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National Weather Service
Office of Hydrologic Development
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Operational Analysis – FY2007

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Executive Summary

The mission of the Office of Hydrologic Development (OHD) is to:

- Provide information and support for our primary customers, the forecasters at National Weather Service River Forecast Centers, Weather Forecast Offices and National Centers, partners within all levels of government, and constituents from academia, the international research community, the private sector, and the public.
- Conduct scientific research and software engineering to develop and maintain data processing systems, analysis, and prediction tools to support operational hydrologic models.
- Obtain and process data to advance the state-of-the-art, produce more accurate river and stream forecasts, and provide valuable services to help the agencies that manage water resources, and make contributions to scientific publications and actively participate in professional societies.

This report focuses on the operational state of the program as of September 30, 2007, and is based on guidance developed by the Department of Commerce. OHD directly facilitates NOAA's Strategic Goal to "serve society's needs for weather and water information." The current program meets established cost, schedule and performance parameters.

This operational analysis (OA) is an annual, in-depth review of the program's performance based on the following:

- Customer Results
- Strategic and Business Results
- Financial Performance
- Innovation

The Advanced Hydrologic Prediction Service (AHPS) and Water Resources programs continue to improve National Weather Service operational forecasting capabilities. In FY2007 AHPS services were initiated at 249 new locations. The Community Hydrologic Prediction System (CHPS) realization plan was completed and a prototype is in place at three River Forecast Centers. A gap analysis was performed and completed for an Experimental Ensemble Forecast System (XEFS), and work has begun to bring this tool into operations. Several programs were re-released to maintain operational relevance.

NOAA's Hydrology Program, which includes OHD, underwent a Program Assessment Rating Tool (PART) review in FY2007. The Hydrology Program received a score of "Moderately Effective".

1.0 Customer Results

OHD leads the research and development activities for NOAA's Hydrology Program. The Hydrology Program supports its customers by providing river level, flood and flash-flood forecast and warnings, water resource information. Customers include emergency response managers; other federal, state and local water management associations; and the general public. Emergency managers use the forecasts and warnings for both strategic, long-term planning as well as tactical, short-term planning. Water resource managers make critical decisions that affect flood control, water supply, river and lake transportation, agriculture and hydropower.

The Hydrology Program provides critical information which provided an estimated cost savings of over $943M annually in FY07 dollars. Details of the economical benefits are described in Use and Benefits of the National Weather Service River and Flood Forecasts.

1.1 Customer Requirements and Costs

The Hydrology Program conducts a biennial customer satisfaction survey of emergency response managers; other federal, state and local water management associations; and the general public to identify successes along with areas for improvement. The survey has shown customer satisfaction with hydrologic services to be higher than average for other Federal programs (79% vs. 71%). The program also continually solicits customer feedback from on its Web pages and evaluates it on a regular basis to prioritize the need for improved or new water forecast information products and services. Additionally, the Hydrologic Service Division (HSD) leads a customer outreach program which serves as the interagency liaison, maintains policy and requirements for and assesses the

performance of the overall hydrologic services program and provides technical support for the River Forecast Centers (RFC) and Weather Forecast Office (WFO) hydrologic operations.

Hydrological services are provided through NWS Web pages at no cost to its customers.

1.2 Performance Measures

These measures align with the "Customer Results Measurement Area" of the Performance Reference Model developed by the Federal Enterprise Architecture Program Management Office (FEA-PMO). Table 1 summarizes the performance measures.

Table 1: Customer Results Performance Measure

Measurement Area	Indicator	FY06 Baseline	FY07Actual Result	Comments
Customer Requirements	Hydrology program customer satisfaction index	79%	79%	New Customer Satisfaction Index Survey to be completed in FY2008
	Hydromet observation data delivery to NWS field offices (Minutes)	3.5 Minutes	2.3 Minutes	
	OHD development environment IT availability	95%	99%	

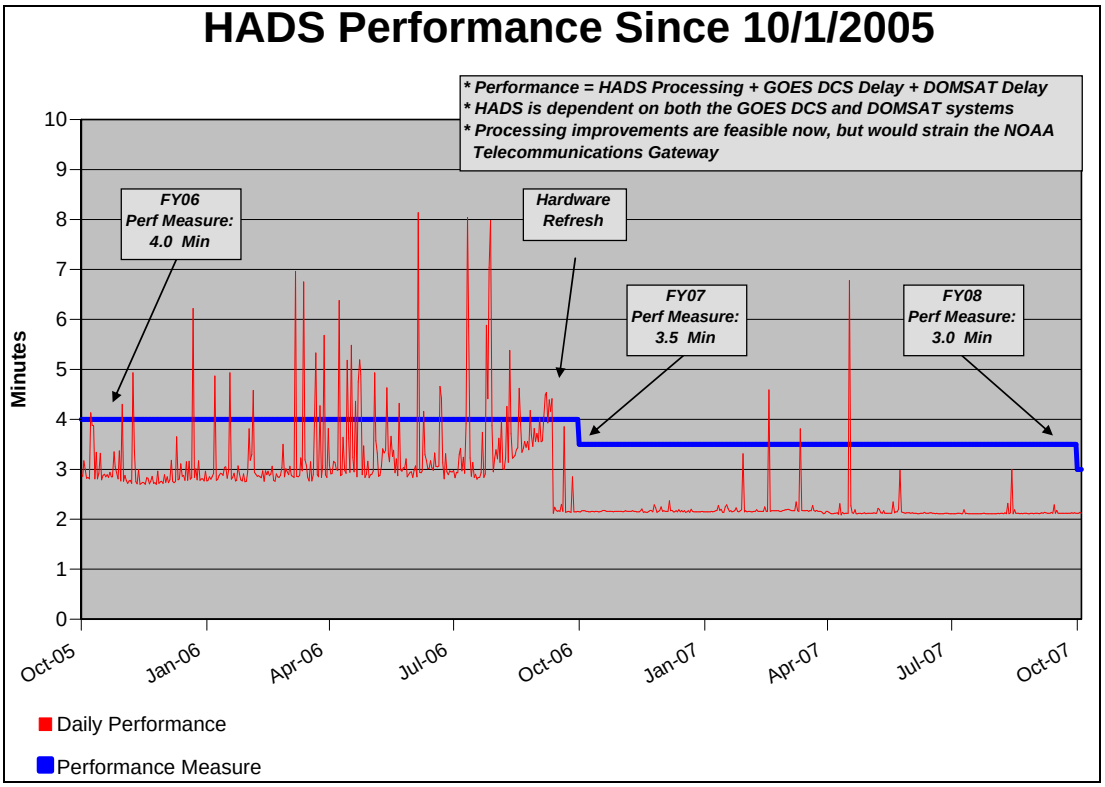


Figure 1: HADS performance continues to improve.

2.0 Strategic and Business Results

OHD and the Hydrology Program facilitate NOAA's Strategic Plan Mission Goal to serve society's needs for weather and water information. Goals and objectives for the past year have been met or exceeded as the result of program management and monitoring processes in place to ensure continued progress. In addition to program initiated controls, independent evaluations are routinely and independently conducted to ensure the program is effectively accomplishing its mission and meeting its long-term goals.

2.1 The Hydrology Program Helps to Achieve Strategic Goals

The Hydrology Program supports the DOC Strategic Goal 3.1 "Advance understanding and predict changes in the Earth's environment to meet America's economic, social, and environmental needs" and the NOAA Goal to "Serve Society's Needs for Weather and Water Information".

Listed below are activities which support the DOC and NOAA goals:

- Implement River and Lake Probabilistic Forecasts locations which incorporate new science to improve forecasts and provide probabilistic information which provides users with information to make risk based decisions.
- Reduce the time for delivery of Hydromet Information to NWS field Offices. Timeliness in delivering data contributes to the efficiency and accuracy for forecast issued by the operational facilities.

2.2 Business Results

2.2.1 Program Management and Controls

The Hydrology Program collects performance information to manage and improve the program; this includes quarterly measures such as flash-flood forecast accuracy and lead times which help evaluate the adequacy of training programs, hydrologic tools and procedures used by forecasters to generate and issue forecasts; and measures such as schedule performance and implementation status to measure timely delivery of services. These measures are reviewed by managers during monthly, quarterly and annual review to evaluate system performance.

Project statuses are reported monthly to the OHD Director to ensure that project targets and goals detailed in the Annual Operating Plan (AOP) are being attained. The OHD Director presents quarterly program updates on cost, schedule and performance to the NOAA executive panel which oversees the NOAA planning, programming and budgeting process. The NOAA Deputy Undersecretary who heads this panel, then meets with the NOAA administrator on a quarterly basis to review cost, schedule and performance result for all NOAA programs.

2.2.2 Monitoring Cost, Schedule and Performance

<u>Cost</u> – The cost for the Hydrology Program in monitored through a monthly report prepared by the OHD financial officer. The report contains financial information on estimated and actual costs versus projected program cost. Monthly budget reviews are held by the Hydrology Program

Manager to assure the program is being managed with cost and schedule. Quarterly reports are submitted to the NOAA executive

Schedule – Key milestones contained in the Annual Operating Plan (AOP) are evaluated each month project managers. The Hydrology Program 'Quad Chart' contains schedule information which is prepared for the NOAA Deputy Undersecretary each quarter. The Exhibit 300 schedule information is updated each quarter. Milestones have consistently been accomplished on or ahead of schedule.

Performance – Performance measures, including cost and schedule are review monthly at the program level. Quarterly and annual reviews are conducted at the NOAA executive level to assure compliance with baseline measures.

2.3 Reviews

NOAA's Hydrology Program, which includes OHD, underwent a Program Assessment Rating Tool (PART) review in FY2007. The Hydrology Program received a score of "Moderately Effective". Details can be found at www.ExpectMore.gov.

2.4 Security

The HADS and DEIT systems are accredited under requirements spelled out in NOA 212-13 (08/06/90) and NWS Information Technology Security Policy that are based on OMB and NIST guidance. System Security Plans, Risk Assessments, and Contingency Plans were certified and approved in August 2007. The last Certification and Accreditations were completed in January 2005; new C&A's are scheduled to be completed in January 2008. Management, operational, and technical security controls are adequate to ensure the confidentiality, integrity and availability of information.

2.5 Performance Measure

The performance measure in Table 2 shows the Hydrology Program performance with respect to Strategic and Business Results. Strategic and Business Results performance measures introduced in FY2000 include the number of locations reporting River and Lake Probabilistic Forecasts. These measures align with the Strategic and Business Results Measurement Area, of the Performance Reference Model developed by the FEA-PMO.

Table 2: Business Results Performance Measures

Measurement Area	Indicator	FY2006 Baseline	FY2007 Actual Result	Comments
Strategic and Business Results	River and Lake Probabilistic Forecasts (Locations)	1993 Locations	1949 Locations	Reflects reduced implementation funding in FY06 and FY07.

3.0 Financial Performance

3.1 Current Performance vs. Baseline

The current OHD financial performance, shown in Figure 2, is based on a pre-established cost baseline (e.g., annual spend plan). Program costs are steady state and consist of staffing and

contractor expenditures, and information technology equipment such as routers, desktops and data storage devices. Other planned project costs cover the support and services contracts at each data center. The final 2007 steady state expenditure was within a four percent variance.

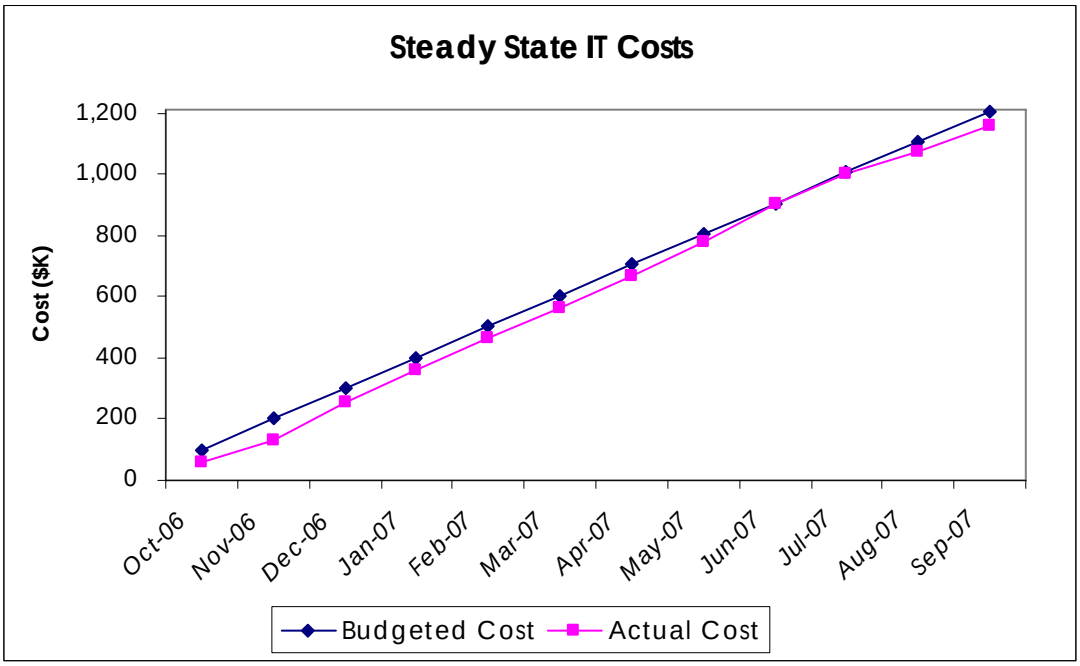


Figure 2: Budget vs. Actual Costs

3.2 Financial Performance Review

OHD's annual spend plan determines the specific dollars to be applied to scientific research (non-IT) and software development / equipment support (steady state IT).

Financial performance is typically subjected to a periodic review for reasonableness and cost efficiency. Weekly budget discussions are held with the program manager, CORs and contract managers to ensure contracts are within cost and on schedule. The contractors issue monthly invoices for all products and services supplied under the contract. These are tracked and evaluated by the COR as well as each government task manager who is responsible for issuing the task order and monitoring the task for deliverables and for the quality assurance of these products and services. Progress meetings are conducted to review each task for its progress, quality, and costs. A detailed review of work and priorities is undertaken if cost is significantly above base lined values. Also, any necessary corrective actions are also identified and implemented.

OHD uses the General Services Administration's (GSA) Federal Supply Schedule Contract Blanket Purchase Agreements (BPAs). The BPAs eliminate contracting and open market costs such as: the search for sources; the development of technical documents and solicitations; and the evaluation of bids and offers. The BPAs further decrease costs, reduce paperwork and save time by eliminating the need for repetitive, individual purchases from the schedule contract. This creates a purchasing mechanism that works better and costs less. By using BPAs, purchases cannot exceed funds available thus always keeping the program within budget.

The OHD funding requirements discussed in this OA report cover a significant portion of the "Support" capability within NOAA's Hydrology Program. The cost lines are reviewed on an annual basis as part of NOAA's Planning Programming Budgeting and Execution System (PPBES) process.

4.0 Innovation to Meet Future Customer Needs

The following projects have been implemented in FY2007, or are being implemented in FY2008 to address future challenges, better meet customer needs, make better use of technology, and lower operating costs.

4.1 AWIPS RELEASE OB7.1

Release OB7.1 was deployed nationally in December 2006.

WHFS AND DATA INGEST :

- A new River Monitor application for providing automatically updated tabular information summarizing river conditions. This initial version is delivered in part for RiverPro VTEC monitoring, and provides general monitoring of river data. It is enhanced in Release OB7.2.
- The ability to store and manage low water (i.e., drought) impact statements in the HydroBase application.
- The ability to perform alert/alarm against lower limit thresholds, to complement the existing upper limit exceedance thresholds.
- The improved ability to specify and manage the display of flow-based flood impact statements in RiverPro, beyond the existing traditional stage-based impacts.
- The separation of HydroView /MPE into distinct applications – one for HydroView and another for MPE (more MPE discussion is given in the precipitation processing section below).

PRECIPITATION PROCESSING :

Enhancements from the Tulsa RFC P3 QPE application are introduced in OB7.1 within the Multi-Sensor Precipitation Estimator (MPE) application. The changes include the introduction of three new grid types: a) Triangulated Local Bias Corrected Multi-Sensor Mosaic; b) Radar Average mosaic; and c) Radar Maximum Mosaic. Site tokens are used to control which grids are actually generated at a given office and which radar mosaic is used for the subsequent grids. The existing MPE polygon editing tools are extended in OB7.1 to allow the user to apply, save, or delete polygon-based edits. Lastly, the MPE application, which is now separate from the HydroView application, has a split-screen feature to allow side-by-side comparison of grids.

4.2 AWIPS RELEASE OB7.2

Release OB7.1 was deployed nationally in Spring 2007.

NWSRFS :

- During the past three months we provided support for problems discovered late in the Beta testing period as well as with the OB7.2 installations. We also provided revised executables which efficiently handle the new Daylight Saving Time definition in emergency release OB7.2.0.2.

VERIFICATION :

• With significant help from OHD personnel, Raytheon was able to complete the testing of the enhanced verification software which is now being tested at OB7.2 beta sites.

WHFS AND DATA INGEST :

• The implementation of the "Mapper" station data display function into WHFS, currently operating as a Western Region local application. It provides a robust method for displaying hydrometeorological data, similar in many ways to the existing WHFS TimeSeries and HydroView station data display control functions. Its benefits are in its more direct methods for displaying desired data sets (i.e., less mouse clicking), its "time-stepping" (quasi-animation) features, and its display speed.

• The data monitoring tool RiverMon provides a tool to monitor information related to river forecast points, including the VTEC event status. This application runs continuously with an automated refresh of color coded tabular information to identify alert/alarm conditions. Related to this is an automated application known as the "observed-forecast monitor" for monitoring differences between river forecasts and observations. This monitoring tool fits within the existing WHFS Alert/Alarm functionality.

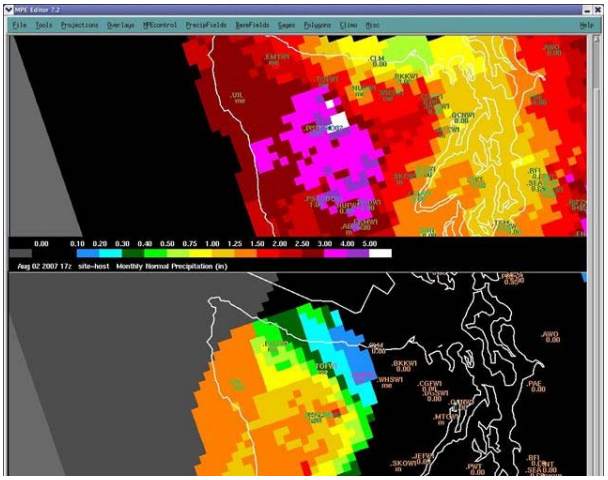
• Some minor enhancements include a new editor interface in HydroBase for the HydroGen support information, a new feature to adjust the icon sizes in HydroView, and new features in the TimeSeries tabular mode for copying forecast time series data and for globally setting quality code attributes.

• Major enhancements were made to the RiverPro functionality to support NWS Directive 10-1703 (VTEC) and 10-922 (WFO Hydro Products). These changes also incorporated numerous changes based on lessons learned in the recently concluded Hydro-VTEC OTE (Operational Test and Evaluation). The changes include full support for operating RiverPro in a practice mode and the new end-to-end ability to generate corrected products.

PRECIPITATION PROCESSING :

A major change to MPE operations in OB7.2 is the incorporation of the Daily QC functions used in the Western Region into MPE operations. The goal is to provide a nationally-supported, baselined application usable by all offices to perform QPE operations. For OB7.2, the existing Daily QC functionality is integrated into MPE. This involved new temperature and freezing level data quality control features, additional precipitation gage quality control options, and assorted interactive features. The MPE Daily QC in OB7.2 still operates in its 6- and 24-hour domain. HSEB is also working to coordinate the delivery of RFC-generated QPE products to the SBN for subsequent receipt and use at WFOs. Changes were made to make these RFC QPE products displayable in D-2D at WFOs, to complement the locally generated QPE products which can be displayed in D-2D as of OB6. HSEB is currently working with NWS communications staff to ensure that the ZET98 QPEBIN products are properly routed on the SBN. Currently, these products are not being routed onto the SBN.

Lastly, a new utility application ("build_hourly") was provided to assemble hourly precipitation reports from sub-hourly data, so that the resulting data



MPE creates high-resolution precipitation for hydrologic modeling.

can be used in MPE operations.

4.3 AWIPS RELEASE OB8.1

OHD continued activities involved with the transfer of all OHD AWIPS baseline source code into Raytheon's configuration management system, Serena ChangeMan Dimensions. The transfer is now complete, but many technical problems in managing, building, and releasing the software by Raytheon have required significant intervention on the part of HSEB. OB8.1 software was delivered to field offices beginning in July 2007.

SRA TOOLS ENHANCEMENTS :

Release OB8.1 will include four significant capability enhancements to the Res-J operation: a hindcasting capability, a "LOOKUP3" capability, diversion from a node, and a variable lag in the LAGK method in Res-J. Riverside Technology, Inc. (RTi) has completed the software changes which implement these enhancements and OHD personnel will complete the handoff procedures to get the enhancements into the AWIPS release.

WHFS AND DATA INGEST :

Within the WHFS software, a new set of database tables are being added to allow definition of forecast services provided for each river forecast point. This information will be used for management of the services provided by the NWS hydrology program and will be incorporated into the broader verification measures effort managed by OCWWS/HSD. A new interactive application (Forecast Services Manager) provides the tools needed to enter and manage the information in the database. The information is expected to be entered by RFCs, although these features are being provided to all offices.

OB8.1 also includes some minor improvements to the HydroGen image generation functions, along with assorted minor changes to WHFS applications.

4.4 AWIPS RELEASE OB8.2

Two major milestones in the development process were met in June, with the completion of the forecaster Pre-Integration Testing (PIT) and the AWIPS Integration Readiness Reviews. OB8.2 is scheduled for release beginning in December 2007.

ENHANCEMENTS TO DETERMINISTIC VERIFICATION :

When AWIPS OB8.2 is installed, the RFCs will gain new software capabilities that will enable them to compute additional verification statistics and analyze the statistics in a more robust manner. Furthermore, users will be able to verify input to the hydrologic models, including precipitation and temperature, while also verifying output from those models. Personnel at ABRFC, NCRFC, OHRFC, and WGRFC spent six weeks testing prototypes of the application to assist Hank Herr improve the application enhancements. We really appreciate the testing and feedback these offices provided and think future users will benefit from their suggestions.

NWSRFS MAT ENHANCEMENT :

As mentioned in the last edition, this enhancement to the DIURNAL technique allows the selection of temperature max/min conversion coefficients calculated specifically for APRFC, CNRFC, and CBRFC. After several months of testing at these offices under ATAN 876, this feature will be included in the OB8.2 release.

RFC BIAS TRANSFER TO WFO RPG :

HSEB is on track with our OB8.2 project RFC Bias Transfer to WFO RPG. This project will enable WFOs to automatically receive a mean-field bias generated at an RFC. The quality control of rain gage data results in better bias information, and RFCs have staff that specializes in this task. The WFO will be able to a) select which RFC they receive the bias from, b) use the RFC generated bias in local MPE operations, and c) select whether to send the RFC generated or locally generated bias to their associated RPG.

SATELLITE-RAIN-GAGE PRODUCTS :

Three new QPE products using satellite data will be incorporated into MPE operations for OB8.2. A raw satellite and locally unbiased satellite product already exist, but no products exist that quantitatively integrate radar and gage data with the satellite data. The three new products to be generated are: satellite-radar, satellite-gage, satellite-radar-gage (SRG). The automatic generation of these fields is expected to replace the manual cut-and-paste now required to combine the satellite field with the radar-gage multi-sensor field in areas with poor radar and gage coverage. This project includes both the generation (through MPE_fieldgen) and display (through MPE_Editor) of the new fields.

4.5 AWIPS RELEASE OB8.3

Although the software for Release OB8.3 will not be formally handed off to AWIPS until December, HSEB has already been working throughout this quarter on several of these enhancements.

4.6 OTHER INNOVATION TO MEET FUTURE CUSTOMER NEEDS

AHPS Website Updates

Three significant improvements to the AHPS Web Pages were implemented in FY2007. First was a new graphical user interface that lets users toggle geo-referenced overlays such as state and county boundaries, highways and rivers. Second was the deployment of static flood inundation maps for sites along the Tar River in North Carolina. As compared to traditional flood warnings which state the height of the river, flood inundation maps graphically depict the areal extent and depth of flooding, which allows emergency managers and other customers to make more informed decisions about evacuation routes, sandbagging, etc. Third was the transition of the NWS Precipitation Analysis web tool to operations. Precipitation Analysis compares high-resolution observed precipitation estimates to average rainfall values. Daily, multi-day, monthly and annual observed, normal, departure-from-normal and percent-of-normal images and downloadable GIS files are used by a diverse group of users.

HydroXC

A visit in September by the Australian Water Information Delegation to establish closer ties for information exchange revealed their interest in our work on Hydrology XML. Apex Digital Services and Dr. Michael Piasecki from Drexel University met with them about the XML schema and the Consortium. There may be opportunities for collaboration in the future.

CHPS FEWS Pilot

On August 15 RTi led a kick-off meeting for the CHPS FEWS Pilot Enhancements project. To recap, these enhancements include:

- Installation of the Pilot at ABRFC (3rd Pilot site, joining NWRFC and NCRFC)

- Develop a MODs-like capability for the SAC-SMA
- Configure all Pilot sites as client-servers, not standalone as now
- Provide additional segment definitions for the Santiam River for NWRFC
- Provide more in-depth training to all Pilot sites
- Provide access to SNOW-17 (replaces Delft's SNOWMELT in the existing Pilot)

A workshop to demonstrate these new features is scheduled for December, at NCRFC.
During a discussion in early September, the CAT agreed that the term 'Initial Operating Capability (IOC)' will refer to the suite of functionality at the CHPS FEWS Pilot sites that will enable those sites to abandon use of NWSRFS as their primary forecasting tool.
Delft recently proposed a user interface design for the MODs-like feature, and held a meeting to review and discuss with the CHPS Acceleration Team (CAT) members in late September.
HSEB, through its RSIS contract, completed testing of the SNOW-17 model and adapter for use within the CHPS FEWS Pilot system, and delivered the code to Delft. HSEB also developed and delivered segment definitions for all basins of the Pilot sites.
In response to a request at the July meeting of HICs in Silver Spring, MD HSEB invited all RFCs to participate in its "chps_fews_pilot" list server forum. The list quickly reached its membership limit and has since been increased to accommodate.

ResSim
The purpose of this project is to integrate use of the USACE HEC's Reservoir Simulation (ResSim) model into CNRFC operations. The project is a joint effort between the HEC, who is enhancing the ResSim and converting it to Linux, and the NWS who will provide a software interface between ResSim and the NWSRFS. HSEB, through its contract with RSIS, Apex, and Delft, has specifically designed this interface to be compatible with CHPS as well as NWSRFS; therefore the solution will incorporate the Delft-FEWS as a significant component.

HEC-RAS
The goal of this project is to provide RFCs with access to the USACE HEC River Analysis System (HEC-RAS) via CHPS (not NWSRFS). HSEB anticipates two phases, the first of which (Phase 1) will be the solution design; this piece has now been contracted out to Delft. The solution is expected to leverage much of the CHPS-based software developed on the ResSim project, without the connection to NWSRFS.

Experimental Ensemble Forecast System (XEFS)
HSEB spent most of this quarter conducting an in-depth analysis of existing prototype software that is related to experimental hydrologic ensembles. That analysis, along with an examination of requirements captured in the XEFS Design and Gap Analysis Report, forms the basis of a high level software design for the XEFS. With the design in place, the XEFS Execution Manager is in the process of putting together a preliminary implementation plan, and specifying cross-functional team composition. An XEFS implementation kick-off meeting is expected in FY2008.

4.7 HADS SYSTEM AND SOFTWARE

The deployment of systems to the NWS Backup Telecommunications Gateway center (the "BTG") has been completed, but we are still waiting for a fully supported real-time data feed to be implemented by NWS OCIO and NWS Gateway personnel. In the meantime, along with a file

transfer function from the Domestic Satellite reception in Silver Spring we have enacted a network connection from HADS at the BTG to the Wallops Island DCS facility. This activity provides a secondary /backup data feed to the BTG systems in case of acquisition failures at the primary site in Silver Spring. We are still lacking an operational path to deliver products from the HADS BTG, but we are capable of transferring SHEF products to the RFCs and to the OHD web environment if it should ever become necessary. The solution to implementing a real-time communication link to the BTG remains as an unsettled issue due to OCIO budget restraints. Meanwhile HADS data processing functions continue in their normal manner. One software deficiency involving the computation of hourly incremental precipitation (PP) from a small subset of data platforms was recently discovered and quickly corrected.

During the past two months a couple of newsworthy events have occurred within the DCS community.

First, at the NESDIS facility in Wallops Island, VA., a new data processing system has been brought on-line to provide backup to the circa 1979 DAPS processor. This new backup system was called into operations several times during July and effectively eliminated down-time and data loss when failures occurred on the original DAPS computer.

The second event, an activity that will eventually enhance availability of GOES DCS data, involves the USGS efforts to field a GOES DCS facility at the EROS data center in Sioux Falls, SD. The GS is on track to begin deployment of a DCS downlink and a network based data relay system during the first-quarter of 2008. Establishing this center will provide an operational backup to Wallops Island and eliminate the ‘single point of failure’ attribute of the GOES DCS.

4.8 HADS DATA NETWORK

The data network continues to expand. The number of data points in the network is now 12,858 and approximately 2.3 million data values are processed each day.

The owners/operators of the GOES DCS platform continue their efforts to migrate their older platforms to the High Data Rate (HDR) systems and change their transmission frequencies to a 1-hour cycle. This activity represents the major portion of the work involved in maintaining the HADS data network as a number of DCPs are replaced each day. The USGS continues to lead this effort as 6,350 USGS platforms processed via HADS with 3,500 of these now uplinking on the 1-hour cycle. The USACE is increasing their effort to move to hourly transmitters as are all other platform operators within the GOES DCS. Of the 12,858 sites processed by HADS, 7,600 now provide new data every hour.