communities should be consulted to determine which scenarios and time horizons to map, based on risk tolerance and criticality. **Former Numbering 5-5 (New Numbering FC 3.5)** FEMA should work with other Federal agencies (e.g., National Oceanic and Atmospheric Administration [NOAA], U.S. Army Corps of Engineers [USACE], USGS), the U.S. Global Change Research Program (USGCRP), and the National Ocean Council to provide a set of regional sea level rise scenarios, based on the Parris, et al., 2012 scenarios, for the coastal regions of the United States out to the year 2100 that can be used for future coastal flood hazard estimation. **Former Numbering 5-7 (New Numbering FC 3.6)** FEMA should prepare map layers displaying the location and extent of areas subject to long-term erosion and make the information publicly available. Elements include: • Establishing the minimum standards for long-term erosion mapping that will be used by FEMA that must be met by partners/communities if it is to be incorporated into the FEMA products; • Working with Federal, State, and local stakeholders to develop these minimum standards via pilot studies; and • Securing funding that can support sustained long-term erosion monitoring and mapping by allowing for periodic updates. **Former Numbering 5-9 (New Numbering FC 3.7)** FEMA should support additional research to characterize how a changing climate will result in changes in Great Lakes and ocean wave conditions, especially along the Pacific Coast. The relative importance of waves on this coast makes this an important consideration. **Former Numbering 5-10 (New Numbering FC 3.8)** For the Great Lakes, the addition or subtraction of future lake level elevations associated with a changing climate is not recommended at this time, due to current uncertainty in projections of future lake levels. **Former Numbering 5-11 (New Numbering FC 3.9)** FEMA should build upon the existing current conditions flood hazard analyses prepared by FEMA for the NFIP to determine future coastal flood hazards. **Former Numbering 5-12 (New Numbering FC 3.10)** FEMA should incorporate local Relative Sea-Level Rise scenarios into the existing FEMA coastal flood insurance study process in one of the following ways: • Direct Analysis: Incorporate sea level rise directly into process modeling (e.g., surge, wave setup, wave runup, overtopping, erosion) for regions where additional sea level is determined to impact the Base Flood Elevation (BFE) non-linearly (e.g., 1FT Sea Level Rise (SLR) = 2FT or more BFE increase). • Linear Superposition: Add sea level to the final calculated total water level and redefine BFE for regions where additional sea level is determined to impact the BFE linearly (e.g., 1FT SLR = 1FT BFE increase). • Wave effects should be calculated based on the higher Stillwater, including sea level rise. **Former Numbering 5-13 (New Numbering FC 3.11)** Maps displaying the location and extent of areas subject to long-term coastal erosion and future sea-level rise scenarios should be advisory (non-regulatory) for Federal purposes. Individuals and jurisdictions can use the information for decision making and regulatory purposes if they deem appropriate.

RECOMMENDATION / IMPLEMENTATION ACTION	
FC 4 (2015)	Provide future conditions flood risk products and information for riverine areas that include the impacts of: future development, land use change, erosion, and climate change, as actionable science becomes available. Major elements are: • Provide guidance and standards for the development of future conditions riverine flood risk products. • Future land use change impacts on hydrology and hydraulics can and should be modeled with land use plans and projections, using current science and build upon existing model study methods where data are available and possible. • Future land use should assume built-out floodplain fringe and take into account the decrease of storage and increase in discharge. • No actionable science exists at the current time to address climate change impacts to watershed hydrology and hydraulics. If undertaken, interim efforts to incorporate climate change impacts in flood risk products and information should be based on existing methods, informed by historical trends, and incorporate uncertainty based upon sensitivity analyses. • Where sufficient data and knowledge exist, incorporate future riverine erosion (channel migration) into flood risk products and information. **Former Numbering 4-7 (New Numbering FC 4.1)** FEMA should evaluate previously issued guidance for future conditions land use and hydrology to incorporate best practices and lessons learned from communities that have implemented the guidance since 2001. **Former Numbering 4-9(New Numbering FC 4.2)** FEMA should determine long-term riverine erosion hazard areas for areas subject to high erosion and provide it to the public in a digital layer. **Former Numbering 4-10 (New Numbering FC 4.3)** FEMA should utilize a national standard for riverine erosion zone delineations that reflects geographic variability. **Former Numbering 5-6 (New Numbering FC 4.4)** FEMA should take the impacts of future development and land use change on future conditions hydrology into account when computing future conditions for riverine areas. **Former Numbering 5-8 (New Numbering FC 4.5)** FEMA should implement riverine erosion hazard mapping (E Zones that define channel migration zones), leveraging existing data, models, and approaches that reflect site-specific processes and conditions. **Former Numbering 5-15 (New Numbering FC 4.6)** FEMA should use observed riverine trends to help estimate what future conditions might look like. In watersheds where floods of interest may decrease in magnitude and frequency, then use existing riverine study results as the basis for flood hazard mapping. In watersheds where floods exhibit increase in magnitude or frequency, then use best available science to determine future hydrology and flood hazards. **Former Numbering 5-16 (New Numbering FC 4.7)** FEMA should work with other Federal agencies via the Advisory Committee on Water Information's Subcommittee on Hydrology to produce a new method to estimate future riverine flood flow frequencies. This method should contain ways to consistently estimate future climate-impacted riverine floods and address the appropriate range of flood frequencies needed by the NFIP. **Former Numbering 5-17 (New Numbering FC 4.8)** FEMA should produce, and should encourage communities to adopt, future conditions products to reduce flood risk.
FC 5 (2015)	Generate future conditions data and information such that it may frame and communicate flood risk messages to more accurately reflect the future hazard in ways that are meaningful to and understandable by stakeholders. This should enable users to make better-informed decisions about reducing future flood-related losses. **Former Numbering 3-3 (New Numbering FC 5.1)** FEMA should frame future risk messages for future conditions data and information such that individuals will pay attention to the future flood risk. Messages may be tailored to different stakeholders as a function of their needs and concerns.

RECOMMENDATION / IMPLEMENTATION ACTION	
FC 6 (2015)	Perform demonstration projects to develop future conditions data for representative coastal and riverine areas across the Nation to evaluate the costs and benefits of different methodologies or identify/address methodological gaps that affect the creation of future conditions data. **Former Numbering 3-1 (New Numbering FC 6.1)** FEMA should perform a study to quantify the accuracies, degree of precision, and uncertainties associated with respect to flood studies and mapping products for existing and future conditions. This study should include the costs and benefits associated with any recommendation leading to additional requirements for creating flood-related products. **Former Numbering 5-3 (New Numbering FC 6.2)** FEMA should conduct future conditions mapping pilots to continue to refine a process and methods for mapping and calculating future flood hazards, and capture and document best practices and lessons learned for each. **Former Numbering 5-14 (New Numbering FC 6.3)** FEMA should support research for future conditions coastal hazard mapping pilots and case studies using the latest published methods to determine the best means to balance the costs and benefits of increasing accuracy and decreasing uncertainty.
FC 7 (2015)	Data and analysis used for future conditions flood risk information and products should be consistent with standardized data and analysis used to determine existing conditions flood risk, but also should include additional future conditions data, such as climate data, sea-level rise information, long-term erosion data; and develop scenarios that consider land use plans, planned restoration projects, and planned civil works projects, as appropriate, that would impact future flood risk. **Former Numbering 4-2 (New Numbering FC 7.1)** FEMA should support expanded research and innovation for water data collection, for example, using Doppler radar. **Former Numbering 4-3 (New Numbering FC 7.2)** FEMA should use a scenario approach to evaluate the impacts of future flood control projects on future conditions flood hazards. **Former Numbering 4-5 (New Numbering FC 7.3)** FEMA should support research on future conditions land use effects on future conditions hydrology and hydraulics. **Former Numbering 4-12 (New Numbering FC 7.4)** FEMA should develop guidance for evaluating locally-developed data from States and communities to determine if it is an improvement over similarly-available national datasets and could be used for future conditions flood hazard analyses. **Former Numbering 4-13 (New Numbering FC 7.5)** FEMA should develop better flood risk assessment tools to evaluate future risk, both population-driven and climate-driven. Improve integration of hazard and loss estimation models (such as Hazus) with land use planning software designed to analyze and visualize development alternatives, scenarios, and potential impacts to increase use in local land use planning. **Former Numbering 5-1 (New Numbering FC 7.6)** Future flood hazard calculation and mapping methods and standards should be updated periodically as we learn more through observations and modeling of land surface and climate change, and as actionable science evolves.
PR 1 (2016)	FEMA should adopt the TMAC's 2015 recommendations that relate to the National Flood Mapping Program's technical credibility from the TMAC 2015 Annual Report.
PR 2 (2016)	FEMA should adopt the future conditions recommendations from the *2015 TMAC Future Conditions Risk Assessment and Modeling* (Future Conditions report). **Former Numbering IA16 8.1 (New Numbering PR 2.1)** FEMA should identify and summarize relevant future conditions-related modeling and mapping projects nationwide (Federal or non-Federal sources) that have technical relevance to the NFIP's mapping program, and capture any data standards, modeling and mapping methods, and/or best practices that can inform FEMA's future conditions mapping program. **Former Numbering IA16 8.2 (New Numbering PR 2.2)** FEMA should review existing State-level riverine erosion hazard mapping programs to determine what data standards, modeling and mapping methods, and/or best practices are transferable (i.e., broadly applicable) for potential nationwide implementation of riverine erosion hazard mapping. FEMA should also capture those standards and methods that are applicable to specific geographies or physical settings (analogous to the coast-specific models and guidance used in FEMA's current coastal flood study process).

RECOMMENDATION / IMPLEMENTATION ACTION	
PR 2 (2016) cont'd	**Former Numbering IA16 8.3 (New Numbering PR 2.3**) FEMA should include consideration of both SLR and long-term coastal erosion in the modeling and mapping of flood hazards in all new coastal future conditions pilots. **Former Numbering IA16 8.4 (New Numbering PR 2.4)** FEMA should leverage completed FEMA pilot studies and other relevant coastal and riverine future conditions projects and programs nationwide to prepare a gap analysis that captures outstanding data standards and methodological elements critical to implementing future conditions mapping nationwide. **Former Numbering IA16 8.5 (New Numbering PR 2.5)** FEMA should use the existing body of knowledge gained through completed future conditions pilots, evaluation of existing future conditions-related programs, and other relevant Federal and non-Federal efforts to commence development of future conditions modeling and mapping standards and guidelines. **Former Numbering IA16 8.6 (New Numbering PR 2.6)** FEMA should convene stakeholders and subject matter experts in the initial scoping, development, and review of new future conditions modeling and mapping standards and guidelines (Implementation Action 8.5). This effort should begin as soon as possible to inform the gap analysis and gap prioritization (Implementation Action 8.4), and enable use of any near-term pilots to address critical information needs. **Former Numbering IA16 8.7 (New Numbering PR 2.7)** FEMA should develop and test multiple approaches for visualizing future conditions flood risk in one or more future mapping pilots, drawing on relevant social science expertise and lessons learned from prior pilots and other completed mapping projects.
PR 3 (2016)	FEMA should complete the implementation of the statutory requirements of the National Flood Mapping Program.
PR 4 (2016)	FEMA should continue to enhance communication and transparency with program stakeholders by, for example, including organizational and contact information on the Internet.
PR 5 (2016)	FEMA should investigate offering multi-year program management grant periods (versus annual) to Cooperating Technical Partnerships (CTPs).
PR 6 (2016)	FEMA should facilitate, partner, and leverage current high resolution topographic data (e.g., Light Detection and Ranging [LiDAR] data, other new and emerging technologies).
PR 7 (2016)	FEMA should work with the Congress and other partners to examine ways to shorten the study process, including the time added to the mapping process by QRs, KDPs, and legislated due process, as identified in TMAC's 2015 Goal 2 Annual Report Recommendation Number 11.
PR 8 (2016)	FEMA should move to a database-derived display, as outlined in the TMAC 2015 Annual Report Recommendation Number 16.
PR 9 (2016)	FEMA should work to identify residual risk areas behind levees and other flood control structures and downstream of dams.
PR 10 (2016)	For non-accredited levees, FEMA should replace the Zone D designation in levee-protected areas with risk zones that are more appropriate for the level of risk.
PR 11 (2016)	FEMA should evaluate the current metrics to better measure the efficient production, valid inventory, and stakeholder acceptance of the National Flood Mapping Program. TMAC recommends that FEMA should: • Discontinue the current Deployment and Mitigation Action metrics and replace them with more effective measures, and • Focus revised metrics on measuring the quality and quantity of flood hazard and risk products delivered to communities.

RECOMMENDATION / IMPLEMENTATION ACTION	
PR 12 (2016)	FEMA should have an inventory metric that reports quantity, quality, and time aspects on national, regional, Tribal, State, and watershed levels: a) **Quantity:** Quantity should be tracked through the life of a floodplain from no study through to detailed study. Statistics should be provided annually. b) **Quality:** Quality should be measured by retaining the existing New, Valid, Updated Engineering (NVUE) metric of the current inventory and adding an NVUE metric for coastal flood hazard miles. c) **Time:** Timing should be measured from Discovery to the issuance of Preliminary maps, and from the issuance of Preliminary maps to Effective maps for active projects.
PR 13 (2016)	FEMA should have a metric that shows progress towards meeting a digital platform goal by area of the Nation to compliment FEMA's current population metrics. This metric could include the total area of the country, as well as progress towards Goal 3 and Recommendation 16 in the TMAC 2015 Annual Report.
PR 14 (2016)	FEMA should evaluate the benefits and costs and its value to the Nation as a result of different levels of funding to the National Flood Mapping Program.

AR = *TMAC Annual Report* (2015), *TMAC 2016 Annual Report*, or *TMAC 2017 Annual Report*, **PR** = *TMAC National Flood Mapping Program Review* (2016), **FC** = *TMAC Future Conditions Risk Assessment and Modeling* (2015), **IA** = Implementation Action

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1. Introduction

Flooding poses a significant threat to life and safety and is the most costly natural hazard in the United States. Since 1978, the National Flood Insurance Program (NFIP) has paid nearly $52 billion in flood insurance claims. Further, flood damage is increasing as a result of sea level changes, changing climatological patterns, and increased development in floodplains (National Wildlife Federation, n.d.).

The Federal Emergency Management Agency (FEMA) plays a crucial role in helping communities reduce the risk of loss of life and property damage from flooding by assessing flood risk through its National Flood Mapping Program (Program) and by disseminating flood risk information.

As mandated by the Biggert-Waters Flood Insurance Reform Act of 2012, as amended (42 U.S.C. §§ 4001–4130) (BW-12),[1] FEMA established the Technical Mapping Advisory Council (TMAC), a Federal advisory committee, to review and recommend improvements to the program and to assess projected future conditions as they relate to flooding.

1.1 Congressional Charter

Pursuant to BW-12, 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 (5 U.S.C. App 2).

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

1.2 TMAC Composition and Operation

The TMAC's bylaws establish and describe rules of conduct, applicable regulations, and membership and operational procedures. The bylaws are included as Appendix B. The 2017 TMAC members, subcommittee members, and Designated Federal Officers are listed in Tables 1-1, 1-2, and 1-3, respectively.

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

Table 1-1: TMAC 2017 Members

TMAC MEMBER	BW-12 TMAC MEMBERSHIP REQUIREMENT
John Dorman, CFM (TMAC Chair) Assistant State Emergency Management Director for Risk Management, North Carolina Emergency Management	State Cooperating Technical Partner Representative
Jeffrey L. Sparrow, P.E., CFM (TMAC Vice Chair) Federal Civilian Market Lead, Michael Baker International	Mapping Member
Christopher J. Bender, Ph.D., P.E., D.CE Senior Coastal Engineer, Taylor Engineering, Inc.	Engineering Member
Nancy Blyler U.S. Army Corps of Engineers Geospatial Community of Practice Lead	U.S. Army Corps of Engineers Designee
Richard Butgereit, GISP Chief Information Officer, Florida Division of Emergency Management	State Geographic Information System Representative
Mark DeMulder Director, U.S. Geological Survey National Geospatial Program (Ret.)	U.S. Geological Survey Representative
Leslie Durham, P.E. Floodplain Management Branch Chief, Office of Water Resources, Alabama Department of Economic and Community Affairs	State Cooperating Technical Partner Representative
Jeffrey L. Giering, CFM State Hazard Mitigation Office, Louisiana Governor's Office of Homeland Security and Emergency Preparedness	State Hazard Mitigation Officer
Carrie Grassi Deputy Director for Planning, New York City Mayor's Office of Recovery and Resiliency	Local Cooperating Technical Partner Representative
Suzanne Jiwani, P.E., CFM Floodplain Mapping Engineer, Member of Association of State Floodplain Managers	Floodplain Management Member
Howard Kunreuther, Ph.D. James G. Dinan Professor and Co-Director, Risk Management and Decision Processes Center, Wharton School, University of Pennsylvania	Risk Management Member
Wendy Lathrop, PLS, CFM President and Owner, Cadastral Consulting, LLC	Surveying Member
Tony LaVoi Geospatial Information Officer (GIO), National Oceanic and Atmospheric Administration	National Oceanic and Atmospheric Administration/Commerce for Oceans and Atmosphere Designee
Robert Mason, P.E. Chief, USGS Office of Surface Water and Delaware River Master	U.S. Department of the Interior Designee
Salomon Miranda, P.E. NFIP Coordinator, California Department of Water Resources, Southern Region Office	State National Flood Insurance Coordination Office Representative
Tim Murphy, P.E., CFM Manager of Mitigation Planning and Technical Programs, Flood Control District of Maricopa County	Regional Flood and Stormwater Management Member
Ngoc Nguyen, P.E. Interim Deputy Operating Officer, Santa Clara Valley Water District	Local Cooperating Technical Partner Representative
Luis Rodriguez, P.E. Director, Engineering and Modeling Division, Federal Insurance and Mitigation Administration, Federal Emergency Management Agency	FEMA Designee
Javier E. Ruiz Acting Director, National Geospatial Center of Excellence, Natural Resources Conservation Service	U.S. Department of Agriculture Designee
Cheryl Small President, Small Consulting LLC	Flood Hazard Determination Firm Member

Table 1-2: TMAC 2017 Annual Report Subcommittees

TMAC SUBCOMMITTEE MEMBER	SUBCOMMITTEE
Brian K. Batten, Ph.D., CFMa Senior Coastal Scientist and Project Manager, Dewberry	Future Conditions
Doug Bellomo, P.E. Civil Engineer, U.S. Army Corps of Engineers	Residual Risk
Christopher J. Bender, Ph.D., P.E., D.CE Senior Coastal Engineer, Taylor Engineering, Inc.	Future Conditions
Chad Berginnis, CFM Executive Director, Association of State Floodplain Managers	Floodplain Management and Mitigation
Nancy Blyler U.S. Army Corps of Engineers Geospatial Community of Practice Lead	Residual Risk
Richard Butgereit, GISP Chief Information Officer, Florida Division of Emergency Management	Floodplain Management and Mitigation
Rachel Hogan Carr Executive Director, The Nurture Nature Center	Residual Risk
Mark DeMulder Director, U.S. Geological Survey National Geospatial Program (Ret.)	Residual Risk
John Dorman, CFM (TMAC Chair) Assistant State Emergency Management Director for Risk Management, North Carolina Emergency Management	Floodplain Management and Mitigation (Subcommittee Co-Chair); Residual Risk; Future Conditions
Leslie Durham, P.E. Floodplain Management Branch Chief, Office of Water Resources, Alabama Department of Economic and Community Affairs	Floodplain Management and Mitigation
Jeffrey L. Giering, CFM State Hazard Mitigation Office, Louisiana Governor's Office of Homeland Security and Emergency Preparedness	Floodplain Management and Mitigation
Carrie Grassi Deputy Director for Planning, New York City Mayor's Office of Recovery and Resiliency	Future Conditions
Kathryn Gross, CFM Hydrologist, Flood Control District of Maricopa County	Floodplain Management and Mitigation
Jesse Hayden Environmental Scientist, Delaware Department of Natural Resources and Environmental Control	Residual Risk
Maria Honeycutt, Ph.D. Coastal Hazards Specialist, National Oceanic and Atmospheric Administration	Future Conditions
Suzanne Jiwani, P.E., CFM Floodplain Mapping Engineer, Member of Association of State Floodplain Managers	Residual Risk (Subcommittee Co-Chair)
Howard Kunreuther, Ph.D. James G. Dinan Professor and Co-Director, Risk Management and Decision Processes Center, Wharton School, University of Pennsylvania	Floodplain Management and Mitigation
Wendy Lathrop, PLS, CFM President and Owner, Cadastral Consulting, LLC	Residual Risk
Tony LaVoi Geospatial Information Officer (GIO), National Oceanic and Atmospheric Administration (NOAA)	Future Conditions (Subcommittee Chair)
Tucker Mahoney, P.E. Coastal Engineer, Risk Management Directorate, Federal Emergency Management Agency	Future Conditions
Doug Marcy Coastal Hazards Specialist, National Oceanic and Atmospheric Administration	Future Conditions
Robert Mason, P.E. Chief, USGS Office of Surface Water and Delaware River Master	Future Conditions

TMAC SUBCOMMITTEE MEMBER	SUBCOMMITTEE
Salomon Miranda, P.E. NFIP Coordinator, California Department of Water Resources, Southern Region Office	Residual Risk
Tim Murphy, P.E., CFM Manager of Mitigation Planning and Technical Programs, Flood Control District of Maricopa County	Floodplain Management and Mitigation
Ngoc Nguyen, P.E. Interim Deputy Operating Officer, Santa Clara Valley Water District	Residual Risk (Subcommittee Co-Chair)
Luis Rodriguez, P.E. Director, Engineering and Modeling Division, Federal Insurance and Mitigation Administration, Federal Emergency Management Agency	Future Conditions
Javier E. Ruiz Acting Director, National Geospatial Center of Excellence, Natural Resources Conservation Service	Future Conditions
Cheryl Small President, Small Consulting LLC	Floodplain Management and Mitigation
Jeffrey L. Sparrow, P.E., CFM (TMAC Vice Chair) Federal Civilian Market Lead, Michael Baker International	Floodplain Management and Mitigation (Subcommittee Co-Chair)
Joshua Stuckey, RS, CFM Chief Administrative Officer, Harris County Public Infrastructure	Floodplain Management and Mitigation
Kathleen White, PhD Lead Climate Preparedness and Resilience Community of Practice, US Army Corps of Engineers	Future Conditions

Table 1-3: TMAC Designated Federal Officers

TMAC DESIGNATED FEDERAL OFFICER	TMAC ROLE
Mark Crowell Physical Scientist, Federal Emergency Management Agency	TMAC Designated Federal Officer
Michael Nakagaki Program Specialist, Federal Emergency Management Agency	TMAC Alternate Designated Federal Officer

1.3 TMAC Responsibilities

The TMAC's responsibilities are as follows:

- Provide the FEMA Administrator with recommendations on:
  - Improving Flood Insurance Rate Maps (FIRMs) and flood hazard information
  - How to cost-effectively improve the accuracy, quality, ease of use, and distribution and dissemination of FIRMs and risk data
- Submit an annual report to the FEMA Administrator that includes recommendations and the TMAC's activities during the previous year
- Meet other responsibilities as mandated by BW-12
- Adhere to the TMAC's bylaws

1.4 TMAC Mission and National Flood Mapping Program 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 principles should guide the future of the National Flood Mapping Program under the NFIP:

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

1.5 TMAC Reports

To date, the TMAC has delivered the reports listed below as required by BW-12 and the Homeowner Flood Insurance Affordability Act of 2014 (HFIAA) (Public Law 113–89, 128 Stat. 1021–22) and in accordance with the Federal Advisory Committee Act:

- ***TMAC 2016 Annual Report*** (December 2016) (hereafter referred to as 2016 Annual Report): The purpose of the 2016 Annual Report was threefold: (1) prioritize the recommendations delivered in the TMAC's three previous reports (*TMAC 2016 Annual Report, TMAC National Flood Mapping Review, TMAC Future Risk Assessment and Modeling report*), (2) give FEMA further suggestions on how to implement the TMAC's recommendations by proposing 28 implementation actions (IAs), and (3) provide two new recommendations. The new recommendations are related to flood risk-rated insurance and how flood hazard and risk data, models, and methodologies tie into the NFIP.
- ***TMAC National Flood Mapping Program Review*** (June 2016) (hereafter referred to as the 2016 Program Review): Review of the ability of the National Flood Mapping Program to provide technically credible flood hazard information in areas where FIRMs are prepared or updated, assuming the program is implemented as designed. The 2016 Program Review also provides FEMA with 14 recommendations that will help FEMA provide technically credible flood hazard data into the future. Recommendation 2 is to implement all of the recommendations in the 2015 *TMAC Future Conditions Risk Assessment and Modeling* report (hereafter referred to as the Future Conditions report).
- ***TMAC Annual Report*** (December 2015) (hereafter referred to as the 2015 Annual Report): The 2015 Annual Report conveyed 22 recommendations on improving the following aspects of the National Flood Mapping Program:
  - Framework data management plan
  - Effective communications of flood hazards and risk
  - Maintenance methodology for the national five-year flood hazard and risk assessment plan
  - Flood hazard identification and risk assessment process
  - Geodatabase-derived digital display implementation plan

  - Transition from 1-percent-annual-chance flood determination to location-specific flood frequency and structure-specific flood risk determination
  - Cooperating Technical Partners (CTPs) metrics, process, and delegation methodology
  - Advancing future conditions modeling and mapping
- ***TMAC Future Conditions Risk Assessment and Modeling*** (December 2015) (hereafter referred to as the Future Conditions report): The Future Conditions report detailed 7 recommendations and 37 sub-recommendations to help FEMA ensure that FIRMs incorporate the best available climate science to assess flood risks and that FEMA uses the best available methodology to take into account the impact of sea level rise (SLR) and future development on flood risk.
- ***TMAC 2015 Annual Report–Interim*** dated October 2015: This interim report, including the TMAC's annual activity report and a preliminary list of recommendations responding to its charge under BW-12.
- ***TMAC Future Conditions Risk Assessment and Modeling Report–Interim*** dated October 2015: This interim report, including a preliminary list of TMAC recommendations responding to its charge under BW-12.

The purpose of the TMAC 2017 Annual Report (hereafter referred to as 2017 Annual Report) is to provide further suggestions, clarification, and guidance on how to implement the TMAC's recommendations and to respond to FEMA's request for clarification and guidance on the following three topics: (1) floodplain management, (2) residual risk (i.e., structure-specific rating), and (3) future conditions (Appendix C). The TMAC responded to FEMA's request by developing five recommendations and nine implementation actions (IAs), which are provided in this 2017 Annual Report.

1.6 FEMA Administrator's Response

In 2016, the FEMA Administrator used the TMAC's 2016 Program Review to inform his HFIAA-required certification of the technical credibility of the National Flood Mapping Program with regard to its ability to provide technically credible flood hazard information when the program is implemented as designed in areas where FIRMs are prepared or updated.

In August 2017, the Administrator delivered a report to Congress on the TMAC's 2015 recommendations (FEMA, 2017c) in accordance with the BW-12 requirement specifying that the FEMA Administrator submit a report to Congress on the TMAC recommendations and actions taken by FEMA to address the recommendations (FEMA, 2017c).

1.7 FEMA's 2017 Tasks for TMAC

In 2017, FEMA asked the TMAC to address floodplain management, residual risk, and future conditions, three key topics in the evolution of the National Flood Mapping Program and the future of flood mapping for the NFIP (see Table 1-4 and Appendix C).

Table 1-4: FEMA's 2017 Tasks for TMAC

TOPIC	ISSUE	TMAC TASKS
Floodplain Management	Floodplain management and mitigation impacts of transitioning away from the 1-percent-annual-chance flood hazard	As FEMA moves away from mapping the 1-percent-annual-chance flood hazard and evolves the flood mapping program to provide structure-specific risk, what are the cascading impacts, issues, and opportunities that FEMA should consider from a floodplain management and mitigation perspective? What mapping tools will be needed to support floodplain management? Is the floodway concept still relevant? If FEMA no longer mapped the floodway, how would floodplain management standards be enforced?
Residual Risk	The National Flood Mapping Program must purposely and strategically enhance, replace, and add flood hazard mapping products in the coming years in order to support a redesign of the flood risk rating structure for the NFIP and to enhance understanding of risk at a more granular level. The most significant gaps are currently in areas affected by levees, dams, and other embankments, as well as areas subject to event-driven erosion.	As FEMA takes on the challenge of delivering flood hazard data that support more robust flood risk rating, how can FEMA more effectively deliver, display, and communicate the hazards that drive credible risk assessments in the following areas? • Residual risk impacted by dams, levees, or other manmade structures • Areas of changing risk due to event-driven coastal erosion What related work of other Federal or State agencies and the private sector should be considered or should inform FEMA's approaches?
Future Conditions	TMAC's 2015 Future Conditions report raised significant issues and opportunities. Many players exist in the development and dissemination of future conditions information, including Federal agencies, non-governmental organizations, States, and others. FEMA needs perspective on the role of all players in the field of future conditions and gaps that remain in the development and dissemination of this information to stakeholders of the NFIP.	Given the current datasets and tools currently being produced by various Federal agencies and non-Federal entities, what additional tools, data, and resources can FEMA provide with respect to future conditions that would be useful to our customers and stakeholders?

Source: Roy Wright, FEMA's Technical Mapping Advisory Council 2017 Tasking Memo

2. Floodplain Management and Mitigation

FEMA asked the TMAC to examine the floodplain management and mitigation impacts and opportunities in transitioning away from the 1-percent-annual-chance line to structure-specific risk. FEMA's request is as follows:

> As FEMA moves away from mapping the 1-percent-annual-chance flood hazard and evolves the flood mapping program to provide structure-specific risk, what are the cascading impacts, issues, and opportunities that FEMA should consider from a floodplain management and mitigation perspective? What mapping tools will be needed to support floodplain management? Is the floodway concept still relevant? If we no longer mapped the floodway, how would floodplain management standards be enforced? (Wright, 2017)

This chapter provides the response to the request.

In addressing the questions related to structure-specific risks, the TMAC is not ignoring that a similar set of questions related to a gradient of risk for undeveloped land would also be beneficial for property owners and regulators in making wise land use decisions.

One of the NFIP's greatest strengths is its partnership with communities in their efforts to mitigate and reduce flood risks through floodplain management and regulation enforcement. Each partnership is based on a quid pro quo relationship that is initiated when a community adopts a floodplain management ordinance and manages its floodplains to reduce flooding risk. FEMA then makes flood insurance available for structures in the community.

Current FIRMs and flood data are used primarily to support the following users and uses:

- Local communities for floodplain management and flood hazard mitigation, comprehensive planning, and emergency management
- Property owners, realtors, and lenders to understand risk
- Flood determination companies and lenders for determining mandatory purchase requirements
- Insurance agents to rate policies

FIRMs are employed by these users, but the FIRM is not an optimal tool for any of them. In some cases, the maps lack detail or metadata that would benefit technical users in assessing and managing flood risks, yet are too detailed or not formatted for some non-technical users to fully understand the risks depicted.

FIRMs were initially intended to support the implementation of the NFIP, but their use has expanded to be used by multiple stakeholders for various purposes. Congress recognized the expanded use and also the importance of flood hazard mapping when it established the National Flood Mapping Program in BW-12.

The TMAC previously recommended that FEMA move toward structure-specific risk assessments as a better tool for rating flood insurance policies and communicating the flood risk for structures and to stop managing

cartographically developed paper products in favor of a database-derived digital display environment. These recommendations are still applicable, and the TMAC also continues to recognize that the rich data that are produced when FIRMs are created are valuable for many aspects of risk management decision making.

FEMA has a unique opportunity as it moves toward creating structure-specific risk assessments for rating flood insurance policies and stakeholder communication to provide users with information best suited to each user's need. As the TMAC previously recommended, FEMA should not focus on one product or tool with the expectation that it will be suitable for all users. By giving users access to geographic information system (GIS) databases and online applications, FEMA will allow users to develop products that are best suited to their needs and capabilities. The products may include:

- Structure-specific risk assessments
- Multiple frequency flood hazard information from low-to-high-frequency events showing graduated risk
- Percent chance of flooding in a year
- Percent chance of flooding over the life of a 30-year mortgage
- Depth grids
- Velocity zones
- Heat maps showing areas of greatest risk
- Future conditions floodplains
- Current and future community risk profile
- Structure footprints
- Structure values
- Historical flooding information

As FEMA considers moving away from the 1-percent-annual-chance line, it should coordinate closely with floodplain managers and mitigation planners to identify and test data and tools that are needed to support floodplain management and mitigation planning. Related to the focus on data and tools, the TMAC recommends that FEMA perform pilot projects to determine possible alternatives or modifications to the floodway concept.

To improve the communication of risk, the TMAC recommends that FEMA not only assign each structure a current conditions risk score, but also assign each structure a future conditions risk score. The current conditions risk score could be used to determine the flood insurance premium and the future conditions risk score could be used to inform property owners about the projected change in risk and the potential change in the flood insurance premium if the owner and/or community does not take mitigation actions.

In Section 2.2 of this report, the TMAC provides FEMA with a potential method of computing risk scores. However, before FEMA implements the use of a structure-specific risk score, the factors used in risk score computations and the sensitivity of the risk score, depending on the variables and methodology, should undergo extensive testing and pilot projects.

Moving away from the 1-percent-annual-chance line would be a major shift for FEMA. The TMAC recommends that FEMA work closely with the NFIP's stakeholders to develop a transition plan. The purpose of the plan would be to identify, understand, and assess the complexities of such a transition, ensure minimal disruption to daily activities, and provide time for stakeholders to adjust their systems and processes.

2.1 New Floodplain Management and Mitigation Recommendations and Implementation Actions

The new floodplain management and mitigation recommendations are listed in Table 2-1.

Table 2-1: New Floodplain Management and Mitigation Recommendations

NUMBER	RECOMMENDATION
AR 25	As FEMA transitions away from the 1-percent-annual-chance line, a risk score for existing and proposed structures should be developed. Each structure should be assigned a current conditions risk score and a future conditions risk score.
AR 26	FEMA should coordinate with floodplain managers and mitigation planners to identify and test data and tools needed to support floodplain management and mitigation as it moves away from the 1-percent-annual-chance line.
AR 27	FEMA should develop, in coordination with stakeholders, a transition plan for moving away from the 1-percent-annual-chance line.

The IAs for the new floodplain management and mitigation recommendations (see Table 2-1) are listed in Table 2-2.

Table 2-2: New Floodplain Management and Mitigation Implementation Actions

IMPLEMENTATION ACTION	ASSOCIATED RECOMMENDATION
IA 25.1: FEMA should perform pilot projects utilizing risk scores to determine the best data and methods to accurately calculate structure-specific risk for floodplain management for existing and new structures.	**AR 25:** As FEMA transitions away from the 1-percent-annual-chance line, a risk score for existing and proposed structures should be developed. Each structure should be assigned a current conditions risk score and a future conditions risk score.
IA 26.1: FEMA should perform pilot projects to understand the implications and opportunities for floodplain management in regard to moving to risk scores and determine other relevant data and tools. **IA 26.2:** FEMA should perform pilot projects to determine possible alternatives or modifications to the floodway concept.	**AR 26:** FEMA should coordinate with floodplain managers and mitigation planners to identify and test data and tools needed to support floodplain management and mitigation as it moves away from the 1-percent-annual-chance line.

2.2 Recommendation AR 25

RECOMMENDATION AR 25

As FEMA transitions away from the 1-percent-annual-chance line, a risk score for existing and proposed structures should be developed. Each structure should be assigned a current conditions risk score and a future conditions risk score.

2.2.1 DEVELOPING A RISK SCORE FOR PROPERTY IN FLOOD-PRONE AREAS

If FEMA moves to structure-specific risk rating, there will be an opportunity to develop risk scores that specify the severity of the hazard for existing and proposed structures that are subject to water-related damage from riverine floods and from storm surges from riverine and coastal floods. The current conditions risk score could be used for rating insurance policies. The future conditions risk score could be used to communicate the difference in future risk and the future insurance premium as a function of the mitigation measures that could be undertaken to maintain or reduce the structure's risk. The future conditions risk score could be modified to reflect the reduction in future losses if mitigation measures are undertaken to reduce risk to the structure. The

TMAC is aware that in some parts of the country, future conditions risk ratings may be the same or better than current conditions risk ratings.

As discussed in Implementation Action 25.1 for Recommendation 25 (see Section 2.4), pilot projects would be needed to determine the best data and methods to calculate an accurate risk score for a structure. The 2016 Annual Report includes the following primary set of data needs for determining a structure's risk:

- **Nature of the Hazard:** Likelihood of floods with different water surface elevations that could cause damage to the structure. The analysis should include multiple recurrence intervals from high-frequency floods (10-year return period) to low-frequency floods (1,000 year return period).
- **Elevation of the Structure:** Relevant building elevations, including lowest floor, mechanical and electrical equipment, and ground elevations, at each structure as identified on the property owner's elevation certificate (if applicable) in relation to the Base Flood Elevation (BFE). This function facilitates a determination of the potential damage to the structure from floods of different water surface elevations.
- **Damage to the Structure:** Inundation depth-damage function for the structure. Developing this function requires data on the relevant structure elevations in relation to the BFE to estimate the impact on the structure caused by floods of different water surface elevations, velocities, waves, erosion, and scour. Historical flood damage could also be used to determine the potential damage to the structure.
- **Average Annualized Loss (AAL):** Anticipated annual loss to a structure. This function is a measure of the potential flood losses over a defined period and is used to compare the estimated damage across multiple flood intervals. This function can also be used to communicate the estimated damage over a particular period, such as 30 years. AAL is equivalent to an annual risk-based insurance premium without any loading cost.

Using the above data, a risk score (RS) can be characterized in many ways and developed using a combination of many variables. Two approaches to calculating the RS are presented below:

- **RS1 – Ratio of AAL to Value of Structure:** RS1 reflects the annual risk-based insurance premium relative to the value of the structure. Structures with a high RS1 have a relatively high probability of significant damage, and structures with a low RS1 have a lower probability of significant damage. Flood insurance is an important form of financial protection for structures with a high RS1. The ratio is multiplied by 1,000 to make it easy to compare scores between structures
- **RS2 – Average Likelihood of Financial Consequence Targets:** RS2 focuses on the likelihood that a flood will have financial consequences based on multiple recurrence intervals or predetermined amounts of damage to the structure. The financial consequences from flooding can be averaged to obtain a consolidated risk score to be used for floodplain management and insurance purposes or individualized for each targeted amount of damage from floods of different magnitudes to help inform decisions to invest in mitigation measures to reduce the risk. The resulting average is multiplied by 100 to convert it to the same dimension as RS1.

RS1 is a correlation between the structure's value and the potential losses from any flood damage for any given year and/or recurrence interval. It may have more appeal to the insurance industry than RS2 because of the direct relationship between potential losses and the insurance premium. Property owners, floodplain managers, and mitigation planners would most likely need a risk score that is more detailed than RS1 and that incorporates varying levels of damage combined with considerations, such as residual risk, repetitive losses, mitigation measures, and community-specific restrictions or discounts.

RS2 is provided as an example of how FEMA could compute a risk score incorporating additional variables into input functions. RS2 focuses on the structure's damage and varying extents of financial consequences from a flood event. The resulting risk score could be used to provide the property owner with information on the possible extent of financial impact due to flooding and to make informed decisions on flood insurance coverage options, such as deductibles.

Risk scores can be calculated for existing conditions based on unmitigated and mitigated scenarios. They can also be based on future conditions to demonstrate the potential long-term benefits of undertaking mitigation measures by determining the increase in risk if the property owner decides not to invest in loss reduction (mitigation).

To illustrate how to calculate an RS1 and RS2, consider Structure A. The structure, which is valued at $100,000, experienced a high probability flood event (10-year or 10-percent-annual-chance flood); a lower probability flood event, representing the current Special Flood Hazard Area (SFHA) delineated 100-year or 1-percent-annual-chance; and a very low probability flood event (500-year, or 0.2-percent-annual-chance). The level of damage from each flood event was different.

Simplified AAL values are calculated for Structure A based on the three recurrence interval floods, but FEMA typically calculates AAL for multiple recurrence intervals (10-, 4-, 2-, 1-, and 0.2-percent-annual chance flood events).[2] Structure-specific risk assessments would be developed as part of a Flood Insurance Study (FIS) for the area by providing estimated damage levels and structure losses based on depth of flooding, including the three annual chances of floods provided in this example.

2.2.1.1 Risk Score Calculations for Structure A

RS1 for Structure A (Unmitigated and Mitigated)

RS1 illustrates a direct relationship between the value of the structure and the anticipated annual losses from flood events. Table 2-3 specifies the damage to Structure A from the three flood events when the structure is unmitigated and mitigated.

Table 2-3: Flood Damage Data for Structure A

FLOOD EVENT	RECURRENCE INTERVAL	STRUCTURE DAMAGE (UNMITIGATED)	STRUCTURE DAMAGE (MITIGATED)
1	10% or 0.1	$20,000	$0
2	1% or 0.01	$30,000	$0
3	0.2 % or 0.002	$50,000	$30,000

2 The method FEMA uses for computing AAL is described in detail in *Guidance for Flood Risk Analysis and Mapping: Flood Risk Assessments* (FEMA, 2016a). The three probabilities of flooding and resulting damage for Structure A are specified well in the example, so the calculation of AAL does not average probabilities and losses across two adjacent percent-annual-chance depth grids as FEMA does in its determination of AAL.

The first step in developing the RS1 risk score for the unmitigated structure is computing the AAL for the structure. From Table 2-3, Structure A has loss values associated with each of the three flood events, so the simplified AAL would be calculated as follows:

AAL= 0.10*$20,000 + 0.01*$30,000 + 0.002*$50,000 = $2,400 per year

RS1 can be calculated by dividing the AAL for the structure by the value of the structure and multiplying by 1,000 to give a value as follows:

RS1 = (AAL/Value of Structure) * 1,000

RS1 (Unmitigated) = ($2,400/$100,000) * 1,000 = 24

The property owner can invest in mitigation measures to protect against future flood losses by elevating the structure to reduce the risk of experiencing damage from the higher frequency flood events. In the mitigated example below, the property owner has eliminated the $20,000 in damage from the 10-percent-annual-chance flood event and the $30,000 in damage from the 1-percent-annual-chance flood event and reduced the damage from the 0.2-percent-annual-chance flood event from $50,000 to $30,000, as reflected in the mitigated Structure A damage in Table 2-3.

A revised AAL is needed to reflect the reduction in flood risk. After mitigation, the only losses would be the reduced losses associated with the low frequency or 0.2-percent-annual-chance flood event, as shown in the revised AAL:

AAL = 0.10*$0 + 0.01*$0 + 0.002*$30,000 = $60 per year

RS1 for the mitigated structure can be calculated by dividing the revised AAL for the mitigated structure by the value of the structure and multiplying by 1,000 to give a value as follows:

RS1 = (AAL/Value of Structure) * 1,000

RS1 (Mitigated) = ($60/$100,000) * 1,000 = 0.6

This simple example of computing RS1 is an uncomplicated way to comprehend the value of investing in mitigation measures to lower a structure's risk. RS1 would be especially valuable if flood insurance premiums were calculated based on the structure's RS1 risk score, thereby creating a direct correlation between mitigation and lower flood insurance premiums.

Table 2-4 shows the flood damage data and RS1 for Structure A (unmitigated and mitigated).

Table 2-4: Flood Damage Data and RS1 for Structure A

FLOOD EVENT	RECURRENCE INTERVAL	STRUCTURE DAMAGE (UNMITIGATED)	RISK SCORE (RS1)	STRUCTURE DAMAGE (MITIGATED)	RISK SCORE (RS1)
1	10% or 0.1	$20,000		$0	
2	1% or 0.01	$30,000	24	$0	0.6
3	0.2 % or 0.002	$50,000		$30,000	

RS2 for Structure A (Unmitigated and Mitigated)

RS2 is a more detailed approach that may be more beneficial to floodplain managers and mitigation planners by incorporating other variables into the calculation. The following example focuses on targeted financial consequences and the likelihood of a flood causing damage of this magnitude. Actual damage estimates for multiple recurrence intervals can be calculated from the structure-specific risk assessment data, and the likelihood of financial consequence targets could then be determined. Financial consequence targets and their likelihood when Structure A is unmitigated and mitigated are provided in Table 2-5.

Table 2-5: Financial Consequences for Structure A

TARGET LEVEL	FINANCIAL CONSEQUENCE TARGET	LIKELIHOOD OF FINANCIAL CONSEQUENCE (UNMITIGATED)	(MITIGATED)
1	$20,000	50%	15%
2	$30,000	30%	10%
3	$50,000	10%	0%

The unmitigated structure has a 50-percent chance of experiencing a flood that causes $20,000 or more in damage, a 30-percent chance of experiencing a flood that causes $35,000 in damage, and a 10-percent chance of experiencing a flood that causes $50,000 in damage. RS2 for the unmitigated structure can be computed by averaging the likelihoods for the three financial consequence targets and multiplying by 100 to get a risk score value. The calculation is as follows:

RS2 = (Sum of likelihood percentages / Number of target levels) * 100

RS2 (Unmitigated) = ((0.50 + 0.30 + 0.10) /3) * 100 = 30

Based on this information, the homeowner could mitigate the structure and reduce the likelihood of experiencing each financial consequence target. The updated computation of RS2 for the mitigated structure would be:

RS2 (Mitigated) = ((0.15 + 0.10 + 0) / 3) * 100 = 8.3

Table 2-6 shows the financial consequences and RS2 for Structure A (unmitigated and mitigated).

Table 2-6: Financial Consequences and RS2 for Structure A

TARGET LEVEL	FINANCIAL CONSEQUENCE TARGET	LIKELIHOOD OF FINANCIAL CONSEQUENCE (UNMITIGATED)	RISK SCORE (RS2)	LIKELIHOOD OF FINANCIAL CONSEQUENCE (MITIGATED)	RISK SCORE (RS2)
1	$20,000	50%		15%	
2	$30,000	30%	30	10%	8.3
3	$50,000	10%		0%	

For the purposes of this example, the values for RS2 are focused on the likelihood of a flood resulting in predetermined amounts of damage to demonstrate flood risk and the benefits of mitigation to the property owner. The likelihood of the target levels are combined to provide an average risk score, but the financial consequence targets could easily be separated to provide the property owner with a more complete assessment of the flood risk for each of the predetermined amounts of damage. Individual risk scores for each damage target could be beneficial in communicating the risk of flooding from smaller flood events and the risk of flooding in terms of financial and safety impacts that should be easily understood by the property owner, essentially moving away from the "in or out" discussions of flood risk.

The RS2 option could easily be applied to specific flood frequency events and focus on other variables, such as depth of flooding, water surface elevations, and velocity. Using this risk score, a floodplain manager or mitigation planner could have a discussion with the property owner on the benefit of a mitigation investment and the resulting reduction in risk. Similar to the RS1 option, RS2 could provide a powerful message to the property owner if flood insurance premiums are tied to the risk score to show the savings in the cost of flood insurance due to a lower risk score. In addition to the benefit of lower insurance premiums, RS2 could be used to communicate increased levels of safety for life and property by demonstrating how mitigation efforts could provide protection from certain levels of flooding.

The options for developing a risk score provided by the TMAC are designed to demonstrate possible methods for computing a risk score based on its intended uses. As discussed in the following IA, pilot projects should be performed to test methods of computing a risk score and uses of risk scores.

2.3 Implementation Action 25.1 for Recommendation AR 25

IMPLEMENTATION ACTION 25.1

FEMA should perform pilot projects using risk scores to determine the best data and methods to accurately calculate structure-specific risk for floodplain management for existing and new structures.

In undertaking these pilot projects with the appropriate sensitivity analyses, FEMA could incorporate future conditions (e.g., land use changes, riverine erosion and channel migration, SLR, climate change) in characterizing the flood risk to property owners with and without investments in mitigation. Other flood-related factors could be used to determine the impact on the risk score, such as residual risk from dams/levees, erosion, and coastal protection areas. The pilot projects could also examine ways to incorporate the effects of uncertainty on estimating the likelihood and impacts of different levels of flooding in constructing a risk score. The pilot projects could also be used to evaluate the inclusion of the risk score on flood insurance premium calculations.

By providing structure-specific risk scores, FEMA would equip communities with a highly effective tool for managing and mitigating flood risk within the community. Risk scores would provide opportunities to communicate flood risk to property owners, and the data from the structure-specific risk assessments could be used to provide examples of ways to reduce individual flood risk and flood risk within the community. Risk scores would also provide opportunities to examine flood risk on proposed structures and provide floodplain managers with additional tools in their dialogue with developers and future homeowners prior to construction. By incorporating the management of flood risk early in the design of structures, property owners would have more opportunities to make minor improvements that would not only reduce their risk of flooding, but also reduce their insurance costs.

Structure-specific risk scores would be useful from a regulatory floodplain management standpoint. For example, a risk score could be incorporated into local regulations so that certain regulatory standards would be triggered based on the score and could potentially be categorized to identify areas most prone to flooding. Also, structures that have experienced historical flood damages (i.e., repetitive losses) could be readily identified at the community level, providing the community with the opportunity to enforce regulatory standards, even in areas not included in the SFHA.

The Community Rating System (CRS) was established in 1990 as a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Currently, nearly 3.8 million policyholders in 1,391 communities participate in the CRS by implementing local mitigation, floodplain management, and outreach activities. Under the CRS, flood insurance premium rates are discounted to reward community actions that meet the three goals of the CRS: (1) reduce flood damage to insurable property, (2) strengthen and support the insurance aspects of the NFIP, and (3) encourage a comprehensive approach to floodplain management.

Having structure-specific risk scores could help communities prioritize mitigation planning on the structures with the highest risk and better inform elected officials of potential impacts of higher standards or potential buyouts. Risk scores could also be considered when evaluating a structure's substantial damage and substantial improvements to readily identify the percent change from improvements or damage, and to ensure that the structure's risk score rating is maintained and that future development is built to a desired risk score target.

One way to encourage communities to continue investing in cost-effective risk reduction measures (e.g., constructing dams, levees or flood walls, property buyouts) would be to incorporate risk scores as an integral component of the Community Rating System (CRS). The pilot project could evaluate inputs to the CRS on risk rating, CRS insurance premium discounts, and mitigation of risk.

2.4 Recommendation AR 26

RECOMMENDATION AR 26

FEMA should coordinate with floodplain managers and mitigation planners to identify and test data and tools needed to support floodplain management and mitigation as it moves away from the 1-percent-annual-chance line.

To participate in the NFIP, communities must adopt and enforce a floodplain management ordinance that complies with relevant Federal and State laws. In return, FEMA agrees to make flood insurance available to property owners in the community.

One of the primary components of a local floodplain management ordinance is the adoption of a flood map that includes the 1-percent-annual-chance line. The 1-percent-annual-chance line is used by floodplain managers and mitigation planners as a critical component of floodplain management decision making. It is also used for determining flood insurance requirements and pricing. In the development of a new tool to better articulate flood hazard risk to the community, the TMAC recommends that FEMA coordinate with and explore the tools currently used by floodplain managers and mitigation partners to identify best practices in the development of an alternative to the 1-percent-annual-chance line that fits the needs of communities with varying levels of technological support.

Floodplain managers currently rely on a collection of core data and tools to determine the extent to which a structure is at risk of flooding:

- Flood map data (including the 1-percent-annual-chance line)
- FIS data
  - Flood profiles
  - Floodway and floodway data tables
  - Coastal transects
  - Primary Frontal Dune (PFD) delineations
- Multiple frequency flood hazard information
- Regulations in 44 CFR Parts 59 et seq.
- State building codes
- Local building codes (if applicable)

Floodplain management core data and tools are supplemented by countless other tools and datasets, which vary by State, Tribe, local community, and the expertise of the floodplain manager. There are also variabilities in State laws and procedures for adopting and implementing local floodplain management ordinances, and even more variabilities in the way each community approaches land use planning and permitting. The availability of additional tools to floodplain managers depends largely on the resources provided by States, Tribes, and local communities; the amount of new development; and the extent of flood risk. The application of data and tools varies extensively between communities. Some communities have robust GIS capabilities, online mapping applications, and/or more stringent local zoning requirements, while other communities have minimal resources and/or only part-time floodplain managers.

While providing more detailed information on flood risk at the structure level is expected to improve the NFIP, moving away from the 1-percent-annual-chance line will affect the way many stakeholders use the data. The roles of the floodplain manager and mitigation planner will likely go through transformations not experienced since the inception of the floodplain management program, despite many incremental reforms to improve the program. Not being able to rely on a mapped line to determine whether a property is inside or outside the designated floodplain will be a paradigm shift for many experienced floodplain managers.

The TMAC identified the following needs of floodplain managers and mitigation planners for regulating development, issuing permits, and performing mitigation activities for FEMA to consider in this transition:

- Significant training by States and FEMA on the use of structure-specific data for regulatory floodplain management requirements
- Easy access to the database(s) with established queries/data outputs for non-technical and novice users
- Ability to print flood risk maps, flood profiles, and floodway data tables on demand for multiple flood frequencies, especially in communities without GIS or mapping capabilities
- Ability to update the database(s) with community-supplied data and new flood study data
- Protocol for updating risk scores, such as after taking mitigation action

The delineation of the SFHA and the 1-percent-annual-chance line has historically been a core tool used by local floodplain managers for enforcement of local ordinances, and many of the local ordinances mandate that communities adopt new flood maps, as issued by FEMA, and revise ordinances to reflect new flood maps. With

a transition from providing a mapped line and designated SFHA, floodplain managers will need alternative tools to use in enforcing floodplain management regulations and providing guidance on the changes to regulating development in flood hazard areas.

The capabilities of individual floodplain managers and mitigation planners vary widely along with the tools and datasets they rely on to regulate development and perform mitigation activities within their communities. As FEMA considers moving away from the 1-percent-annual-chance line, floodplain managers and mitigation planners will need support in transitioning their local programs. The level of support necessary, in both data and tools, will vary depending on the technical capabilities of the floodplain management staff, local zoning limitations, and community resources.

Given the wide variation in needs, the TMAC recommends that FEMA coordinate with floodplain managers and mitigation planners to identify and test the data and tools needed to allow them to transition from the 1-percent-annual-chance line to structure-specific risk assessments. The coordination will allow FEMA to determine and test the data and tools that will be required.

2.5 Implementation Actions for Recommendation AR 26

The IAs for Recommendation AR 26 are Implementation Actions 26.1 and 26.2.

IMPLEMENTATION ACTION 26.1

FEMA should perform pilot projects to understand the implications and opportunities for floodplain management in regard to moving to risk scores and determine other relevant data and tools.

Many property owners are motivated by the desire to lower their flood insurance premium or eliminate the flood insurance requirement. A clear and comparable risk score assigned to individual structures will help property owners begin to accept ownership of flood risk and seek ways to improve a less-than-desired risk score.

Throughout the Risk Mapping, Assessment, and Planning (Risk MAP) process, FEMA's mapping partners seek ways to incorporate the more detailed study data and products into online applications to improve floodplain management at the local level. In areas where the Risk MAP process has been deployed and where States and communities are providing the additional data needed for structure-specific risk assessments, communities are beginning to realize a benefit from having the more detailed data available. Several States, such as North Carolina and Alabama, collect building footprints and structure-specific data. Similarly, many other communities collect structure-specific information on the highest risk/repetitive loss properties. The level of effort to develop multiple-frequency flood hazard data, risk assessments, percent chance of flooding, and depth grids for individual structures is not significantly greater than it is for census blocks, especially when compared to the greater utility of the information.

As previously recommended by the TMAC in the 2015 Annual Report, FEMA will need to conduct a thorough review of existing regulations and policies to identify the necessary changes to floodplain management and mitigation programs with a transition from providing the 1-percent-annual-chance line to providing structure-specific risk scores. The TMAC believes the best methodology to develop this situational understanding is to conduct pilot projects using risk scores as a key component, along with current tools to identify the opportunities in the methodology shift.

Fundamental issues during the pilot projects will arise as to how floodplain management is implemented locally, and these issues will need to be addressed as FEMA tests the implications and opportunities of the methodology shift. The TMAC anticipates that some of the hurdles FEMA will need to consider in the effort to provide better flood risk management tools will include the following:

- Requirements in 44 CFR § 60.3 related to the concept of BFE and related components
- State and local ordinances requiring flood map adoption
- Correlation and understanding of the differences between a risk score and the current methodology in making floodplain management decisions
- Elevation certificate changes
- "No rise" requirements and Letter of Map Change (LOMC) implications
- CRS and other higher standard implications

North Carolina's online flood risk application has been profiled in previous TMAC reports and could serve as a testing ground for the tools and data needs of a national structure-specific risk score approach to floodplain management. Local floodplain managers who have been using the online flood risk application could provide input on best practices for practical application in local communities. Pilot projects in other communities with structure-specific risk assessments may also benefit FEMA. Lastly, FEMA should ensure that pilot projects take into account various perspectives and scenarios.

IMPLEMENTATION ACTION 26.2

FEMA should perform pilot projects to determine possible alternatives or modifications to the floodway concept.

One of the objectives of the NFIP is to encourage sound floodplain management practices that minimize potential future flood losses to new and substantially improved structures and guide new construction to avoid worsening the flood hazard for existing development. Federal floodplain management regulations encourage sound riverine floodplain management practices by requiring communities to ensure that new construction is elevated and that a certain level of conveyance is maintained within the 1-percent-annual-chance floodplain. These regulations help limit the potential increases in flood losses due to development within the floodplain. The regulation on maintaining conveyance is tied to the floodway regulations in 44 CFR § 60.3(b–d). Maintaining conveyance is accomplished through a minimum allowable rise to the BFE using the two approaches listed below:

- **With designated floodway:** Restricts development within a delineated floodway unless it can be proven that the development would have no impact on floodway flood elevations.
- **Without designated floodway:** Requires review of all proposed development within the entire 1-percent-annual-chance floodplain on a case-by-case basis to ensure that the cumulative effect of development, existing and anticipated, will not increase water surface elevations greater than 1 foot.

The TMAC believes the concept of a restricted use area, such as a floodway, that restricts the amount of development with the intent of limiting future flood losses is still relevant and potentially a necessary and valuable tool for State and local floodplain managers.

To evaluate how a restricted use area could be incorporated as FEMA transitions from the 1-percent-annual-chance-line, the TMAC recommends that pilot projects be performed to explore possible alternatives or

modifications to the floodway concept and evaluate the possible impacts to Federal, State, Tribal, and local floodplain regulations.

Pilot projects to determine possible alternatives or modifications to the floodway concept could consider the following:

- Survey of State, Tribal, and local floodplain managers to seek input on the impacts to their communities of any modifications to the floodway concept and how important they consider the floodway concept as a tool in maintaining conveyance. The survey could gather information on the amount of insured losses that occur within floodways to evaluate whether the States, Tribes, and communities that have higher floodway standards have fewer losses or whether the average claims being paid are lower. The information could be used to determine whether development in floodways is a problem and whether regulating to a higher standard would create a benefit by reducing claims and claim amounts.
- Evaluation of the ease of use of the current floodway approach and any possible new approaches for State and local floodplain management programs. Implementing regulations in which floodways are not designated can be difficult, even for technically advanced communities. The requirement for considering the cumulative effect of existing and anticipated development along the watercourse may be overlooked, only considered in a general way, or even ignored by some communities, especially those with limited technical resources. The cost of developing the floodway should also be included.
- Evaluation of the effectiveness of the current methods for determining conveyance and whether better methods of determining the minimum amount of conveyance that should be maintained are known. These methods would also need to be able to be applied to a variety of modeling practices beyond 1-dimensional (1-D) modeling. Developing floodways using a method based on 1-D steady-state principles can be difficult, complex, and possibly inappropriate if the method uses unsteady 1-D flow models or 2-D models.
- Evaluation to determine whether the current focus on conveyance preservation should be retained or other technical criteria should be used instead of or in conjunction with conveyance, such as level of hazard using a relationship between depth and velocity.
- Evaluation of 44 CFR § 60.3(b–d) to determine whether changes and/or new guidance for communities are recommended as FEMA considers transitioning from the 1-percent-annual-chance line.
- Evaluation to determine how modifying the methodologies for identifying the floodway could impact State, Tribal, and local floodplain programs that have adopted more restrictive regulations than the minimum conveyance standards in the current Federal regulations.
- Evaluation to determine whether the existing technical information associated with currently designated floodways could still be used by either FEMA or State, Tribal, and local floodplain managers as FEMA shifts

from the 1-percent-annual-chance line if pilot projects determine that no changes are needed to the regulations or current methodology.

- Evaluation of the potential impacts to other FEMA, NFIP initiatives, and other programs and agencies that could arise from any modifications to the floodway concept.

2.6 Recommendation AR 27

RECOMMENDATION AR 27

FEMA should develop, in coordination with stakeholders, a transition plan for moving away from the 1-percent-annual-chance line.

The 1-percent-annual-chance line is used by a network of stakeholders with different needs and purposes. The 1-percent-annual-chance line is embedded in Federal, State, Tribal, and local regulations; regulations that mandate the purchase of flood insurance; Federal and stakeholder websites; as well as program interfaces and systems, training programs, and Federal agency lender audit programs.

The development and execution of a comprehensive transition plan in coordination with stakeholders are necessary elements in the transition from the 1-percent-annual-chance line. Communication and coordination with all stakeholders is essential to determining how the transition would affect stakeholder requirements, processes, procedures, and current regulations, and to minimize unintended consequences. These stakeholders include, but are not limited to, floodplain managers, mitigation planners, U.S. Fish and Wildlife Service (Coastal Barrier Resources Act and Otherwise Protected Areas), other Federal agencies, relevant State/local/Tribal natural resource management agencies, Write-Your-Own insurance companies, NFIP Direct Servicing Agents (DSAs), insurance agents, lenders, Federal regulators, private insurers, zone determination companies, and FEMA contractors (e.g., mapping contractors, CTPs, the NFIP System of Record for Statistical Reporting and Accounting, CRS).

A phased approach is needed. An initial exploratory phase could consist of three elements: (1) consulting with stakeholders and assessing feasibility; (2) conducting pilot projects (see IA 25.1 and IAs 26.1 and 26.2); and (3) evaluating project results in parallel with the existing flood maps to determine what, if any, unexpected concerns or issues may surface for stakeholders. The second exploratory phase would involve preparing a feasibility report to determine how to proceed with a transition (completely away from the 1-percent-annual-chance line; partially away; or not away, but add structure-specific information).

In developing a transition plan, FEMA should:

- Consult with stakeholders to determine the feasibility of transitioning away from the 1-percent-annual-chance line for the purposes of floodplain management and flood mitigation planning/project execution and to identify which mapping tools and products would be needed, including the floodway (consistent with FEMA's request to the TMAC). Results of the exploration should inform the pilots projects identified in Recommendations 25 and 26.
- Prepare a feasibility report after the pilot projects are completed to determine whether to proceed with a complete transition from the 1-percent-annual-chance line to structure-specific information for the purposes of floodplain management and mitigation planning.

- Identify any aspects of the transition that require regulatory or statutory action (e.g., mandatory purchase requirements; or Federal, State, Tribal, and local floodplain management regulations) to ensure that revisions are undertaken in a timely manner to support the implementation time frame for the new methodologies.
- Evaluate whether the continued use of the 1-percent-annual-chance floodplain is needed during the transition to determine insurance requirements and to satisfy lenders' concerns with respect to compliance with regulations and the requirement that homeowners within the SFHA purchase and maintain flood insurance as a condition of a Federally insured mortgage.
- Identify any changes needed to Federal, State, Tribal, and local floodplain management regulations and determine which ones need to be in place before a community's FIRMs are switched to a risk score approach. State Model Ordinances will need to be updated; local communities, tribes, and States will need to update procedures for floodplain permitting and documentation for their permit files; and FEMA will need to determine whether these actions will impact the timeline of the transition.
- Determine whether the transition from the 1-percent-annual-chance line should be linear with a focus on geographic areas, such as FEMA Regions, States, or counties.
- Identify processes and procedures that may impact the Map Service Center and the delivery of maps and data. Consider that communities and others may need something similar to a FIRMette and consider how flood risk scores can be displayed on the FIRMette.
- Identify the timeline to review and revise all documents, forms, and publications on floodplain management, flood insurance, and flood risk. Examples include, but are not limited to, Standard Flood Insurance Policy Forms; *NFIP Flood Insurance Manual* (FEMA, 2017a); *NFIP Adjuster Claims Manual* (FEMA, 2013); *NFIP CRS: Coordinator's Manual* (FEMA, 2017b); Standard Flood Hazard Determination Form; the Elevation Certificate; MT-EZ, MT-1, and MT-2 forms; outreach material; call center scripts; training documentation; websites; and marketing sites.
- Identify processes that would be needed to revise the flood risk score for a structure. Evaluate the new processes or revisions to existing processes that would be necessary for communicating changes/updates to the flood risk score and data (map changes/updates) to stakeholders, and the processes that would need to be implemented for protests, challenges, or appeals.
- Identify and validate new rating engines to accommodate flood risk score rating methodologies. Determine how moving away from the 1-percent-annual-chance line may affect special rating situations, pre-FIRMs, grandfathering, newly mapped areas, and submit-to-rate and special-rate structures.
- Determine the need for a form (similar to an Elevation Certificate) that contains the risk score and supporting information. Identify the data that may be required on such a form for insurance, floodplain management, and mitigation planning purposes.
- Determine how the transition from the 1-percent-annual-chance line may affect FEMA's CRS. Consider impacts to policy premium discounts; points earned by communities for various activities related to floodplain management, such as the points awarded for various levels of freeboard required within a community; and situations in which the SFHA is used in CRS's adjustment factors and the calculation of these adjustment factors.

3. Residual Risk

In general, people underestimate their risks of flooding, and this underestimation directly affects the ability of a community to prepare for flooding, exacerbating losses. In its current state, the Nation's flood mapping poses limitations to communicating the flood risk information that communities need, arguably inhibiting informed decisions around resilience and floodplain management. However, better communicating flood risk information to a range of audiences through the national flood mapping program can inform key community and individual decisions on flood preparedness, land use, infrastructure, and emergency response, thereby reducing the magnitude of losses and disruption that communities experience.

In the context of floodplain management, "risk" is quantified as the likelihood or probability of experiencing flooding multiplied by the consequences of flooding, including the suffering and damages from such an event.

The approaches to reduce and manage risk to lives and properties include non-structural (affecting human behavior), structural (intending to control water flow or height), and mitigation (ways to reduce the severity of damage) (National Research Council, 2013). "Residual risk" is the risk that remains *after* consideration of natural or human-induced measures to reduce known risks. In the context of this chapter, the TMAC uses the definition of residual risk from FEMA's *Coastal Construction Manual*: "exposure to loss remaining after other known risks have been countered, accounted for, or eliminated" (FEMA, 2011).

One of the issues that FEMA asked the TMAC to examine is how the National Flood Mapping Program should address residual risk. FEMA's request is as follows:

> As FEMA takes on the challenge of delivering flood hazard data that support more robust flood risk rating, how can FEMA more effectively deliver, display, and communicate the hazards that drive credible risk assessments in the following areas?
>
> - Residual risk impacted by levees, dams, and other manmade structures; and
> - Areas of changing risk due to event-driven coastal erosion.
>
> What related work of other Federal or State agencies and the private sector should be considered or should inform FEMA's approaches? (Wright, 2017)

Despite the perception that structural measures like dams and levees eliminate risk (Ludy and Kondolf, 2012), areas behind levees and below dams are subject to residual risk. Areas protected by dams and levees could be overtopped from floods that are beyond the protective structures' design capabilities. In addition, protected lands could be flooded if a dam or levee fails due to geologic hazards or structural failures. In such instances, the once "protected" communities and infrastructure experience unplanned exposure to increased water volume, velocity, higher water surface elevations, and longer duration of inundation in areas unable to drain. This unplanned flooding can cause severe damages to people, property, and infrastructure, which are likely not mitigated and are unprepared for such events. The flooding from failure or inadequacies of dams and levees can be further exacerbated by drainage systems that are either overwhelmed or incapacitated. These unintended and unanticipated flooding effects are examples of the type of risk that remains in spite of structural approaches to floodplain management.

Because risk is equal to the product of probability and the consequences of flooding, we know that as long as there are adverse effects (or consequences) from a potential flood in an area, no matter how low the probability of flooding is, there will always be risk and this risk cannot be ignored.

There are also risks associated with storm-induced coastal erosion that may not be fully addressed in the current NFIP mapping and floodplain management standards. For example, the Increased Flooding Scenarios product is a flood risk product produced by FEMA that shows how inundation extents change as water level increases, but the product does not include information about additional erosion that may result from increases that are caused changes in wave energy.

The TMAC notes that, even beyond flood control structures and coastal erosion, there are forms of residual risk that are not given much attention in the NFIP. One form relates to the elevation of structures to an insufficient height in the face of larger flooding events. While national minimum standards require that the lowest floor or lowest horizontal structural member be elevated to at least the BFE (44 CFR § 60.3), the water surface during a flood event may rise significantly beyond this elevation, causing flood damage even when additional freeboard is required through higher State or local standards. The resulting additional damage is generally unanticipated by landowners.

Another form of residual risk relates to the damage sustained by structures outside the mapped 1-percent-annual-chance floodplain. Owners of these structures, which are not subject to the mandatory flood insurance purchase requirements of the NFIP, may not expect these structures to be subject to inundation. For some, the perception is that structures are safe from flooding if there is no requirement to buy flood insurance, but the Nation has experienced inundation of areas beyond the mapped 1-percent-annual-chance floodplain. Owners of buildings in these areas may not currently be aware of the estimated water surface elevation of events beyond the BFE and are, therefore, unprepared for the additional flooding risks.

The TMAC presents below its recommendation and potential IAs for FEMA's consideration in addressing the residual flood risk related to levees, dams, and other flood control structures and coastal erosion in the National Flood Mapping Program. These recommendations and IAs provide an avenue to evaluate and educate the public about residual risks.

3.1 New Residual Risk Recommendation

Table 3-1: New Residual Risk Recommendation

NUMBER	RECOMMENDATION
AR 28	FEMA should develop a series of mapping prototype products aimed at more effectively communicating residual flood risk related to levees, dams, and event-driven coastal erosion. Products developed should incorporate end user and stakeholder testing, and FEMA should develop standards for routine production and presentation, if applicable.

3.2 Implementation Actions for Residual Risk Recommendation

Table 3-2: Implementation Actions for New Residual Risk Recommendation

IMPLEMENTATION ACTION	ASSOCIATED RECOMMENDATION
IA 28.1: FEMA should conduct pilot projects with communities and other stakeholders to evaluate how effective the prototypes are at communicating residual risk. **IA 28.2:** Once prototypes are developed and evaluated, FEMA should leverage the existing flood study process and other community engagement touchpoints to communicate residual risk. **IA 28.3:** FEMA should refine existing non-regulatory products and develop new non-regulatory products to clarify coastal flood risks in the vicinity of erodible features, and highlight the spatial areas affected by event-driven coastal erosion and Primary Frontal Dune (PFD) delineation. Possible products include: 1. Delineation of model results in the vicinity of the eroded PFD. 2. Representation of the regulatory flood zones in the absence of an erodible dune feature.	**AR 28:** FEMA should develop a series of mapping prototype products aimed at more effectively communicating residual flood risk related to levees, dams, and event-driven coastal erosion. Products developed should incorporate end user and stakeholder testing, and FEMA should develop standards for routine production and presentation, if applicable.

3.3 Recommendation AR 28

RECOMMENDATION AR 28

FEMA should develop a series of mapping prototype products aimed at more effectively communicating residual flood risk related to levees, dams, and event-driven coastal erosion. Products developed should incorporate end user and stakeholder testing, and FEMA should develop standards for routine production and presentation, if applicable.

Difficulties in communicating flood risk to the public are well documented, but the difficulty of communicating residual risk is compounded substantially. The concept of residual risk is harder to understand and less represented in official tools and products than flood risk. For instance, NFIP regulations do not define residual risk, and current FIRM methodology and presentation do not address residual risk at all. The result is that the public is not aware of the potential level of damage from residual risk. There are a number of issues that likely contribute to this widespread lack of understanding risk and residual risk. First, levees and dams tend to communicate a false sense of security (Motoyoshi 2006). In addition, frequently, when communities aim to comply with the NFIP, the primary focus tends to be on "getting out of the floodplain" on building a levee to safely pass the 1-percent-annual-chance flood or elevating a building above the BFE with the emphasis on the hazard and little to no discussion on potential consequences of flooding.

In addition, the public generally does not understand the meaning of the published BFE, which is the level that water is anticipated to reach ***or exceed*** during the 1-percent-annual-chance flood event. The public is also generally unaware that other less frequent but more severe events (than the 1-percent-annual-chance flood) can occur, and that those events would affect properties outside of the SFHA. Therefore, simply advising the public of the minimum elevation requirements or using shaded and unshaded X zones on a map is insufficient to convey the residual risks of higher water levels and more extensive inundation areas.

Additionally, the residual risks inherent in areas where the risk is shaped by dams and levees are not sufficiently calculated or conveyed, leaving affected parties generally unprepared or unaware. For event-driven coastal erosion, the current FIRMs and flood risk products do not accurately represent the true risks and, in some cases, can be misleading as to the level of risk, as further explained in the discussion of IA 25.1 (see Section 2.3).

An opportunity exists to improve the public's understanding of residual risk, and working tools are already in place to support that effort. FEMA already calculates water surface elevations for floods with a range of probabilities, not just for the 1-percent-annual-chance event. Additionally, inundation mapping and depth grids are produced for these events, providing a different means of conveying messages about flood risks beyond what is presented on FIRMs. In coastal areas, the PFD is already mapped for current flood risk products, and this information can be used to better explain residual risk.

The understanding of residual risk could be improved through the creation of a series of prototype products that visually display the extent of residual hazards. Further, the prototypes could incorporate general education on the concept of residual risk and could be assessed for effectiveness through community and stakeholder testing, leading to a better understanding of how to best educate the public on residual risk. IAs 25.1 and 26.1 provide examples of the activities that could take place to support this recommendation.

The TMAC proposes developing a new product(s) aimed at increasing public awareness of the impacts of flooding in areas protected by levees, dams, and other flood control structures. Residual risk in coastal areas is addressed in IA 26.1 (see Section 2.5).

3.3.1 CONCEPTUAL PRODUCT FOR CONSIDERATION

The TMAC proposes a conceptual prototype to address residual risk issues associated with dams and levees. The TMAC purposefully avoided any proposals to quantitatively define "residual risk," knowing that it is more important to effectively communicate that flood hazards and related flood risks are dynamic, not known with certainty, and vary over time and space. Background on the residual risks for levees is provided to give context to the suggested prototype.

Levees are constructed to prevent flood damage, but their major weakness is the residual risk when levees are overtopped during flood events exceeding the scope of the levee design. This risk is more difficult to communicate in riverine environments because a small increase in river flood stage creates a large depth of flooding on the landward side. It is a complex risk to evaluate because it depends on many factors such as initial design standards, maintenance procedures, and changing hydrology and hydraulics.

Communities readily realize that non-accredited levees pose a flooding risk, but it can be hard to communicate that accredited levees also have a significant residual risk. Areas behind non-accredited levees are typically subject to zoning ordinances and have mandatory flood insurance purchase requirements at rates that, in some cases, ignore any flood protection from the levee. Therefore, those who live behind non-accredited levees typically may have a better understanding of their risks than those who live behind accredited levees.

By comparison, levees that are accredited as meeting 44 CFR § 65.10 design and maintenance standards have their landward sides mapped as moderate flood risk on FIRMs. Federal mandatory insurance purchase requirements do not apply in moderate flood risk areas. Some may have the perception that if there is no requirement to purchase flood insurance, they are safe from flooding. It is hard to communicate that accredited levees have a significant residual risk.

FEMA has developed the Levee Analysis Mapping Procedure (LAMP) to evaluate the risk associated with non-accredited levees and has significant information on both accredited and LAMP levees.

In addition, the U.S. Army Corps of Engineers (USACE) maintains the National Levee Database and the Rehabilitation and Inspection Program, and has been conducting detailed risk evaluations of a limited number of levees. FEMA and the USACE are working together, but the differences between FEMA's accreditation program and the USACE's inspection program can be confusing to communities.

The TMAC suggests creating a three- to five-tier flood exposure index prototype that is computed using flood probability and flood depth behind levee, and includes what is known about the condition of the levee system. Although the elements that are used to compute the index may eventually incorporate velocity, duration, erosion, and other aspects of the hazard, the TMAC suggests starting with depth and probability for three reasons: (1) both are readily available metrics that are relatively easily derived from data already collected by FEMA, (2) depth has been found to effectively communicate the uneven nature of the hazard within inundation areas, and (3) depth is a key driver for flood damage and mortality. Over time, the product could evolve to include the other factors noted above, particularly if these factors are developed more routinely with FEMA map updates and as they become less costly to compute.

For the purposes of developing a beta product upon which FEMA could collect feedback, depth should be a simple difference between the computed flood stage and measured ground elevation at various flood return periods. The TMAC recommends that in coastal areas, the flood stage include wave heights, wave run-up, wave overtopping, and storm-induced erosion, when possible.

For any given area, depths can be computed and multiplied by their corresponding probability of being equaled or exceeded. As a matter of routine, FEMA currently develops hydraulic models with multiple frequencies: 0.2-, 1-, 2-, 4-, and 10-percent-annual-chance exceedance events, as well as the "1-percent plus"[3] in riverine areas, when deemed appropriate, with depths generally developed for the 100 year frequency. The TMAC proposes that the probability times depth be calculated for each return period, but that the final product only show the highest values calculated when looking at all return periods. This value could be adjusted for a good, fair, or poor maintenance condition of the levee.

Table 3-1 shows the suggested values for probability times depth in a five-tier system. The number of tiers, colors, and words used to describe each, and the thresholds for moving from one level to another are likely to change as FEMA collects feedback from users.

Table 3-3: Prototype Flood Exposure Index

RULES WHEN PXD IS ...			EXPOSURE INDEX	
< 0.002			Low	1
≥ 0.002	to	≤ 0.01	Med-Low	2
> 0.01	to	≤ 0.03	Medium	3
> 0.03	to	≤ 0.04	Med-High	4
> 0.05			High	5

PxD = Probability times depth

There are several things to note using this system. First, all areas with a value lower than 0.002 for probability times depth will be classified "Low." This means that even land with a zero depth or land that is beyond the reach

3 The 1-percent-plus flood elevation is defined as a flood elevation derived by using discharges that include the average predictive error for the regression equation discharge calculation for the Flood Risk Project. This error is then added to the 1-percent-annual-chance discharge to calculate the new 1-percent-plus discharge. The upper 84-percent confidence limit is calculated for gage and rainfall-runoff models for the 1-percent-annual-chance event.

of the 0.2-percent-annual-chance event will still have an assigned exposure index. This represents a subtle but significant shift that is aimed at ensuring that users are clear that flooding is possible everywhere.

Second, because the index is a function of variously sized floods, land behind levees (which are not often designed for floods as large as the 500-year event) will experience depths in some cases that result in a "High" index value. This classification may cause some confusion, but will also provide an opportunity for education and dialogue regarding additional risk mitigation actions. For example, a homeowner may see that his or her home is not in the SFHA, but if the exposure index is "High" for that area, the homeowner would be better informed about whether flood insurance is needed.

Third, the proposed exposure index is a function of probability and depth, making it a hybrid between flood risk (probability and consequences) and what has traditionally been described as flood hazard (flood frequency and depth). The index is not a function of the value of improved property, which would skew the eye toward developed areas and be less useful for future planning purposes. Because the index is a hybrid, describing it as a surrogate for flood risk or flood hazard would be technically inappropriate; thus, it is best described as an "exposure index" that is developed to help communicate residual risk.

Lastly, the methodology is flexible and scalable. Large floods (beyond the 500-year) could be added in the future, additional tiers could be developed to provide greater insight, and other factors (e.g., velocity waves, erosion) could be accounted for the technology advances and data development costs are reduced. This approach could also be used as FEMA transitions away from the 1-percent-annual-chance line.

The flood exposure index could help people avoid being surprised by flooding, promote proactive flood risk management, and better position communities and people to adapt to ever-changing flood risks. Achieving these goals collaboratively with users is critical and, if done well, would help FEMA meet the congressional mandate to "identify, review, update, maintain, and publish NFIP Flood Insurance Rate Maps (FIRMs) with respect to areas of residual risk [and] areas that could be inundated as a result of the failure of a levee, dam, or other flood control structure." [4]

3.3.2 ADDITIONAL CONSIDERATIONS FOR DAMS

The residual risks associated with levees versus those of dams are different. Assessing the residual risk associated with dams is difficult and further challenging communication of the risk to non-technical audiences. There are flooding risks both upstream and downstream from normal dam operations and from the effects of dam failure. However, risk assessment is complicated beyond the technical details related to dam design, dam function, and dam failure by human factors: lives and property are at risk, even when the risks appear to have been addressed.

Dams present residual risk in several ways that are not currently understood by or communicated to those most likely to experience it. Some of the issues regarding residual risk and communication and planning connections that make dams unique are as follows:

- Dam inspection reports are designed to capture the risk from dams, but these reports are not easy to access.
- Dam inundation maps from either emergency spillway operations (normal) or unplanned dam failures (unexpected) are not easily accessible to the public, land use planners, or other decision makers that could have an effect on potential consequences below a dam.

4 Biggert-Waters Flood Insurance Reform Act of 2012, Pub. L. No. 112-141, 126 Stat. 405 (2012), Sec. 100216.

- Emergency action plans are designed to account for risk from dams, but they often incorrectly assume proper maintenance of infrastructure. In addition, the economics of the greater repair costs for older infrastructure to address safety concerns play a part in risk planning.
- During planned or unplanned releases from reservoirs, there may or may not be notification to downstream residents. Some releases are not under the control of the State or jurisdiction experiencing flooding downstream, causing communication challenges.
- Dams are rated based on the loss-of-life hazard, not on potential property damage. Increasing spillway and emergency spillway capacity to reduce fatalities can still increase downstream property damage.
- When development is allowed downstream of the dam, the required spillway capacity must be increased to reduce fatalities in the event of a dam breach, but could result in increased fatalities during normal flood conditions. Some States are regulating the dam failure inundation area to prohibit development that changes the hazard classification.
- The availability of data about dam risks with regard to fatalities is typically limited to regulatory agencies.
- Most dam reservoirs are used for recreation, water supply, or hydroelectric generation, and loss of these uses poses a secondary residual risk.

Because the residual risk associated with dams has many layers and the data are not readily available, FEMA should develop a pilot program that develops techniques for communicating the residual risk downstream of dams. The studies of pilot sites should evaluate how to communicate risk for both normal operations and dam failure conditions, how to include evaluations of infrastructure deterioration in determining the risk that is communicated, and how to determine the appropriate audience for the information.

3.4 Implementation Actions for Recommendation AR 28

IMPLEMENTATION ACTION 28.1

FEMA should conduct pilot projects with communities and other stakeholders to evaluate how effective the prototypes are at communicating residual risk.

One of the biggest challenges in effectively communicating flood risk is taking complex technical information and presenting it in a way that people unfamiliar with the science can use to inform their choices. Because a lack of understanding of flood risk could exacerbate flood losses in the long term, it is critical to identify and evaluate potential options that improve the communication of flood risk information. The following discussion describes how flood mapping can communicate our understanding of flood risk and offers an option for improvement.

This challenge arises in part because flood risk is a function of both the damage that can occur from flooding and the likelihood of that damage occurring. To date, FEMA flood maps and most discussions around floodplain management focus on the flood hazard and tend to leave out discussions on flood damages and risk. The challenge is compounded because both ends of the risk spectrum (low probability/high consequence and high probability/low consequence) are often perceived differently, though their values technically are the same.

Flood damage is caused when floodwater and things of value subject to water damage intersect. Large flood hazards that do not contact anything of value present little risk; conversely, small floods that cause significant damage to things of value present high risk. Accordingly, the message conveyed by flood hazard maps and flood risk maps is often quite different for any given geography or demography.

The difference in the message is best demonstrated by comparing two maps. Figure 3-1 shows a typical FEMA flood map that depicts the 1-percent-annual-chance flood hazard. It is a rather monotone product, showing just one color across the entire area inundated. Figure 3-2 depicts the same magnitude flood, but shows varying depths within the hazard area. Note that the hazard cuts across a geography made up of both open space and improved property. The area of greatest hazard is the center of the river channel where floodwater is deepest, but there is still no designation of economic risk. Figure 3-3 is a flood risk map in which the hazard has been converted into estimated damage (in dollars) to improved property and multiplied by the probability of the event. In Figure 3-3, open space areas are shown properly as having less economic risk than those where improved property exists.

Figure 3-1: Typical FEMA flood hazard map depicting the 1-percent-annual-chance flood hazard

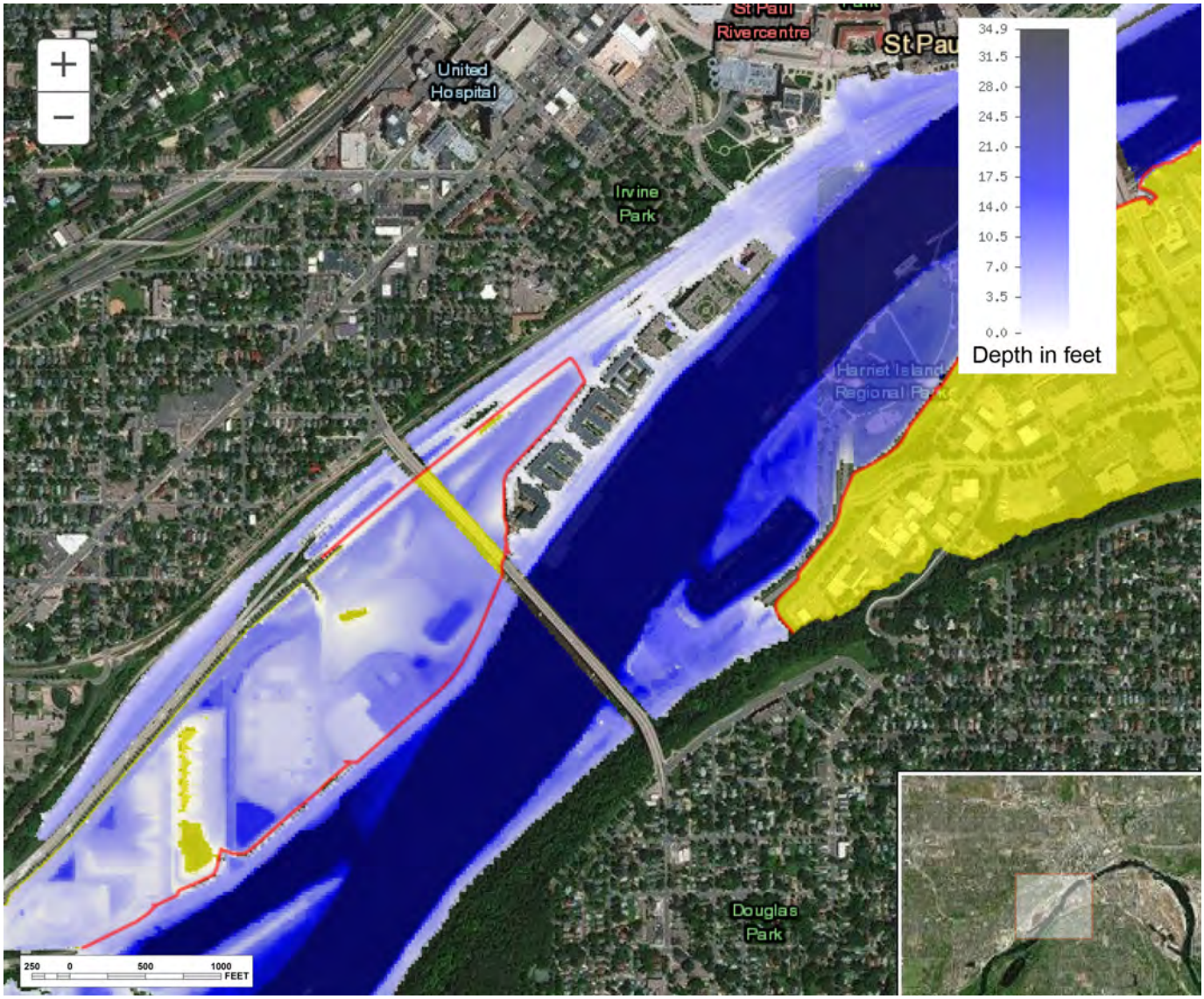

Figure 3-2: Flood hazard map depicting varying depths within the hazard area

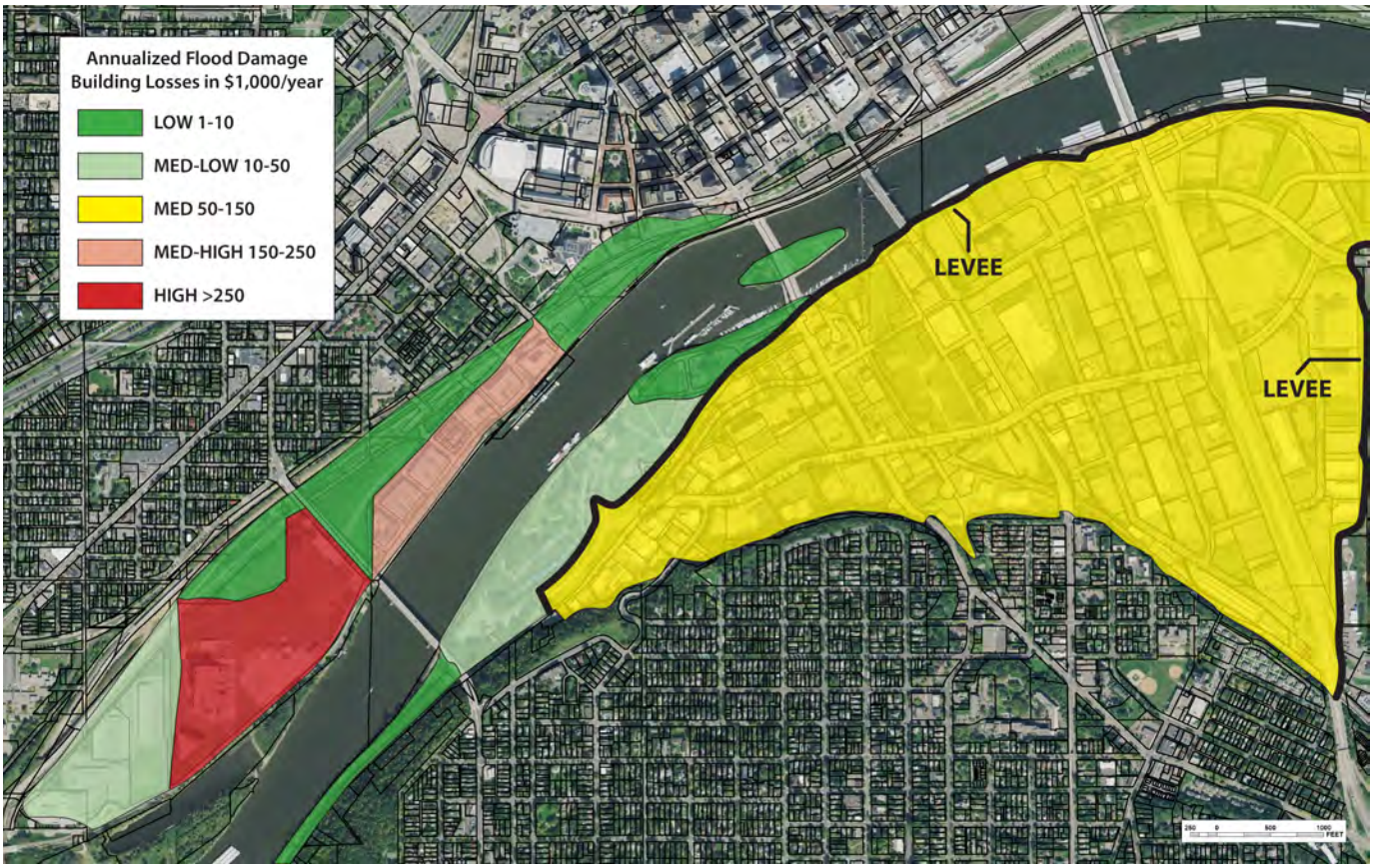

Figure 3-3: Flood risk map in which the hazard has been converted into estimated damage (in dollars) to improved property and multiplied by the probability of the event

Note that if using only Figure 3-1, it could be unintentionally communicated that the hazard and/or risk (there is no distinction between the two in Figure 3-1) is binary, meaning there is a hazard/risk or there is zero hazard/risk. Further, note that in Figures 3-2 and 3-3, areas of the highest hazards (deepest floodwater) and highest risk (high monetary losses) do not necessarily overlap. Hazard and risk are, therefore, not uniformly distributed as might be assumed by looking only at Figure 3-1.

Congress directed FEMA to "identify, review, update, maintain, and publish NFIP rate maps with respect to areas of residual risk…[and] areas that could be inundated as a result of the failure of a levee, dam, or other flood control structure."[5] This residual risk mapping directive is an opportunity to improve the Nation's understanding of flood risk and the dialogue on how best to manage it going forward.

For the purposes of this report, it is assumed that Congress' intent is to more effectively communicate the uneven and uncertain nature of flood hazards and risks across the Nation and to reduce the surprise often expressed by flood victims. A wide range of potential products could be developed to more effectively communicate residual risk, but no single product will meet all the needs of every user.

5 Biggert-Waters Flood Insurance Reform Act of 2012, Pub. L. No. 112-141, 126 Stat. 405 (2012), Sec. 100216.

These new products would effectively communicate residual risk to the end users, who are not steeped in the science of flood hazard analysis and risk assessment. The products would help FEMA establish related mapping standards and routine production and maintenance processes. To ensure that such information is effectively communicated, FEMA should involve the end users in the testing and development of such communication.

The value of using and evaluating visual tools to communicate risk has been demonstrated in other instances. For example, the NOAA National Weather Service recently released new Storm Surge Watch and Warning products, which provide a visual display of coastal areas expected to be within a Storm Surge Watch or Warning area during an acute storm event (see Figure 3-4).[6] These products, generated through the National Hurricane Center, underwent social science research testing and evaluation to ensure that their design and implementation met the needs of end users with respect to the visual extent and depth of inundation from storm surge. The National Weather Service also conducted social science testing of other flood communication products, including emerging products that incorporate uncertainty information, and has incorporated recommendations to improve the delivery of flood forecast tools to end users and stakeholders.

FEMA can use this model of prototype development, testing, iterative development, product launch, and continual user feedback to guide the creation of an exposure index as proposed in Section 3.3.1, the coastal products proposed in IA 28.3, and other products that may be proposed in the future.

The initial residual risk products will need to evolve over time, much as the FEMA flood hazard maps for administering the NFIP have. The intent of these products is to focus on more effectively communicating residual risk and not to mandate flood insurance purchase requirements or flood insurance pricing.

IMPLEMENTATION ACTION 28.2

Once prototypes are developed and evaluated, FEMA should leverage the existing flood study process and other community engagement touchpoints to communicate residual risk.

Well-designed residual risk products should be part of an ongoing, stand-alone educational tool for communities and individuals. Care should be taken to incorporate into the product design a sufficient companion educational piece that provides an in-depth understanding of what the index is presenting and actionable steps that members of the public can take to protect themselves from the indicated risks.

6 See http://www.nhc.noaa.gov/experimental/surgewarning/ for more examples of these prototype products.

Figure 3-4: Prototype Storm Surge Watch/Warning Graphic

FEMA should develop a plan for sharing this educational piece, combined with the exposure index tool or other flood risk products, with communities experiencing residual risk. FEMA already has a robust FIS process that incorporates multiple opportunities to engage with local communities through regularly scheduled meetings during the course of the study and its adoption. The FIS process presents an ideal opportunity for presenting residual risk information. FEMA also has other engagement points with communities via the mitigation planning process, administration of the NFIP, and other touchpoints that could be leveraged to provide residual risk information to communities. The TMAC also suggests partnering with other Federal agencies, including the USACE, to circulate these tools and educational pieces so they reach the broadest possible audience.

The complexity of residual risk requires a sustained educational effort for multiple audiences: community leaders, stakeholders, acutely affected communities, and a more general public audience that may not live near a flood control structure or are impacted by coastal event-based erosion risk, but may encounter residual risk through work, travel, or other encounters. Production of tools and a companion educational piece represent the first step in a sustained effort to share complex information in a user-tested, effective manner.

IMPLEMENTATION ACTION 28.3

FEMA should refine existing non-regulatory products and develop new non-regulatory products to clarify coastal flood risks in the vicinity of erodible features, and highlight the spatial areas affected by event-driven coastal erosion and Primary Frontal Dune (PFD) delineation. Possible products include:

1. Delineation of model results in the vicinity of the eroded PFD.
2. Representation of the regulatory flood zones in the absence of an erodible dune feature.

Mapping flood hazards near erodible coastal features requires engineering judgment and can depend on models with significant uncertainty. Coastal BFEs include modeled storm surge, wave setup, and wave height or wave run-up components, which together determine the hazard. However, the combination of these elements is generally not obvious to users, and their relation to erodible features can be difficult to understand. The BFEs only offer discrete lines and, much like the inland inundation maps, they only provide a binary (either there is a particular flood risk or there is not) presentation of flood risk.

A number of flood risk products are already available for coastal areas, but they only provide a binary presentation of risk—either there is a particular flood risk or there is not. In addition to refining these products, the TMAC proposes the development of two additional flood risk products.

3.4.1 REFINEMENTS TO EXISTING FLOOD RISK PRODUCTS

A series of non-regulatory mapping products have been developed by FEMA, all of which have some relevance to areas affected by coastal erosion (FEMA, 2014). Three of the flood risk products are Dune Size and Location, Increased Flooding Scenarios, and Simplified Coastal Zones.

The Dune Size and Location product shows the PFD along the shoreline. This mapped display of the PFD is an excellent way of showing the extent and location of erodible features. The Dune Size and Location product may support risk rating products once developed.

The Increased Flooding Scenarios product shows how inundation extents change as water level increases and is a useful visualization tool, but it does not tell the complete story and can be misleading without additional education on the limitations of what it represents. In coastal areas, increases in water level may be coupled with changes in wave energy and thus may change the erodibility of land features. It is important to communicate

that inundation areas are larger as water levels increase, but any additional erosion resulting from increased wave energy will not be shown on the maps.

As stated in Coastal-Specific Non-Regulatory Datasets Guidance document, "it may not be appropriate to develop this dataset in areas where the mapped boundary does not directly reflect the underlying terrain, such as where a primary frontal dune has been delineated." This speaks to the special nature of the PFD, and of the difficulty in communicating hazards in erodible areas. Rather than default to a "No Data" value on the PFD for this non-regulatory product, FEMA should create a new classification to highlight the spatial extent of the PFD. Language such as "risk unknown due to erosion" or "risk enhanced by erosion" is more meaningful than "no data."

The Simplified Coastal Zones product groups flood zones according to wave height characteristics. The flood risk information of this product can also be misleading, so the TMAC suggests it be refined. Generally, flood risk products that do not require the PFD to be included within Zone VE, should separate the areas of the dune subject to modeled risk from those mapped due to dune geomorphology. The Simplified Coastal Zones non-regulatory mapping product should not, by default, include the PFD in the High Wave Action polygon. Unlike the FIRM, this will show that the PFD and Zone VE should be considered separately in the context of flood risk. The TMAC suggests that the High Wave Action polygon include the modeled Zone VE and the PFD be designated as such.

3.4.2 SUGGESTED NEW FLOOD RISK PRODUCTS

The TMAC suggests FEMA consider the development a new flood risk product, tentatively named "Modeled Hazards in Erosion Zones," that includes more detail than the Simplified Coastal Zones product. Currently, in the FIRM, not all modeled results are mapped near the PFD. The new flood risk product should show these model results to communicate the modeled risk more clearly. This product could also identify the area of dune that is designated Zone VE due to the PFD delineation.

FEMA should also develop a second flood risk product, tentatively named "Erosion-Induced Failure Scenario," to highlight the impact of erodible dune features on coastal flood hazards. A product that answers the question "What would flood zones look like if the erodible dune did not exist?" would provide floodplain managers with a visualization of a no-dune coastal hazard map. This would reveal areas most vulnerable to coastal hazards when the dune becomes compromised. This product would also provide a way to educate the public on the uncertainty of determining the erosion response of dunes by presenting a worst-case scenario.

3.4.3 CREATION OF AN EXPERT PANEL

The TMAC recognizes the importance of implementing Recommendation AR 9 (2015 Annual Report) ("FEMA should review and update existing coastal event-based erosion methods for open coastal, and develop erosion methods for other coastal geomorphic settings"), which was underscored by Mr. Roy Wright's letter to the TMAC dated January 26, 2017 (Wright, 2017; Appendix C). In light of the importance of the directive and the potential impact to the program on a national level, the TMAC recommends that a panel of coastal thought leaders be created to inform and advise FEMA as it works to achieve this goal. The expert panel would be tasked with formulating a plan for FEMA to undertake Recommendation AR 9, while considering potential consequential impacts to related parts of the NFIP. Members of the TMAC represent a broad cross section of NFIP experts, and they recognize that a narrowly focused expert panel would better serve FEMA and stakeholders.

The proposed coastal expert panel should include academics; engineering consultants; Federal, State, and local government agency representatives; and floodplain managers. Similar panels and groups have been convened in the past to investigate specific topics, make recommendations to FEMA, and develop study guidelines and specifications. Various groups have already generated suggestions to update or alter erosion analyses and PFD practices. This expert panel should first compile relevant past reports in order to vet, update, and refine previously published suggestions. A new plan should wholly supersede older reports and suggestions in order to avoid ambiguity arising from contradictions or similarities.

In addition to developing an implementation plan for Recommendation 9 from the 2015 Annual Report, the new expert panel should consider the need for an updated PFD designation and regulations. The TMAC acknowledges that the PFD can be identified independently from any flood hazard identification and that its only relationship to the 1-percent-annual-chance floodplain is the current regulations requiring minimum Zone VE mapping in areas where a PFD exists. The TMAC believes methodologies have advanced enough to allow for more separation between the PFD and Zone VE. The dune is a vitally important resource in coastal flood risk management and must be protected from encroachment and irresponsible development. Therefore, while a plan should be developed for updating erosion analysis methods, the associated impacts to PFD delineation, relevance, and utility need to be conveyed.

The objective of a new expert panel should be to develop a plan that considers actions that can be enacted on a short time scale under the current regulations and also long-term actions that may require regulatory or programmatic changes. The plan should include prioritized, actionable steps that allow FEMA to update its methodology while testing and refining proposed methodology changes. Long-term recommendations should allow for advancements in the state of the science. The plan should also address implications to the PFD at each short- and long-term implementation step, and include general conclusions and recommendations regarding the continued utility of the PFD under the present erosion methodology.

3.5 Conclusion

Information alone on residual risk is often insufficient for supporting decision making. How information is presented—including its design, wording, delivery method, timing, and source—can strongly influence how well recipients understand the information and decide to prepare or respond. To ensure that the information on residual risk is effective, clear, and actionable, the flood risk products and educational materials should be tested. The TMAC highly recommends testing these products with communities and stakeholders through use of social science research methods, such as focus groups, surveys, and interviews. Testing will help identify areas where product modification or improvement is needed to achieve intended knowledge and action outcomes. Iterative testing of prototypes and messaging can test effectiveness across a range of identified audiences. Results should inform standards for how products are designed and presented to audiences.

Adequately communicating risk, including residual risk from dams and levees and risk from coastal event-driven erosion, is necessary to support appropriate decision making by individuals, households, local government agencies, and communities. These entities must decide whether, when, and which actions to take to prevent loss of life and property in life-threatening situations. The TMAC's recommendations and IAs outline the need for and new means of providing information and data about residual risk.

4. Capture of End User Needs for FEMA's Future Conditions Products

In its January 25, 2017, tasking memorandum to the TMAC, FEMA acknowledged the numerous recommendations and sub-recommendations provided by the TMAC in the 2015 Future Conditions report, and noted the proliferation of future conditions-related data and information being provided to States and communities from diverse governmental and non-governmental sources. As FEMA considers steps to incorporate future conditions into its mapping program, the agency "seeks to avoid unnecessary redundancies and overlaps with these ongoing efforts" (Wright, 2017).

Discussions between the TMAC's Future Conditions subcommittee and FEMA revealed that a lack of understanding regarding the information needs and priorities of FEMA's customers and stakeholders is a principal challenge to FEMA's efforts to move ahead with future conditions risk assessment and mapping. Such an understanding is critical for FEMA to evaluate implementation options and make decisions on how to allocate limited resources among the full suite of program changes recommended by the TMAC in 2015 and 2016. To help the TMAC focus its attention on this most pressing challenge, FEMA revised its tasking in May 2017 as follows:

> Given the current datasets and tools currently being produced by various Federal agencies and non-Federal entities, what additional tools, data and resources can FEMA provide with respect to Future Conditions that would be useful to our customers and stakeholders? (Wright, 2017)

4.1 Pertinent Previous Future Conditions Recommendations and Implementation Actions

In some of its previous reports and recommendations (see Table 4-1), the TMAC identified general issues related to capturing the information needs and priorities of FEMA's customers and stakeholders. Stakeholder and partner engagement was a recurring theme across most of the IAs provided in the 2016 Annual Report, though the specific organizations or individuals to be engaged varied based on the underlying task. For example, PR 2.7 called for soliciting end-user preferences for visualizing future conditions products, while PR 2.6 called for enlisting subject matter experts and stakeholders in developing technical modeling and mapping guidelines and standards once the form and function of future conditions products are established. The other items in Table 4-1 would, if completed, contribute limited information on customer and stakeholder needs, but none would provide the comprehensive view of gaps and priorities that FEMA is seeking to guide its implementation planning and initial product development.

Table 4-1: Pertinent Previous Related Recommendations and Implementation Actions

PREVIOUS RECOMMENDATIONS (R) AND IMPLEMENTATION ACTIONS (IA)	
FC 2	**Communicate accuracy and uncertainty.** Identify and quantify accuracy and uncertainty of data and analyses used to produce future conditions flood risk products, tools, and information. (R)
FC 5	**Design products with stakeholders in mind.** Generate future conditions data and information such that they may frame and communicate flood risk messages to more accurately reflect the future hazard in ways that are meaningful to and understandable by stakeholders. This information should enable users to make better-informed decisions about reducing future flood-related losses. (R)
PR 2.1	**Future conditions modeling and nationwide mapping projects.** FEMA should identify and summarize relevant future conditions-related modeling and mapping projects nationwide (Federal or non-Federal sources) that have technical relevance to the NFIP's mapping program, and capture any data standards, modeling and mapping methods, and/or best practices that can inform FEMA's future conditions mapping program. (IA)
PR 2.2	**Riverine erosion hazard mapping.** FEMA should review existing State-level riverine erosion hazard mapping programs to determine what data standards, modeling and mapping methods, and/or best practices are transferable (i.e., broadly applicable) for potential nationwide implementation of riverine erosion hazard mapping. FEMA should also capture those standards and methods that are applicable to specific geographies or physical settings (analogous to the coast-specific models and guidance used in FEMA's current coastal flood study process). (IA)
PR 2.3	**Coastal erosion.** FEMA should include consideration of both sea level rise (SLR) and long-term coastal erosion in the modeling and mapping of flood hazards in all new coastal future conditions pilots. (IA)
PR 2.4	**Gap analysis of data standards and methodological elements.** FEMA should leverage completed FEMA pilot studies and other relevant coastal and riverine future conditions projects and programs nationwide to prepare a gap analysis that captures outstanding data standards and methodological elements critical to implementing future conditions mapping nationwide. (IA)
PR 2.5	**Future conditions modeling and mapping standards and guidelines.** FEMA should use the existing body of knowledge gained through completed future conditions pilots, evaluation of existing future conditions-related programs, and other relevant Federal and non-Federal efforts to commence development of future conditions modeling and mapping standards and guidelines. (IA)
PR 2.6	**Stakeholder input on future conditions modeling and mapping standards and guidelines.** FEMA should convene stakeholders and subject matter experts in the initial scoping, development, and review of new future conditions modeling and mapping standards and guidelines (IA 8.5). This effort should begin as soon as possible to inform the gap analysis and gap prioritization (IA 8.4), and enable use of any near-term pilots to address critical information needs. (IA)
PR 2.7	**Visualizing future conditions flood risk.** FEMA should develop and test multiple approaches for visualizing future conditions flood risk in one or more future mapping pilots, drawing on relevant social science expertise and lessons learned from prior pilots and other completed mapping projects. (IA)

FC = TMAC Future Conditions Risk Assessment and Modeling (2015)
PR = TMAC National Flood Mapping Program Review (2016)

4.2 Implementation Status

After receiving the Future Conditions report, FEMA established a framework for evaluating and implementing the recommendations and sub-recommendations, including assessing estimated resources, level of effort, time frame, challenges, impacts, and other considerations (FEMA, 2016c). FEMA subsequently prepared a report to Congress that summarized FEMA's response to the Future Conditions report and the 2015 Annual Report, and delivered that report to Congress in August 2017.

The TMAC considered FEMA's initial implementation framework when it crafted the seven IAs in the 2016 Annual Report (see Table 4-1). The IAs represent a sequence of steps that FEMA could take to advance future conditions product development from its current localized pilot projects to regional or nationwide mapping coverage. The IAs focus first on capturing the existing state-of-the-science and best practices (PR 2.1, PR 2.2, and PR 2.7), identifying and filling gaps in methods (PR 28.3 and PR 2.4), and then developing modeling and mapping standards and guidelines (PR 2.5) with stakeholders and subject matter experts engaged in that process (PR 2.6).

In developing the 2016 IAs, the TMAC assumed (based on preliminary statements from FEMA) that FEMA intended to complete future conditions analyses as an add-on to the existing FIS engineering workflow and then issue the results as an additional, non-regulatory layer onto the existing FIRM product. FEMA has since indicated this is not a foregone conclusion; the agency is currently taking a broad view in evaluating options for developing future conditions products, including those that could be done separately from the FIS/FIRM production process. Additionally, as stated in its May 2017 tasking memo, FEMA is interested in better understanding customer and stakeholder needs and priorities, which introduces uncertainty to the path toward implementation. As a result, delaying further action on the IAs that presume a particular implementation path (i.e., PR 2.3–PR 2.6) would be appropriate, while other IAs remain ripe for completion (i.e., PR 2.1, PR 2.2, and PR 2.7).

4.3 New End User Needs Assessment Recommendation

Table 4-2: New End User Need Recommendation

NEW RECOMMENDATION	
AR 29	**Conduct Stakeholder Needs Assessments.** FEMA should initiate stakeholder needs assessments to identify end users' highest priority needs for future conditions products and services that support its current flood-related programs and their evolution over time.

4.4 New End User Need Implementation Actions

Table 4-3: New Implementation Actions

IMPLEMENTATION ACTION		PREVIOUS ASSOCIATED RECOMMENDATION(S) AND IAS	
IA 29.1	**Stakeholder and Partner Involvement.** FEMA should engage a broad array of Federal, State, Tribal, and community-level stakeholders; private-sector stakeholders; and partners throughout the design, planning, execution, and interpretation of the comprehensive Needs Assessment.	None	
IA 29.2	**Capture Critical Product Variables.** FEMA should ensure that the comprehensive Needs Assessment collects information on users' intended applications and addresses key analytical variables, such as relevant timeframe(s), spatial resolution, level of study, future conditions scenarios (e.g., land use, erosion, sea level rise), product type, uncertainty, and visualization preferences.	FC 2	Identify and quantify accuracy and uncertainty of data and analyses used to produce future conditions flood risk products, tools, and information.
		FC 5	Generate future conditions data and information such that it may frame and communicate flood risk messages to more accurately reflect the future hazard in ways that are meaningful to and understandable by stakeholders. This information should enable users to make better-informed decisions about reducing future flood-related losses.
		PR 2.7	FEMA should develop and test multiple approaches for visualizing future conditions flood risk in one or more future mapping pilots, drawing on relevant social science expertise and lessons learned from prior pilots and other completed mapping projects.
IA 29.3	**Ongoing Needs Assessment Capacity.** FEMA should integrate an ongoing future conditions needs gathering step as part of the standard flood study process and during other local community engagement touchpoints, using information gained to adapt FEMA's products to respond to evolving user needs and advancements in science and technology.	FC 5	Generate future conditions data and information such that it may frame and communicate flood risk messages to more accurately reflect the future hazard in ways that are meaningful to and understandable by stakeholders. This information should enable users to make better-informed decisions about reducing future flood-related losses

IA = Implementation Action, **FC** = TMAC Future Conditions Risk Assessment and Modeling (2015), **AR16** = TMAC 2016 Annual Report

4.5 Recommendation AR 29

FEMA has requested the TMAC's assistance in identifying what future conditions–related data, tools, and resources FEMA could provide that would be useful to FEMA's customers and stakeholders and also avoid duplication with products and services already provided by other agencies and non-governmental organizations. Although TMAC members are able to represent the perspectives of their respective employers and/or sponsoring sectors or organizations, they do not reflect the full suite of potential end users for FEMA's future conditions flood hazard products, nor are they aware of all existing data, approaches, or applications.

To move forward on implementation most constructively, FEMA needs an initial, comprehensive account of existing customer and stakeholder needs and priorities for future conditions products, as well as an ongoing mechanism to learn how user requirements may evolve over time. At the outset of implementation, a comprehensive needs assessment would provide FEMA with information critical to identifying which future conditions data and interpretive products provide the greatest support to FEMA's existing flooding-related missions and programs (e.g., floodplain management, risk communication, hazard mitigation, flood recovery). The comprehensive assessment should also help FEMA differentiate between the products the agency should produce itself versus those that should be delivered by other agencies and organizations. As more States and communities gain experience in managing future conditions flood risk, their needs for FEMA's products may change considerably. Additionally, advances in climate science and the availability of actionable data on future flooding may also alter user priorities and the products FEMA decides to generate. To keep abreast of these changes and build adaptive capacity into its product suite, FEMA should seek feedback on future conditions product needs whenever interacting with communities concerning flood map updates or during other relevant engagement points (e.g., resilience meetings, post-flood recovery).

Thus, the TMAC recommends the following:

RECOMMENDATION AR 29

FEMA should initiate stakeholder needs assessments to identify end users' highest priority needs for future conditions products and services that support its current flood-related programs and their evolution over time.

4.6 Implementation Actions for Recommendation AR 29

To ensure that the needs assessments collect the information required to inform FEMA's programmatic planning, implementation, and long-term management of a future conditions product suite, the TMAC has identified several IAs that provide potential direction and focus for both the assessment mechanics (i.e., suggestions on how to conduct the information gathering) and the topics to be explored.

IMPLEMENTATION ACTION 29.1

FEMA should engage a broad array of Federal, State, Tribal, and community-level stakeholders; private-sector stakeholders; and partners throughout the design, planning, execution, and interpretation of the comprehensive Needs Assessment.

Reaching representatives from across the diverse stakeholder and partner spectrum for future conditions–related products will be critical to both the success of the initial, comprehensive needs assessment and FEMA's efforts to apply the results. The TMAC comprises representatives from many of FEMA's key customers and stakeholder groups and, as such, the TMAC members bring substantial expertise on the status of current future conditions science and risk management tools and approaches currently available and in use nationwide. Because the TMAC is not completely representative of FEMA's customer and stakeholder base and the TMAC may eventually sunset, FEMA should also plan to engage with other Federal partners and State, Tribal, community, and private-sector stakeholders throughout the comprehensive Needs Assessment process.

The TMAC encourages FEMA to leverage existing partnering efforts and groups, including the CTP network and the Resilient Nation Partnership Network, and to use diverse approaches and mechanisms to reach community-level users that span relevant hazard types (i.e., coastal and riverine) and varying capacity for using future conditions information. In addition to capturing the needs and priorities across the full, diverse spectrum of users, reaching out broadly could enable FEMA to document previously unknown future conditions datasets, tools, or approaches—information that FEMA could use in clarifying the agency's unique role and potentially inspiring FEMA's product workflows or formats.

IMPLEMENTATION ACTION 29.2

FEMA should ensure that the comprehensive Needs Assessment collects information on users' intended applications and addresses key analytical variables, such as relevant timeframe(s), spatial resolution, level of study, future conditions scenarios (e.g., land use, erosion, sea level rise), product type, uncertainty, and visualization preferences.

States, communities, businesses, and other organizations and individuals use variety of future conditions–related products that span a wide range of time frames (from decades to a century), spatial scales, and risk tolerances. End users are also asking for information on the uncertainty of future conditions information and the likelihood of specific outcomes. Ultimately, FEMA's resources for future conditions mapping will be finite, so it is imperative that the comprehensive Needs Assessment collect information on expected users' intended applications and document their preferences on key analytical variables. For example, some communities may be interested in future conditions products for planning and infrastructure investment analysis, while others may be interested in incorporating future conditions data into building codes or other development requirements. Other communities may be interested in using these products for risk communications. The products may require different levels of precision and/or spatial resolution to achieve their unique goals.

Through its briefings to and committee discussions with the TMAC, FEMA has mentioned the potential to use flood hazard type as a means to phase implementation of future conditions modeling and mapping, with coastal areas having the greatest readiness in terms of actionable science and tested methods concerning SLR and its interaction with extreme event-related flooding (Batten, 2017). In terms of topical and geographic focus, FEMA may elect to emphasize the collection and analysis of coastal community needs and priorities in the comprehensive Needs Assessment. However, as noted in the Future Conditions report and 2016 Annual Report, land-use change, riverine erosion, and channel migration are aspects of riverine future conditions for which actionable science and methods are currently available either nationally or regionally; in fact, many States and communities across the United States currently assess and/or manage these future flood risks. FEMA should

leverage its considerable internal effort, external partner engagement, and general visibility surrounding the comprehensive Needs Assessment to document riverine community needs and priorities with respect to future conditions, inclusive of climate- and non-climate-related impacts.

Finally, as noted in the discussion of IA 8.7 in the 2016 Annual Report, a long-standing issue has been the difficulty of depicting future conditions flood risk in ways that are understandable and meaningful to FEMA's diverse target audiences. The comprehensive Needs Assessment should include a social science component that explores user understanding and preferences for different visualization approaches.

IMPLEMENTATION ACTION 29.3

FEMA should integrate an ongoing future conditions needs gathering step as part of the standard flood study process and during other local community engagement touchpoints, using information gained to adapt FEMA's products to respond to evolving user needs and their evolution over time.

Although the comprehensive Needs Assessment will provide information critical to FEMA's programmatic planning and initial implementation of a future conditions product suite, rapidly evolving user requirements and improved climate science could limit the long-term value of the assessment results. To ensure its decisions about which products to produce remain responsive to customer and stakeholder needs and grounded in best-available and actionable science, FEMA should integrate a smaller scale, needs gathering step as part of the standard flood study and community engagement process. In planning for implementation of a future conditions risk assessment and mapping program, FEMA may find it advantageous to use information gained in an ongoing manner (i.e., study by study or timed with other community engagement points, such as resilience meetings) to create a knowledge base that would help adapt its products over time. Such an approach could help FEMA develop an adaptive capacity for proactively managing and altering its future conditions products, something that has not been possible for the regulatory, present-conditions flood hazard products.

4.7 Applying Comprehensive Assessment Results

In its tasking to and discussions with the TMAC, FEMA identified the criticality of having a sound understanding of customer and stakeholder needs for future conditions products and services before scaling up from pilot projects into a full-scale, national modeling and mapping effort. A well-designed and executed comprehensive Needs Assessment, conducted considering the elements outlined in this chapter, should position FEMA to not only plan for implementation, but also to address more substantively the full array of action-oriented future conditions recommendations and IAs provided by the TMAC in 2015 and 2016.

5. TMAC Goals and Recommendations 2015-2016

GOAL 1: ACCURATE DATA, MODELS, AND RISK ASSESSMENTS

AR 2
Develop National program 5-year plan.

AR 3
Develop National program goals and metrics.

AR 4
Work with partners to ensure topo data is collected to Federal standards.

AR 5
Document HV accuracy of topo data.

AR 6
Review updated statistical models (Bulletin 17C).

AR 7
Develop guidance for selection and use of riverine and coastal models.

AR 8
Develop guidance related to coastal 2D storm surge modeling.

AR 9
Update coastal event-based erosion methods.

FC 1
Provide future conditions flood risk products using standardized timeframes.

FC 2
Identify and quantify accuracy and uncertainty of data.

FC 3
Provide flood hazard products for coastal areas that includes erosion and SLR using scenario approach.

FC 4
Provide flood hazard products for riverine areas that includes future conditions.

FC 5
Generate future conditions data to frame and communicate messages.

FC 6
Perform demonstration projects.

FC 7
Future conditions should be consistent with existing conditions analysis and future conditions scenarios.

PR 1
FEMA should adopt TMAC's 2015 recommendations that relate to the National Flood Mapping Program's technical credibility from the TMAC 2015 Annual Report.

PR 2
FEMA should adopt the future conditions recommendations from the 2015 TMAC Future Conditions Risk Assessment and Modeling report.

PR 3
FEMA should complete the implementation of the statutory requirements of the National Flood Mapping Program.

PR 4
FEMA should continue to enhance communication and transparency with program stakeholders by, for example, including organizational and contact information on the Internet.

GOAL 1 (continued)

PR 5
FEMA should investigate offering multi-year program management grant periods (versus annual) to Cooperating Technical Partnerships (CTPs).

PR 6
FEMA should facilitate, partner, and leverage current high resolution topographic data (e.g., Light Detection and Ranging [LiDAR] data, other new and emerging technologies).

PR 7
FEMA should work with Congress and MAPPING partners to examine ways to shorten the study process, including the time added to the mapping process by QRs, KDPs, and legislated due process, as identified in Recommendation 11 in the *TMAC 2015 Annual Report*.

PR 8
FEMA should move to a database-derived display, as outlined in the TMAC 2015 Annual Report Recommendation 16.

PR 9
FEMA should work to identify residual risk areas behind levees, and other flood control structures and downstream of dams.

PR 10
For non-accredited levees, FEMA should replace the Zone D designation in levee-protected areas with risk zones that are more appropriate for the level of risk.

PR 11
FEMA should evaluate the current metrics to better measure the efficient production, valid inventory, and stakeholder acceptance of the National Flood Mapping Program.

PR 12
FEMA should have an inventory metric that reports quantity, quality, and time aspects on national, regional, tribal, state, and watershed levels.

PR 13
FEMA should have a metric that shows progress towards meeting a digital platform goal by area of the nation to complement FEMA's current population metrics. This metric could include the total area of the country, as well as progress towards Goal 3 and Recommendation 16 in the TMAC 2015 Annual Report.

PR 14
FEMA should evaluate the benefits and costs and its value to the nation as a result of different levels of funding to the National Flood Mapping Program.

AR 23 (2016 Annual Report)
FEMA should develop, in conjunction with others in the public and private sectors, flood risk-rated insurance premiums for all structures within and outside the identified Special Flood Hazard Area. These premiums should be based on the nature and severity of the flood hazard, and structure elevation and other characteristics, as well as structure damage functions and vulnerability.

AR 24 (2016 Annual Report)
FEMA should communicate to the property owner and the relevant interested parties on the cost of risk-rated insurance today and over time for new and existing structures to make the risk transparent. The data should include the benefits and cost that mitigation measures will have on these premiums.

GOAL 2: TIME AND COST-EFFICIENT GENERATION OF DATA

AR 11
Update MIP to add greater flexibility.

AR 12
Determine cost impact due to new program requirements.

AR 13
Integrate process for mass LiDAR-based LOMA.

GOAL 3: UTILIZATION OF COST-EFFICIENT TECHNOLOGIES

AR 16
Transition to database-derived, digital display environment.

GOAL 4: INTEGRATED FLOOD RISK MANAGEMENT FRAMEWORK

AR 10
Transition to structure-specific flood frequency .determination.

AR 14
Transition to structure-specific risk assessment.

GOAL 5: AWARENESS OF FLOOD HAZARD AND RISK DATA

AR 1
Implement process to assess needs of users.

AR 15
Communicate messages that consider long-term resilience strategies.

GOAL 6: ADDED VALUE PARTNERING AND LEVERAGING

AR 17
Consider NAPA recommendations on agency cooperation and federation.

AR 18
Partner to ensure availability of accurate water level and stream flow data and enhance the NHD.

AR 19
Implement strategies to incentivize stakeholders to increase partnerships.

AR 20
Develop measures to evaluate CTP capabilities and competencies and increase responsibilities.

AR 21
Establish National Flood Hazard Risk Management Coordination Committee.

GOAL 7: PERMANENT, SUBSTANTIAL PROGRAM FUNDING

AR 22
Define financial needs to implement recommendations.

KEY

Recommendation Sources:

AR	TMAC Annual Report (2015) or TMAC 2016 Annual Report
FC	TMAC Future Conditions Risk Assessment and Modeling (2015)
PR	TMAC National Flood Mapping Program Review (2016)

Acronyms:

CTP	Cooperating Technical Partner
FEMA	Federal Emergency Management Agency –
GIS	Geographic Information Systems
KDP	Key Decision Point
LiDAR	Light Detection and Ranging
NAPA	National Academy of Public Administration
NFIP	National Flood Insurance Program
NHD	National Hydrography Dataset
QR	quality review
Risk MAP	Risk Mapping, Assessment, and Planning
SLR	sea level rise
TMAC	Technical Mapping Advisory Council

Transformation of Mapping

INITIATIVES

Structure-Based Risk Assessments

BENEFIT: Transform the NFIP to protect current and future generations

National Program 5 Year Plan

BENEFIT: Increase transparency and leveraging of Federal funds

Future Conditions

BENEFIT: Stop building future problems


KOMATSU
DANGER

6. Acronyms and Abbreviations

AAL	Average Annualized Loss
AR15	TMAC 2015 Annual Report
AR16	TMAC 2016 Annual Report
AR17	TMAC 2017 Annual Report
BFE	Base Flood Elevation
BW-12	Biggert-Waters Flood Insurance Reform Act of 2012
CDS	Customer and Data Services
CE	Civil Engineering
CFM	Certified Flood Manager
CFR	Code of Federal Regulations
CRS	Community Rating System
CTP	Cooperating Technical Partner
DFO	Designated Federal Officer
DHS	Department of Homeland Security
FACA	Federal Advisory Committee Act
FC	*TMAC Future Conditions Risk Assessment and Modeling* (2015)
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FOIA	Freedom of Information Act
GIO	Geospatial Information Officer
GIS	Geographic Information System
GISP	GIS Professional
HFIAA	Homeowner Flood Insurance Affordability Act of 2014
HQ	Headquarters
HUC8	Hydrologic Unit Code 8
IA	Implementation Action
KDP	Key Decision Point
LAMP	Levee Analysis Mapping Procedure
LiDAR	Light Detection and Ranging
LOMA	Letter of Map Amendment
MIP	Mapping Information Platform
NAPA	National Academy of Public Administration
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NVUE	New, Valid, Updated Engineering
PFD	Primary Frontal Dune
PLS	Professional Land Surveyor
PR	TMAC National Flood Mapping Program Review (2016)
PTS	Production Technical Services
QA/QC	Quality Assurance/Quality Control
Risk MAP	Risk Mapping, Assessment, and Planning
RS	risk score
SFHA	Special Flood Hazard Area
SLR	Sea Level Rise
TMAC	Technical Mapping Advisory Council
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey


BOBBY SIZZLE
07

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Appendix A: TMAC Charter

U.S. Department of Homeland Security
Federal Emergency Management Agency
Technical Mapping Advisory Council
Charter

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 statutory 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.

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 Management Directorate 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 FY2017 and $800,000 for FY2018. This includes surge support for all direct and indirect expenses. Three staff directly support the TMAC. One full-time, and two part-time FTEs.

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 FEMA Administrator may also appoint an Alternate 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) of the Biggert-Waters Flood Insurance Reform Act of 2012, 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;

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;
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 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 up to 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 up to an additional one- or two-year term. The Administrator has the authority to extend reappointments for up to 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 records of the TMAC, established subcommittees, or other subgroups of the Council, shall be maintained and handled in accordance with General Records Schedule 6.2, or other approved agency records disposition schedule. These records are available for public inspection and copying, in accordance with the Freedom of Information Act (Title 5, United States Code, section 552).

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 29, 2017
Department Approval Date

July 31, 2017
CMS Consultation Date

August 03, 2017
Date Filed with Congress

Appendix B: TMAC Bylaws

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.

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 up to an additional

one-year term. No Chair or Vice Chair shall serve longer than three years, unless the DFO determines that an extension of term of a Chair or Vice Chair is necessary in order to complete their oversight of an outstanding task or report. In the event that the DFO determines that such an extension is necessary, such extension shall not extend the Chair or Vice Chair's appointment for a period in excess of six months. 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 50-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 may be named to serve on a specific subcommittee and may contribute to others as requested.

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.

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).

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 a third 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 may 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 may 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.

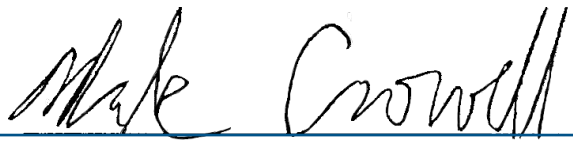
Once the TMAC achieves consensus on a report and recommendations, the TMAC Chair is responsible for providing a final version of the report to the FEMA Administrator. The final report and any accompanying memoranda will be posted on the TMAC website.

ARTICLE X RECORDKEEPING

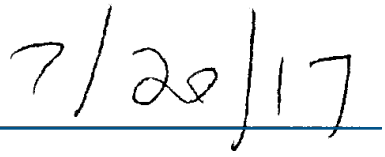
The DFO maintains all records of the advisory Council in accordance with FACA and FEMA policies and procedures. All documents, reports, or other materials presented to, or prepared by or for the Council, constitute official government records and are available to the public upon request.

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:

Appendix C: FEMA 2017 TMAC Tasking Memo

U.S. Department of Homeland Security
Washington, DC 20472

FEMA

January 25, 2017 (revised May 2017)

MEMORANDUM FOR: Technical Mapping Advisory Council

FROM: Roy E. Wright
Deputy Associate Administrator for Insurance and Mitigation

SUBJECT: FEMA's Technical Mapping Advisory Council 2017 Tasking

I appreciate the hard work of the Technical Mapping Advisory Council (TMAC) to date and the work that it will continue to do as the Federal Emergency Management Agency (FEMA) transitions its flood data, redesigns its insurance risk rating, and transforms its products and services to best meet the needs of policyholders and the community. In 2017, on behalf of the FEMA Administrator, I would like the TMAC to focus its efforts and provide insight on several specific topic areas, which will best position FEMA to continue to evolve the National Flood Insurance Program to meet the needs of policyholders and property owners. We appreciate the suggestions and potential topics identified by several TMAC members. I was pleased to see consistency and similarities between the topics FEMA was considering and the suggestions put forward by the TMAC.

The attached document lists three topic areas of particular significance to FEMA's flood mapping program and provides context, current considerations, and a targeted "ask" for each topic. These topics were selected with consideration for the potential topic areas identified by TMAC members, as well as with input from FEMA Regional and Headquarters engineers. The issues outlined in the attachment will help inform the evolution of the mapping program and the future of flood mapping for the NFIP. These topics have been provided to the TMAC for consideration as the focus of the TMAC's 2017 Annual Report and recommendations.

I appreciate the Council's continued dedication to sharing its knowledge and developing recommendations for FEMA that will further strengthen our evolving flood mapping program, reduce risk, and help keep our Nation safe.

Sincerely,

Roy E. Wright
Deputy Associate Administrator
Federal Insurance and Mitigation Administration

Attachment

www.fema.gov

ATTACHMENT
This attachment provides additional context for the issues that FEMA is asking the TMAC to address in 2017.

Issue 1: Floodplain Management and Mitigation impacts of transitioning away from the 1-percent-annual-chance flood hazard

Context:

Today, national flood insurance is available in more than 22,000 participating communities across the United States. In exchange, those communities have agreed to adopt and enforce minimum land use standards and building codes. Flood hazard mapping is an important part of the National Flood Insurance Program (NFIP), as it is the basis for insurance ratings and the minimum floodplain management standards.

One of the greatest strengths of the NFIP is this partnership with communities, which includes their efforts to mitigate and reduce flood risks through floodplain management and building codes. While the NFIP sets minimum Federal standards, those are intended to be a launching place for more aggressive standards and mitigation by the community, based on the risks they face.

While tremendous mitigation and resiliency benefits are associated with having minimum Federal standards, the situation also presents some challenges. Currently, the NFIP's flood mapping program is structured around a binary Base (1-percent-annual-chance) Flood Elevation (BFE) line on a flood map, and a property is either inside or outside of that line. If the owners are within that line and have a Federally backed mortgage, they have to buy insurance. This "in or out" perspective gives property owners and policyholders a false sense of risk and doesn't communicate the full spectrum of risk. The way we've historically mapped flood hazards, and the mandatory purchase associated with the 1-percent BFE delineation, make it difficult for our policyholders to understand their risk.

Consistent with the TMAC's recommendations, we are laying the foundational framework for transforming our flood mapping program to provide structure-specific flood frequency determinations. As we work to evolve the mapping program to transition away from the 1-percent-annual-chance flood hazard as the basis for insurance ratings, we must also understand and address the cascading impacts of this change, particularly on floodplain management.

From a floodplain management perspective, the 1-percent-annual-chance flood hazard and associated floodway on the Flood Insurance Rate Maps are used as the basis for establishing and enforcing floodplain management standards in the community. As the NFIP and flood mapping program evolve into a structure-specific, risk-based program, is the floodway concept still relevant? If we no longer mapped the floodway, how would floodplain management standards be enforced?

Request to TMAC:

As FEMA moves away from mapping the 1-percent-annual-chance flood hazard and evolves the flood mapping program to provide structure-specific risk, what are the cascading impacts, issues, and opportunities that FEMA should consider from a floodplain management and mitigation perspective? What mapping tools will be needed to support floodplain management? Is the floodway concept still relevant? If we no longer mapped the floodway, how would floodplain management standards be enforced?

Issue 2: The National Flood Mapping Program must purposely and strategically enhance, replace, and add flood hazard mapping products in the coming years in order to support a redesign of the flood risk rating structure for the NFIP and to enhance understanding of risk at a more granular level. The most significant gaps are currently in areas affected by levees, dams, and other embankments, as well as areas subject to event-driven erosion.

Context:

FEMA is undertaking an effort to redesign risk rating for the NFIP. Essential to this effort is ensuring that the National Flood Mapping Program efficiently produces flood hazard data for a risk-based analysis to improve understanding and/or ownership of flood risk at a given location or structure and supporting transformative change in how the program reflects gradation of flood risk for flood insurance rating and risk communication.

Currently, the flood risk products and hazard information that FEMA delivers focus on specific likelihoods of the flood hazard, with a particular focus on the 1-percent exceedance level for NFIP rating and floodplain management. As the TMAC, National Academies, FEMA actuaries, and others have pointed out, FEMA should adopt a risk-based approach that considers the full range of flood hazards and the resulting outcomes. To that end, FEMA is considering how to better reflect risk from routine flooding to low-probability but high-consequence events. FEMA is actively working to develop next-generation costal and riverine studies to support a risk-based approach, but gaps remain.

First, the 2016 TMAC National Flood Mapping Program Review noted that FEMA does not currently account for critical hazard conditions specific to areas affected by dams, levees, or other manmade structures. BW-12 calls for FEMA to begin to identify such hazards as part of the NFIP defined in statute.

Second, the 2015 Annual Report's Recommendation 9 calls for FEMA to review and update coastal event-based erosion methods for open coasts, and to develop event-based erosion methods for other coastal geomorphic settings. Additionally, it is noted that FEMA's use of the Primary Frontal Dune (PFD) to identify Coastal High Hazards Areas does not lend itself to a multiple-frequency determination. The program would welcome input on how to evolve FEMA's assessment of erosion so that it is consistent with the state of the science, applies to the many types of coastlines, and does not inhibit the ability of the NFIP to evolve with a more effective risk rating design. We are also interested in learning the TMAC's perspective on the continued utility of the PFD designation or if the NFIP can, or should, function without it.

Request to TMAC:

As FEMA takes on the challenge of delivering flood hazard data that support more robust flood risk rating, how can FEMA more effectively deliver, display, and communicate the hazards that drive credible risk assessments in the following areas?

- **Residual risk impacted by dams, levees, or other manmade structures; and**
- **Areas of changing risk due to event-driven coastal erosion**

What related work of other Federal or State agencies and the private sector should be considered or should inform FEMA's approaches?

Issue 3: The TMAC's 2015 *Future Conditions Risk Assessment and Modeling* (Future Conditions report) raised significant issues and opportunities. Many players exist in the development and dissemination of future conditions information, including Federal agencies, non-governmental organizations, States, and others. Perspective on the role of all players in the field of future conditions and gaps that remain in the development and dissemination of this information to stakeholders of the NFIP is needed.

Context:

In January 2016, the TMAC delivered its Future Conditions report. This statutorily mandated report included seven overarching recommendations and numerous sub-recommendations. The TMAC's recommendations and sub-recommendations provide substantial input and guidance into how FEMA may generate some future conditions data and information.

Over the past decade, the amount of information being provided to States and communities concerning future conditions flooding and erosion hazards has dramatically increased. This is especially true for sea level rise (SLR) projections and SLR planning information. At present, multiple Federal agencies (including the U.S. Army Corps of Engineers, the National Atmospheric and Oceanic Administration, the U.S. Geological Survey, and the Environmental Protection Agency), nationally scoped non-governmental organizations (e.g., The Nature Conservancy, Climate Central, and the National Research Council), and various State and regional bodies are producing and disseminating this information.

In this crowded space, FEMA seeks to avoid unnecessary redundancies and overlaps with these ongoing efforts. This is for several reasons. First, many communities, especially coastal ones, are not able to absorb and act on the vast amounts of data already available, especially if they seem to conflict due to uncertainty in the science. Second, the cost to produce the datasets as described in the Future Conditions report is significant; therefore, if similar data are already available, this cost should be avoided. Third, before any data is produced, FEMA wishes to ensure that it is data that are actually needed by our customers and that it is provided in a way that is most useful to them. Given this, FEMA would like to better understand the TMAC's perspective on the unmet needs or gaps in this field that the TMAC envisions FEMA's participation could fill.

To give these recommendations the full weight of the consideration that they are due and to design and implement an effective future conditions program in response to them, FEMA would like to continue working with the TMAC in 2017 to better understand the role this agency should play in providing communities with future conditions information. We want to ensure that we fully understand the need that is not being met by other Federal, or non-Federal, resources as we develop new products.

Request to TMAC:

Given the current datasets and tools currently being produced by various Federal agencies and non-Federal entities, what additional tools, data and resources can FEMA provide with respect to Future Conditions that would be useful to our customers and stakeholders?

Appendix D: TMAC Administrative and Public Meetings – Fiscal Year 2017

MEETING DATE	MEETING TYPE	LOCATION	BUSINESS PURPOSE
October 26–27, 2016	Administrative	Virtual	The TMAC welcomed new council members and deliberated on draft language for inclusion in the TMAC 2016 Annual Report.
November 30, 2016	Administrative	Virtual	The TMAC Designated Federal Officers provided the new TMAC members with an orientation on the administrative aspects of the TMAC and an overview of the first 2 years of council activity.
December 13–14, 2016	Public	3101 Wilson Blvd., Arlington, VA	The TMAC reviewed, deliberated on and approved recommendations and narratives to be incorporated in the TMAC 2016 Annual Report.
January 27, 2017	Administrative	Virtual	The TMAC conducted an administrative meeting to review technical edits to the TMAC 2016 Annual Report and to review the TMAC 2017 tasking memo from FEMA.
March 22–23, 2017	Public	3101 Wilson Blvd., Arlington, VA	The TMAC discussed the 2017 TMAC topics. The council received briefings from subject matter experts on topics such as floodplain management impacts, flood insurance rating process design, FEMA future sea level rise and erosion projection assessment, and effective risk communication.
May 23, 2017	Public	Virtual	The TMAC reviewed draft topic outlines and content to be incorporated in the TMAC 2017 Annual Report.
July 25–26, 2017	Public	U.S. Geological Survey, Reston, VA	The TMAC reviewed, deliberated on, and approved recommendations to be incorporated in the TMAC 2017 Annual Report.
September 13–14, 2017	Public	Location TBD	The TMAC reviewed, deliberated on, and approved final TMAC 2017 Annual Report content for production and submission to the FEMA Administrator.

TBD = to be determined

Appendix E: TMAC 2017 Subcommittee Meetings – Fiscal Year 2017

Floodplain Management / Structure-Specific Risk Subcommittee Meetings

MEETING DATE	BUSINESS PURPOSE
March 6, 2017	Prepared for discussions at the March 22–23, 2017, TMAC public meeting.
March 30, 2017	Discussed the outline development.
April 24, 2017	Discussed the draft outline.
June 20, 2017	Discussed feedback from the TMAC public meeting in May and the path forward for the report.

Residual Risk Subcommittee Meetings

MEETING DATE	BUSINESS PURPOSE
February 22, 2017	Kickoff Meeting. Discussed the draft outline and subject matter expert needs.
March 15, 2017	Discussed needs for the topic of residual risk from dams and received a presentation from FEMA on levees.
April 12, 2017	Received a presentation from FEMA on the residual risk tasking.
July 3, 2017	Conducted a working session on the current draft of the document.

Future Conditions Subcommittee Meetings

MEETING DATE	BUSINESS PURPOSE
March 6, 2017	Kickoff meeting. Reviewed the tasking and proposed subcommittee schedule.
March 13, 2017	Discussed the proposed approach for 2017 Annual Report and confirmed plans for the March 22–23, 2017, TMAC Meeting.
March 20, 2017	Discussed questions to raise to the full TMAC during the March 22–23, 2017, TMAC meeting.
April 24, 2017	Held Q&A sessions with FEMA on the 2015 report to Congress and with Tucker Mahoney on FEMA's path forward.
May 8, 2017	Reviewed updated version of the 2017 Tasking Memo from FEMA. Discussed impacts from the new 2017 tasking on our planned approach for the 2017 Annual Report. Discussed expectations for upcoming TMAC public meeting.
May 15, 2017	Discussed the path forward for the future conditions portion of the report.
June 5, 2017	Discussed the path forward for the future conditions portion of the report.

Appendix F: TMAC Recommendations and Implementation Actions 2015–2017


BURKE
CONSTRUCTION INC.
732-775-6959

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 1 (2015)	FEMA should establish and implement a process to assess the present and anticipated flood hazard and flood risk products to meet the needs of 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. **Former Numbering IA16 2.1 (New Numbering AR 1.1)** FEMA should construct and implement, and measure the effectiveness of public communication strategies that reflect how individuals acquire and process information on low-probability, high-consequence events. The strategies would include: • Using a variety of media to illustrate and communicate flood hazard and risk information to different audiences and generational groups; • Illustrating location-specific inundation levels by working with private-sector mapping companies and other partners to integrate street-level photos with overlays of flood levels at multiple return intervals into FEMA's mapping platform; • Working with real estate listing services to display flood hazard and risk information data for their customers; and • Displaying historical flood information, including flood boundaries and depths, where available.
AR 2 (2015)	FEMA should develop a national five-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 five-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. **Former Numbering IA16 1.1 (New Numbering AR 2.1)** FEMA should publish the State Geographic Information System (GIS) Standard Operating Procedures on a graphical web interface so that sources of local geospatial information are readily available to everyone. **Former Numbering IA16 3.1 (New Numbering AR 2.2)** FEMA should develop, with input from stakeholders, a list of factors to be used for prioritizing flood hazard and risk assessment studies across the country.
AR 3 (2015)	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. **Former Numbering IA16 3.2 (New Numbering AR 3.1)** FEMA should merge the Coordinated Needs Management Strategy (CNMS) and Risk Mapping, Assessment, and Planning (Risk MAP) Progress websites so users can see in one place what needs updating and what is being updated. **Former Numbering IA16 3.3 (New Numbering AR 3.2)** FEMA should evaluate whether adding the number or density of Light Detection and Ranging (LiDAR)-based Letters of Map Amendment (LOMAs) to Secondary Element contributes to the CNMS metric effectiveness.
AR 4 (2015)	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 3D Elevation Program (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.
AR 5 (2015)	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.

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 6 (2015)	FEMA should periodically review and consider use of new publicly available statistical models, such as the proposed Guidelines for Determining Flood Flow Frequency, Bulletin 17C, for flood-frequency determinations.
AR 7 (2015)	**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. **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.
AR 8 (2015)	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.
AR 9 (2015)	FEMA should review and update existing coastal event-based erosion methods for open coasts, and develop erosion methods for other coastal geomorphic settings.
AR 10 (2015)	FEMA should transition from identifying the 1-percent-annual-chance floodplain and associated Base Flood Elevation (BFE) as the basis for insurance rating purposes to a structure-specific flood frequency determination and associated flood elevations. **Former Numbering IA16 1.2 (New Numbering AR 10.1)** FEMA should develop a strategy for obtaining the building footprints and relevant building elevations of properties throughout the Nation to be used in determining structure-based flood risk. **Former Numbering IA16 6.1 (New Numbering AR 10.2)** FEMA and its partners should identify data needs and standards for developing and maintaining accurate, location-specific flood frequency information, including associated flood conditions (e.g., velocity, waves, erosion, duration), for both present and future flood conditions. **Former Numbering IA16 6.4 (New Numbering AR 10.3)** FEMA should perform a demonstration(s) to learn from and document data requirements, processes, and standards necessary for nationwide implementation for structure-based risk assessment.

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 11 (2015)	FEMA should modify the current workflow production process and supporting management system, the Mapping Information Platform (MIP), to reduce unnecessary delays created by redundant tasks and the inflexibility of the system. The process and system are not currently 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). **Former Numbering IA16 4.1 (New Numbering AR 11.1)** FEMA should develop a process for reviewing various aspects of the Flood Insurance Study (FIS) workflow and procedures to ensure that: • Workflow efficiencies and cost-effectiveness, including during the Key Decision Point (KDP) process, are encouraged; • Complementary reporting systems are integrated; • Revisions to the FIS workflow and procedures incorporate a dynamic, digital display environment system; • All internal paperwork required for publishing the notice in the Federal Register is reviewed; • Best Management Practices are incorporated; and • Guidance from FEMA HQ and/or Regional offices is documented and shared. **Former Numbering IA16 4.2 (New Numbering AR 11.2)** FEMA should take into consideration the following items at the next review of the MIP system: • Integrate the MIP and KDP process into one system. • Provide mapping partners more visibility on Data Validation Tasks (i.e., who is responsible for these tasks at the Regional office) and ensure more proactive coordination is implemented before and after the data validation tasks. • The MIP should take into account the uniqueness of Cooperating Technical Partners (CTPs) and enable more flexibility in all areas of the flood production process, including product upload, geographic areas, metadata requirements, and Quality Assurance/Quality Control (QA/QC) reviews. • Transition the MIP to a geodatabase system, similar to the CNMS, in which information is saved geospatially and used to run customized queries and reporting for Regional offices, mapping partners, and CTPs. • Enhance functionality to create auto-generation of template correspondence (e.g., Summary of Map Actions [SOMA] letters). • Provide greater flexibility in user controls. • Provide additional user access to related information. • Add risk product workflows. • Integrate an efficient solution to seamless mapping or HUC or State geographic areas. **Former Numbering IA16 4.3 (New Numbering AR 11.3)** FEMA Regions should clearly document and communicate MIP workflow validation and QA/QC procedures, correspondence protocols and approvals, documentation requirements, and other Region-specific guidance expectations of the flood study process. Additionally, FEMA Regions should regularly update partners with staff changes and roles and responsibilities for the Regional staff. **Former Numbering IA16 4.4 (New Numbering AR 11.4)** FEMA Headquarters (HQ) should develop additional guidance and training for mapping partners related to the Code of Federal Regulations (CFR) requirements for due process and Federal Register notifications. Regions should also be encouraged to create addendums that communicate their specific requests and internal timelines for their coordination activities with Production Technical Services(PTS) contractors and CTPs. **Former Numbering IA16 4.5 (New Numbering IA 11.5)** The TMAC recommends that FEMA work with the Customer and Data Services (CDS) contractor to evaluate the ability to migrate the MIP into a relational database system that can access data from other components of the flood insurance study program, such as a revised version of the Flood Insurance Rate Map (FIRM) database. Further efficiencies in reporting, data integration, and archival processes can occur if both a MIP database and FIRM database systems can relate to one another.
AR 12 (2015)	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 for all partners.
AR 13 (2015)	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.

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 14 (2015)	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 toward 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. **Former Numbering IA16 6.2 (New Numbering AR 14.1)** FEMA and its partners should identify data needs and standards for developing and maintaining accurate structure characteristics needed for risk estimation. Included in this should be a review of building characteristics data in existing flood risk estimation models, projects, programs, and databases. **Former Numbering IA16 6.3 (New Numbering AR 14.2)** FEMA and its partners should review and, if needed, modify flood damage functions to better capture structure-specific damage resulting from various flood hazards.
AR 15 (2015)	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.
AR 16 (2015)	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 is 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 application forms) and Letter of Map Change (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[OFA]), 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. **Former Numbering IA16 5.1 (New Numbering AR 16.1)** FEMA should implement the following features into a future, dynamic, database-derived, digital display environment to manage the update, maintenance, and dissemination of all flood hazards and risk data across the country: • Data are geospatial and captured in a relational geodatabase. • Data can be dynamically queried and displayed (point and click). • Develop a new website that features user-specific inputs, and where data provide one access point for multiple sources of flood hazard data and risk assessment information. • Products are developed on-the-fly using dynamic data calling features. • The new website and database support scalability, based on data availability, population, flood frequency and population impacted, and flood insurance penetration. **Former Numbering IA16 5.2 (New Numbering AR 16.2)** FEMA should perform a demonstration(s) to learn from and document data requirements, processes, and standards necessary for nationwide implementation of a geodatabase-derived, digital display environment. **Former Numbering IA16 5.3 (New Numbering AR 16.3)** FEMA should utilize the National Flood Hazard Risk Management Coordination Committee to implement the TMAC's vision, including the new database-derived, digital display environment.
AR 17 (2015)	FEMA should consider National Academy of Public Administration (NAPA) 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.

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 18 (2015)	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.
AR 19 (2015)	FEMA should develop and implement a suite of strategies to incentivize communities, nongovernment organizations, and private sector stakeholders to increase partnering and subsequent contributions for flood hazard and risk updates and maintenance. **Former Numbering IA16 7.2 (New Numbering AR 19.1)** FEMA should investigate opportunities and obstacles to implementing multi-year funding cooperative agreements that complement the five-year CTP Plan. **Former Numbering IA16 7.3 (New Numbering AR 19.2)** FEMA should facilitate and fund demonstration projects for CTPs to incentivize program innovation and efficiencies.
AR 20 (2015)	FEMA should work with CTPs to develop a suite of measures that communicate the project management successes, 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. **Former Numbering IA16 7.1 (New Numbering AR 20.1)** FEMA should evaluate the LOMC Review Partnership pilot program and develop clear program requirements, responsibilities, and performance metrics. This information should be used to formally establish the LOMC Review Partnership program, and increase the number of designated communities, where appropriate.
AR 21 (2015)	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 five-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.
AR 22 (2015)	FEMA should define the financial requirements to implement the TMAC's recommendations and to maintain its investment in the flood study inventory.
AR 23 (2016)	FEMA should develop, in conjunction with others in the public and private sectors, flood risk-rated insurance premiums for all structures within and outside the identified Special Flood Hazard Area (SFHA). These premiums should be based on the nature and severity of the flood hazard, structure elevation, and other characteristics, as well as structure damage functions and vulnerability.
AR 24 (2016)	FEMA should communicate to the property owner and other interested parties the cost of risk-rated insurance today and over time for new and existing structures to make the risk transparent. These data should include the benefits and cost that mitigation measures will have on these premiums.
AR 25 (2017)	As FEMA transitions away from the 1-percent-annual-chance line, a risk score for existing and proposed structures should be developed. Each structure should be assigned a current conditions risk score and a future conditions risk score. **AR 25.1** FEMA should perform pilot projects utilizing risk scores to determine the best data and methods to accurately calculate structure-specific risk for floodplain management for existing and new structures.
AR 26 (2017)	FEMA should coordinate with floodplain managers and mitigation planners to identify and test data and tools needed to support floodplain management and mitigation as it moves away from the 1-percent-annual-chance line. **AR 26.1** FEMA should perform pilot projects to understand the implications and opportunities for floodplain management in regard to moving to risk scores and determine other relevant data. **AR 26.2** FEMA should perform pilot projects to determine possible alternatives or modifications to the floodway concept.
AR 27 (2017)	FEMA should develop, in coordination with stakeholders, a transition plan for moving away from the 1-percent-annual-chance flood line.

RECOMMENDATION / IMPLEMENTATION ACTION	
AR 28 (2017)	FEMA should develop a series of mapping prototype products aimed at more effectively communicating residual flood risk related to levees, dams, and event-driven coastal erosion. Products developed should incorporate end user and stakeholder testing, and FEMA should develop standards for routine production and presentation, if applicable. **AR 28.1** FEMA should conduct pilot projects with communities and other stakeholders to evaluate how effective the prototypes are at communicating residual risk. **AR 28.2** Once prototypes are developed and evaluated, FEMA should leverage the existing flood study process and other community engagement touchpoints to communicate residual risk. **AR 28.3** FEMA should refine existing non-regulatory products and develop new non-regulatory products to clarify coastal flood risks in the vicinity of erodible features, and highlight the spatial areas affected by event-driven coastal erosion and Primary Frontal Dune (PFD) delineation. Possible products include: • Delineation of model results in the vicinity of the eroded PFD • Representation of the regulatory flood zones in the absence of an erodible dune feature
AR 29 (2017)	FEMA should initiate stakeholder needs assessments to identify end users' highest priority needs for future conditions products and services that support its current flood-related program and the program's evolution over time. **AR 29.1** FEMA should engage a broad array of Federal, State, Tribal, and community-level stakeholders, private-sector stakeholders, and partners throughout the design, planning, execution, and interpretation of the Needs Assessment. **AR 29.2** FEMA should ensure that the Needs Assessment collects information on users' intended applications and addresses key analytical variables, such as relevant timeframe(s), spatial resolution, level of study, future conditions scenarios (e.g., land use, erosion, sea level rise), product type, uncertainty, and visualization preferences. **AR 29.3** FEMA should integrate an ongoing future conditions needs gathering step as part of the standard flood study process and during other local community engagement touchpoints, and use the information gained to adapt FEMA's products to respond to evolving user needs and advancements in science and technology.
FC 1 (2015)	Provide future conditions flood risk products, tools, and information for coastal, Great Lakes, and riverine areas. The projected future conditions should use standardized timeframes and methodologies wherever possible to encourage consistency and should be adapted as actionable science evolves. **Former Numbering 3-4 (New Numbering FC 1.1)** FEMA should define a future population metric that uses a standard future population database along with various budget scenarios for keeping the data current to predict the percent of the population covered at various points in the future. **Former Numbering 3-5 (New Numbering FC 1.2)** FEMA should take into account future development (excluding proposed flood control structures for the base condition/scenario) for future conditions mapping. An additional scenario can be generated that does include future flood control structures. **Former Numbering 3-6 (New Numbering FC 1.3)** FEMA should use population growth as an indicator of areas with increased potential flood risk. **Former Numbering 4-4 (New Numbering FC 1.4)** FEMA should develop guidance for how local zoning and land use planning can be used to identify where and how land use will change in the future, and incorporate that into local hazard and risk modeling. **Former Numbering 4-11 (New Numbering FC 1.5)** FEMA should develop a policy and standards on how to consider and determine erosion zones that are outside of the SFHA as they ultimately affect flooding and environmental conditions within the SFHA. **Former Numbering 5-2 (New Numbering FC 1.6)** FEMA should use a scenario approach for future conditions flood hazards calculation and mapping that will allow users to evaluate the robustness of proposed solutions to a range of plausible future conditions, including uncertain land use and climate change impacts.
FC 2 (2015)	Identify and quantify accuracy and uncertainty of data and analyses used to produce future conditions flood risk products, tools, and information. **Former Numbering 3-2 (New Numbering FC 2.1)** FEMA should use future risk assessments to take into account the likelihood of events occurring and their impacts, as well as the associated uncertainties surrounding these estimates. **Former Numbering 3-7 (New Numbering FC 2.2)** FEMA should publish multiple future conditions flood elevation layers that incorporate uncertainty so as to provide a basis for building designs that lower flood risk.

RECOMMENDATION / IMPLEMENTATION ACTION	
FC 3 (2015)	Provide flood hazard products and information for coastal and Great Lakes areas that include the future effects of long-term erosion and sea/lake level rise. Major elements are: • Provide guidance and standards for the development of future conditions coastal flood risk products; • Incorporate local relative sea/lake level rise scenarios and long-term coastal erosion into coastal flood hazard analyses; and • Consider the range of potential future natural and man-made coastal changes, such as inundation and coastal erosion. **Former Numbering 4-1 (New Numbering FC 3.1)** FEMA should use a scenario approach when considering shoreline location for the estimation of future conditions flood hazards. At least two scenarios should be evaluated, one in which the shoreline is held at its present location, and another in which the shoreline is eroded according to the best available shoreline erosion data. **Former Numbering 4-6 (New Numbering FC 3.2)** FEMA should develop guidance for incorporating future conditions into coastal inundation and wave analyses. **Former Numbering 4-8 (New Numbering FC 3.3)** FEMA should develop consistent methods and models for long-term coastal erosion hazard mapping. **Former Numbering 5-4 (New Numbering FC 3.4)** FEMA should use Parris, et. al., 2012, or similar global mean sea level scenarios, adjusted to reflect local conditions, including any regional effects (Local Relative Sea Level) to determine future coastal flood hazard estimates. Communities should be consulted to determine which scenarios and time horizons to map, based on risk tolerance and criticality. **Former Numbering 5-5 (New Numbering FC 3.5)** FEMA should work with other Federal agencies (e.g., National Oceanic and Atmospheric Administration [NOAA], U.S. Army Corps of Engineers [USACE], USGS), the U.S. Global Change Research Program (USGCRP), and the National Ocean Council to provide a set of regional sea level rise scenarios, based on the Parris, et al., 2012 scenarios, for the coastal regions of the United States out to the year 2100 that can be used for future coastal flood hazard estimation. **Former Numbering 5-7 (New Numbering FC 3.6)** FEMA should prepare map layers displaying the location and extent of areas subject to long-term erosion and make the information publicly available. Elements include: • Establishing the minimum standards for long-term erosion mapping that will be used by FEMA that must be met by partners/communities if it is to be incorporated into the FEMA products. • Working with Federal, State, and local stakeholders to develop these minimum standards via pilot studies. • Securing funding that can support sustained long-term erosion monitoring and mapping by allowing for periodic updates. **Former Numbering 5-9 (New Numbering FC 3.7)** FEMA should support additional research to characterize how a changing climate will result in changes in Great Lakes and ocean wave conditions, especially along the Pacific Coast. The relative importance of waves on this coast makes this an important consideration. **Former Numbering 5-10 (New Numbering FC 3.8)** For the Great Lakes, the addition or subtraction of future lake level elevations associated with a changing climate is not recommended at this time, due to current uncertainty in projections of future lake levels. **Former Numbering 5-11 (New Numbering FC 3.9)** FEMA should build upon the existing current conditions flood hazard analyses prepared by FEMA for the NFIP to determine future coastal flood hazards. **Former Numbering 5-12 (New Numbering FC 3.10)** FEMA should incorporate local relative sea-level rise scenarios into the existing FEMA coastal flood insurance study process in one of the following ways: • Direct Analysis: Incorporate sea level rise directly into process modeling (e.g., surge, wave setup, wave runup, overtopping, erosion) for regions where additional sea level is determined to impact the base flood elevation (BFE) non-linearly (e.g., 1FT Sea Level Rise (SLR) = 2FT or more BFE increase). • Linear Superposition: Add sea level to the final calculated total water level and redefine BFE for regions where additional sea level is determined to impact the BFE linearly (e.g., 1FT SLR = 1FT BFE increase). • Wave effects should be calculated based on the higher Stillwater, including sea level rise. **Former Numbering 5-13 (New Numbering FC 3.11)** Maps displaying the location and extent of areas subject to long-term coastal erosion and future sea-level rise scenarios should be advisory (non-regulatory) for Federal purposes. Individuals and jurisdictions can use the information for decision making and regulatory purposes if they deem appropriate.

RECOMMENDATION / IMPLEMENTATION ACTION	
FC 4 (2015)	Provide future conditions flood risk products and information for riverine areas that include the impacts of: future development, land use change, erosion, and climate change, as actionable science becomes available. Major elements are: • Provide guidance and standards for the development of future conditions riverine flood risk products. • Future land use change impacts on hydrology and hydraulics can and should be modeled with land use plans and projections, using current science and build upon existing model study methods where data are available and possible. • Future land use should assume built-out floodplain fringe and take into account the decrease of storage and increase in discharge. • No actionable science exists at the current time to address climate change impacts to watershed hydrology and hydraulics. If undertaken, interim efforts to incorporate climate change impacts in flood risk products and information should be based on existing methods, informed by historical trends, and incorporate uncertainty based upon sensitivity analyses. • Where sufficient data and knowledge exist, incorporate future riverine erosion (channel migration) into flood risk products and information. **Former Numbering 4-7 (New Numbering FC 4.1)** FEMA should evaluate previously issued guidance for future conditions land use and hydrology to incorporate best practices and lessons learned from communities that have implemented the guidance since 2001. **Former Numbering 4-9(New Numbering FC 4.2)** FEMA should determine long-term riverine erosion hazard areas for areas subject to high erosion and provide it to the public in a digital layer. **Former Numbering 4-10 (New Numbering FC 4.3)** FEMA should utilize a national standard for riverine erosion zone delineations that reflects geographic variability. **Former Numbering 5-6 (New Numbering FC 4.4)** FEMA should take the impacts of future development and land use change on future conditions hydrology into account when computing future conditions for riverine areas. **Former Numbering 5-8 (New Numbering FC 4.5)** FEMA should implement riverine erosion hazard mapping (E Zones that define channel migration zones), leveraging existing data, models, and approaches that reflect site-specific processes and conditions. **Former Numbering 5-15 (New Numbering FC 4.6)** FEMA should use observed riverine trends to help estimate what future conditions might look like. In watersheds where floods of interest may decrease in magnitude and frequency, FEMA should use existing riverine study results as the basis for flood hazard mapping. In watersheds where floods exhibit increases in magnitude or frequency, then use best available science to determine future hydrology and flood hazards. **Former Numbering 5-16 (New Numbering FC 4.7)** FEMA should work with other Federal agencies via the Advisory Committee on Water Information's Subcommittee on Hydrology to produce a new method to estimate future riverine flood flow frequencies. This method should contain ways to consistently estimate future climate-impacted riverine floods and address the appropriate range of flood frequencies needed by the NFIP. **Former Numbering 5-17 (New Numbering FC 4.8)** FEMA should produce, and should encourage communities to adopt, future conditions products to reduce flood risk.
FC 5 (2015)	Generate future conditions data and information such that it may frame and communicate flood risk messages to more accurately reflect the future hazard in ways that are meaningful to and understandable by stakeholders. This information should enable users to make better-informed decisions about reducing future flood-related losses. **Former Numbering 3-3 (New Numbering FC 5.1)** FEMA should frame future risk messages for future conditions data and information such that individuals will pay attention to the future flood risk. Messages may be tailored to different stakeholders as a function of their needs and concerns.
FC 6 (2015)	Perform demonstration projects to develop future conditions data for representative coastal and riverine areas across the Nation to evaluate the costs and benefits of different methodologies or identify/address methodological gaps that affect the creation of future conditions data. **Former Numbering 3-1 (New Numbering FC 6.1)** FEMA should perform a study to quantify the accuracies, degree of precision, and uncertainties associated with respect to flood studies and mapping products for existing and future conditions. This study should include the costs and benefits associated with any recommendation leading to additional requirements for creating flood-related products. **Former Numbering 5-3 (New Numbering FC 6.2)** FEMA should conduct future conditions mapping pilots to continue to refine a process and methods for mapping and calculating future flood hazards, and capture and document best practices and lessons learned for each. **Former Numbering 5-14 (New Numbering FC 6.3)** FEMA should support research for future conditions coastal hazard mapping pilots and case studies using the latest published methods to determine the best means to balance the costs and benefits of increasing accuracy and decreasing uncertainty.

RECOMMENDATION / IMPLEMENTATION ACTION	
FC 7 (2015)	Data and analysis used for future conditions flood risk information and products should be consistent with standardized data and analysis used to determine existing conditions flood risk, but also should include additional future conditions data, such as climate data, sea-level rise information, long-term erosion data; and develop scenarios that consider land use plans, planned restoration projects, and planned civil works projects, as appropriate, that would impact future flood risk. **Former Numbering 4-2 (New Numbering FC 7.1)** FEMA should support expanded research and innovation for water data collection, for example using Doppler radar. **Former Numbering 4-3 (New Numbering FC 7.2)** FEMA should use a scenario approach to evaluate the impacts of future flood control projects on future conditions flood hazards. **Former Numbering 4-5 (New Numbering FC 7.3)** FEMA should support research on future conditions land use effects on future conditions hydrology and hydraulics. **Former Numbering 4-12 (New Numbering FC 7.4)** FEMA should develop guidance for evaluating locally-developed data from States and communities to determine if it is an improvement over similarly-available national datasets and could be used for future conditions flood hazard analyses. **Former Numbering 4-13 (New Numbering FC 7.5)** FEMA should develop better flood risk assessment tools to evaluate future risk, both population-driven and climate-driven. Improve integration of hazard and loss estimation models (such as Hazus) with land use planning software designed to analyze and visualize development alternatives, scenarios, and potential impacts to increase use in local land use planning. **Former Numbering 5-1 (New Numbering FC 7.6)** Future flood hazard calculation and mapping methods and standards should be updated periodically as we learn more through observations and modeling of land surface and climate change, and as actionable science evolves.
PR 1 (2016)	FEMA should adopt the TMAC's 2015 recommendations that relate to the National Flood Mapping Program's technical credibility from the TMAC 2015 Annual Report.
PR 2 (2016)	FEMA should adopt the future conditions recommendations from the *2015 TMAC Future Conditions Risk Assessment and Modeling* report. **Former Numbering IA16 8.1 (New Numbering PR 2.1)** FEMA should identify and summarize relevant future conditions-related modeling and mapping projects nationwide (Federal or non-Federal sources) that have technical relevance to the NFIP's mapping program, and capture any data standards, modeling and mapping methods, and/or best practices that can inform FEMA's future conditions mapping program. **Former Numbering IA16 8.2 (New Numbering PR 2.2)** FEMA should review existing State-level riverine erosion hazard mapping programs to determine what data standards, modeling and mapping methods, and/or best practices are transferable (i.e., broadly applicable) for potential nationwide implementation of riverine erosion hazard mapping. FEMA should also capture those standards and methods that are applicable to specific geographies or physical settings (analogous to the coast-specific models and guidance used in FEMA's current coastal flood study process). **Former Numbering IA16 8.3 (New Numbering PR 2.3**) FEMA should include consideration of both SLR and long-term coastal erosion in the modeling and mapping of flood hazards in all new coastal future conditions pilots. **Former Numbering IA16 8.4 (New Numbering PR 2.4)** FEMA should leverage completed FEMA pilot studies and other relevant coastal and riverine future conditions projects and programs nationwide to prepare a gap analysis that captures outstanding data standards and methodological elements critical to implementing future conditions mapping nationwide. **Former Numbering IA16 8.5 (New Numbering PR 2.5)** FEMA should use the existing body of knowledge gained through completed future conditions pilots, evaluation of existing future conditions-related programs, and other relevant Federal and non-Federal efforts to commence development of future conditions modeling and mapping standards and guidelines. **Former Numbering IA16 8.6 (New Numbering PR 2.6)** FEMA should convene stakeholders and subject matter experts in the initial scoping, development, and review of new future conditions modeling and mapping standards and guidelines (Implementation Action 8.5). This effort should begin as soon as possible to inform the gap analysis and gap prioritization (Implementation Action 8.4), and enable use of any near-term pilots to address critical information needs. **Former Numbering IA16 8.7 (New Numbering PR 2.7)** FEMA should develop and test multiple approaches for visualizing future conditions flood risk in one or more future mapping pilots, drawing on relevant social science expertise and lessons learned from prior pilots and other completed mapping projects.
PR 3 (2016)	FEMA should complete the implementation of the statutory requirements of the National Flood Mapping Program.
PR 4 (2016)	FEMA should continue to enhance communication and transparency with program stakeholders by, for example, including organizational and contact information on the Internet.

RECOMMENDATION / IMPLEMENTATION ACTION	
PR 5 (2016)	FEMA should investigate offering multi-year program management grant periods (versus annual) to Cooperating Technical Partnerships (CTPs).
PR 6 (2016)	FEMA should facilitate, partner, and leverage current high resolution topographic data (e.g., Light Detection and Ranging [LiDAR] data, other new and emerging technologies).
PR 7 (2016)	FEMA should work with the Congress and other partners to examine ways to shorten the study process, including the time added to the mapping process by QRs, KDPs, and legislated due process, as identified in TMAC's 2015 Goal 2 Annual Report Recommendation Number 11.
PR 8 (2016)	FEMA should move to a database-derived display, as outlined in the TMAC 2015 Annual Report Recommendation Number 16.
PR 9 (2016)	FEMA should work to identify residual risk areas behind levees and other flood control structures and downstream of dams.
PR 10 (2016)	For non-accredited levees, FEMA should replace the Zone D designation in levee-protected areas with risk zones that are more appropriate for the level of risk.
PR 11 (2016)	FEMA should evaluate the current metrics to better measure the efficient production, valid inventory, and stakeholder acceptance of the National Flood Mapping Program. TMAC recommends that FEMA should: • Discontinue the current Deployment and Mitigation Action metrics and replace them with more effective measures, and • Focus revised metrics on measuring the quality and quantity of flood hazard and risk products delivered to communities.
PR 12 (2016)	FEMA should have an inventory metric that reports quantity, quality, and time aspects on national, regional, Tribal, State, and watershed levels: a) **Quantity:** Quantity should be tracked through the life of a floodplain from no study through to detailed study. Statistics should be provided annually. b) **Quality:** Quality should be measured by retaining the existing New, Valid, Updated Engineering (NVUE) metric of the current inventory and adding an NVUE metric for coastal flood hazard miles. c) **Time:** Timing should be measured from Discovery to the issuance of Preliminary maps, and from the issuance of Preliminary maps to Effective maps for active projects.
PR 13 (2016)	FEMA should have a metric that shows progress towards meeting a digital platform goal by area of the Nation to compliment FEMA's current population metrics. This metric could include the total area of the country, as well as progress towards Goal 3 and Recommendation 16 in the TMAC 2015 Annual Report.
PR 14 (2016)	FEMA should evaluate the benefits and costs and its value to the Nation as a result of different levels of funding to the National Flood Mapping Program.

AR = TMAC Annual Report (2015), TMAC 2016 Annual Report, or TMAC 2017 Annual Report, **PR** = TMAC National Flood Mapping Program Review (2016), **FC** = TMAC Future Conditions Risk Assessment and Modeling (2015), **IA** = Implementation Action