USACE/NWS/USGS Fusion Team

Report #1

Fusion Team Submission
May 2010

US Army Corps of Engineers

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USACE/NWS/USGS Fusion Team
Executive Summary

In June 2008, a large portion of the Upper Mississippi River basin experienced major to record flooding. Several federal agencies worked closely together on a daily basis during that and other floods such as in 2008, to provide precipitation and river forecasts and warnings to the public. This report addresses the ongoing collaboration between the U.S. Army Corps of Engineers (USACE), the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS), and the U.S. Geological Survey (USGS) to enhance collaboration and continue to improve those services. While the 2008 tri-agency collaborative forecasts were good in many respects, there were also areas cited for improvements by numerous stakeholders (state and local officials, navigation industry, etc.). For this reason, then Brigadier General (P) Michael J. Walsh, Commander of the USACE Mississippi Valley Division (MVD), called for a River-Rainfall Summit to discuss the issues among the agencies and to hear from the public regarding the service provided to them. The first Rainfall-River Forecast Summit was held in October 2008. One of the actions from this Summit was to form a "cell" by fusing the USACE/NWS/USGS agencies into a team with a common mission to improve river forecast services.

The Fusion Team was quickly formed, first met December 16-17, 2008, and immediately set to work. The Fusion Team consists of several members from each of the three federal agencies (USACE, NWS and USGS), as well as a representative from the navigation industry. The team developed a mission statement; "The Fusion Team mission is to collaboratively develop a process for improving the accuracy and utility of rainfall/river forecasts within the Mississippi River Basin employing the expertise and experience of the cell's member agencies." In addition, the team identified a series of action items that would start the journey to fulfilling the mission statement. To date, 55 action items have been identified and 31 have been completed.
Significant improvements in process have been achieved. They include but are not limited to the following:

- Improved Interagency Information exchange and collaboration.
- Improved river forecast dissemination to the public.
- Improved consistency of data among the three agencies.
- Collaboration on developing a new forecasting model (NWS/Corps).
- Alignment of annual River Forecasters Workshop to Fusion Team mission.
- Development of internal performance metrics.
- An understanding that the single most important metric is CUSTOMER SATISFACTION.

Since the formation of the Fusion Team and its initial meeting in December 2008, emphasis has been on identifying the issues which could contribute to uncertainty and inaccuracies in developing forecasts. These issues related to a number of focus areas: cross agency training and operations, enhanced communication and collaboration,

accurate data available concurrently to all three agencies, technical forecast improvements and river forecast improvements. The majority of the action items completed to date address areas under the focus areas in which to improve the processes and procedures at and between the agencies. As a result of these actions, the Fusion Team is confident that, by improving our processes and procedures, the overall accuracy of the forecasts has been improved. However, the Fusion Team also realizes that to our stakeholders and the public, a more definitive assessment of the accuracy of forecasts and the actual degree of improvement is desired and that our stakeholders and the public are the ultimate arbitrators of our success.

The next phase of the Fusion Team activities will concentrate on quantifying the impact the improvements in processes and procedures have, and will continue to have, in optimizing the accuracy of the forecasts. The Fusion Team has begun to identify action items and team members to conduct an assessment of forecast accuracy and the degree to which the efforts to date have been effective in improving the accuracy. Those action items include developing the metrics with which to measure accuracy of the forecasts not only regionally and seasonally but also with respect to extreme events (such as flood peaks and droughts). In addition, the Fusion Team will look for improved communication and coordination methods with our stakeholders and the public to improve their awareness of the impacts of the Fusion Team efforts.

Fusion Team Report

Multi-federal agency collaboration to improve rainfall and river forecasts in the Mississippi Valley

May 21, 2010

I. Introduction

In June 2008, a large portion of the Upper Mississippi River basin experienced major to record flooding. "Although the 2008 flooding event was less severe than that in 1993, which brought devastating flooding to the area, significant portions of the region were hit much harder in 2008. ... The damage affected the lives and livelihoods of many people in many communities, sometimes catastrophically. Eleven people in six states lost their lives as a direct result of the flooding. ... Flooding inflicted major damage on residences, agriculture, businesses, public services, and transportation.... Reports indicate damages of more than $5 billion." [1]

There are several federal agencies that work closely together on a daily basis and especially during floods such as in 2008, to provide precipitation and river forecasts and warnings to the public. This report addresses the ongoing collaboration between the U.S. Army Corps of Engineers (USACE), the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS), and the U.S. Geological Survey (USGS) to enhance collaboration and continue to improve those services. The USGS provides information on the state of the nation's rivers and the NWS uses that data to provide river forecasts and warnings to the nation. USACE uses rainfall and river observations and forecasts to reduce damage due to flooding and to regulate locks and dams for the navigation industry (specific agency mission statements can be found in Appendix A).

While the 2008 tri-agency collaborative forecasts were good in many respects, there were also areas cited for improvements by numerous stakeholders (state and local officials, navigation industry, etc.). For this reason, then Brigadier General (P) Michael J. Walsh, Commander of the USACE Mississippi Valley Division (MVD), called for a River-Rainfall Summit to discuss the issues among the agencies and to hear from the public regarding the service provided to them. The first Rainfall-River Forecast Summit was held in October 2008. One of the actions from this Summit was to form a "cell" by fusing the USACE/NWS/USGS agencies into a team with a common mission to improve river forecast services.

[1] National Weather Service, 2009: Central United States Flooding of June 2008, Service Assessment Report

II. USACE/NWS/USGS Fusion Team

A. Introduction

The Fusion Team was quickly formed, first met December 16-17, 2008, and immediately set to work. During 2009, several Fusion Team actions were put into operation in time for the major 2009 flood on the Red River of the North. After that flood, the team facilitated a second Summit in October 2009 and its purpose was similar to the first: to hear from our stakeholders regarding river forecast services. Details on the issues cited at the Summits can be found at http://mvswc.mvs.usace.army.mil/fusion/fusion.htm.

The Fusion Team consists of several members from each of the three federal agencies (USACE, NWS and USGS), as well as a representative from the navigation industry. Each agency added field experts; the current membership can be found in Appendix B. Plans are for the team to continue while actions are ongoing and new actions are formed to further enhance river forecast services to the Public. Results, to date, are further described in the following sections.

B. Mission Statement

The Fusion Team mission is to collaboratively develop a process for improving the accuracy and utility of rainfall/river forecasts within the Mississippi River Basin employing the expertise and experience of the cell's member agencies.

The Fusion Team is comprised of representatives from the National Weather Service, U.S. Geological Survey and the U.S. Army Corps of Engineers. The Fusion Team will develop a plan for improvements that can be made given the current science, manpower and level of funding. The ultimate goal is to optimize the accuracy and utility of the forecasts provided to the Public in accordance with all applicable regulations.

C. Actions and Accomplishments

Since the first meeting in December of 2008, the tri-agency Fusion Team has taken action to address issues cited by numerous stakeholders. In some cases, such actions were already ongoing by one or more of the agencies. Following is a summary of the multi-agency progress and Fusion Team accomplishments to date. The specific Fusion Team action items can be found in Appendix C.

1. USACE/NWS/USGS Interagency Information Exchange and collaboration

    a) Web-based pre-flood briefings

    In early January of 2009, the agencies and emergency management community had web-based briefings as well as

preparedness meetings to discuss flood potential and planning. These briefings were noted as extremely valuable. The Fusion Team together with other members of the agencies have worked to continue and to enhance these briefings; some optimization has been achieved by going beyond political or agency boundaries.

b) Instant Messaging – NWS Chat

The NWS, in collaboration with Iowa State University, developed NWS Chat for use by partners both internal and external to the NWS. In early 2009, the NWS North Central River Forecast Center (NCRFC) created an agency chatroom to allow outside agencies to directly discuss flood-related or other river issues, in real time. Leadership at NCRFC urged USACE and USGS in Minnesota and North Dakota to conduct a trial utilization of the technology during the flooding in the Red River of the North basin. Fusion Team members also took the action to utilize NWS Chat and evaluate its effectiveness as a coordination tool.

NWS Chat was a great communication success during the 2009 Red River of the North flooding in Minnesota and North Dakota. The NWS and USACE were able to get crucial river information in real time from the USGS.

On February 4, 2010, the Fusion Team facilitated a widespread test of the chat tool in preparation for flooding the upcoming spring. The test covered much of the Mississippi and Missouri basins. The test revealed some areas that still needed work, but overall was successful in getting multiple agencies communicating in real time. A second test of the chat tool was conducted on March 9, 2010 and verified that many of the areas needing work from the first test had been corrected.

Benefits from multi-agency use of NWS Chat:

- Information is immediately available to all participants.
- Communications are more efficient and on one common platform.
- NWS products are available instantly with live links vs. delayed web hydrographs.
- All information is automatically logged to a file for later review.

NWS Chat is available on mobile platforms in the field.NWS chat provides an excellent vehicle for disseminating critical information (e.g., levee breaks, discharge measurements, gage problems) to a wide audience, thereby ensuring all parties are situational aware. The benefit of the one-stop portal for information available to all at one time cannot be overemphasized. The logging feature is a great

advantage in that it provides a permanent record for later review, while a phone call or conference call is typically not recorded.

It should be stressed that NWS Chat is a good coordination tool to be used between the more formal, standard coordination meetings and conference calls with other Federal, state, and local agencies involved with addressing the impacts of these events (such as flood fighting groups). NWS Chat is not a substitute for the more formal, regularly scheduled coordination meetings, but will improve overall coordination and dissemination of information during these events.

c) Interagency Flood Playbook

The agencies are developing individual agency flood playbooks and a generic tri-agency Flood Playbook that documents tri-agency coordination, collaboration, communication and operations that occur prior to, during and after high impact flood events. The playbooks will be used to conduct annual tri-agency flood simulation exercises. The document also includes guidelines to make interagency conference calls and webinars more efficient.

d) Electronic data exchange

Prior to the formation of the Fusion Team, the agencies developed a means to share model data, preliminary river forecasts and forecast precipitation ensembles. The Fusion Team cited these methods as somewhat limited and is pursuing a more enhanced interoperability between the agencies.

2. Web Services

a) River forecast summary information from one source

An NWS navigation river forecast product/summary was created that incorporates information from numerous NWS forecast offices on the navigable, open part of the Mississippi and Missouri Rivers. This product depicts the lowest river level forecast fromNebraska City to St. Louis on the Missouri; and from St. Louis to Baton Rouge on the Mississippi. It is accessible from

http://www.crh.noaa.gov/product.php?site=LSX&product=RVA&issuedby=MIS

or from the River Watch page, www.riverwatch.noaa.gov, select "River Forecasts Without Forecasted Precipitation" from the left-

hand menu. The Zero QPF forecasts represent the conditions forecasted if no additional precipitation occurs over the watershed during the forecast period. In effect, this will represent the minimum stage forecasts for the system during the forecast period.

3. Instrumentation

a) Discharge Measurements

To ensure the most accurate discharge data are disseminated among all the agencies and the public, the team has facilitated the collaboration of agencies making discharge measurements to ensure that all are taking discharge measurements consistent with standard practices as listed by the International Organization for Standards (ISO 2537; ISO 4369; ISO/TS 24154). Per Fusion Team action, the USGS and USACE also conducted a comparative study of various flow measuring instruments to determine if the differences were significant. The Price AA current meter and the Acoustic Doppler Current Profiler were compared and results found the two showed no significant difference in flow measures.

b) Stage and Discharge Data

The fusion team is currently developing an understanding regarding onsite/offsite corrections to gages. The goal is to find an optimal solution to ensure consistent information is delivered to all agencies and communicate suggested policy to the respective agencies.

c) Streamgages

The team developed tri-agency procedures for requesting USGS rapid deployment gages (RDGs) in needed locations. Deployment of RDGs depends on the availability of equipment, funding for installation and monitoring, and an identified plan for returning the gage once the need for it has passed.

Emergency management feedback after the Midwest Flood of 2008 noted that an inventory of gages with ownership and/or maintenance responsibility information needs to be more readily available or managed such that emergency responders can take quicker action to report gage problems. The team will determine the optimum method to address this request.

4. River Forecasts

a) Rating Curve extensions

To facilitate forecasting of extreme floods, situations arise where rating curve extensions are needed. Even when flooding is not imminent, the new ensemble probabilistic forecasting process requires simulation of historic floods that may have discharges above the current rating. The team developed a two-pronged approach to extending ratings:

(1) For critical model points (check points) along the river, the USGS would be given a list (in order of priority) of those sites needing a rating extension. A check point is a point that is critical in modeling and is typically found in larger water sheds. USGS will evaluate and extend ratings where possible under established USGS technical guidelines, Completion of this task is at the discretion of the USGS Water Science Centers, acknowledging their personnel and funding limitations.

(2) USACE and NWS will further evaluate and reprioritize the remaining critical model points that were not extended because of either technical or funding/personnel limitations. If a rating extension was not possible due to funding limitations, funding may be found to enable USGS to do the hydraulic computations for rating extensions. If a major flood is imminent, USGS can extend the ratings in the major flood area using hydrologic judgment. This kind of rating extension will not be an official part of the USGS database and will only be done to meet a present emergency (e.g., real-time forecasting, levee construction/modification) situation where no other alternative is available.

b) Operational Collaboration

USACE and NWS have shared forecast information in the past, however, recent flood and low water events revealed a need for closer collaboration to develop a more consistent forecast between the two organizations. A daily collaborative process was attempted between the NCRFC and USACE Corps districts in the upper Mississippi basin. While some additional consistency was achieved, timing of the two agency's operations precluded the ability to create one collaborated forecast. Fusion Team efforts are underway to evaluate both agency forecasts and look for additional improvements in accuracy through a common review process (Ref. section 6).

c) Forecast Development

The NWS is in the process of implementing a new river modeling system. Through this effort and Fusion Team actions, NWS and USACE are collaborating on implementing HEC-RAS at NWS RFCs.

5. Personnel

a) Cross utilization of agency staff and expertise

The Team developed procedures for the NWS to request USGS and USACE expertise onsite at the RFC during significant flood events. The senior USGS and USACE members of the Fusion Team developed and currently maintain/update lists of personnel who can be deployed to the RFCs during significant flood events. A USACE employee from the St. Paul District (MVP) and the USGS Data Chief from the Iowa Water Science Center were co-located at the Chanhassen RFC during the 2009 Red River of the North flood event. The liaisons significantly improved the coordination and communication between the NWS, USACE and USGS during that event.

b) Cross train USACE/NWS/USGS staff

The Fusion Team arranged to expand on previous USACE/NWS River Forecasters Workshops by adding a Fusion Team exercise to review a collaborated forecast that had a negative customer impact. The review revealed the need to develop the capability to capture event information on the fly and use that to further enhance tri-agency staff training. The annual River Forecasters Workshop will be further aligned to Fusion Team mission by reviewing events identified by the agencies for the improvement of river forecasts.

USGS, through the Fusion Team, has conducted training in discharge measurements to ensure that all agencies use the same methods, thereby ensuring consistent flow readings.

Familiarization training is also planned with the navigation industry in order to see, first hand, how the river forecasts are utilized in navigation.

6. Performance Metrics

USACE and NWS have both used performance metrics to ascertain

forecast accuracy, however, this was done on an individual agency basis. The Fusion Team is developing a common set of metrics so that the results can be more easily shown to the public, especially to the navigation industry. Results will include metrics over specific time periods (e.g., years, seasons) as well as on particular events. To assist with citing an event, a tri-agency "internal" web site is being created such that USACE/USGS/NWS staff can enter event-specific information, in near real time, for later review.

USACE and NWS will produce performance analyses beginning with the Mississippi River at St. Louis. The Fusion Team cited the following critical river levels at St. Louis: 5, 20, 25 and 40 ft (Flood Stage = 30 ft). Critical stages are dictated by the channel conditions which change, however these levels are considered critical most of the time. Performance measures will include Probability of Detection, False Alarm and Mean Absolute Error. Per results of Summit II in St. Paul, the NWS is also reviewing forecast accuracy for weekday vs. weekend river forecasts issued by the North Central and Missouri Basin RFCs.

Performance metrics will be provided to the public and the Fusion Team will continue to get stakeholder input as the ultimate metric for forecasting success.

D. Issues cited and tasked outside of the Fusion Team

1. Web Services

   a) Outreach is ongoing in all the agencies to educate the public and other users of river forecasts regarding how and where to get river information. For example, one public participant at Summit I was not sure of where to get historical river gage data (historical data can be found on a USGS website at http://waterdata.usgs.gov/nwis/sw/).

   b) There is also an effort within Integrated Water Resources Science and Services (IWRSS) to have one web portal for USACE/NWS/USGS river information (described in the next section, III.E).

2. Rainfall Forecasts

A Summit recommendation was to extend rainfall forecasts further out in time in order to provide additional lead time. This has been addressed through a change in NWS policy to clarify that field offices are allowed to extend forecast precipitation time horizons used in NWS river forecasts.

3. River Forecasts

In order to best utilize additional future rainfall in both quantity and extension of time to provide added lead time, we need to move toward probabilistic river forecasting. The NWS is in the process of implementing the Community Hydrologic Prediction System that will enable the use of software which will provide a short-term probabilistic river forecast.

E. Link with Integrated Water Resources Science and Services (IWRSS)

Integrated Water Resources Science and Services (IWRSS) is a developing multi-agency program designed to enhance collaboration, leverage existing and new partnerships, and to leverage new models, data, systems, and water science to better address growing demand for relevant and reliable water information. IWRSS is a collaborative effort, currently involving the NWS, USGS and USACE, to meet the rapidly growing demand for enhanced water resources information. An associated detailed Strategic Road Map can be found at http://www.nohrsc.noaa.gov/~cline/IWRSS/IWRSS_ROADMAP_v1.0.pdf. A primary focus of the IWRSS Consortium is to align multiple agencies with water-related missions to better integrate services and service delivery, improve river and flood forecasts, and provide new summit-to-sea water resources forecasts. Goals for the program are:

1. Integrate services and service delivery
2. Improve accuracy and lead time of river forecasts
3. Provide new “Summit to Sea” high resolution water resources information and forecasts

The Fusion Team objectives also address the first and second IWRSS goal and therefore could assist in the further development of IWRSS by providing a demonstration within the Mississippi Valley. A demonstration could include advanced modeling and interoperability at the database level such that data would be accessible to all agencies, simultaneously. Planning for this demonstration is ongoing within the Fusion Team.

III. Conclusions and Path Forward

Since the formation of the Fusion Team and its initial meeting in December 2009, emphasis has been on identifying the issues which could contribute to uncertainty and inaccuracies in developing forecasts. These issues related to a number of focus areas: cross agency training and operations, enhanced communication and collaboration, accurate data available concurrently to all three agencies, technical forecast improvements and river forecast improvements. The majority of the action items completed to date address areas under the focus areas in which to improve the processes and procedures at and between the agencies. As a result of these actions,

the Fusion Team is confident that, by improving our processes and procedures, the overall accuracy of the forecasts has been improved. However, the Fusion Team also realizes that to our stakeholders and the public, a more definitive assessment of the accuracy of forecasts and the actual degree of improvement is desired.

The next phase of the Fusion Team activities will concentrate on quantifying the impact the improvements in processes and procedures have and will continue to have in optimizing the accuracy of the forecasts. The Fusion Team has begun to identify action items and team members to conduct an assessment of how accurate forecasts have been and the degree to which the efforts to date have been effective in improving the accuracy. Those action items include developing the metrics with which to measure accuracy of the forecasts not only regionally and seasonally but also with respect to extreme events (such as flood peaks and droughts). In addition, the Fusion Team will look for improved communication and coordination methods with our stakeholders and the public to improve their awareness of the impacts of the Fusion Team efforts.

Michael J. Walsh
Major General, U.S. Army
Mississippi Valley Division

Gary M. Carter
Director, NOAA/NWS Office
of Hydrologic Development

7-26-10

Stephen F. Blanchard
Chief, Office of
Surface Water, U.S.
Geological Survey

Appendix A - USACE/NWS/USGS Mission Statements

USACE Mission Statement

The USACE Mission is to provide vital public engineering services in peace and war to strengthen our Nations security, energize the economy, and reduce risks from disasters.

In support of the USACE Mission, the Mississippi Valley Division's mission statement is to serve the Mississippi Valley Region by managing the watersheds and developing collaborative engineering solutions that will reduce risks through the reduction of flood damage potential, maintain and enhance navigation, and protect/ restore / enhance environmental ecosystems; while being prepared to respond to Regional and National emergencies.

USGS Mission Statement

The Water Resources Discipline (WRD) is one of four science disciplines of the U.S. Geological Survey (USGS). The WRD mission is to collect and disseminate reliable, impartial, and timely information that is needed to understand the Nation's water resources.

WRD actively promotes the use of this information by decision makers to --

- Minimize loss of life and property as a result of water-related natural hazards, such as floods, droughts, and land movement.
- Effectively manage groundwater and surface-water resources for domestic, agricultural, commercial, industrial, recreational, and ecological uses.
- Protect and enhance water resources for human health, aquatic health, and environmental quality.
- Contribute to the wise physical and economic development of our Nation's resources for the benefit of present and future generations.

NWS Mission Statement

NOAA's National Weather Service provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community.

Appendix B - Fusion Team Members

Signatory Authorities

USACE	Major General Michael J. Walsh Commander U.S. Army Corps of Engineers Mississippi Valley Division
NOAA/NWS	Gary M. Carter Director, Office of Hydrologic Development NWS Headquarters
USGS	Stephen F. Blanchard Chief, Office of Surface Water USGS Headquarters

Chairman

USACE	Charles E. Shadie, P.E. Chief, Watershed Division Mississippi Valley Division

Advisory Committee

USACE	David R. Busse, St. Louis District
NOAA/NWS	Noreen O. Schwein, Central Region Headquarters
USGS	Robert R. Holmes, Jr., Office of Surface Water

Technical Members

USACE	Joan Stemler, St. Louis District Jim Stiman, Rock Island District Kevin Grode, Missouri Basin, Northwestern Division Trent Schade, Great Lakes and Ohio River Division
NOAA/NWS	Ben Weiger, Southern Region Headquarters Scott Dummer, North Central River Forecast Center Tom Adams, Ohio River Forecast Center Jeff Graschel, Lower Mississippi River Forecast Center Kevin Low, Missouri Basin River Forecast Center
USGS	Shane Barks, Missouri Water Science Center George Arcement, Louisiana Water Science Center

Appendix C - Fusion Team Action Items

Item #	Action	Status	Date Complete
1	Hold MVR (USACE Rock Island District)/River Industry Action Committee (RIAC) meeting.		10/7/08
2	Ensure Chester & Cape Girardeau MVS (USACE St. Louis District) forecasts are sent to LMRFC (Lower Mississippi RFC).		11/1/08
3	Ensure 22 TW/Illinois/Missouri flows used by MVS are sent to NCRFC.		11/1/08
4	Develop cross training for river forecasters.	Annual forecaster workshops with agency reviews will continue until further notice.	Ongoing
5	Develop a plan to cross-train NWS RFC/USACE personnel on USGS discharge methods and data processing techniques.	Evaluation of pilot and follow-up training set for March 2, 2010. Training will be fine-tuned for other RFCs.	3/2/10
6	Develop a cross training schedule to allow NWS/USACE to spend time with the towing industry in order to learn the impact of river stage forecasts and how they are used.	Awaiting input from navigation	
7	Develop tri-agency coordinated meeting list.		1/26/09
8	Collate a list of critical "check points" along major rivers for which rating curves need to be extended prior to next flood event. A "check point" is defined as a point that is critical in modeling; typically in larger water sheds.	Ref. spreadsheet: all critical gages for ratings one sheet.xls	11/1/09
9	Develop plan to get critical rating table extensions in a timely manner during specific events.	Ref. spreadsheet: *all critical gages for ratings one sheet.xls*	2/1/09
10	Develop process to coordinate requests for real-time rating extensions.		2/1/09
11	Investigate tri-agency use of NWS Chat; expand use for enhanced coordination.	Upper Mississippi and Missouri basin test completed	2/4/10

Item #	Action	Status	Date Complete
12	Share forecasts from lower three USACE districts (Memphis (MVM), Vicksburg (MVK), New Orleans (MVN)) and Ohio (LRD) with NWS LMRFC.	Ref. #35	2/1/09
13	Develop and implement plan to deal with draw down curve corrections.	Ref #26	2/27/09
14	Explore feasibility of co-development of HEC-RAS river forecast models.	Ref. #36	2/4/09
15	Develop common template for Action Items.		1/16/09
16	Draft Flood Event Playbook to enable water resource agencies to better coordinate, collaborate, and communicate inter-/intra-agency activities during high impact water resource events (floods, droughts, spills, dam failures, etc).	First draft presented 6/23/09	3/30/10
17	Conduct Tri-agency Flood Exercise		
18	Conduct training session between USGS and Corps to review official USGS measurement techniques and procedures.	Initial discussion between USGS and MVD completed. A presentation was made on USGS discharge measurement techniques at the Tri-Agency Coordination Meeting held November 17-18, 2009. Procedures were presented for making both Price AA meter and ADCP measurements. Training occurred in Baton Rouge meeting with MVD.	3/2/10
19	Develop procedure to deploy USACE Liaison to RFC during a major flood.	Further actions in 37 and 42	1/16/09
20	Develop procedure to deploy USGS Liaison to RFC during a major flood.	Further actions in 38 and 43	3/26/09
21	Create 24/7 secured POC list for COE/NWS/USGS personnel.	POC list delivered to COE. COE awaiting all agencies security approval for posting to Fusion Team extranet (internal) site.	
22	Evaluate recession hydrographs.	Evaluate recessions on an event basis.	Ongoing

Item #	Action	Status	Date Complete
23	Reduce the number of coordination briefings among federal agencies during high impact flood events.	Based on feedback from partners, will address "consolidation" through efficiencies in the presentations (e.g., common format of information, same agenda order with each call).	
24	Produce No Rain/Navigation Forecast (or Zero QPF/ River Forecast Minimum product)	Available at http://www.riverwatch.noaa.gov/noQPF.shtml	7/7/09
25	Develop a river stage forecast evaluation process as it relates to the navigation industry.	Awaiting input from navigation	
26	Establish policy for dealing with gage height differences due to USGS draw-down curves or other procedures	Complete for draw down curves; an action team will address other, similar corrections (Ref. #46)	2/27/09
27	Follow up meeting with navigation industry to discuss due outs	Meetings are held on a regular basis.	Ongoing
28	Develop plan and needed items that could be funded through ARRA (e.g., LIDAR, HEC-RAS development)	Funds were not available.	9/30/09
29	Set date and agenda for 2009 River Forecasters Workshop		6/24/09
30	Develop and implement plan to make concurrent discharge measurements above 1,000,000 cfs using the standard current meter and Doppler techniques.	Additional discussions and plans were made with appropriate personnel from the USGS and COE.	May 2009
31	Present initial Fusion Team actions from Summit I to navigation industry at Inland Waterway Conference.		March 2009
32	Evaluate pilot and follow-up of cross training for NWS RFC/USACE personnel on USGS discharge methods and data processing techniques. Share process with other USGS/NWS/USACE offices in Mississippi Valley. (Ref #5)	Evaluation is ongoing and will be completed by next tri-agency meeting (October 2010).	
33	Evaluate effectiveness of NWS/USACE cross training with the towing industry in order to learn how the NWS/USACE products and services are used. (Ref #6)	Awaiting input from navigation	

Item #	Action	Status	Date Complete
34	Pursue USACE approval for USACE staff to use NWSchat (Ref. #11)		11/17/09
35	USACE lower districts develop SHEF formatted forecast and deliver to LMRFC. (Ref #12)		3/1/09
36	Assign team to develop collaborative HEC-RAS model for a portion of the upper Mississippi. (Ref. #14)	USACE team members were selected. Work between NCRFC, MVP, MVR and MVS is ongoing	
37	Select pool of candidates to be Corps Liaison to RFC during a major flood. (Ref. #19)		3/1/09
38	Select pool of candidates to be USGS Liaison to RFC during a major flood. (Ref. #20)		3/1/09
39	Develop Fusion Team web site		8/26/09
40	Demonstrate how forecasts have improved since the 2008 Summit.	NWS and USACE have shown improvements through different verification systems. An action team will look into developing a common performance measure as a Fusion Team metric.	
41	Draft Fusion Team Report	2nd draft completed 10/23/09; 3rd draft 2/8/10; 4th draft 2/21/10; 8th draft completed 4/20/10. Final completed 5/18/10.	5/18/10
42	Create a list of supplies and procedures to make USACE deployment quick and efficient. Laptop needs to have air card, NWS Chat connection, cell phone, e-mail access, etc. (Ref. #19)		
43	Create a list of supplies and procedures to make USGS deployment quick and efficient. Laptop needs to have air card, NWS Chat connection, cell phone, e-mail access, etc. (Ref. #20)		3/1/10

Item #	Action	Status	Date Complete
44	Request USACE districts in Mississippi River basin provide 14-day release schedules to NWS RFCs.		
45	Get permission to use Pidgin client for NWS Chat operations. Determine tri-agency naming conventions for handles (names). Conduct follow-on chat test. (Ref. #11)		3/9/10
46	Ensure consistent river gage data across all agencies.	Interim solution is being tested for distribution to all Corps offices.	
47	Create internal web page for tri-agency staff and/or Fusion Team.		4/1/10
48	Evaluate impact levels at specific forecast points such as St. Louis.	Compile POD, FAR and MAE metrics for impact levels at specific locations; begin with St. Louis.	
49	Develop Team Charter with ground rules.		5/7/10
50	Address IT security issues between agencies to achieve better interoperability. Share data such as national levees database and Corps Maps.	NWS Fusion Team rep. received access on 4/26/10 and will work with IT group to include in NWS situational display.	
51	Update playbook on an annual basis. Conduct annual flood simulation exercise amongst federal water partners. (Ref. #16)		Annually
52	Create an inventory of gages with ownership and/or maintenance responsibility and determine optimum way to assist emergency management in reporting gage problems.		Annually