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HYDROLOGIC SERVICES PROGRAM MANAGEMENT

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SUMMARY OF REVISIONS: This directive supersedes NWS Instruction 10-901, “Hydrologic Services Program Management,” dated July 9, 2011. The following revisions were made to this instruction:

- 1) Removed reference to the National Precipitation Verification Unit in 2.1.4.
- 2) Removed section 2.2.h “Program management – The Director, OHD acts as the NOAA focal point for hydrology.”
- 3) Removed section 2.7.e “Storm Prediction Center – produces event-based, short-term rainfall rate forecasts.”
- 4) Moved wording from 2.10 to new section 2.11 “Hydrometeorological Development Relationships.”
- 5) Changed title and content of 3.1.1.5 from “AHPS Review Committee” to “Hydrology Program Review Committee.”
- 6) Changed title of Section 3 from “Interdisciplinary and Partnered Programs” to “Interdisciplinary and Partnered Hydrologic Programs for a Weather Ready Nation.”
- 7) Added new section 3.2, River Forecast Program.
- 8) Moved Water Resources Forecasting section 3.2 to 3.4.
- 9) Changed all occurrences of “forecast inundation” [map] to “flood forecast inundation” [map].
- 10) Changed all occurrences of “HPC” (Hydrometeorological Prediction Center) to “WPC” (Weather Prediction Center).
- 11) Amended section 3.7.1.2 “River Forecast Centers” to strengthen role of the Service Coordination Hydrologist (SCH) in Flood Safety Program.

(Signed)

July 29, 2014

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Date

Hydrologic Services Program Management

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1 Introduction

The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) Policy Directive 10-9 provides high-level policies for the Hydrologic Services Program. This instruction explains how NWS Policy Directive 10-9 is implemented by providing a more detailed description of headquarters and field office activities required to support and carry out the Hydrologic Services Program.

2 Hydrologic Services Program Activities

The Hydrologic Services Program is managed in accordance with Department of Commerce (DOC), NOAA, and NWS policies. The Assistant Administrator for Weather Services has final management authority over the Hydrologic Services Program. Under the oversight of the Assistant Administrator, several organizational units are responsible for aspects of the Hydrologic Services Program as identified in the following sections. Mission statements for these organizational units are provided in the NOAA Organizational Handbook.

2.1 Office of Climate, Water, and Weather Services

The Office of Climate, Water, and Weather Services (OCWWS) is responsible for a wide variety of activities that support the NWS Hydrologic Services Program. OCWWS accomplishes these responsibilities through functions of its divisions as described in the following sections.

2.1.1 Hydrologic Services Division

In coordination with NWS regions, the OCWWS Hydrologic Services Division (HSD) manages the NWS Hydrologic Services Program through the following activities:

- a. Service coordination – coordinate issues and activities related to hydrologic services with NWS Headquarters offices, NWS Regional Headquarters (RHQ), NOAA, and Congressional offices.
- b. Interagency collaboration – coordinate technical, policy, and operational issues which impact hydrologic services with federal agencies having a complementary water mission, as well as water resource needs of other national, regional, state and tribal partners. Collaborate with these agencies to resolve multi-agency issues and work together with the Hydrologic Program Managers, River Forecast Centers (RFCs), and Weather Forecast Offices (WFOs) to enhance the hydrologic services in a nationally consistent manner.
- c. Outreach – conduct and participate in national-level outreach activities to increase external awareness on flood safety and the uses and benefits of NWS hydrologic services for decision support related to flood hazards and water resources.
- d. Service requirements – compile and evaluate requirements received through national-level outreach activities and integrate them into national policies, plans, and requirements specifications.
- e. Field office requirements – assimilate field office requirements for hydrologic software systems acquired by the RHQ and others and provide them to the Office of Hydrologic Development (OHD), Office of Science and Technology, and other development entities. OCWWS HSD also provides appropriate developmental and management entities with requirements for computational hardware, communications, staffing, facilities, and observing systems needed by the Hydrologic Services Program.

- f. Service and operations policy – develop and maintain hydrologic service and operations policy through the National Directives System and other mechanisms.
- g. Service and operations planning – develop strategic plans for the enhancement and evolution of NWS hydrologic services and operations. Support NWS and NOAA strategic development (e.g., NWS Road Map).
- h. Hydrologic systems support services – provide on-call support services for hydro-meteorological forecast systems used in RFC and WFO.
- i. Hydrologic data network services – work with other NWS entities and partners to maintain and expand the data network required for hydrologic forecast and warning services and in support of water resources services, including activities related to automated flood warning systems (AFWS).
- j. Training – Assimilate hydrologic training requirements of field personnel and ensure development of needed national training. Also assist in the provision of hydrologic services-related training for field office personnel.
- k. National hydrologic information – compile and provide flood loss statistics and information on national hydrologic conditions for the National Hydrologic Assessment through the Hydrologic Information Center.

2.1.2 Meteorological Services Division

The Meteorological Services Division supports the Hydrologic Services Program by managing NWS weather services programs, serving as the primary link between the NWS and weather-sensitive industries, and developing the plans, policies, and procedures for weather operations and services which support hydrologic forecast and warning operations.

2.1.3 Climate Services Division

2.1.4 Performance and Awareness Division

The Performance and Awareness Division supports the Hydrologic Services Program by conducting verification for river forecasts and flood/flash flood warning products. The division also supports hazard awareness activities for extreme hydrologic events and manages the service assessment process initiated after events causing substantial loss of life and/or property such as regional floods.

2.1.5 Training Division

The Training Division supports the Hydrologic Services Program by overseeing the annual process of allocating training resources for hydrologic science, operations, and decision support services in support of the NWS Weather-Ready Nation initiative. The Training Division's components (NWS Training Center, Warning Decision Training Branch, and the Forecast Decision Training Branch) provide instructional resources and training management in support of operational hydrology. The Training Division also manages the grant supporting COMET®, which provides instructional resources focused on hydrologic science as applied to operations and the Weather-Ready Nation initiative. Close coordination occurs with the hydrologic components of the Branches and COMET® to ensure the development and provision of hydrologic training materials meets the needs and requirements of the Hydrologic Services Program. The Training Division facilitates the creation and maintenance of the Hydrology Professional Development Series (PDS) list of Professional Competency Units (PCUs) and

associated Instructional Components (ICs). The Hydrology PDS is a means to identify and prioritize training for NWS Hydrology in support of the Weather-Ready Nation initiative.

2.1.6 Observing Services Division

The Observing Services Division supports the Hydrologic Services Program by maintaining standards, policies, procedures, and plans for NWS surface and upper air observing services. Many of these observing systems provide data used in hydrologic operations and services.

2.1.7 Operations and Requirements Division

The Operations and Requirements Division supports the Hydrologic Services Program by processing requirements for the NWS systems infrastructure which supports hydrologic operations.

2.2 Office of Hydrologic Development

The OHD supports the Hydrologic Services Program through a number of activities, including:

- a. Hydrologic development – develop and maintain models, systems, and procedures in response to requirements provided by OCWWS HSD.
- b. Web page administration – oversee the development and implementation of the national hydrologic web presence which provides access to Advanced Hydrologic Prediction Service (AHPS) and Water Resources Forecasting products and information.
- c. Hydrometeorological data delivery – evolve and maintain the operational system used to provide data to NWS field offices – the Hydrometeorological Automated Data System (HADS).
- d. Hydrologic remote sensing – provide remotely-sensed and derived hydrologic data products used by WFOs, RFCs, National Centers for Environmental Prediction (NCEP), and other users through the National Operational Hydrologic Remote Sensing Center (NOHRSC).
- e. Research and operations planning – develop strategic plans related to the evolution of hydrologic science, and the transition of hydrologic science research to hydrologic operations.
- f. Applied research – in collaboration with outside research institutions, cooperating agencies, RFCs, WFOs, RHQ and NCEP, conduct applied research and development activities needed to infuse new hydrologic science into the operational hydrologic systems at National Centers and field offices.
- g. RFC development – oversee the RFC development process as described in directives under [NWS Policy Directive 80-7, River Forecast Center Development Management](#).

2.3 Office of Science and Technology

The Office of Science and Technology (OST) supports the Hydrologic Services Program through the following activities:

- a. Science and technology management – maintain overall responsibility for plans, programs, and development in NWS science and technology activities.

- b. Operational applications and systems development – plan and develop applications providing observed and forecast information used in hydrologic operations at WFOs and RFCs.
- c. Technology and applications integration – ensure that hydrologic technologies and applications developed by the OHD are integrated into operational NWS systems. Process requirements for system upgrades to accommodate hydrologic needs.

2.4 Office of Operational Systems

The Office of Operational Systems (OOS) supports the Hydrologic Services Program through the following activities:

- a. Engineering services and infrastructure support – provide engineering software management, facilities, communications, and logistical services for NWS field offices.
- b. System management – manage NWS observing, forecasting, and dissemination systems required to conduct hydrologic operations and provide services.
- c. NWS Telecommunications Operations Center (TOC) – manage, operate, and supply software and data support for the NWS Telecommunications Gateway essential to the dissemination of public warnings, forecasts, guidance, and observational data
- d. Communications network management – administer and maintain an NWS-wide communications network (OPSnet)
- e. Systems security oversight – ensure security controls are in place to protect systems and data, including those used in the support of the Hydrologic Services Program. Ensure security controls are implemented for OPSnet at an appropriate system level
- f. System acquisition – manage the acquisition of large-scale systems which host or support operational hydrologic services

2.5 Office of the Chief Information Officer

The Office of the Chief Information Officer (OCIO) supports the Hydrologic Services Program through the following:

- a. Provide key information technology (IT) planning for the NWS, including coordination and development of all NWS IT security and critical IT infrastructure activities.
- b. Develop, monitor, and coordinate the overall NWS systems architecture in coordination with the weather system architecture activities of the OST and develop hardware and software management policies and standards for the NWS.
- c. Provide overall planning and policy oversight for the NWS use of the Internet, and develop NWS telecommunications policies and guidance.

2.6 Regional Headquarters

Regional Directors assign hydrology program responsibilities for the region to regional Division Chiefs, RFC Hydrologists-in-Charge (HIC) and WFO Meteorologists-in-Charge (MIC). Each RHQ has staff managing a regional hydrology program. Alaska Region is assigned hydrologic program responsibilities for the Pacific Region. Regional hydrology program responsibilities include but are not limited to:

- a. Hydrologic service delivery oversight – monitor and assess the practices, local policies, and performance of the hydrology program at each RFC and WFO in the region. This includes support for Service Hydrologist program leadership activities
- b. Forecast improvement – direct and support improvements to RFC and WFO hydrologic modeling and forecast operations. This includes supporting hydrometeorological operations such as those for quantitative precipitation forecasts (QPF) and flash flood, as well as overseeing routine WFO/RFC interactions and longer-term collaborative activities
- c. Decision Support Services – support field offices in large-scale hydrologic events utilizing the Incident Command System (ICS) structure or similar operational structure. Report significant event information to the NWS Operations Center
- d. Training – facilitate training activities specific to local field office requirements and hydroclimatologies in the region
- e. Policy/procedure implementation – develop Regional Supplements to National Directives for the Hydrologic Services Program. Ensure WFO and RFC compliance with National Directives and Regional Supplements on Hydrologic Services Program operations.
- f. Service, science, and operations planning – develop strategic plans for hydrologic service and science improvements within the region consistent with national level plans and improvements.
- g. Outreach – represent NWS, NOAA, and DOC in regional intra-agency, interagency, and river basin commission activities. Seek out, receive, and assimilate service requirements from partners and other stakeholders in the region.
- h. National requirements – assimilate hydrologic systems and services requirements from WFOs and RFCs, conduct intra-regional coordination, and provide requirements to appropriate National Headquarters divisions per the established process. Coordinate regional data requirements and resolve data problems affecting hydrologic operations in the region’s WFOs and RFCs.
- i. Regional requirements – work with WFOs and RFCs to establish regional requirements (e.g., for data, hardware, etc.) for provision of hydrologic services. Work with other regional staffs to meet these requirements.
- j. Information exchange – work with WFOs, RFCs, other RHQs, and National Headquarters as appropriate to facilitate the sharing and exchange of information, procedures, software, and related items between field offices and regions.
- k. National Headquarters interactions – represent Hydrologic Services Program concerns of the regional director and field offices to the NWS Headquarters and provide regional input to procedures, plans, proposals, training, and other products developed by NWS Headquarters. Communicate national concerns/issues to the regional director and field offices as appropriate.
- l. Service assessment – provide assessments of field office performance during significant hydrologic events to the regional director and/or NOAA/NWS management as appropriate.

Other RHQ functions support the hydrology program in areas such as training, observation/data collection, climate, verification, and system operations.

2.7 National Centers for Environmental Prediction

The NCEP collects global meteorological data and uses it to generate a wide variety of environmental guidance information. Individual national centers support the Hydrologic Services Program through activities briefly summarized as follows:

- a. NCEP Central Operations – executes the numerical analysis and atmospheric forecast models and ensembles of models used in everyday hydrometeorological analysis at RFCs and WFOs.
- b. Weather Prediction Center (WPC) – produces national QPF and probabilistic QPF (PQPF) products for all types of weather systems. These gridded QPF products are used as guidance by WFO and RFC forecasters, and after possible editing to account for local hydrometeorological conditions, serve as input to RFC models. The WPC also produces other products which assimilate hydrometeorological information on a national basis, including a flood outlook product and a flash flood hazards product.
- c. Environmental Modeling Center – develops, maintains, and improves the atmospheric models which produce the graphical and numerical output (e.g., forecast precipitation and temperature) used in short- and medium-term AHPS products.
- d. Climate Prediction Center – provides products quantifying how precipitation and temperature is expected to deviate from climatic averages through the long-term forecast period.
- e. National Hurricane Center – provides official NWS forecasts for the movement and strength of tropical weather systems.

2.8 River Forecast Centers

Each RFC conducts hydrologic and/or hydraulic modeling of river basins, provides hydrologic forecasts and guidance for one or more major river basins, and carries out decision support and liaison activities with partners. RFCs assimilate data and forecasts from multiple sources including the NCEP, WFOs, and other partners. This information is used in real-time modeling and forecast operations and to create a wide variety of products for distribution to WFOs, partners and other users. Each RFC supports multiple WFOs. RFC operations are described in [NWS Instruction 10-911, *River Forecast Center Operations*](#) and RFC products and services are described in [NWS Instruction 10-912, *River Forecast Center Products Specification*](#).

2.9 Weather Forecast Offices

Each WFO provides hydrologic forecasts, warnings, and related products and decision support services to partners and other users for its local area of responsibility. WFOs also provide gridded temperature and precipitation forecasts that can be used in RFC hydrologic models and forecasts. Service Hydrologists and hydrology focal points serve as the Hydrology Program Manager (HPM) at each WFO. As part of an integrated mode of operations, the entire WFO operational staff participates in hydrologic activities, including issuing event-based and routine hydrologic products and collecting/quality controlling the data. WFO hydrologic operations are described in [NWS Instruction 10-921, *Weather Forecast Office Hydrologic Operations*](#) and WFO hydrologic products and services are described in [NWS Instruction 10-922, *Weather Forecast Office Hydrologic Products Specification*](#).

2.10 WFO/RFC/NCEP Operational Relationship

WFO, RFC, and NCEP staffs work as a team to provide hydrologic forecast and warning services from floods to droughts to minimize the loss of life and property and to meet the growing water resources service needs of our Nation. Managers at WFOs, RFCs, and NCEP ensure effective operational interactions through a team effort of their operational staffs while recognizing the uniqueness of each entity's operations.

NWS hydrologic forecasts in the short-term (out to 7 days), medium-term (7 out to 14 days), and long-term (2 weeks out to 3 months or more) time scales are heavily dependent on the effective coupling of hydrologic and meteorological observations, analyses, and forecast information from WFOs, RFCs, and NCEP. Quantitative precipitation estimates (QPE) from radar, satellite, and ground-based observations; snowpack information; QPF; temperature forecasts; and forecasts for other hydrometeorological variables serve as critical input to the hydrologic modeling process for all time scales. Extended-range meteorological forecasts and predictions from global climate models are important input to long-term hydrologic forecasts. Other key inputs include data provided by partner agencies.

The operational coupling of hydrologic and meteorological observations and forecasts for all time scales requires effective real-time and non-real time coordination between the RFCs, WFOs, and NCEP. The RFC Hydrometeorological Analysis and Support (HAS) function is the catalyst for this coordination. Key hydrometeorological coordination activities of these three partners can be summarized as follows:

- a. NCEP – provides discussions and related products on current/forecast meteorological conditions and hosts coordination conference calls during significant weather events.
- b. RFCs – collaborate with WFOs and NCEP on forecast parameters such as QPF, produce discussions on current/forecast hydrologic conditions, and notify WFO and NCEP forecasters of important changes in current or forecast streamflow conditions. RFC coordination activities also include supporting WFO hydrologic modeling operations, coordinating changes in radar parameters, and providing technical expertise on hydrologic events and other water-related issues.
- c. WFOs – notify RFCs when changing hydrometeorological conditions, observations, or meteorological forecasts indicate the need for updated hydrologic forecasts and when data quality problems have been identified such as with specific gage readings or precipitation estimations

Other joint coordination activities between these partners, that managers encourage include: pre-event conference calls, optimization of the hydrometeorological data network, site visitations, joint training, workshops, collaborative research projects, flood drills, and collaborative preparation of long-term outlooks.

2.11 Hydrometeorological Development Relationships

WFOs, RFCs, RHQ, NCEP, and OHD collaborate in the development of hydrometeorological applications such as flash flood models, precipitation processing algorithms, and QPF techniques. Hydrologic modeling and hydrometeorological data techniques developed by the OHD

and other NOAA and NWS entities are vital in supporting these interactions. The goals of these interactions are to further the NWS mission by:

- a. Integrating interrelated aspects of hydrologic and meteorological sciences into WFO, RFC, and NCEP operations
- b. Encouraging hydrometeorological collaboration activities between WFOs, RFCs, NCEP, and the OHD
- c. Supporting integrated operations, where appropriate, within field offices

3 Interdisciplinary and Partnered Hydrologic Programs for a Weather-Ready Nation

The special hydrometeorological relationships and interdisciplinary programs described in this section need the support of all managers participating in the Hydrologic Services Program. The NWS has the primary responsibility among federal agencies to provide advanced signals of hydrologic conditions via flood warnings and river forecasts in the United States. The provision of these water prediction and warning services are significantly influenced by anthropogenic activities associated with water management and water use/regulation (e.g. reservoirs, diversions, withdrawals). In order to provide these important water resources services, collaboration with other federal agencies, as well as state, tribal, and local partners, is crucial.

3.1 Advanced Hydrologic Prediction Service

AHPS is a national effort to provide enhanced hydrologic information and products through the infusion of new science and technology. The goal of AHPS is to improve river forecasts and flood warnings nationwide to meet the diverse and evolving needs of partners and other users.

3.1.1 Office Roles

3.1.1.1 Weather Forecast Offices

WFOs coordinate AHPS-related forecast services with local, county, and state partners and relay new requirements to RFCs and RHQ. WFOs assimilate and update much of the metadata that accompanies AHPS products, such as the location information for forecast points.

3.1.1.2 River Forecast Centers

The forecast information output from RFC hydrologic modeling systems serves as the foundation for AHPS products. RFCs coordinate AHPS-related forecast services with partners having comparable areas of responsibility such as river basin commissions and district or regional offices of Federal agencies, and relay new requirements to RHQ.

3.1.1.3 Regional Headquarters

Managers of hydrology programs in RHQ oversee AHPS activities of their field offices, participate in coordination meetings with partners in state or regional agencies with comparable levels of responsibility, and relay requirements for AHPS products and services to NWS headquarters.

3.1.1.4 NWS Headquarters

The AHPS program is managed by OHD. The AHPS Program Manager in OHD conducts planning, administers the budget, and guides and tracks implementation for the program. OCWWS HSD assimilates service, science, and operational requirements for AHPS and provides prioritized requirements to OHD. OCWWS HSD also develops general operations concepts for AHPS as well as other plans for specific AHPS components.

3.1.1.5 Hydrology Program Review Committee

Planning and prioritization for the Hydrology Program is provided by the Hydrology Program Review Committee (HPRC). The HPRC is comprised of HICs from each of the 13 RFCs, representatives from NWS RHQ, OCWWS, and OHD.

3.2 River Forecast Program

WFOs, RFCs, NCEP, and NOHRSC work as a team to provide hydrologic forecast and warning services from floods to droughts to minimize the loss of life and property and to meet the growing water resources service needs of our Nation. NWS hydrologic products and services support decision makers from a spectrum of service sectors including emergency management, agriculture, hydropower, reservoir and watershed management, river commerce, municipal and industrial water supply, and recreation.

3.2.1 Office Roles

3.2.1.1 Weather Forecast Offices

WFOs assess and monitor the threat of river flooding 24 hours a day, 7 days a week to provide timely and accurate life-saving flood forecasts, watches, and warnings. Toward this end, WFOs integrate a spectrum of RFC, NCEP and NOHRSC guidance and hydrometeorological data to provide routine river forecast services and critical, event-based warning and decision support services. In addition, WFOs work with dam operators to provide timely warnings for floods that result from infrastructure failure such as dam break and levee breaches. In coordination with RFCs and RHQ, WFOs assess the adequacy of the river and precipitation gage network, coordinate the need for new forecast services with local, county, and state partners and relay new requirements to RFCs and RHQ.

3.2.1.2 River Forecast Centers RFCs routinely generate short-range (deterministic) through long-range (probabilistic) river and water resources analyses and forecasts. Information and forecasts from the RFCs serve as the basis for local flood warnings, watches, and advisories issued by the WFOs. These RFC products typically incorporate guidance from WPC, CPC, NOHRSC, and the WFOs, and emphasize flooding impacts from meteorological events based on geographic area, land use, time of the year, and other factors. In order to provide objective simulations of future river flows, RFCs calibrate, operate, and verify numerical hydrologic models based on temperature, rainfall, snowpack, soil characteristics, quantitative precipitation forecasts (QPFs), water use/reservoir regulation data, and several other variables. Some RFCs, especially those in mountainous regions, also provide water-supply volume and peak-flow forecasts based on snow pack in high elevations. These water supply forecasts are used by a wide range of decision makers, including those in agriculture, hydroelectric dam operation and electricity generation, and water resources management. RFCs routinely coordinate with their

associated WFOs, federal water partners, stakeholders, and the WPC.

3.2.1.3 Regional Headquarters

RHQs manage the RFC and WFO river forecast and flood program for the region, providing appropriate regional procedures and policies. They also play a supportive role for large scale and/or long term significant events where field office resources can become overtaxed. This support is typically in the areas of media response, partner briefings, coordination, and administrative assistance.

3.2.1.4 NWS Headquarters

NWS Headquarters manages the national River Forecast and Flood Program and provides appropriate national procedures and policies. NWS Headquarters develops river forecast and flood applications and transitions appropriate tools and techniques from the research to operational environment. The OCWWS Performance Branch supports the software and databases used in river forecast and flood warning verification and OCWWS HSD monitors and reports on verification statistics.

3.3 Flash Flood Program

The NWS Flash Flood Program was originally implemented in 1970. According to Operations Manual Letter 74-8, *Management of the Flash Flood Program*, dated March 21, 1974, the program was implemented to provide a flood warning service when timely stage forecasts cannot be provided by RFCs. This led to a program based largely on watch/warning products for areas, issued by weather offices and supported by areal RFC products known as flash flood guidance. Because heavy precipitation from convective weather systems is the primary cause of flash floods, and flash flood watches and warnings are most often handled on a defined area basis like other weather events, a meteorological perspective has historically prevailed in the Flash Flood Program.

Collaborative efforts to improve flash flood guidance, short-term QPF, and QPE have led to more timely areal flash flood products. However, forecasting technologies that improve the site-specificity and information content of warning products are allowing flash flooding to be increasingly addressed from a hydrologic perspective. These technologies include:

- a. The Flash Flood Monitoring and Prediction (FFMP) function, which provides the ability to pinpoint individual basins threatened by flash flooding
- b. The Site-Specific Hydrologic Prediction (SSHP) function, which allows products to include stage/flow forecasts for specific locations in small stream basins
- c. Distributed rainfall-runoff models, which allow hydrologic processes to be more realistically simulated in stream basins of all sizes

AHPS supports these and other technologies used in the Flash Flood Program. National Headquarters, RHQ, and field offices account for the application of geographic information systems (GIS), hydrologic science, and computer modeling in determining the decision support infrastructure for the Flash Flood Program.

3.3.1 Office Roles

3.3.1.1 Weather Forecast Offices

WFOs assess and monitor the threat of flash flooding 24 hours a day, 7 days a week to provide timely and accurate life-saving flash flood forecasts, watches, and warnings. Toward this end, WFOs integrate a spectrum of RFC, NCEP and NOHRSC guidance, Doppler weather radar Next Generation Radar (NEXRAD)-based precipitation estimates, satellite National Environmental Satellite, Data, and Information Service (NESDIS)-based precipitation estimates, and real-time telemetered precipitation and stream gage observations to provide critical decision support services. In addition, WFOs work with dam operators to provide timely warnings for flash floods that result from infrastructure failure such as dam break or over-topping and levee breaches. WFOs are the point of issuance for flash flood watches, warnings and associated follow-up products. WFOs use applications such as the Flash Flood Monitoring and Prediction: Advanced (FFMPA) and Site Specific Hydrologic Prediction (SSHP) in their flash flood operations and provide on-station upkeep of these systems. Some flash flood applications are developed at local WFOs and may eventually be utilized at other WFOs.

3.3.1.2 River Forecast Centers

RFCs provide the gridded guidance used in WFO flash flood operations. This guidance reflects or at least indexes the conduciveness of the ground, as affected by soil moisture or other surface characteristics, to producing flash flooding in response to precipitation. Some RFCs partner with the U.S. Geological Survey in developing flash flood guidance for burn scar areas and debris flows.

3.3.1.3 Regional Headquarters

RHQs manage the Flash Flood Program for the region, providing appropriate regional procedures and policies.

3.3.1.4 NWS Headquarters

NWS Headquarters manages the national Flash Flood Program and provides appropriate national procedures and policies. NWS Headquarters develops flash flood applications and transitions appropriate tools and techniques from the research to operational environment. The OCWWS Performance Branch supports the software and databases used in flash flood warning verification and OCWWS HSD monitors and reports on verification statistics.

3.4 Water Resources Forecasting

The Water Resources Forecasting activity builds on AHPS and other NOAA services and delivers new services at higher resolution (down to the neighborhood scale) with more information; such as soil moisture, soil temperature, snow pack, and surface runoff volume. It enables NOAA to provide nationally consistent water quantity and quality condition forecasts via: 1) a national digital database which assimilates hydrometeorological data and observations, and 2) an advanced modeling system which brings the current state of science to NWS hydrology.

The evolving national digital database integrates fresh water resource observations and analysis components such as precipitation estimates, snowpack analysis, and soil moisture data. The goal

of this database is to increase the amount, type, and accuracy of water resources information for use within the NOAA and by partners and other users.

The advanced modeling system, known as the Community Hydrologic Prediction System (CHPS), engages NOAA and the external (federal and non-federal) research community in the advancement of water prediction science. CHPS builds on existing modeling capabilities, standard protocols, and open data exchange standards to develop a common suite of tools for making water predictions. CHPS facilitates the sharing of data and algorithms between government, university, and private sector research groups. The goal is to use CHPS to develop and infuse new science to produce a new suite of high-resolution forecasts (including estimates of uncertainty) for streamflow, soil moisture, soil temperature, water quality, and many other variables directly related to watershed conditions.

3.4.1 Office Roles

3.4.1.1 Weather Forecast Offices

WFOs coordinate services that can be provided through the water resources forecast activity with local, county, and state partners and relay new requirements to RFCs and RHQ.

3.4.1.2 River Forecast Centers

RFCs implement and maintain hydrologic modeling systems under the CHPS architecture and develop new modeling and data management capabilities following CHPS standards in collaboration with entities in the larger water community. RFCs coordinate services that can be provided by the water resources forecast activity with partners having comparable areas of responsibility, such as river basin commissions and district or regional offices of Federal agencies, and relay new requirements to RHQ.

3.4.1.3 Regional Headquarters

Managers of hydrology programs in Regional Headquarters oversee their field office's efforts in the water resources forecast activity and relay state/regional partner's requirements to NWS Headquarters.

3.4.1.4 NWS Headquarters

The water resources forecast activity is managed by the OHD in conjunction with and through the same structure as the AHPS program. OCWWS HSD assimilates service, science, and operational requirements for water resource forecast services, and provides prioritized requirements to OHD.

3.5 Flood Forecast Inundation Mapping Program

The NWS has undertaken an expanded effort to provide information on the spatial extent and depth of flood waters in the vicinity of NWS river forecast locations. The key product of this program is a web-based flood forecast inundation mapping interface which allows users to display maps for various levels of flooding including observed and forecast stages, user-selected stages, and established flood categories. The maps can be used to show if roadways, streets, buildings, airports, and other structures are likely to be impacted by floodwaters. Combined with river observations and NWS forecasts, these maps enhance the communication of flood risk and

provide users additional information for mitigating the impacts of flooding and building communities that are more resilient.

There are four critical phases in the implementation of flood forecast inundation maps: (1) Planning/Scoping – identifying users who need such maps for NWS forecast locations and are willing to partner with the NWS in their development, (2) Hydrologic/Hydraulic/Geospatial Analyses – performing the engineering, scientific, and technical analyses necessary to produce a map, (3) Implementation – making the map available through the interface in the NWS’s Hydrologic Services Program web presence (AHPS web pages), and (4) Maintenance – providing changes and updates necessary to keep a map current.

3.5.1 Office Roles

Since the development of flood forecast inundation maps involves significant financial resources, human capital, data requirements, and data analysis, NWS leverages the capabilities, expertise, and resources of partners who can contribute towards the development of flood forecast inundation maps for new areas. Offices at all levels of the NWS contribute to the process. For each river location or group of locations for which maps will be developed, a project team is formed consisting of WFO, RFC, and RHQ personnel and the technical mapping partner.

3.5.1.1 Weather Forecast Offices

WFOs demonstrate the benefits of flood forecast inundation maps to local and state partners and identify those who want to work with the NWS to develop flood forecast inundation maps. WFOs assist in evaluating the feasibility of creating flood forecast inundation maps for specific locations in their areas of responsibility. They coordinate with partners to acquire the supporting data required to develop flood forecast inundation maps and provide these data to the project team. WFOs review the final flood forecast inundation maps and use them to review and revise the impact information associated with local forecast locations which they provide through the NWS hydrologic web presence and in flood products.

3.5.1.2 River Forecast Centers

RFCs demonstrate the benefits of flood forecast inundation maps to their partners with regional responsibilities, such as river basin commissions and district offices of Federal agencies, and identify those who want to work with the NWS in this effort. RFCs assist in evaluating the feasibility of creating flood forecast inundation maps for specific locations in their areas of responsibility. They implement and maintain the modeling infrastructure necessary to support new forecast locations as necessary. RFCs evaluate the GIS shapefiles and the hydraulic model output used in the development of flood forecast inundation maps. They also participate in the final review of flood forecast inundation maps.

3.5.1.3 Regional Headquarters

RHQs oversee WFO and RFC efforts to seek out partners interested in establishing flood forecast inundation maps for specific locations. Once partners have been identified, they notify NWS headquarters and begin coordinating the next steps in the development process with the partners and NWS headquarters. Regional Headquarters manage flood forecast inundation mapping projects, serving as the central point of coordination. They coordinate requests for various types

of supporting data with WFOs and RFCs. They communicate quality control and quality assurance (QA/QC) standards for supporting data and sign off on final QC reviews (note: RHQs may designate an RFC to perform some of these functions).

3.5.1.4 NWS Headquarters

Funding support for enhancement of the NWS AHPS Flood forecast inundation Mapping Web Interface, updates to the NWS AHPS Flood forecast inundation Mapping Guidelines, and training is determined through HPRC and managed by OHD. The National Flood Forecast Inundation Mapping Services Leader within OCWWS HSD leads the national effort to implement flood forecast inundation maps and enhance this program. He/she leads a team of representatives from RHQs, WFOs, and RFCs which performs the following functions:

- Collect and prioritize requirements for development and enhancement of flood forecast inundation maps
- Provide program management support to regional managers, WFOs, and RFCs
- Advise RHQs and partners on the collection and QA/QC of required supporting data
- Prioritize and schedule map development with the AHPS program
- Monitor the actual development of maps and reports status to the AHPS program
- Work with regions to ensure quality of the final product
- Ensure that required training is provided to WFOs, RFCs, and RHQs personnel

3.6 Hydrologic Remote Sensing Program

OHD maintains NOHRSC in Chanhassen, Minnesota. NOHRSC is collocated with the North Central RFC and Minneapolis/St. Paul WFO. A complete backup facility is maintained in Hanover, New Hampshire. RFCs and WFOs serving areas where seasonal snow cover is a significant hydrologic variable use products and services provided by NOHRSC when developing a variety of hydrologic products such as spring flood outlooks, water supply outlooks, river and flood forecasts, and reservoir inflow forecasts. Additionally, NOHRSC provides and supports GIS data sets and applications used by the RFCs in generating automated hydrologic forecast basin boundaries.

3.6.1 Information Sources

NOHRSC maintains an airborne snow survey program that provides airborne snow water equivalent data for much of the U.S. and Canada. NOHRSC ingests a broad variety of point, gridded, and modeled data sets from various sources within NOAA including: NESDIS; NCEP; the Global Systems Division (GSD); and the NWS Advanced Weather Interactive Processing System (AWIPS). NOHRSC ingests Landsat and near-real-time, Advanced Very High Resolution Radiometer (AVHRR), MODerate resolution Imaging Spectroradiometer (MODIS) satellite data via the internet. Additionally, NOHRSC receives data sets from other Federal, state, and Canadian cooperators.

3.6.2 Operations

Remotely sensed and simulated snow cover products, provided through the four NOHRSC programs described in this section, support the Hydrologic Services Program.

3.6.2.1 Airborne Gamma Radiation Snow Survey Program

The NOHRSC uses low-flying aircraft to make near real-time, airborne surveys of snow water equivalent over large regions of the country where snow is a significant hydrometeorological variable. The same technology is used to survey soil moisture conditions.

3.6.2.2 Satellite Hydrology Program

The satellite hydrology program uses data from polar orbiting satellites to map areal extent of snow cover and flood inundation, in near real-time, over the coterminous U.S. and Alaska. Satellite-based products are produced and made available in image format in a reasonable time frame after satellite overpass. Satellite derived areal extent of snow cover is assimilated into NOHRSC's snow model.

3.6.2.3 Snow Data Assimilation Program

The snow data assimilation program simulates gridded snow water equivalent and other snow pack properties using a distributed energy-and- mass-balance snow model known as the SNODAS (SNOW Data Assimilation System). Output from a mesoscale atmospheric model is used to force the snow model. All available ground-based, airborne, and satellite-derived snow observations are assimilated by the SNODAS to produce a “best” gridded-field estimate of snow water equivalent and other snowpack properties.

3.6.2.4 Geographic Information System Support Program

The NOHRSC uses high-resolution GIS databases in carrying out its mission to produce remote sensing and simulated gridded snow pack products. NOHRSC provides GIS-based applications and data sets to RFCs and WFOs in support of hydrologic modeling and flash flood operations, such as the Integrated Hydrologic Automated Basin Boundary System (IHABBS) and associated data sets, which are used by RFCs when generating, updating, modifying, or editing hydrologic basin boundaries. RFCs provide their finalized basin boundaries to the NOHRSC, which makes them available for use in AWIPS, NEXRAD, and other applications.

3.6.3 Products and Services

The NOHRSC generates products and data sets in a resolution, format, and time frame required to support the NWS Hydrologic Services Program. Products are distributed, in near real-time, over AWIPS to NWS users and over the Internet to all users at: <http://www.nohrsc.noaa.gov> or via an FTP-based data subscription service. Information on NOHRSC products and links to these products are provided in [*Hydrologic Information on the Web: A Manual for Users*](#).

3.6.4 Office Roles

In carrying out its mission, the NOHRSC interacts with NWS offices and external entities according to guidelines in the following sections.

3.6.4.1 River Forecast Centers

The NOHRSC coordinates operational snow pack modeling and assimilation, airborne snow survey, and satellite data collection schedules and activities with appropriate RFCs. These RFCs

incorporate NOHRSC-assimilated data into their hydrologic modeling and forecast operations. In interacting with the NOHRSC, RFCs are responsible for: (1) requesting specific basins where satellite snow cover mapping is needed, (2) requesting establishment of new flight lines, and (3) providing requirements for airborne snow measurements to be taken for existing flight lines. RFCs work with their supported WFOs to ensure that all ground-based snow data collected by WFOs (e.g., snow water equivalent, snow depth, and snow density) are encoded in Standard Hydrometeorological Exchange Format (SHEF) and distributed over AWIPS for use by the NOHRSC snow data assimilation program and incorporation into SNODAS. The NOHRSC interacts with RFCs to provide IHABBS software and database support upon request.

RFCs may request emergency or non-scheduled airborne snow surveys in coordination with their supported WFOs and RHQ. When possible, these requests should be submitted to the NOHRSC seven to ten days before the required survey date. Meeting requests with shorter lead-time may cause schedule conflicts with other airborne surveys. In evaluating conflicting requests involving two or more areas, the criticality of airborne data to the hydrologic forecasting effort for each area should be evaluated in coordination with the affected offices and RHQ.

3.6.4.2 Weather Forecast Offices

Through their supporting RFCs, WFOs request: (1) specific basins where satellite snow cover mapping is needed, (2) establishment of new NOHRSC flight lines, and (3) emergency snow surveys on existing on existing flight lines. Additionally, WFOs encode all available ground-based snow data (e.g., snow water equivalent, snow depth, and snow density) in SHEF products which are distributed via AWIPS and used in NOHRSC's SNODAS model. WFOs incorporate NOHRSC data into products disseminated to the public, mass media, partners, and other users.

3.6.4.3 Regional Headquarters

Before the onset of cold weather each year, the NOHRSC holds planning meetings at the regional level to lay out schedules for airborne data collection during the snow accumulation season and to coordinate SNODAS-related activities. NOHRSC provides RHQ with information of concern to WFOs and RFCs regarding NOHRSC status and products. RHQ, or the RFCs as delegated by RHQ, provide requirements to the NOHRSC for model-, airborne-, satellite-, and GIS-based products within the regions. Cancellations of scheduled airborne survey missions are coordinated with RHQ as well as affected RFCs and WFOs. Hydrology program managers in RHQ relay information on NOHRSC status and products to their regional directors and resolve conflicting requests for airborne surveys from field offices located in the same region. Conflicting schedule requests between regions should be resolved through coordination and if necessary, are resolved by the OHD Director.

3.6.4.4 Office of Hydrologic Development

The Chief, NOHRSC provides reports on status of NOHRSC to the Chief, Hydrology Laboratory in the Office of Hydrologic Development. These status reports include data collection schedules, airborne and satellite data sets, program accomplishments, and plans.

3.6.4.5 NOAA Aircraft Operations Center

NOHRSC coordinates with the NOAA Aircraft Operations Center to ensure that suitable, reliable, snow survey aircraft and NOAA Corps pilots are available to support the airborne snow survey program.

3.6.4.6 Local, State, Federal, and International Agencies and Commissions

The NOHRSC maintains contacts with key local, state, and Federal agencies and organizations across the U.S. and Canada. Periodic contacts are required to ensure the appropriate exchange of data, products, and technology between the NOHRSC and these external interests. NOHRSC represents the NWS and NOAA at various local, state, Federal, and international agencies and commissions on issues associated with the generation and use of satellite and airborne remotely sensed data, the simulation of snow pack properties for the U.S. using an energy-and-mass-balance snow model, and operational products used in the NWS Hydrologic Services Program.

NOHRSC serves as a liaison between the NWS and Natural Resources Conservation Service (NRCS). NOHRSC maintains a database of reference information on NRCS SNOwpack TELemetry (SNOTEL) and snow course observation locations. This reference information is made available to WFOs and RFCs upon request.

3.6.4.7 Commercial and Private Sectors

The NOHRSC distributes gridded snow pack products to interested commercial and private sector stakeholders via a public-facing website (<http://www.nohrsc.noaa.gov/>) and an FTP-based data subscription service.

3.7 Outreach and Flood Safety Program

WFOs routinely conduct local outreach and education to heighten public and partner awareness of flood risks and NWS hydrologic services. On average, floods cause about 90 deaths per year and over 8 billion dollars in damage (ref. <http://www.nws.noaa.gov/hic/>). Destructive flooding can affect any area of the U.S. and its territories. To help Americans guard against the dangers of flooding, the NWS has a Flood Safety Program aimed at arming America's communities with the safety skills necessary to save lives and property.

3.7.1 Office Roles

The NWS supports flood safety activities at several organizational levels to increase the American public's awareness of the dangers of flooding.

3.7.1.1 Weather Forecast Offices

WFO HPMs, with the support of Warning Coordination Meteorologists (WCM) and Service Coordination Hydrologists (SCH), perform the vital flood safety outreach activities at the local level. Key flood safety outreach activities of warning coordination meteorologists and hydrology program managers include:

- Establishing and maintaining the necessary flood coordination and information sharing mechanisms between the WFO and local, county, and state emergency managers and other government officials

- Leading flood safety activities at schools and community/city/county events
- Working with news media outlets in the WFO area to help them disseminate the most useful flood safety information
- Developing flood safety programs and materials tailored to the pressing hydrologic issues faced in the local WFO area. For example, the phrase “Turn Around Don’t Drown®” was originated by a WFO as part of a new outreach effort

3.7.1.2 River Forecast Centers

RFC outreach primarily involves partners and other users operating on the large river basin scale. RFC SCHs serve as the lead to support and partner with WFOs in outreach and safety activities. SCHs develop a network of partners and users to coordinate outreach and flood awareness to a broad set of partners and stakeholders.

3.7.1.3 Regional Headquarters

Managers of hydrology programs at RHQ provide leadership, expertise, and financial support for WFO flood safety efforts. They document best practices to ensure that highly effective flood safety efforts developed by individual WFOs are known and available to all of their field offices.

3.7.1.4 National Headquarters

National outreach focuses primarily on enhancing relationships with National Headquarters of other Federal agencies and supporting outreach efforts of RHQ and field offices. National outreach is led by the National Hydrologic Outreach Program Coordinator in OCWWS HSD. Flood safety activities of the National Hydrologic Outreach Program Coordinator include:

- Ensuring NWS hydrologic services outreach activities and information meet the changing needs of our diverse partners and other users
- Planning and participating in training, education, and outreach activities such as user forums, workshops, and conferences and/or webinars
- Developing, disseminating, and maintaining outreach information such as brochures briefings, user guides, videos, and web-based resources

3.7.2 Outreach Materials

Nationally developed hydrologic outreach brochures are stored in the National Logistics and Supply Center in Kansas City, MO. Requests for outreach materials should be made directly to NLSC by calling (816) 926-7794. Two internet web sites ([AHPS Toolbox](#) and the [TADD Toolbox](#)) also contain hydrologic outreach resources. These include Fact Sheets, online versions of DVDs, printable brochures and flyers, educational links, magazine articles, and publications.

3.7.3 Flood Safety Awareness Week

[Flood Safety Awareness Week](#) occurs each year, typically during March. This national campaign is aimed at raising the awareness to the dangers of flooding and ways to protect property. In the past, typical themes have been:

- AHPS
- Turn Around Don't Drown®
- Floods, Droughts, and other Related Phenomena
- Flood Insurance

3.7.4 Flood Safety - Turn Around Don't Drown

The flood safety phrase “Turn Around Don't Drown®” is a registered trademark of NOAA, U.S. Department of Commerce (Trademark Registration Numbers: 2,853,276 and 2,853,277). This phrase is used in many outreach efforts aimed at reducing the number of vehicle-related drownings, injuries, and water rescues during flood events. NWS employees may use this phrase in any official flood safety activity. Policies and procedures on use of the phrase “Turn Around Don't Drown®” by internal (i.e., NOAA/NWS employees) and external entities (i.e., non-NOAA/NWS employees and NOAA/NWS employees working in an unofficial capacity) are provided in a separate document which can be found [here](#).