# Implementation
# of
# Advanced Hydrologic Prediction Service

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE


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# EXECUTIVE SUMMARY

Advanced Hydrologic Prediction Service (AHPS) is provided through modernization of the National Weather Service (NWS) hydrology program.

Providing new services:

- More accurate and comprehensive predictions of river height and flood potential
- Longer term forecasts, from days to months, with probabilistic information to assist in risk based decision making
- High resolution, visually oriented forecast products at 4,000 locations nation wide
- Distribution of graphical information on NWS Web sites

And product suits:

- Hydrographs, providing near term river height and flow forecasts
- Probabilistic forecasts, providing graphical forecasts from days to months into the future
- Flood inundation maps, providing a graphical display of forecasted flood areas

By:

- Incorporating new forecast models at River Forecast Centers (RFCs) and Weather Forecast Offices (WFOs)
- Conducting research and infusing new science and technology into existing models
- Improving model performance by incorporating additional data (e.g. climate predictions, precipitation estimates and forecasts, reservoir releases)
- Refreshing aging hydrologic forecasting infrastructure

This document provides an overview of program activities and coordination process leading to National implementation of AHP Service.

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## 1.0 INTRODUCTION

The need for AHP Service is addressed in the NWS Strategic Plan for Weather, Water, and Climate Services and provide NOAA's customers additional time to prepare for floods or droughts, more accurate water forecasts and flood warnings, and better information for decision making. This document defines what must be implemented for these services to be provided.

### 1.1 Objective

Provide improvements to current river and flood forecasting capabilities and improve communications between the NWS, cooperating agencies, and NWS customers.

Make use of modernized NWS technologies and proven hydrologic sciences to produce and deliver better water forecasts and flood warnings. AHP Service builds upon existing services and systems, including:

- The NWS' 13 River Forecasting Centers (RFCs) and 121 Weather Forecast Offices (WFOs);
- Ongoing partnerships with other government and private sector organizations;
- Modernization programs including the Next Generation Weather Radar (NEXRAD), Geostationary Satellite System (GOES), Automated Surface Observation System (ASOS), and Advance Weather Interactive Processing System (AWIPS); and,
- The National Weather Service River Forecast System (NWSRFS) platform for further development and implementation of AHP Service.

### 1.2 Goals

AHP Service goals are to provide river and flash-flood forecast customers:

- Additional time to prepare for floods or droughts
- More accurate water forecasts and flood warnings
- Better information for decision making

## 2.0 IMPLEMENTATION COORDINATION

The AHPS Review Committee will lead AHPS project planning, execution and tracking activities. AHPS projects will be conducted by teams who report to the committee. The mission of the committee is to develop and promote sound program policy and plans for the integration of science into AHP Service.

The committee will consist of representatives from the Hydrologic Service Divisions in the NWS Regions, the Office of Climate, Water and Weather Services, the Office of Hydrologic Development, the Office of Science and Technology, and the National AHPS Program Manager. The AHPS Program Manager will chair the committee and report to the Operations Committee of the NWS Corporate Board.

## 3.0 PROGRAM ACTIVITIES

The NWS Office of Hydrologic Development along with NWS River Forecast Centers (RFCs) and the scientific community are involved in collaborative activities to infuse new science and technology into hydrologic forecast services. Additional projects provide for maintenance and enhancement of the existing NWS river forecast system and its infrastructure.

### 3.1 Science Infusion

The NWS Hydrology Laboratory working in conjunction with the RFCs, National Center for Environmental Prediction (NCEP), and scientific/academic community, will incorporate new science techniques and technology to increase the accuracy and timeliness of hydrologic products.

#### 3.1.1. Short-Term Ensemble Forecast

Develop techniques to provide short-term (hours to days) ensemble forecasts to be implemented within the existing data structure and system architecture. Existing approaches to account for uncertainty in short-term forecasts are too costly to implement, especially when they are scaled up to a National basis.

#### 3.1.2. Distributed Modeling

Develop distributed modeling approaches for river and flash flood applications. This activity will investigate methods for using spatial information to improve basin outlet simulations. The ability of distributed models to accurately predict streamflow at interior locations will be investigated as a pathway to improved flash flood forecasting approaches. Additionally, this activity will address the AHPS goal for more accurate river forecasts through hydrologic modeling at finer temporal and spatial scales.

### 3.1.3. River-Routing Calibration

Rivers are dynamic in nature and will require the use of numerical models accounting for both steady and unsteady flow conditions. Implementation of a dynamic river-routing model is especially important for locations where spatial information is to be provided, e.g. flood-forecast mapping.

### 3.1.4 Radar Quantitative Precipitation Estimation (QPE) and Forecasting (QPF)

High resolution rainfall estimates (in space and time) and forecasts of rainfall from minutes to months in the future are provided by radar, satellite, and rain gauges. These data sources are arguably the single most important input to both lumped and distributed hydrologic models. Short-term radar-derived rainfall forecasts are critical to flash-flood forecasting since atmospheric models do not work well for forecasts less than 6 hours.

This activity is necessary to develop next-generation QPE and QPF algorithms and products. New algorithm components will be developed and evaluated to correct stratiform rainfall estimation errors common in the cool seasons and to produce unbiased rainfall fields for all seasons. Additionally, development will be undertaken to provide probabilistic and polarized radar rainfall estimates using the new polarmetric WSR-88D radar. This activity will reduce existing deficiencies in rainfall estimation algorithms and produce more reliable deterministic and probabilistic rainfall estimated for all seasons and geographic regions.

## 3.2 Software Enhancements

Software enhancements enable AHPS to be provided via a workstation based environment in a user friendly way.

### 3.2.1 River Forecast System

Enhance and maintain NWS river forecasting suite of software tools. This activity will support the NWS river forecast mission by developing and maintaining user friendly tools used for providing hydrologic forecast services. In addition, it will provide the RFCs with new science and software technology including enhancements to the existing ensemble forecast modeling systems; software enhancements for short and long term probabilistic products; and other user requested enhancements.

### 3.2.2 Interactive Hydrologic Forecasting System (IHFS)

The hydrologic software infrastructure will be updated to current IT practices such as improved data base architectures, user friendly graphical user interfaces, and new software languages. This will reduce IHFS operational and maintenance costs and providing a cost effective environment for the implementation of new requirements.

### 3.2.3 Flood Forecast Mapping

The Flood Forecast Mapping Application (FLDMAP) will be enhanced to visually display inundated areas. The will require changes to FLDMAP for adequately mapping a flood in the presence of man-made structures and provide mapping for probabilistic flood forecasts. Additionally, a web mapping capability will be developed to allow users to view flood maps using a web browser.

### 3.2.4 Flash Flood Monitoring and Prediction

Flash floods are one of the most destructive natural phenomena in this country. Increasing the lead time of flash flood warning is essential to improving safety across the nation. Enhancements to existing procedures and the development of new forecasting methods will be incorporated to improve flash flood forecasts. This includes completing the development of the existing flash flood projection (FFP) algorithm that derives a one-hour quantitative precipitation forecast using WSR-88D radar data updated every 5 minutes so that a prediction of flash flood threat localized regions can be provided to forecasters and the public.

### 3.2.5 Verification Techniques

AHPS enhancements need to be measured relative to improvements they provide to the NWS river and flood forecasting mission. This will be accomplished by developing user friendly techniques and systems for measuring hydrologic forecast improvements. Verification results need to be in a form easily understood by the general public.

An important part of the verification of forecasts is the verification of the input rainfall fields that drive the models. Procedures will be developed to perform objective validation of improvements to radar rainfall fields. Radar derived rainfall quantities will be compared to rainfall estimates from rain gauges and existing techniques using satellite data.

### 3.2.6 Precipitation Processing System (PPS) and Multisensor Precipitation Estimator (MPE)

Improvements to the Radar rainfall estimates will be realized through software and science improvements to Precipitation Processing System (PPS) and Multisensor Precipitation Estimator (MPE) algorithms. These algorithms work together to generate rainfall estimates at each radar site which are combined regionally alone with data from rain gauges to produce best-estimate rainfall fields.

### 3.3 AWIPS RFC Enhancements

The current AWIPS system capacity for processing and storage needs to be increased to support AHPS product generation. This will be accomplished by augmenting AWIPS with a File Server and Linux Cluster. The first phase will provide prototype equipment to baseline AHPS product run times and develop requirements for production systems. The second phase will provide equipment to augment AWIPS at the RFCs and the Hydrology Laboratory.

### 3.4 Field Implementation

The modernization of the NWS hydrology program is dependent upon the initial and continuing process of implementing new science and technology at NWS field offices. This implementation process involves data collection, calibration, stabilization, verification, and user feedback.

#### 3.4.1 Data Collection and Analysis

The data collection and analysis phase involves the acquisition and analysis of several data bases. These include the following data bases/sources:

- Historical data bases to support model calibration
- Hydrometeorological and climate data
- Snow data from airborne remote sensing platforms
- High resolution digital terrain data

#### 3.4.2 Model Calibration

The calibration process involves adjustment of model parameters to minimize differences between a simulated forecast, using historical data, and observed information taken at the time of an event

#### 3.4.3 Product Development

A suite of high resolution, visually oriented graphical products will be generated by the RFCs and WFOs for dissemination to the user community. While products need to be standardized it is also recognized flexibility is required to meet diverse customer needs.

#### 3.4.4 Product Verification

Verification provides a systematic process to measure improvements in forecast warning accuracy and lead time brought about by AHPS implementation. Probabilistic Products will be verified and validated prior to public dissemination.

### 3.4.5 Product Dissemination

NWS web sites will serve as the primary vehicle for product dissemination. Products will be easily accessed by the general public through the use of techniques such as click and point, maps with zoom capability, and user-friendly menus. Individual RFCs and WFOs will provide local web access which provides for easy access to adjacent sites.

### 3.4.6 Outreach and Training

National, regional, and local training and outreach programs will be conducted to provide a better understanding of AHP Service. These programs will target both forecasters and external users. They will include a wide range of activities including meetings with individual emergency managers, presentations to local organizations and users, and National conferences and workshops.

### 3.4.7 User Feedback

User feedback forms will be used to involve costumers in the implementation process. This will range from user meetings to solicit comments on product output and usability, to user training programs providing in-depth knowledge on product generation and use.