A Core Suite of AHPS Graphical Hydrologic Products and Information

Report of the
AHPS Products and Information Team

March 2003

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NOAA's National Weather Service
Silver Spring, MD 20910

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U.S. DEPARTMENT OF COMMERCE
Donald L. Evans, Secretary

National Oceanic and Atmospheric Administration
Vice Admiral Conrad C. Lautenbacher, Jr., Administrator

NOAA's National Weather Service
John J. Kelly, Jr., Assistant Administrator

Preface

"You cannot step twice into the same river, for other waters are continually flowing in."
- Heraclitus: ca. 500 BCE

This phrase epitomizes the theme of "look to the future" that was the basis of the charge of the Advanced Hydrologic Prediction Service (AHPS) Products and Information Team (APIT). In February 2002, the APIT was provided with a vision of "easy access to a consistent core suite of AHPS graphic products and information." The team was comprised of representatives from all NWS Regions (one representative for both the Alaska and Pacific regions) and Headquarters.

The members of the APIT thank all of those who took the time to provide us with survey responses and feedback information. Special thanks go to Glenn Austin and Thomas Graziano for their guidance and suggestions during the team's tenure. The team would also like to express their appreciation to their supervisors and the regional and office directors for providing the opportunity to work on this project.

It is our hope that the core suite of AHPS products will result in improved service to NWS customers.

Gregg B. Rishel
Team Leader

March 2003

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List of Team Members

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This report was researched and written using a consensus process. For any decision team members were individually asked if they agreed, disagreed or abstained. No decision moved forward if any team member disagreed. All team members were given an opportunity and time to question any decision or recommendation made by the team. This report is a consensus report with all team members fully supporting this result. If there had been any areas of disagreement, those would be clearly marked.

Executive Summary

The Advanced Hydrologic Prediction Service (AHPS) Product and Information Team (APIT) was formed to define a core suite of AHPS graphical products. This core suite was intended to support the full spectrum of NWS hydrologic services from flash floods through extended-range river forecasts. The team was to establish standards to ensure the content and format were consistent and there would be consistent and easy access to these products. The team engaged in a rigorous examination of existing graphical products and an aggressive customer input effort upon which all recommendations could be based.

Customer feedback indicated a wide range of interest for NWS hydrologic information. Some customers want to see virtually any information the NWS might have, while others only want to see specific information. Providing the breadth of information required by some without overwhelming others and doing so with consistent, easy access is a formidable challenge. Customers also made it clear that they would like to see clear labels, clear categories of information, sufficient supplementary information to enable the person to make a judgment, and easier navigation from the national picture to the actual point of interest.

There was a common theme of responses both to our survey and in our discussions with customers – they like what they understand and are comfortable using. Customer feedback illustrated a clear message regarding probability forecasts – many are having difficulty understanding what they mean and how they should be used. Even NWS employees told us the probability products were confusing. Efforts on training and outreach regarding probability forecasts will have to be enhanced to help customers understand these products.

Our surveys indicated many NWS graphical products have been developed based on regional or local perspectives and customer input. In addition, comments on our survey indicated NWS personnel are reluctant to step back and look at the agency-wide picture. A cultural change is required if the NWS is to implement a core suite of AHPS graphical products. Our survey participants told us they have definite need for our hydrologic information, but many of our current practices make it difficult for them to understand or utilize it.

The recommendations of the APIT are based on the premise the core suite will be provided at every AHPS point or area all the time when data are available in a nationally consistent format. If the data are not available, then an explanation of why the information is not available, when it will be available, and other sources for similar information will be provided. A link to a contact person to request additional information will also be included.

Much of the core suite is based loosely on existing graphical displays. Several components of our recommendations will require significant development work before the products can be produced and a format determined.

The core suite should be considered a baseline of AHPS graphical products. Many locations will have additional hydrologic information available to meet customer needs. The recommendations emphasize the need to make the core suite information understandable and useable to customers. Towards this end, descriptive information is to be included with all core suite graphics. The

team recommends that a comprehensive customer survey be conducted for hydrologic services. Information from such a survey could be used to further refine the core suite. Such a survey should be undertaken shortly after the initial implementation of the core suite and at intervals matching the implementation of additional key components as new portions of the core suite come on line. The team also envisions that the core suite will evolve over time as technology and customer requirements change.

In all, the APIT identified a seven-member core suite of AHPS graphical product categories based on customer feedback. In addition, the team developed some recommendations regarding implementation to ensure that the core suite would be consistently and easily accessed.

The core suite consists of:

1. Hydrologic Conditions
2. Information for a Point Location
3. Supplemental Information on a Point Location
4. Skill Information
5. Precipitation Information
6. Water Resources Information
7. Partnered Information (Flood Mapping)

Objective

The principle objective of the AHPS Products and Information Team (APIT) is to define a core suite of graphical NWS hydrologic products and information. The core suite is intended to support the full spectrum of NWS hydrologic services from flash floods through extended-range river forecasts. The team was directed to consider both observed and forecast data in the informational content of its recommendations. In addition to these generic guidelines, the team's recommendations are intended to specifically address the establishment of standards a) to ensure that the content and format of the core suite of products are consistent and b) to ensure consistent and easy access to these products and information are provided to NWS customers. Customer input was to be included in the definition process used by the team.

The core suite of graphical products will ensure a set of NWS hydrologic services with a consistent look and feel will be available throughout the country. This concept will ensure the NWS hydrologic services program is aligned with other agency programs with this goal.
The core suite of graphical hydrologic products will encompass information with widespread application and usage. It should be viewed as a baseline of AHPS graphical products, rather than providing everything for everyone. Individually, offices are fully expected to provide additional information tailored to meet the needs of regional and local customers.

The establishment of a consistent look and feel for a group of hydrologic products will help answer the frequently asked question "What is Advanced Hydrologic Prediction Service (AHPS)?" The core suite will provide a centerpiece that everyone within and outside the agency can point to when asked, "What is AHPS?" This potential result requires, the information contained in the core suite and the formats utilized be easy to understand and interpret. Ease of understanding is a critical component of the core suite, especially as the agency strives to infuse new science and technology into our services. The formats used to convey the core suite must paint a clear picture in order to appeal to a wide audience. Advanced hydrologic services will only be beneficial if our customers can obtain the information they need easily and in a way they understand.

The APIT definition of a core suite of graphical hydrologic products is intended to be a starting point. Future enhancements and revisions are expected as technology warrants and customer input dictates.

Background Information

The NWS hydrology program is currently facing many challenges related to providing hydrologic products and information. AHPS implementation is becoming a reality, and with it has come a number of questions and issues the agency needs to address in order to move forward with its implementation. The APIT was formed in order to provide resolution to several of these questions.

The use of the World Wide Web by the NWS as a means of conveying hydrologic information has grown rapidly in recent years. Most of the Web development has been done at local offices to meet local needs. As a result, there is considerable variation across the country in how similar information is disseminated. This variation has created a situation where customers can have difficulty in finding and understanding the information they look to the NWS to provide. The problem is especially acute for customers with national interests. The APIT recommendations will assist the NWS in providing a consistent approach to the presentation of graphical hydrologic products and information.

The adoption of a consistent core suite of graphical products will help to streamline software development and support. Presently, individual approaches to providing graphical products result in requests for specific software capabilities. Providing these new capabilities along with previous ones often requires developers to use complex approaches. This adds to development time, increases the potential for program problems, and makes support more difficult. The APIT recommendations will provide a framework for reducing workload in this area in the long term.

Team Charter

Vision: Easy access to a consistent core suite of AHPS graphic products and information

Mission: Define a consistent core suite of graphical NWS hydrologic products and information which support the full spectrum of hydrologic services from flash floods through extended-range river forecasts. Hydrologic information includes observed and forecast data. Establish standards to ensure a) the content and format of the core suite of products and information are consistent and b) consistent and easy access to these products and information.

Scope of Authority/Limitations:

- Recommendations must be efficient and cost effective
- Travel expenses will be covered by each team member's Region/Office
- Team will consult with internal and external partners and customers to include the media, state and local emergency managers, and federal partners
- Team will consider new and emerging technologies for product and information access and query to include the Internet, Geographic Information Systems (GIS), and wireless communications.
- Team will coordinate activities with the Hydrologic Services Team and the E22 Next Team, and other NWS teams as appropriate, to ensure the efficient use of resources and complementary recommendations.

- Team will ensure compliance with Section 508 - Rehabilitation Act and the Architectural and Transportation Barriers Compliance Board Electronic and Information Technology (EIT) Accessibility Standards

Termination Date: The team will be formed and commence activities in February 2002 and remain assembled until the final report is presented to the Corporate Board.

Success Criteria/Deliverables:
- *Mid May 2002:* Provide status report of team activities to the HSD Chiefs at their biannual meeting
- *December 2002:* Provide briefing on team activities and status at the National Hydrologic Program Managers Meeting
- *NLT February 28, 2003:* Provide final report, including recommendations to the Corporate Board

Team Membership: One representative each from: OCWWS, OHD, NCEP, OST and the Regions

The only deviations from this charter involved team membership. NCEP did not offer a member to the team. An OST representative attended a portion of the team kickoff meeting but did not participate in any team conference calls or other activities. Attempts were made to obtain his involvement.

Team Charge

The APIT was charged by Greg Mandt to streamline the delivery of key hydrologic graphical products and to prevent the process of their delivery from becoming bureaucratic. We were told to start with no preconceived ideas of what existing products should or should not be in the core suite. Nothing was to be considered sacred and, likewise, all possibilities should be considered for inclusion. The only real limitation placed on the type of information to be included was it should have broad appeal or interest to our customers. This was not to diminish the value of information which has regional interest or is of interest to specific types of customers: rather, the core suite was to act as a baseline of services to which information tailored to regional or specific interest could be added. We were encouraged to "think outside the box" about what graphical hydrologic services the NWS should be providing to customers. Our instructions were to not let current technology or science limitation prevent information from being included in the core suite. In fact, our definition of core suite could be used to help drive future agency development activities.

We were directed to include input from both internal and external stakeholders in our deliberations on what information should be included in the core suite and how it should be presented. Greg stressed the need for the core suite to be understandable to a broad range of customers and that it have a consistent look and feel. Uniform and easy access was to be a consideration as well. Overall, we were given great latitude in defining the core suite of graphical hydrologic products.

Definition of Core Suite

In order to define a core suite of graphical hydrologic products, the team determined we would have to come to an agreement on what was meant by a "core suite." The team identified a number of approaches to this definition in attempts to account for the variability of hydrologic regimes across the nation. The predominant theme in our discussions was the core suite would be available everywhere all the time. In order to make this definition workable everywhere, we added the clarification it would only be available if the necessary data were available. For example, the team did not feel they could require observed stream flow hydrographs be available if a river was dry, frozen or no gauge was available. This definition provides consistency across the breadth of the NWS and promotes expansion of hydrologic services, provided resources are found to expand the availability of information and data on which the core suite are based.

The team's definition of the core suite is:

> *"The information provided at an AHPS point or area presented in a nationally consistent format. The information is to be issued at every designated AHPS point or area all the time whenever the appropriate data is available. Whenever the data is not available, an explanation will be provided of why it is unavailable, when it will be available, and other potential sources for similar information. Also, an email address for a contact person will be provided to request additional information."*

Data Collection and Analysis

The APIT determined it would need to consider both existing graphical hydrologic products and potential products if it was to accomplish its goals. A time line was created to establish the best course of action to achieve this goal. The team developed an approach of brainstorming all the current and potential hydrologic information, compiling a list of existing graphical hydrologic products, conducting a preliminary survey to select customers, examining current research in graphical presentation, and surveying as many people as possible. The iterative approach we outlined would provide ample information on which to base our recommendations for a core suite of graphical hydrologic products.

Preliminary Work

The first major task the team accomplished was to brainstorm and compile a list of all hydrologic information that the NWS could possibly provide. All of the team members contributed toward compiling this list by examining all of the Web pages and other graphical sources with their regions or office areas for the types of information currently being provided. They were also instructed to discuss potential information with others. This information and the information obtained from their own knowledge and experiences were added to the mix. The resulting list consisted of information the NWS was already providing to customers in some form and information the NWS could potentially provide if there was a customer need. This initial list appears in Appendix A. The contents of this list were considered to be the potential members of the core suite.

The next major task in our time line was to compile a list of representative samples of all the types of hydrologic information currently available from the NWS. Each regional/headquarters representative was tasked with researching and compiling this information for their respective areas. The team members thoroughly searched the Web sites created by NWS offices. They also looked at text products, experimental products, and graphics to come up with a comprehensive list of all information provided by the NWS. This list was compiled into a master list with links to the Web pages. The list of sample products appears in Appendix B. The team considered this list to be a starting point for determining what information should be included in the core suite and the types of graphical formats that were most understood and useful to our customers.

Preliminary "Core Suite" and Creation of Survey

The products and information from the compiled lists were then scrutinized by the team for consideration to be included in a preliminary core suite of hydrologic products. The team decided to form a small selection of existing products from some broad informational categories into a survey. Our intent was to send this first survey to customers who had previously agreed to review NWS material on hydrologic products and to NWS employees. Based on the feedback from this survey, the team then intended to construct a survey for a larger audience.

The team spent considerable time examining the existing products and deciding which should be included in the survey. Our selections were based on a desire to provide a variety of formats and information, since our principle desire was to obtain feedback on the types of information

customers understood and the formats they found most useful. Our selection process also provided consideration of the length of the survey and the desire to gain as much information as possible without overburdening respondents. Once the graphics were selected, each team member was tasked with creating corresponding survey questions. Again, we attempted to strike a balance between obtaining information and keeping the survey length manageable.

The finalized graphics and questions were then compiled into a Web-based survey, which automatically placed results into a database for compilation. The survey was first announced to the aforementioned group of customers via email in early August 2002. NWS employees were notified of the survey and asked for feedback in September after approval was obtained from the NWS Employees Organization. A link to this survey, related information, and a link to a summary of the survey results can be found in Appendix C.

The response to the Web survey was quite good. Out of approximately 300 individuals in the initial group, responses from over 100 were received. Many of these respondents also provided comments, which were very informative in specifying what types of information were important, and format types that were most understandable. In addition, several hundred NWS employees responded to the survey, providing considerable insight into the internal perspectives regarding graphical hydrologic products. A detailed summary and analysis of the survey results appears in Appendix D of this document.

Attempting to Reach a Larger Customer Base

Near the end of September 2002, the team was moving toward its goal of receiving feedback from the largest possible customer base. The team decreased the size and complexity of the original survey in order to get approval from the NOAA Clearance Officer. The team made initial contact with the NOAA Clearance Officer and was informed that OMB had toughened the standards for surveys to the public, so our task became more difficult.

At the beginning of October 2002, the team submitted the modified survey to the NOAA Clearance Officer. He told us he or OMB would not approve the draft survey. The biggest problem was the survey would not provide a representative sample and the questions were written in a way the analysis could be misleading. The officer was open to seeing a modified survey where the questions were in a yes or no feedback format. The team decided to modify the survey into a yes/no format and submit it to the NOAA Clearance Officer once again.

In mid October, the yes/no draft of the survey was submitted to the NOAA Clearance Officer for approval. At the same time, this version of the survey was given to all of the NWS employees attending the Hydrologic Program Managers' (HPM) Conference in New Orleans in December 2002. The team felt this was the perfect place to get quality feedback from those people who deal most closely with our customers and partners in the hydrologic community. The survey included in the attendees' packets was complemented with a poster presentation which highlighted the information represented in the survey. Appendix A shows the survey and Appendix A is a summary of the results from this survey.

On December 20, 2002, the NOAA Clearance Officer with the following explanation rejected the yes/no version of the survey: "I cannot approve this survey. While I appreciate the statement no statistical analysis will be used, it is also clear that there is no practical utility to this experiment without a controlled population. For example, questions about uncertainty assume something about people's understanding of risk. The preferred format for the presentation of data will rely on the purpose for which people would use them. And what happens if someone is blue-green colorblind? (Not to say that I'm requiring 508 compliance, but that the results of this survey would be affected by it without them knowing.) I would approve a controlled experiment to determine this information, but not an open web study."

Based on the deadline of the end of February for presenting its recommendations to the Corporate Board, the team decided it could not pursue another survey. Rather, the team decided to recommend responses from future surveys and other customer feedback be used to refine the recommended core suite of graphical hydrologic products and information.

Summary of Findings

The APIT collected information related to the content and format of AHPS graphical products by conducting surveys, holding direct discussions with customers, and receiving feedback from existing Web sites. We also examined some of the ongoing research regarding presenting graphical information and customer use of the World Wide Web. This material provided valuable insight into the information customers want to access, how it could be displayed, present NWS practices regarding graphical products, and shows where improvements can be made to promote understanding and more effective use of NWS information.

Information Content

Customer feedback indicated a wide range of interest for NWS hydrologic information. Some customers want to see virtually any information the NWS might have, while others only want to see specific information. An example of this is precipitation information where our surveys did not provide any clear-cut user preference for any specific display but did offer a wide range of desirable information. The only categories of information in the surveys where non-NWS negative responses were nearly as high as the positive responses were for point data (14 positive, 21 negative) and gage only displays (16 positive, 15 negative). Further, comments indicated attention should be paid to the needs of the users for precipitation information, implying the existing NWS attempts at providing precipitation information are not meeting customer needs or expectations. These results illustrate the challenge the NWS faces in trying to provide consistent information to meet the needs of the widest possible audience.

Among all the graphics included in the team's survey and in our discussions with customers, hydrographs are the graphics most commonly used by the professional and casual users of hydrologic information. Feedback from customers indicates a strong preference for observed and forecast stage (and/or flow) information in the form of a hydrograph. Customers like this type of graphical display because they understand it and can use it effectively. This became a common theme of responses both to our survey and in our discussions with customers – customers like what they understand and are comfortable using.

Customer feedback illustrated a clear message regarding probability forecasts – many are having difficulty understanding what they mean and how they should be used. The number of responses under "Average" and "Not sure" to our survey questions in this category was fairly high. For example, when we polled a group containing NWS and non-NWS people, the total responses under these two categories were higher than under either positive or negative responses for all the graphics. This high proportion indicates the NWS needs to devote more attention to explaining the data graphics to internal and external users. One comment from an NWS respondent is worth noting: "Remember we will be providing this material for all customers, not just statisticians." If NWS employees are telling us our current information is confusing, then how will our customers understand it? Outreach will only be successful if the messenger is comfortable with the message. It is important to remember that it is better to familiarize the staff about new statistical tools for forecasting before they are disseminated or else they will stand no chance of success. Efforts on training and outreach regarding probability forecasts will have to be enhanced and increased to gain better understanding of these products.

Format

Current research on the use of the World Wide Web shows the most useful sites are those which are kept simple. A recent study by Georgia Tech University, http://www.gvu.gatech.edu/user_surveys/survey-1998-10/tenthreport.html#e-, illustrated this point. This study found 'convenience' was a factor for 82% of individuals using the Web. The study further stated the main dissatisfying experience of respondents were sites confusing or disorganized sites (74.5% of individuals).

Customer feedback and research results provided some specific information on how information should be displayed. Explanations about graphics are extremely valuable in making them understandable to customers. The adage "a picture is worth a thousand words" may have some truth here. However, research on data graphics and visual presentation of data clearly illustrates it is more helpful to combine text with pictures. Customers repeatedly asked for labels and text explanations in conjunction with the graphical display on information. Feedback indicated there is sensitivity in using colors, especially for those who are color-blind. Consideration for this sensitivity would ensure that products are understandable and useful to a greater number of potential customers. We also heard if information is for a large spatial area, the customer should be able to reach information for a specific location within three mouse clicks. If it takes longer, people are likely to say, "too many clicks for not enough information." Ease of access to the information is important to NWS customers.

In short, the customers of NWS hydrologic information would like to see clear labels, clear categories of information, supplementary information to enable the users to make a judgment, and easier navigation from the national picture to the actual point of interest.

Current Practices

Many NWS graphical products have been developed based on regional or local perspectives and customer input. Some reflect a focus on serving a specific group or type of customer. This practice was suitable when dissemination by means other than the Web was a primary mechanism or when widespread use of the Web was not as common as it is today. NWS products (text and graphic forecasts, watches, and warnings) are now visible 24 hours a day, and many people have access to the Web. This is good because it expands the fold; however, it also requires the NWS provide information in a useful and usable manner to a variety of people, not just those with specific knowledge.

The feedback we have received is the NWS needs to do more in meeting the requirement we provide information in an understandable and useable manner by a wide range of people. Customers indicated in our survey and in direct discussions it is a common occurrence for NWS Web sites to have such basic elements as size of the graphic, explanations of colors, categories, or abbreviations, proper titles for graphics, etc. either ignored or inadequately addressed. The result is confusion for our customers. The NWS can project the attitude, since we understand, all customers will also understand. For example, here is a comment on water supply information from our survey: "There [are] two distinct audiences here: professionals in hydrology, and the

public. The public needs much more of an explanation to understand why their reservoir/lake is not full or overflowing." Customers told us the NWS needs to make a conscious attempt to provide information in formats to help them and others to understand it.

Comments on our survey and anecdotal feedback illustrates that NWS respondents confound the issues related to product content and format with their local affinities, specific local needs, and their reticence to step back and look at the agency-wide picture. A common refrain whenever someone is questioned about information or product format on their local Web site is to hear, "But this is what our customers want." In many cases, there is little or no feedback to support this position. While it may be some local customers are pleased with these products, the products often do not have wide appeal or may be difficult for others to understand. Some of the comments from NWS employees regarding our survey reinforced this by complaining about possibly not being able to use the graphics they presently are displaying or simply that changes might be forthcoming. The general reluctance to accept change by the NWS was also mentioned to team members on a number of occasions in their personal contacts with customers, including the Flash Flood Workshop in Boulder last August.

The attitude projected by this feedback and input must be changed if the NWS is going to implement a core suite of graphical hydrologic products and continue to improve our service to our customers. Our customers have told us they have definite requirements for our hydrologic information, but many of our current practices make it difficult for them to understand or utilize it. The APIT has a challenge to develop a definition of a core suite of products to meet customer desires for ease of understanding and usability while providing a pathway which will be acceptable within the agency.

Customer Input

The team was unable to gain clearance for a detailed customer survey. The currently approved list of survey questions is far too general to provide the specific information the team wanted to collect. Our efforts to create questions to address the specific topics of interest to the team based on the approved list of questions were rejected by the NOAA clearance officer and the Office of Management and Budget (OMB). The NOAA clearance officer expressed concern about our survey approach (a web-based questionnaire), suggesting it would result in biased information since only a subset of the general populous would be surveyed. We were told the NWS had a history of conducting biased surveys using the information from them in an incorrect fashion. This created a catch-22 for the team since we needed specific input on the content and format from our customers who need hydrologic information.

The team suggests the NWS undertake an effort to resolve the issues regarding customer surveys with NOAA and OMB and conduct a survey to collect customer input on the information and format of graphical hydrologic products. We recommend an initial survey be done shortly after the initial implementation of the core suite. Further, we suggest subsequent surveys be conducted after each new major element of the core suite is implemented. It is the team's understanding OCWWS had contracted to survey other NWS programs for customer perceptions of products and services. We recommend a similar effort be undertaken for hydrologic services. This information could then be utilized to refine the team's recommended core suite.

Introduction to Recommendations

The definition of the core suite, "The information provided at an AHPS point or area presented in a nationally consistent format. The information is to be issued at every designated point or area all the time whenever the appropriate data is available" adopted by the team has been used as the basis for our recommendations. The core suite of graphical hydrologic products will consist of seven groups of information: 1) hydrologic conditions at points and areas, 2) summary information for a point, 3) supportive information for a point, 4) skill information, 5) precipitation information, 6) water resource information, and 7) partnered information. This section of the report will include a detailed discussion of the informational content and format of each of these core products. In addition, the team will provide some recommendations toward implementing this core suite. The team envisions most NWS river forecast points or areas will become designated as "AHPS" points as the program is implemented nationally. This will ensure national consistency of baseline graphical hydrologic products and meet the desires expressed by a wide variety of NWS customers for some standardization of displays of hydrologic information.

The team's core suite recommendations will cover products the agency can implement fairly quickly and information which will require additional development and effort. The team recognized the need for recommendations to solidify AHPS implementation, and five of the recommended core suite products are based largely on existing information and formats that have been at least partially tested. These products will require some development to provide all of the functionality the team envisions. The other two core suite products are less developed but have received considerable customer interest. The team has placed these in the core suite as placeholders and has attempted to identify requirements for development work to make the information they contain available operationally. Once the information is available, the best format for displaying it can be investigated.

The team considers the core suite to be a baseline of hydrologic services. During the team's deliberations of what should and should not be included in the core suite, we evaluated a large number of products that are not included in our recommendations. This does not mean that the team felt this information was not important. On the contrary, we found significant support for such information in our surveys. However, we also found from our surveys that this information did not carry the same degree of importance across the entire area served by the NWS. Some examples of this information are listed and described in Appendix F titled Information Not Included in the Core Suite. Information outside of the core suite is recognized as being valuable to customers, and our recommendations should not impede this information from being provided to meet customer needs. The team does encourage nationally consistent approaches to the display of this non-core suite information in order to make it easily available and understandable to all potential customers.

The team has made a concerted effort to ensure the core suite displays provide the information in a manner whereby the hydrologic rationale becomes obvious to customers who are non-experts. Further, the team attempted to make basic information available in the default displays, while allowing persons desiring more detailed or complex information the capability of obtaining it by making selections on the same display. The team recognized the need for descriptive

information concerning the core suite graphics and worked to ensure such information would be readily available to the persons via pop-up windows, pull down screens and other listings. These descriptions are intended to ensure clarity and understanding of the information to a wide range of customers. The specific contents of the team's recommendations for the core suite carry an implied "when available" label, meaning that if the information is available for that point at that time it will displayed. For example, observations for every point are not available every day; however, when they are available they will be displayed. A final word on the displays has to do with time labels. The NWS uses universal time in many of its activities to aid in coordination across time zones. However, to many customers Universal Time is confusing at best and they find prevailing local time most useful. In keeping with a customer friendly approach, the team recommends that prevailing local time be used whenever possible for all core suite displays.

Recommendation 1 — Hydrologic Conditions Information

The NWS's customers and partners who utilize hydrologic information have a wide range of needs for our data, forecasts, and guidance. The results from the team survey and other feedback indicate a strong preference for clear, simple graphics that are easily understood and utilized. Customers also expressed the desire to see the overall picture of hydrologic conditions and the ability to focus into an area or point of interest. In fact, nearly 90 percent of the respondents to our survey indicated at least one of the current river conditions graphics met their needs for information of this type. Finally, customers in a number of forums have expressed the desire to see all hydrologic conditions in a single place, rather than having to look one place for areal flooding and another location for point flooding products. In order to accommodate these needs, a highly customizable, yet user friendly, dissemination approach must be devised which is displayed in a manner that is universally understood by our customers. This is the foundation behind the following concept.

The entry to the AHPS product dissemination via web pages will work similarly to the way the weather products are disseminated. A customer entering from the NWS's home page by clicking on the Rivers tab will see the AHPS Web page on "River Conditions and Flooding." The customer will default to a map of the United States (including Alaska, Hawaii, Guam, and Puerto Rico) depicting general information on flood conditions across the area. This will include both areal and point conditions. Categories for Near Flood Stage, Above Flood Stage, Flood Statement, Urban and Small Stream Advisory, Flood Watch and Flash Flood Warning will be graphically represented on the map. Figure 1 illustrates this conceptualization.

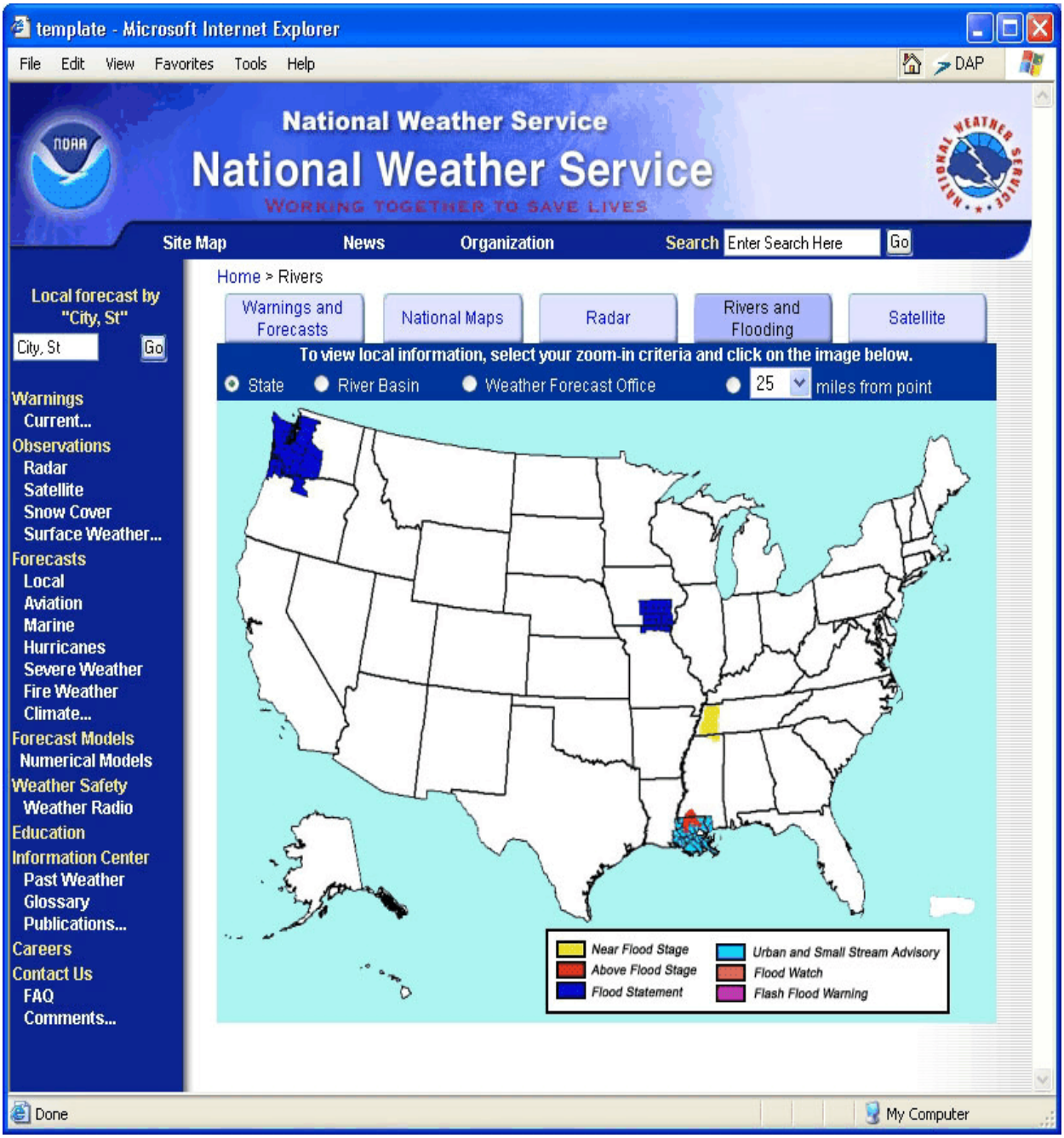


Figure 1. Conceptual Interface to Hydrologic Conditions

Site-specific representations (Near Flood Stage and Above Flood Stage) will have the entire river basin highlighted in the appropriate color to denote the category. This will ensure that the area of concern does not get lost on such a coarse-scale map. Hydrologic conditions for area representations will highlight the county or zone in the appropriate color.

Customers will have the ability to zoom from this page into an area of interest based on their specific needs. When the customers click on the area of interest on the map, they would zoom

into a portion of the country. Selectable options for zoomed display would include: a selected state (the default), river basin, WFO area of responsibility, or into an area within a 25-, 50-, 100- or 200-mile radius of the point selected. When the customers click on their area of interest, a Web page would be dynamically created based on their selection. This page could be bookmarked so the customers could retrieve their customized page at any time. This Web page would contain a map providing greater detail of the hydrologic situation along with other user tools described below.

Figure 2 is an example of a page where the customer zoomed into a state – Louisiana. The zoomed-in page would contain a map depicting all of the river forecast points in the area of interest along with the areal conditions. This page would also contain navigation buttons so the customer could easily move around the country, a key to the river conditions on the map, and the ability to redraw the map to user specifications.

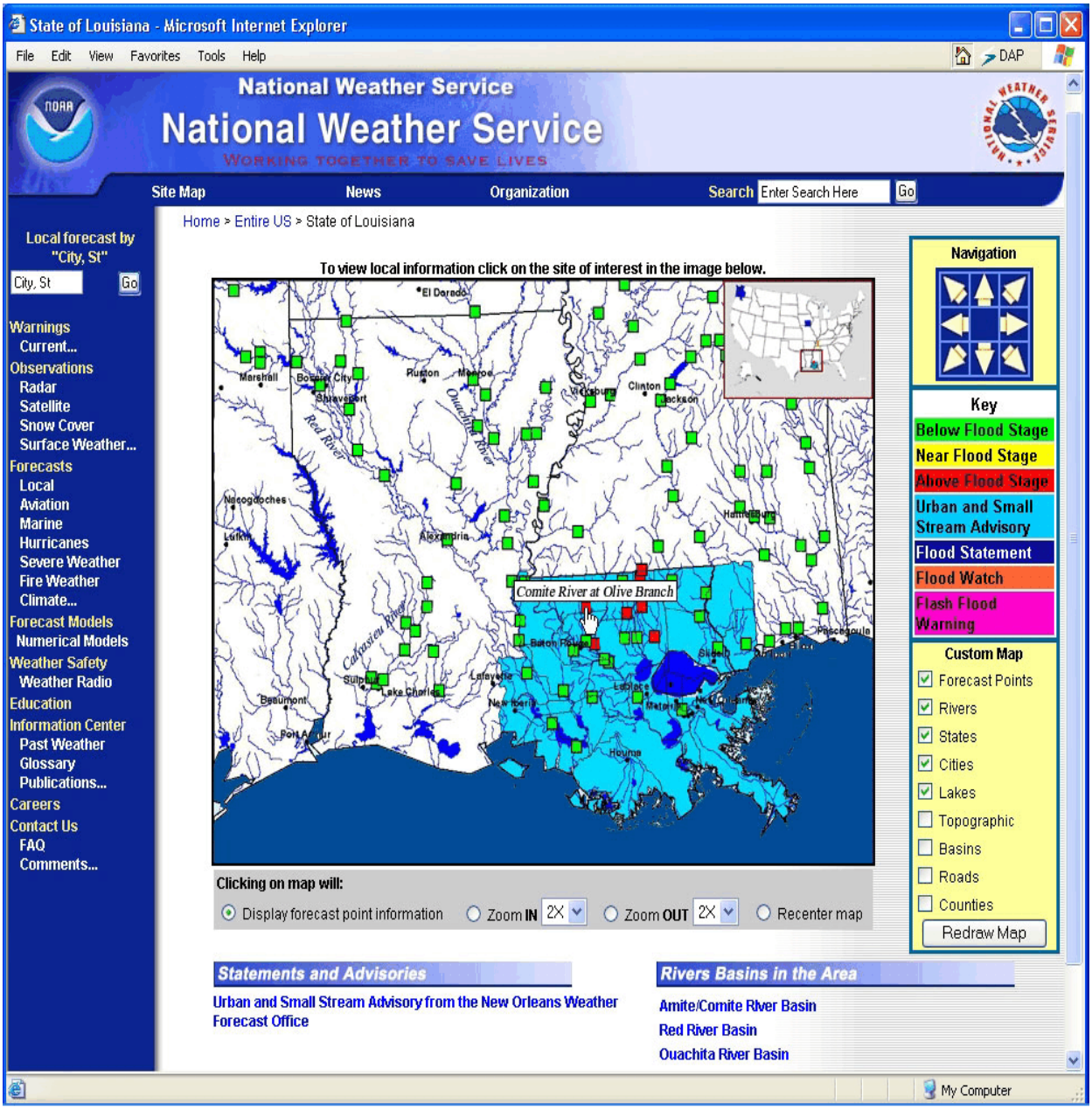


Figure 2. Conceptual "Zoomed-in" Page

The map on this page indicates details of the river forecast points such as below flood stage (green), near flood stage (yellow), and above flood stage (red) along with areal hydrologic conditions. The river forecast point conditions will be based on current and forecast conditions. For example, if a point is either in flood or forecast to go above flood, it will be indicated in red. The forecast indicating flooding could be either a flash flood forecast or a river flood forecast.

The customer can click on the map to get details about the river forecast point (see *Recommendation 2*). Areal hydrologic conditions, such as flash flood potential, will be indicated

on the map with a clickable link below the map directing the customer to the text product, if applicable.

The customer will also have the ability to click on the map in order to zoom in, zoom out, or re-center the map. Another area on the Web page will allow customers to redraw the map on the page to their specifications. The zoomed-in map will default with forecast points, rivers, state boundaries, major cities, and lakes with the ability to add topography, river basins, roads and counties. All of these options can be toggled on or off.

An inset map on this page will show the customer exactly where the zoomed-in map is in reference to the United States.

Recommendation 2 — Summary Information for a Point

A hydrograph (a two-dimensional plot of water height [or flow] vs. time) is the most common, and a very popular, hydrologic product and is considered by many to be the flagship product of all hydrologic products. Feedback clearly tells us that customers like it because it is simple to understand and they can use its information effectively. Thus, the team has chosen the hydrograph to be an integral part of the core suite of AHPS information. A hydrograph should be available for every AHPS point.

Customers also told the team that they want a consistent look and feel to NWS products. The team feels that having an identical product (aside from dynamic data) from site to site is far more important than its specific recommendations as to which color or position a feature has.

The proposed layout to the hydrograph Web page follows the weather forecast format of having three main components of the body of the page: 1) extreme events, in this case flooding, are highlighted at the top of the page; 2) a "forecast at a glance" segment contains icons indicating river status during the forecast period; and 3) a segment containing more detailed information regarding observed and forecast water levels in the form of a hydrograph. An example of the recommended (default) layout is provided in Figure 3. Supplemental information is to be provided with each hydrograph including links to text data and products, the public weather forecast for the gage area, and other core suite products in the menu bar above the main body of the page.

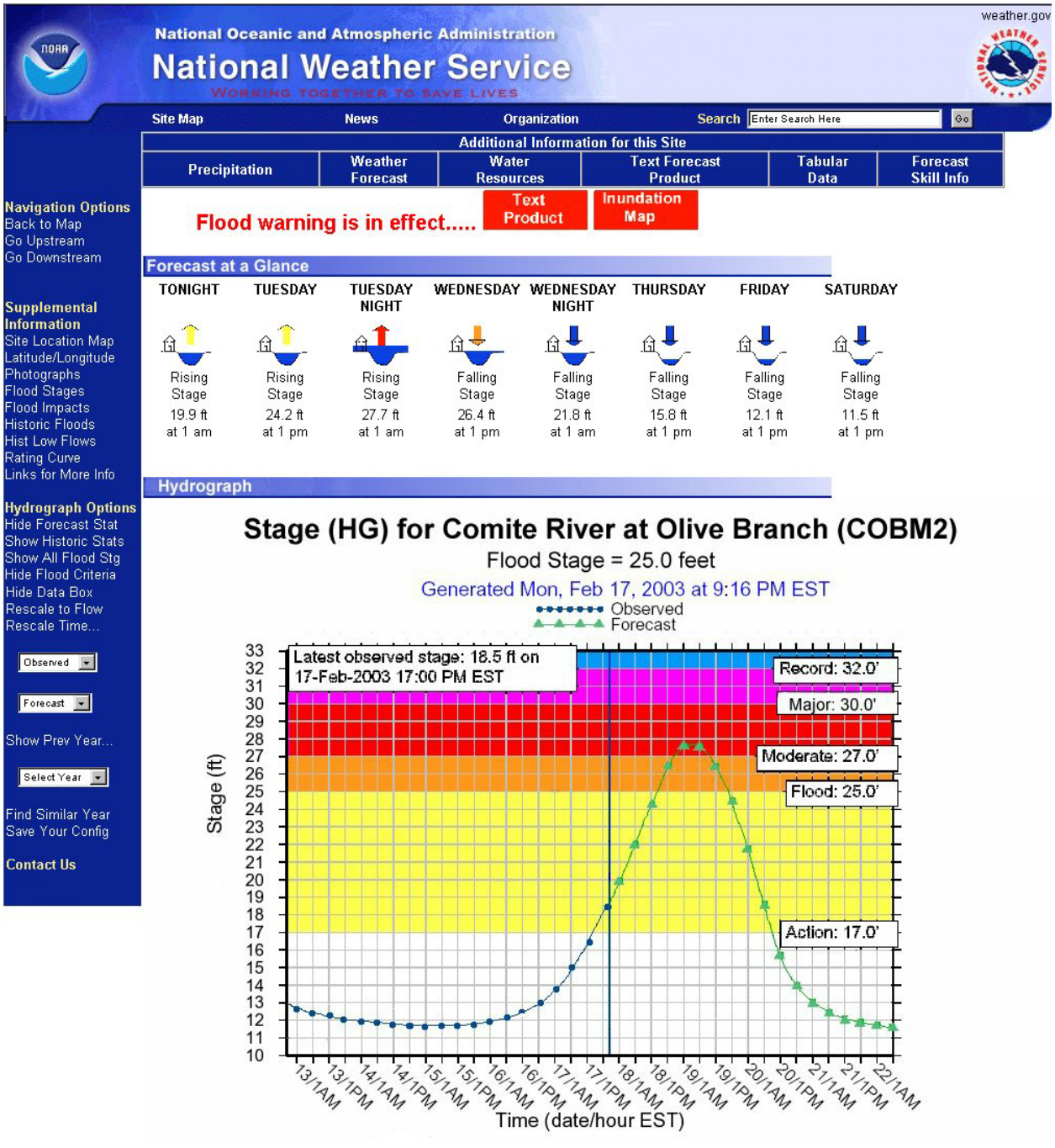


Figure 3. Sample Web Page with Default Hydrograph

Survey responses and other customer feedback indicated a strong preference for clear, easy to understand information. The forecast at a glance segment is an attempt to meet this requirement for information related to current and forecast river conditions. The icons would provide at a glance a pictorial rendition of the river conditions expected during a given current or forecast period. A standard set of icons depicting various river conditions would be available. The

prevailing condition for the current and each of the forecast periods would determine which of the icons appeared on the display.

The conflicting feedback of customers having different requirements is addressed through the support of the Web page by a database and the ability of the customer to select specific features to suit their needs. Beginning with a basic hydrograph as the default graphic, customers will be able to select from a number of choices to quickly redraw the hydrograph to meet their needs. Examples of configurable changes include changing the observed and/or forecast time periods, showing or hiding historical statistical data for comparison to current values, showing or hiding flow data on the right vertical axis, and showing previous year(s) of data on the same hydrograph as the current data. Examples of hydrographs with all options turned "off" and all options turned "on" are provided in Figure 4 and Figure 5, respectively.

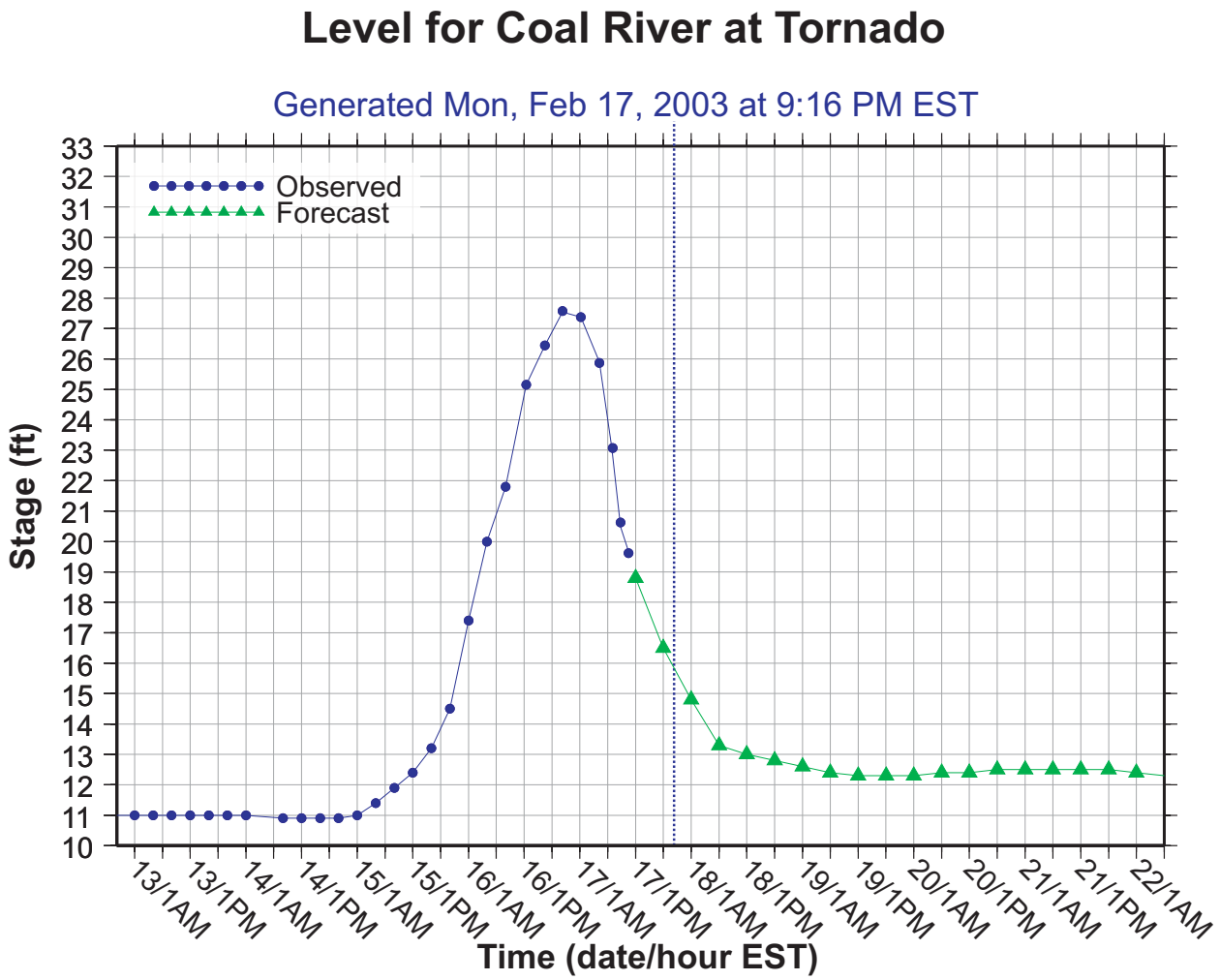


Figure 4. A Sample Hydrograph in Its Simplest Form

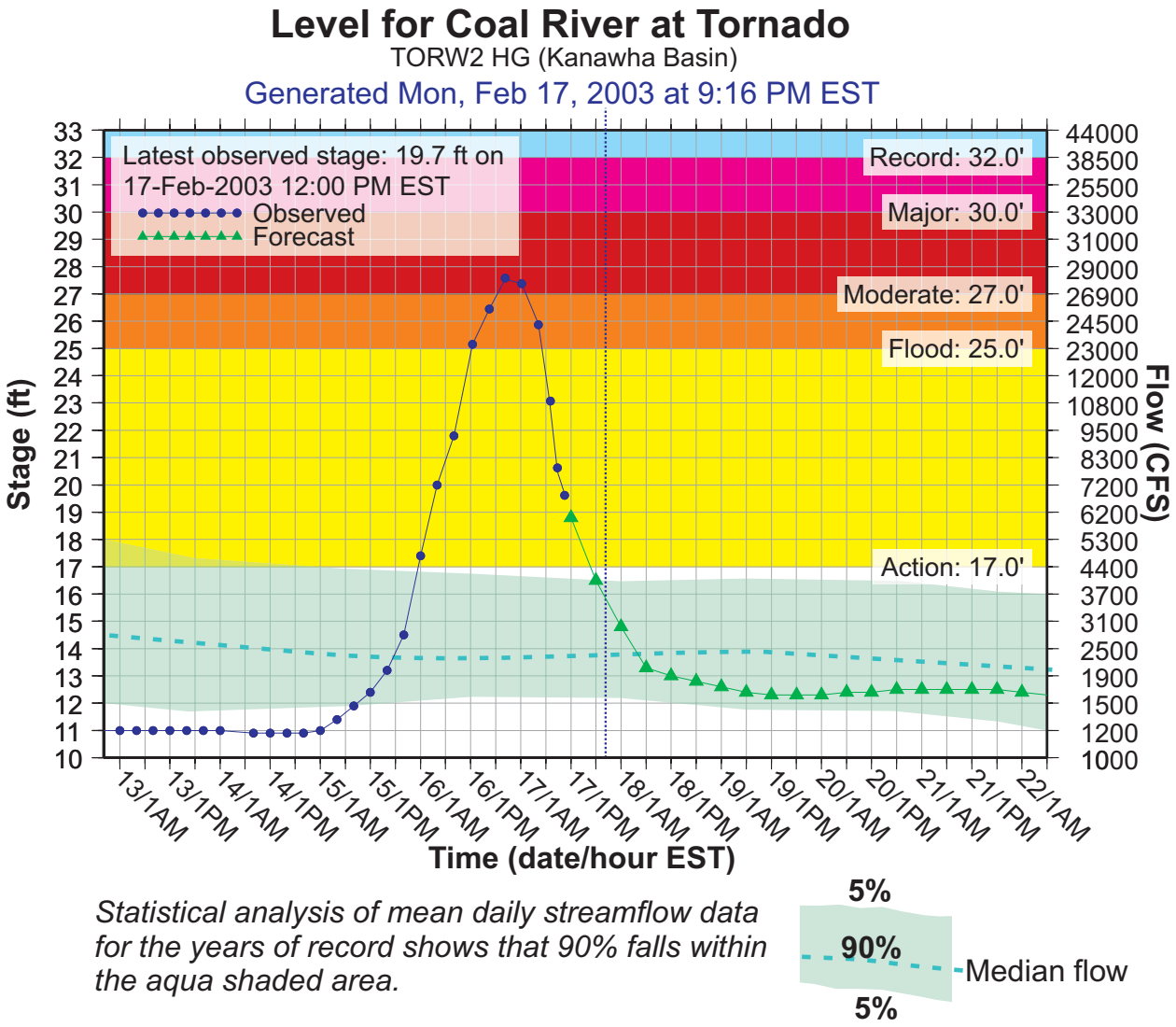


Figure 5. Sample Full-featured Hydrograph

Outlined below is a list of the team's recommendation for the hydrograph. All recommendations are made assuming that the data or capabilities are, or will be, available with emerging technology.

1. The graphic must contain a trace of three days of observed data and a minimum of 3 days of deterministic forecast data by default. The default for forecast data should be 5 days instead of 3 if uncertainty information is shown on the hydrograph. Colors of each trace should be distinguishable from one another and be visually distinct from any other colors used on the graph. A legend must indicate which is which.

2. Observed values must be plotted with a small symbol, such as a circle, triangle, etc., and connected with a line or spline, except if a gap exists in the data for longer than *X* hours, where *X* is a site-specific value determined through coordination between the service hydrologist and the RFC. Time interval *X* is chosen to be small enough so that one can

assume that the river stage could not fluctuate much in the span of time indicated by *X*. The color used for the observed trace should be standard among all AHPS hydrographs. The team recommends blue, for this value.

3. Forecast values must be plotted with a different small symbol and connected with a line or spline, except if gap *X* exists (see previous bullet) such as when a crest forecast is plotted a couple of days after the last six-hour forecast stage. The color used for the forecast trace should be standard among all AHPS hydrographs. The team recommends green, for this value. If uncertainty forecasts are available, this information will be displayed by default.

4. The height of the hydrograph shall span from at least one foot below the graph's minimum stage (observed and forecast combined) to at least five feet higher than the graph's maximum stage (i.e., from *min – 1* to *max + 5*). This is called the hydrograph's natural vertical extent. This range seems to satisfy most customers based on external user feedback

5. Adequate grid lines must be present within the hydrograph to assist in estimating a stage at a given time. The grid lines should be colored light-to-medium gray so that their presence is not distracting. Some or all the gridlines must be annotated with stage on the left vertical axis in feet and time (date/hour) on the bottom horizontal axis. A second vertical axis on the right is optional for labeling flow values in CFS.

6. Significant stage thresholds must be annotated if the threshold occurs within the vertical bounds of the hydrograph (see number 4 above). Moreover, regions above the thresholds must be shaded in the color of the annotated stage they exceed. For example, if yellow is used to indicate Action stage, then the background of the hydrograph at and above Action stage must be yellow up to the stage that another significant stage threshold exists. Examples of significant threshold stages are Action, Minor Flood, Moderate Flood, Major Flood, and Record Flood. The team suggest standard colors be used for these threshold stages, which are yellow, orange, red, magenta, and light blue, respectively.

7. A vertical bar drawn on the hydrograph in a different color or line style shall indicate the time of hydrograph generation.

8. Supplemental labels, including the most recent observed value, along with the time of the reading, must be indicated in plain language. The time of product generation shall also be indicated in plain language. Important disclaimers, such as the gage giving erratic readings because of an ice jam, must also be indicated in plain language. Much of this information could be put into a single text box or label on the hydrograph.

9. The graphic must include the name of the river and gage site, i.e., "Ohio River at Cincinnati."

10. The vertical axis must be labeled with the parameter of the axis with units (i.e., "*Stage (ft)*", or "*Flow (CFS)*" if a rating curve is not available to convert flow to stage). The horizontal axis must be labeled as "*Time*" with at least a date and hour as the unit. All times labeled on AHPS hydrographs must be in **local** time.

11. The hydrograph should show probabilistic information as an option (see below). Observed traces shall have historical statistics shown. Forecast traces shall have conditional simulated statistics indicated. The specific look of probabilistic information on a hydrograph, or what exceedance thresholds are best, is not yet well defined.

12. Hydrographs should be configurable in the following ways, provided the technology is in place to allow on-the-fly hydrographs to be created. Furthermore, the team recommends that users' preferred configuration be persistent from visit to visit:
    a. The observed and forecast data displayed should be specifiable from one to ten days or longer, depending on availability of data.
    b. The hydrograph's natural vertical extent defaults to *min-1* to *max+5* feet, but the values of 1 and 5 shall be user-configurable.
    c. The internal ID of the gage site, and the SHEF physical element being plotted (e.g., HG, HT, or HP) should be togglable (off by default) and shown in the title, subtitle, or vertical axis label of the hydrograph.
    d. Normals and statistical information shall be togglable (off by default) and shall consist of a cyan-colored dashed line indicating the "normal" or long-term mean for the dates plotted. It should also include a statistical 90% range of the river level shaded in a light cyan color.
    e. Whether the graph's vertical range should be adjusted to show *all* significant stages should be togglable (off by default). Normally, just significant stages that exist within the natural vertical extent of the hydrograph are shown.
    f. Whether the graph should show *any* significant stages should be togglable (on by default).
    g. Whether the label text box appears (see 8) should be togglable (on by default).
    h. For sites with flow *and* stage information available (e.g., through a rating curve), whether the right-side vertical axis is labeled with Flow values should be togglable (off by default).
    i. Probabilistic (statistical) information should be togglable (on by default).
    j. Climatic normal stages should be optionally underlain (off by default).

13. Related supplemental information must accompany the display of the site's hydrograph. Such supplemental information should include:
    a. Any hydrologic watches or warnings in effect for the site
    b. A link or other pointer to Gage Zero Datum (in feet)
    c. A link or other pointer to an available inundation map when stage is above bankfull
    d. A link or pointer to a tabular text product listing the data graphed in the hydrograph

e. A link or pointer to observed or forecast precipitation information (APIT *Recommendation 5*).
f. A link or pointer to the weather forecast for the site
g. A link or pointer to skill information. (APIT *Recommendation 4*)
h. A link or pointer to water resources information (APIT *Recommendation 6*).
i. A link or pointer to the upstream or downstream points, if they exist
j. A link or pointer to an overview of the river basin in which the site exists (included in APIT *Recommendation 3*)
k. A link or pointer to gage site photos (included in APIT *Recommendation 3*)
l. A link or pointer to historical crests (included in APIT *Recommendation 3*)
m. A link or point to flood impacts at various stages (included in APIT *Recommendation 3*)
n. A link or pointer to other E19 information (included in APIT *Recommendation 3*)

Recommendation 3 — Supportive (Static) Information for a Point

Information describing the characteristics, site, and flood impacts at each location are the contents of this recommendation. Responses by non-NWS persons indicated they preferred clear and understandable information. A number of the comments to our survey specifically requested descriptive and supportive information about the locations where NWS hydrologic forecasts were available. The AHPS Web pages currently deployed by Central and Eastern Regions contain a significant amount of this type of information. Customer feedback on these pages has been very positive in regards to this descriptive information. They have repeatedly said the information describing the location makes the hydrologic information more understandable and enhances their ability to use NWS hydrologic forecasts. The only specific change customers have requested is to streamline the information so the text is not as extensive. The APIT has tried to build on the past success of the existing AHPS Web pages by enhancing the supportive information with more graphic representations.

The displays of the supportive information will be linked to the display of *Recommendation 2* so customers have easy access to this information. Prominently displayed will be acknowledgment of the cooperating agencies (i.e., observed stage information appears courtesy of the USGS) and links to cooperating agencies (i.e., USGS, U.S. Army Corps of Engineers, Bureau of Reclamation, etc.). The supportive information will appear in two graphic displays with enough text to ensure the information is clear and understandable.

The first graphical display will be a forecast point location map (Figure 6). The map detail must be balanced so as not to provide too much information to potential vandals and yet still provide sufficient details to provide visual clues about prominent structures, roads, railway lines, etc. which may be affected by flooding. It also needs to provide enough information about the gage location so customers can relate conditions at their locations with the observations and forecasts at the gage location. The map information should be coordinated with the gage owners to ensure the detail provided is acceptable to them.

Historical Stages

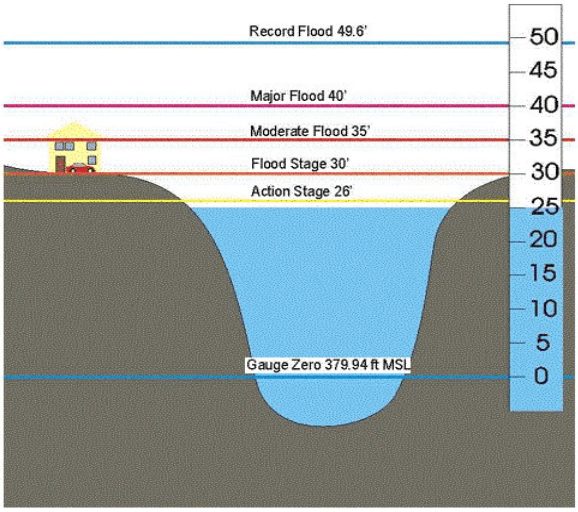
Top 5 Historical Crests
(1) 49.58 ft on 08/01/1993
(2) 43.23 ft on 04/28/1973
(3) 42.0 ft on 04/01/1785
(4) 41.89 ft on 05/22/1995
(5) 40.3 ft on 07/02/1947
More Past Crest and Flow Information

Top 3 Low Water Events
(1) ?.? ft on 12/23/1863
(2) -6.1 ft on 01/16/1940
(3) -5.7 ft on 01/26/1963
More Past Event and Flow Information

Map of Area

Impacts

54.0 Feet	The Metro East St Louis and Fish Lake levees which protect 71,000 acres are overtopped.
52.0 Feet	St Louis floodwall is overtopped.
50.8 Feet	This is the 500 year frequency level.
49.6 Feet	This is the RECORD FLOOD LEVEL that was reached on August 1 1993.
49.0 Feet	Hartford Public Water supply is threatened
48.0 Feet	The Harrisonville and Prairie DuPont levees protect 37,360 acres.
47.7 Feet	The Columbia levee protects 14,000 acres.
47.2 Feet	This river level is expected to be exceeded once in every 100 years
44.3 Feet	This river level is expected to be exceeded once in every 50 years.
44.1 Feet	Chouteau Island Pump Station begins to flood. Power to the Chouteau Island Pump Station disconnected... The Harrisonville and Columbia Levees are overtopped...
43.2 Feet	This flood level was reached on April 28 1973.
42.0 Feet	Riverview Blvd becomes flooded.
40.0 Feet	Major flooding begins. Also at this level the Choteau Island Levee is overtopped.
39.0 Feet	The Chouteau Island levee protects 2400 acres.
36.9 Feet	This river level is expected to be exceeded once in every 10 years.
36.0 Feet	Railroad tracks become flooded.
35.0 Feet	Moderate flooding begins.
33.0 Feet	Floodwall at Prairie Street is closed.
31.0 Feet	Water begins entering the downtown parking garage.
30.0 Feet	Flood Stage - Floodwall at Lacledes Landing is closed.
26.0 Feet	At 26 feet levee protects 2000 acres.
18.5 Feet	Levee parking begins to be inundated.
0.0 Feet	20 barge limit restrictions are placed on all tows. Draft of barges can only be 8.5 feet instead of 9 to 10 feet. At -2.5 and below a 16 barge limit in effect. At -4.0 and below 8.0 feet draft restriction is in place. At -4.5 and below all navigation halts.



Cooperating Agency

U.S. Geological Survey (USGS) Data and Site Info for St. Louis

Photos of Area

- Municipal Airport Flooding
- Levee parking flood
- 1995 event picture #1
- 1995 event picture #2
- 1995 event picture #3
- 1995 event picture #4
- 1995 event picture #5

NWS St. Louis
12 Missouri Research Park Drive
St. Charles, Missouri 63304
(636) 441-8467

Email: w-lsx.webmaster@noaa.gov
Web: www.crh.noaa.gov/lsx

Figure 6. Supportive Information

The second graphical display will be a myriad of information concerning river levels depicted against a channel cross section (Figure 6). A depiction of the actual channel cross section will be used when available; otherwise, a default shape will be depicted. A staff gage will be depicted beside the cross section display. Textual values will relate to both the cross section and the staff gage. The specific river stages corresponding to action stage, flood stage, minor flood stage, moderate flood stage, major flood stage, and flood of record will be noted on the cross section and staff whenever they are available. A pop-up window will be available to provide definitions of each of these designations to help alleviate any potential misunderstanding by customers. The gage datum will be displayed on the cross section in correct relative location with respect to the cross section and provided textually as well. Key river stages for flood impacts will be denoted on the cross section and the staff gage. Textual descriptions of the impacts at the stages will also be provided. Finally, high- and low-water marks (denoted by river levels and the dates they occurred) will be displayable on the cross section and the staff gage. This information will allow customers to relate current observations and forecasts to past events.

This particular display will not appear as a default; however, customers will have a clear mechanism for including this information on their display.

The final information category to be provided within this recommendation is annotated photographs of the river. The photographs should be used to illustrate impacts at specified stages of areas within the reach of the river served by the location being viewed. The annotated photographs will be listed with a short description linked to the actual photograph. Customers will merely have to click on the description they want to see to view the photograph. **Error! Not a valid bookmark self-reference.** provides an example of such an annotated photograph. The team recommends the annotation be maintained separately from the photograph so that changes to the text can be made without altering the photograph.

Mississippi River flooding Municipal Airport at 35.5 feet on 2/15/1998.

Figure 7. Example of an Annotated Photograph

Recommendation 4 — Skill Information

The purpose of this member of the core suite is to provide customers with information about the skill of the NWS forecasts at a point so they may use the forecast more intelligently and effectively. One of the questions most commonly asked by customers about NWS forecasts is "How good are they?" At almost every presentation about the AHPS made by team members, customers wanted to know how well the forecasts verify and how much they can trust our forecasts. Existing hydrologic forecast skill displays were reviewed and the scientists developing methods for evaluating the river stage forecast skill were consulted. From these consultations the team determined the scientific development required to produce a high quality, scientifically valid product was not complete. The team felt it was important to allow scientific development to determine the specifics of skill information ultimately included in the core suite, and therefore does not make any specific recommendation regarding the content and format of these products at this time.

The California Nevada River Forecast Center places skill information on its Web site for the forecast customers to review. This present effort is restricted to water supply forecasts. See http://www.wrh.noaa.gov/cnrfc/water_supply/2002/2002_verification.pdf for an example. The Office of Climate Water and Weather Services Performance and Evaluation Division manages a "Statistics on Demand" Web site for river stage forecasts that use alternative statistics. The Southern Region has implemented its own river stage verification program based on categories. See http://www.srh.noaa.gov/verification/hydrology/. Each process has limitations and advantages. At this time, no one method is clearly better than another.

As a part of ongoing AHPS development, the OHD and the University of Arizona are conducting research into methods for evaluating river stage forecasts. The OHD is reviewing the existing approaches for verification as they apply to river stage forecasts. The University of Arizona is developing new methods for verifying probabilistic forecasts. This research will culminate in recommendations for verification processes to meet the needs of managers, forecasters, and forecast users.

The team recommends waiting until the scientific research required to validate a coherent evaluation strategy for NWS river stage forecasts is completed before a set of graphical displays is selected for the core suite. While it would be possible to define a core product at this time, the team felt it was important to allow the scientific development to be completed prior to defining content and format in order to insure AHPS delivers the highest quality products. The science - not the bureaucracy - should define the product. The team felt the additional development time required to establish a scientifically sound product would be well spent and would not lead to a delay in AHPS implementation, given the volume of work to implement the remainder of the core suite

Recommendation 5 — Precipitation

Precipitation is the most predominant contributor to changes in river levels most of the time over most of the country. Snowmelt, reservoir releases, and ice jams can certainly affect river stages; however, their contribution is often local or regional in nature. Precipitation information is extremely important to NWS customers. Our survey and other feedback indicate a keen interest across a wide customer base for both observed and forecast precipitation. In fact, precipitation information was often mentioned in the same breath as river level information in conversations with customers when discussing hydrologic information needs. The APIT has therefore chosen precipitation information to be among the core suite of AHPS graphical products.

The respondents to our survey indicated a wide array of preferences for specific precipitation information and format. Some of the clear choices were data in a grid format (over a five to one positive to negative preference ratio by non-NWS respondents), estimates based on gage and radar (a fourteen to one preference), and short time frames (a seven to one preference). Items, which had preference ratios near or less than one, had some following. Point data was preferred at a two to three ratio, and gage only data had nearly equal positive and negative responses. Discussions with individuals or groups of customers indicated that many have needs for data in specific time periods. Based on all of this feedback, the team decided that an information "mining" approach was needed for providing precipitation information in the core suite of AHPS graphical products.

The default display in the core suite for precipitation will be two precipitation maps – one for observed (best estimates) precipitation and the other for forecast precipitation. The term "precipitation" in this context refers to all precipitation without regard to its type (e.g., rain, snow, sleet, etc.). The term "best estimates" means the precipitation estimates being used operationally by the NWS. The default area will be the area selected in *Recommendation 1* or a 50-mile radius. An interface will be available to allow customers to select information other than the defaults.

The default observed precipitation map will be 24 hours of accumulation based on estimates available for the most recent full hydrologic day (Figure 8). The default forecast precipitation (Quantitative Precipitation Forecast) map must be 24 hours of accumulation for the subsequent hydrologic day. A scale or legend will be present to show what values correspond to which colors. The team recommends the colors used to indicate values be discrete, not continuous, because continuous colors are more difficult to discern by those who have some level of color-blindness.

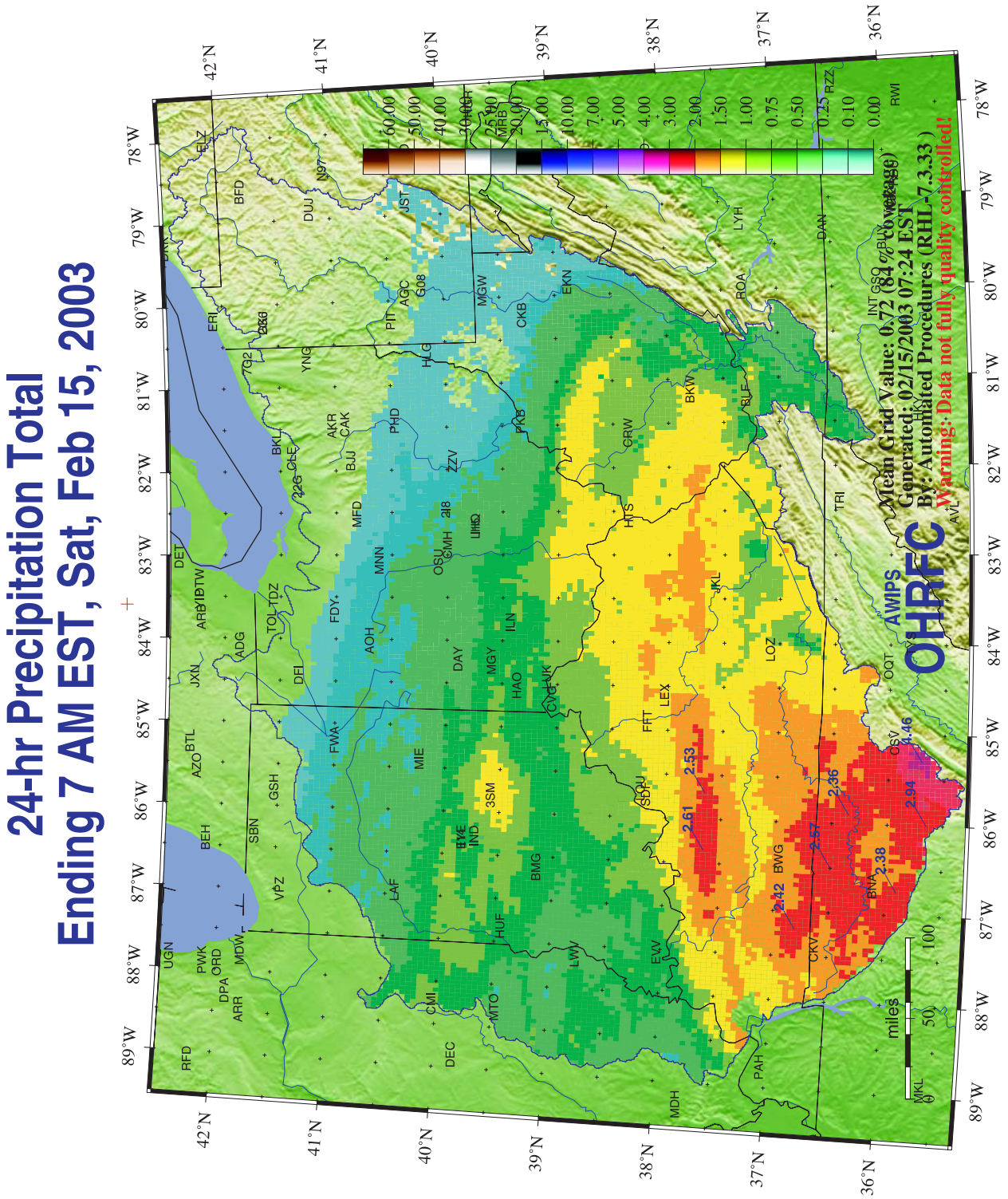


Figure 8. Sample of Observed Precipitation Map.

Forecast precipitation amounts and the estimates of observed precipitation information will be in the form of color-coded gridded data. Gridded data resolution will be ~4km or finer. If only point data is available as the source of precipitation data, a technique shall be used to create

gridded data from the point data. Grid maxima (the highest five or ten peaks) will be indicated by a text label and a pointer to the location of occurrence on all precipitation maps (see Figure 8).

The interface for customer selection of precipitation other than the defaults will permit the selection of alternative time frames for observed and/or forecast precipitation information. Forecast information will go out to as long as data is available. Observed data will extend back at least one year. The customer will be able to select the number of hours or days to build a precipitation accumulation map. Figure 9 is an example of a 90-day precipitation accumulation. A selection for storm total precipitation will be available as well. In addition to static precipitation maps, a capability to loop or animate the one- or six-hour sub-periods for a specified time frame is desirable. Customers will have the capability to change the map coverage area to sizes such as local, regional (RFC-based), and national maps for both observed and forecast precipitation. The period of accumulation will be labeled clearly in local prevailing time on every map displayed. For displays over large regions, data mosaicking from multiple sources is suggested. Additional facts about the grid labeled on the map, such as the mean grid value, percent coverage of precipitation > 0, and product generation time, are useful information. These will be available to customers by toggles with the default being that they are not displayed.

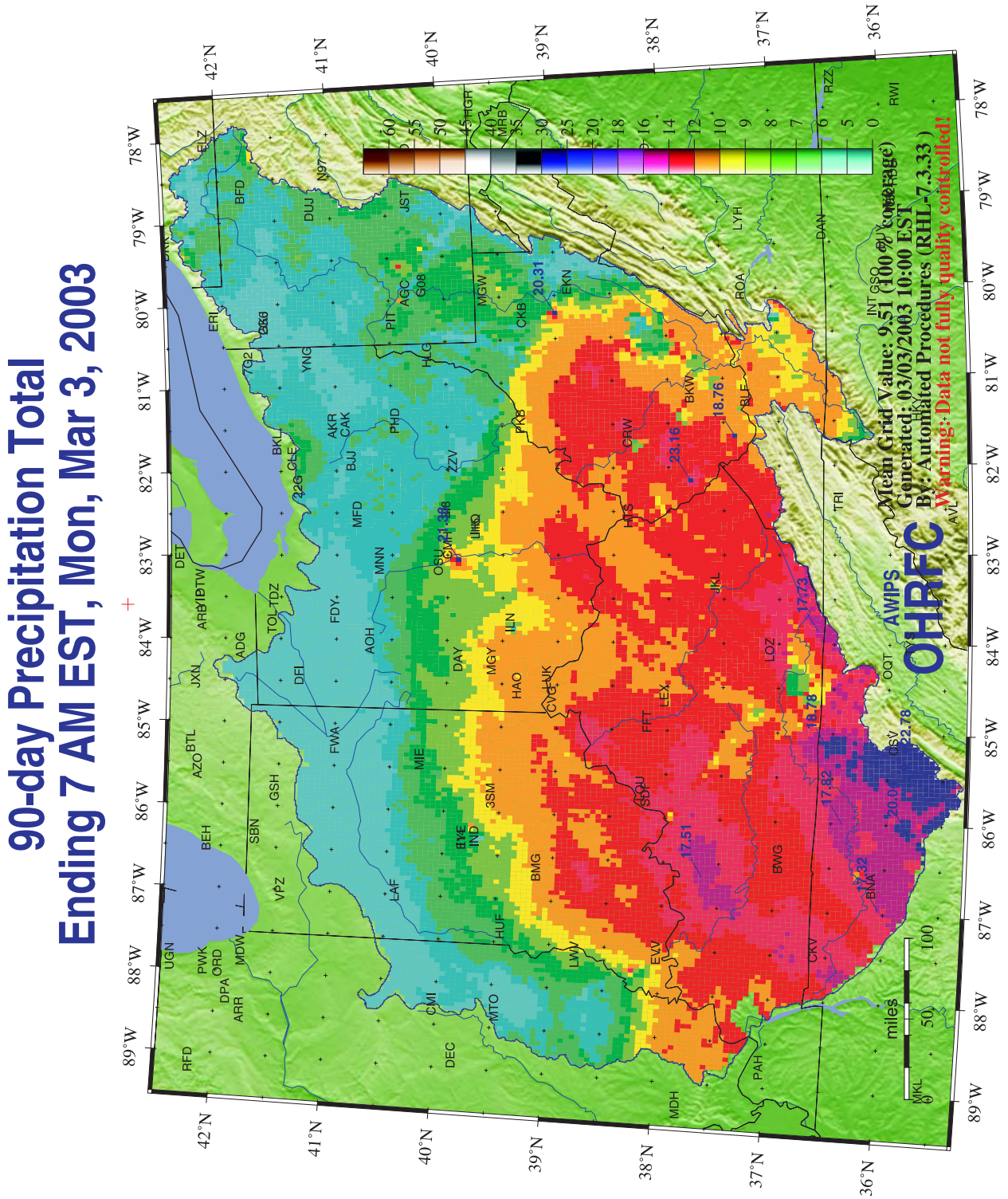


Figure 9. 90-Day Precipitation Accumulation.

Customers will have the ability to select precipitation information from specific sources, i.e., radar-only or gauge-only. Such information will be clearly labeled as to the source. The same

capabilities for information display, which are available for the default best estimates of observed precipitation, will be available for these precipitation sources.

The precipitation display and interface will be accessible from the displays for *Recommendations 1 and 2*. In the context of a point location, the customer will be able to select a time series display of precipitation gage readings at the site (when available) with user-selectable start and end times. This display will have defined links to the display for *Recommendation 6 — Water Resources Information* in order to access precipitation information as a departure from normal. Details of this display are available in the next section of the report. The display will also contain a pointer or link to the National Climatic Data Center in order for the customer to access archived precipitation data. When the National Digital Forecast Database has been implemented for all forecast areas, the Team recommends a link be added to this page.

Recommendation 6 — Water Resources Information

The customer demand for water resources information increases with each passing year. The NWS has placed considerable effort in meeting this demand. Spring flood outlooks have been produced locally, regionally, and nationally for years. Web development at RFCs and WFOs has provided graphical depictions of precipitation compared to normal and water supply forecasts. The implementation of AHPS has provided long-range probabilistic forecasts to an increasing number of customers. Widespread drought has further increased the demand for information related to soil moisture and water availability. This part of the core suite is intended to provide the baseline products to meet some of the customer requirements for water resources information. Some regional and local products, i.e., water supply forecasts, will be necessary to augment the core suite contents.

Precipitation accumulation departure from normal is the first component of this recommendation. This information will be provided for a user-selected area (either from *Recommendation 1* or independently) with a default accumulation of 90 days (Figure 10). A color scale would depict the percentage of normal with different colors for percentages of plus or minus 10, 25, 50, 75, 100, 200, and so on. The display will provide the valid time period. An interface would be provided to allow customers to request departures from normal for other specified time periods ranging from seven days to one year. This section will be linked to *Recommendation 5 — Precipitation*, allowing customers easy access to all types of precipitation information.

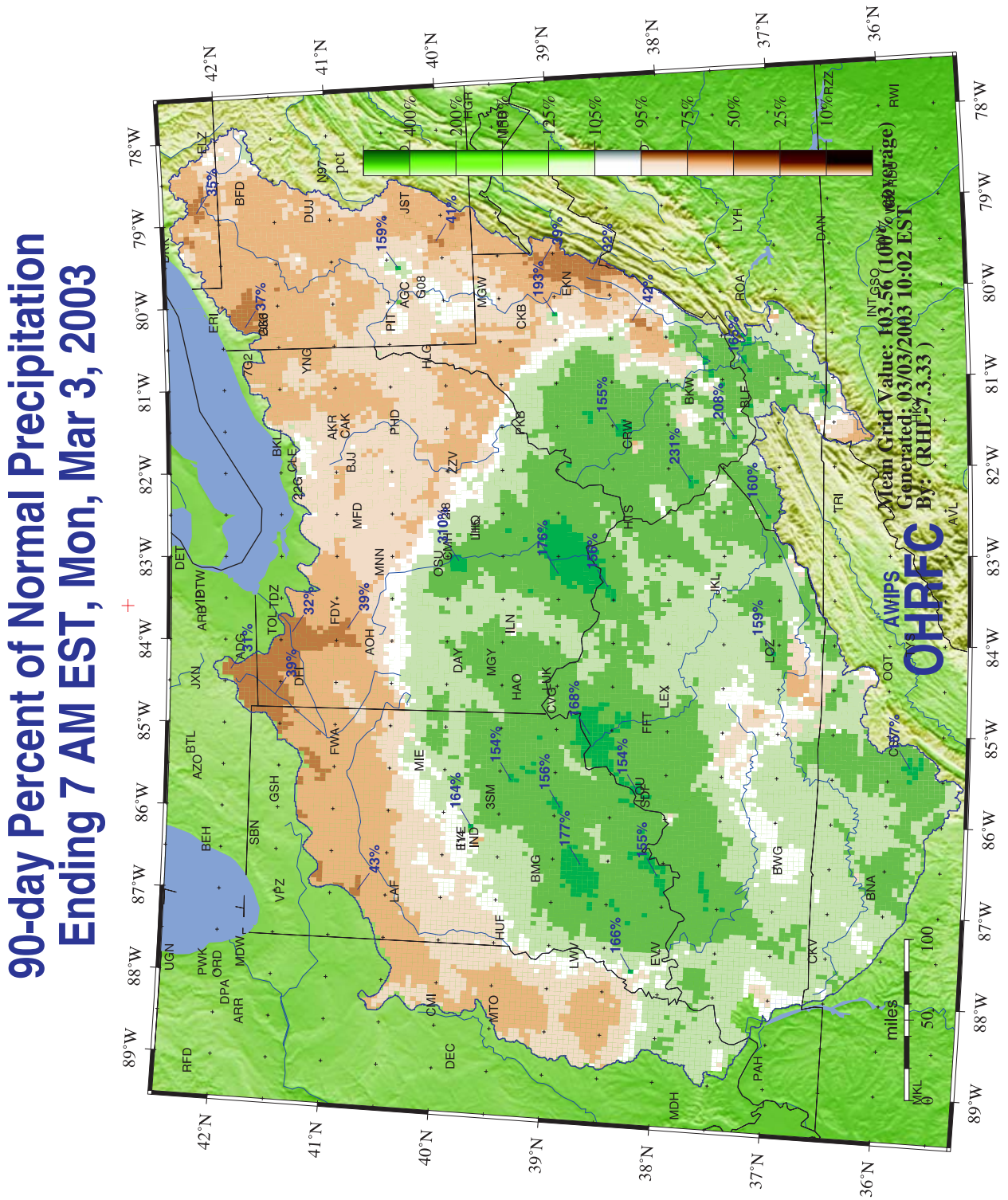


Figure 10. Precipitation Percent of Normal.

The team's surveys and other contacts with customers indicated a strong desire for departure from normal precipitation information. Survey results showed a nearly seven to one ratio (33 positive responses to 5 negative) of NWS customers desiring departure from normal precipitation

information. NWS contacts with regional, state, and local entities responsible for drought response have consistently stated the requirements for precipitation departure from normal information. In fact, many drought plans use this information as a key input to the determination of specific actions. Preference for a specific time frame of information in the surveys was not clear. For example, neutral responses (19) were nearly as high as negative (21) and higher than positive (13) when customers were asked if they wanted monthly data. The team selected 90 days as the default display based on anecdotal input from customers. This time frame seemed to provide some usefulness across most of the country. Shorter time periods are almost useless in the West and much longer periods may miss significant events in the East.

The second element of this portion of the core suite provides long-range (14 days and longer) probability forecast information to NWS customers. There are two parts to this section. The first is a display of the 90-day probability of river stage exceeding values plot for the location selected in Recommendation 1 or other customer selected location (Figure 11). The second part will follow the data mining approach. A customer interface will allow customers to select from a variety of information types, display formats, and time intervals (Figure 12).

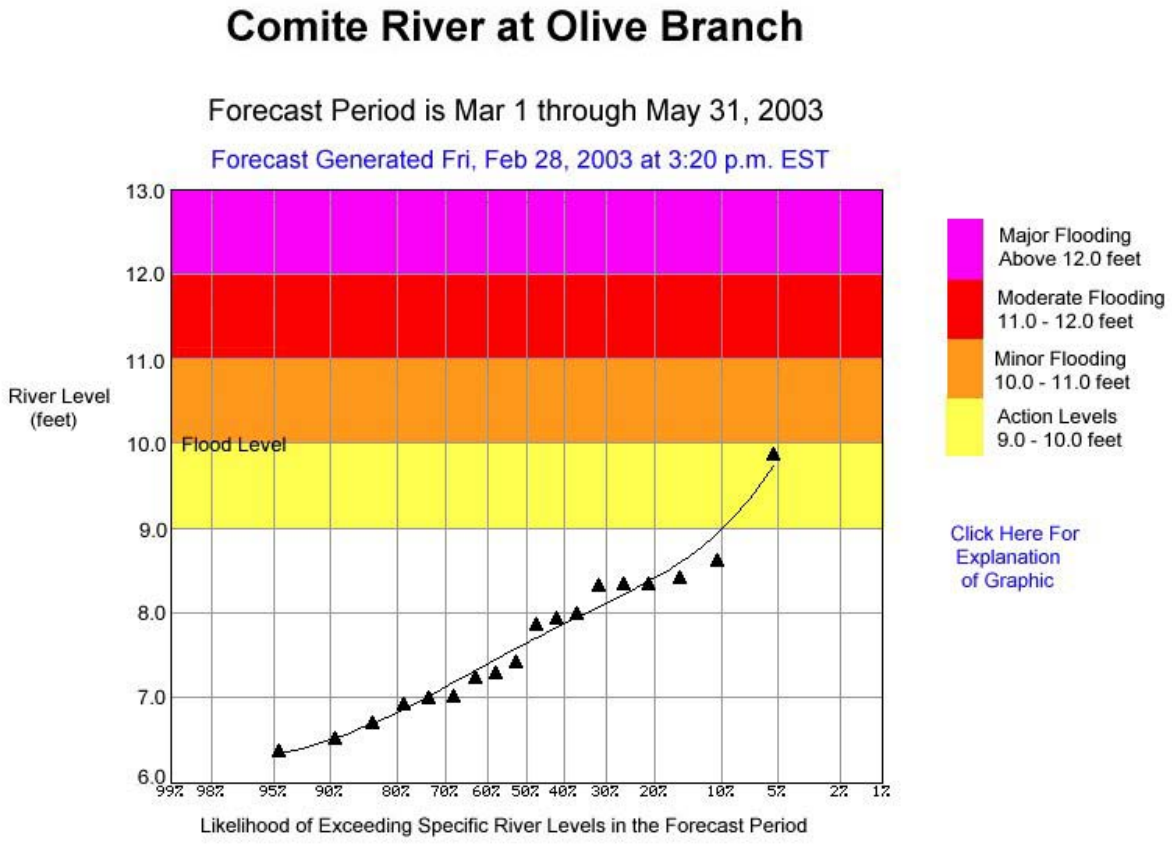


Figure 11. 90-Day Probability of River Stage Exceeding Values

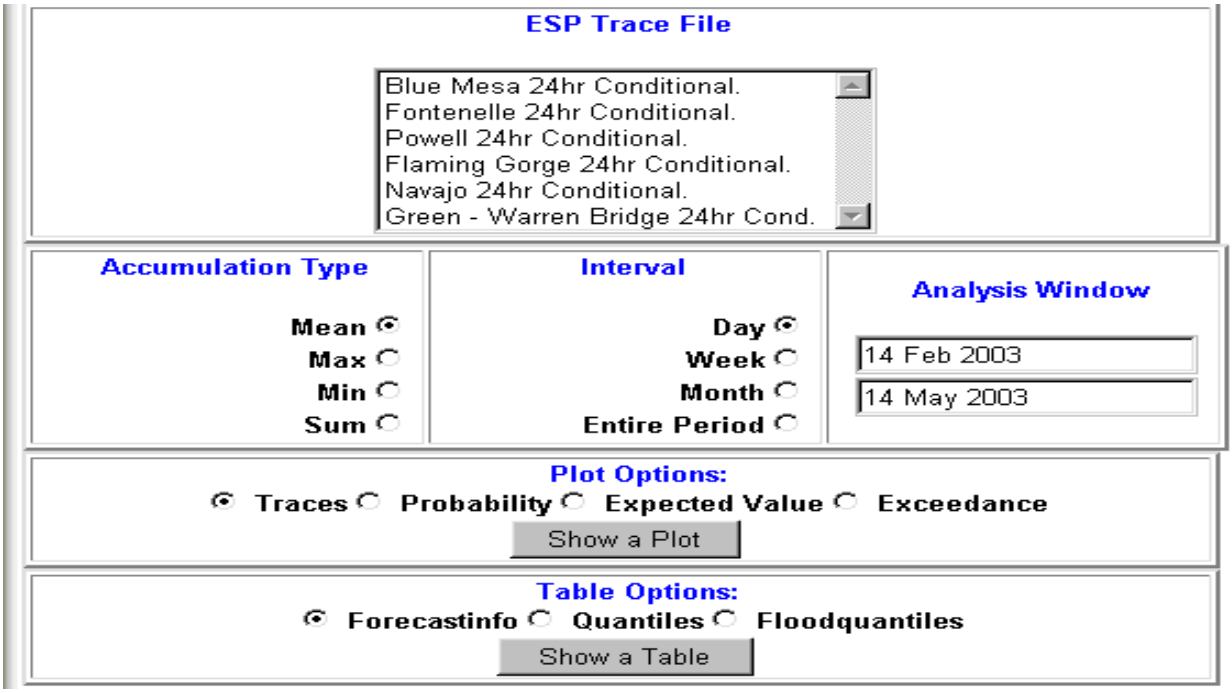


Figure 12. Sample Interface for Selecting Other Probability Plots

The display plot would include a complete description including the time frame, distribution used, meaning of the triangles, etc. It would include an explanation of how the information contained in the graph could be used, along with its limitations and ways it should not be interpreted. The default display should be driven by the current flow conditions. For example, a plot showing the probability of going above important river heights would be the default if the current flow was a percentage (say 50%) of normal or higher. If the flow was lower (i.e., drought conditions), then a plot showing the likelihood of going below important river levels would be the default.

The customer interface would provide the mechanisms for queries to access a database to produce a wide variety of graphical products. An example of these products would be the likelihood of a stage/flow/volume of interest displayed as either the being exceeded or of lower observed values being experienced. The likelihood of filling a reservoir to a specified pool elevation would be another example of the type of products customers could create for themselves. Initial versions of some of these products are currently available; however, some development work is needed to display these products in a more understandable way for our customers.

The interface would contain explanations of the possible accumulations types, display intervals, and time frames. Each of the plot options would be explained as well, along with discussions on how to properly interpret and utilize the information displayed. The discussions would also include limitations of the information and display and cautions of potential misinterpretations. The table display options would have a discussion to aid customers in selecting and interpreting the table to best fit their needs.

A plot of the probability for the maximum river stage over the next 90 days was selected as the default graphic display based on the results of the team's survey. This display received a much better positive to negative ratio (31/11 versus 25/22) than the other probability graphic depicted in the survey. Comments in the survey also showed a distinct preference for this graphic compared to the other one.

The concepts of probabilistic forecasting have only been available in widely disseminated NWS forecasts in the last three years. The responses to our survey and other customer feedback indicate that customers are having difficulty understanding them, let alone using them. The numbers of responses under "Average" and "Not sure" are fairly high. For example in the non-NWS responses to the survey, total responses under these two categories for usefulness of the information (27 for Graph A) are higher than under either positive (25) or negative (22) responses for all the graphics. The comments in our survey reflect "unease," "unfamiliarity," and "dislike" for "probabilistic forecasts." This was true for both NWS and non-NWS respondents. This indicates the need for better training and explanation of these graphics both internally and externally if customers are going to find them understandable or usable.

Partnering agencies such as the Corps of Engineers, Bureau of Reclamation (BOR), NRCS, etc. have found NWS probability forecasts quite informative and useful. These agencies have stated a requirement for a wide variety of probability information both in informational type and in time period of interest. The operational prototype of a user interface for "building-your-own" probability products has received considerable positive feedback. Dave Mathews of the BOR stated, "This user interface is just what the doctor ordered. It provides us the capability of getting a wide range of the forecast information we can utilize in our operational models."

The team chose its recommendations in this area in recognition of the requirements for long-range probability forecasts and the identified need for more development and training in this area. The chosen display should be updated as new display capabilities for long-range forecasts are developed and NWS and customer understanding of probability forecasts mature.

The third member of this recommendation is a display of a soil moisture indicator (Figure 13). The soil moisture indicator summarizes the regional dry/wet moisture conditions for the area or a portion of the area (RFC forecast basin) displayed. The indicator will provide a quick reference to those interested in drought conditions or high runoff potential. There will be at least three different levels of soil moisture depicted on the indicator – wet, moist, and dry. Additional levels are shown in Figure 13.

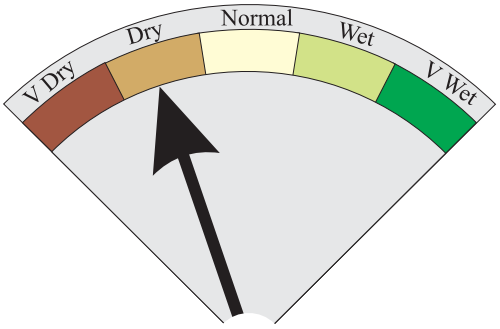


Figure 13. Soil Moisture Meter

A measure on which to base the indicator does not currently exist. The team recognizes that to implement this portion of its recommendation some development work will be required. Since the NWS has few direct measurements of soil moisture, this indicator will have to be based on some sort of modeling estimate of soil conditions. One possibility is that a mechanism could be developed to obtain the measure (perhaps percentages of the upper zone tension water) from the Sacramento Soil Moisture Accounting process used by most RFCs.

This item is included in the core suite based on input from customers interested in drought and potential flooding. We currently tell customers how much rain we expect to fall and what river response we expect. However, we do not currently provide information nationally on our estimation of the present state of soil moisture. Customers have asked for this information to assist them in making their decisions. For example, during drought periods customers often ask local NWS offices, "How much help will this coming storm be to our conditions?" If this indicator were available, they could obtain an answer for themselves by looking at it and the forecast precipitation information available in Recommendation 5.

The final member of this part of the core suite will also contain links to other NWS and partner agency water resources information (NRCS reservoir storage, USGS streamflow compared to normal, the Drought Monitor, etc.). The team recognized that other portions of the NWS as well as a number of our partners have water resource information available to customers. This display would provide easy access to this information via direct hyperlinks.

Recommendation 7 — Partnered Information

Flood Forecast Mapping was identified under this category. NWS prototype flood forecast mapping systems have been demonstrated in two areas of the country, the Juniata River Basin in Pennsylvania and the Tar River Basin in North Carolina. Partners and customers in these areas have requested animations of flood forecast time series and desire the flood potential depicted in a probabilistic fashion. One AHPS goal is to expand river inundation mapping to additional forecast points and other areas throughout the country. However, inundation mapping requires significant topographic data, additional system development, and NWS policy clarification. The APIT recommends the scientists and system architects lead the design of a standard format for the flood forecast map. Flood forecast mapping is a key element in the AHPS. The APIT considered flood forecast mapping sufficiently important to insist the scientists be provided the opportunity to complete their work without the constraint of a predetermined format.

Data acquisition and analysis will be conducted through local, state, and federal partnerships for years to come. Development of flood forecast mapping in the Tar River Basin is being made possible by a cooperative agreement and collaborative effort between the North Carolina Flood Plain Mapping Program, the NWS, and the NOAA Coastal Services Center. Flood mapping efforts in the Susquehanna River Basin in Pennsylvania include the Susquehanna River Basin Commission, The U.S. Army corps of Engineers, the USGS, and several state agencies. FEMA has acted as an additional partner in NWS flood mapping efforts. FEMA has been quite involved in Flood Inundation Mapping for mitigation and flood insurance studies. In addition, the USGS has a continuing project which encompasses the mapping of water in river courses and flood plains. Just how these other agencies' programs will ultimately relate to NWS flood mapping efforts is unknown. However, it is clear that these partnerships will require continued coordination and support if the most effective and efficient means of producing flood maps for customers is to be realized.

While two operational prototypes for providing flood mapping have been demonstrated, the APIT determined several regions had questions regarding the transfer of this capability to an operational mode. There is a lack of detailed documentation for either prototype system, so there is a general lack of understanding about the modeling and system requirements. In addition, a selection between the two systems cannot be done without better documentation. No clear process has been defined for expanding flood forecast mapping services. Consequently, even the RFCs using the operational prototype are not expanding this service. Finally, the prototypes appear to have significant resource requirements, and the availability of these resources is unknown at this time.

Feedback from customers has indicated serious concerns over whether or not the NWS should be involved with creating flood maps. At the Flash Flood Workshop in Boulder, Colorado, in August 2002 and at the Southwest Association of ALERT Systems in Houston, Texas, in October 2002, customers stated flood mapping was a public entity function and should not be pursued by the NWS. Whether these concerns are valid is outside the scope of the APIT.

However, the team feels this issue needs to be addressed and NWS policy clarified before a format for flood maps is defined.

Due to the significant number of unanswered questions and issues regarding the operational implementation of flood mapping, the team determined it was premature to identify a format for flood maps. From the team's standpoint, it seems more prudent to survey NWS customers on choosing a more consistent product look when these questions are answered. The APIT is in full agreement flood forecast mapping should be included in the core suite where the data are available.

Figure 14 illustrates a prototype flood forecast map. It is a map from Lewistown, Pennsylvania. It illustrates a flood map using historical data from several past flood events.

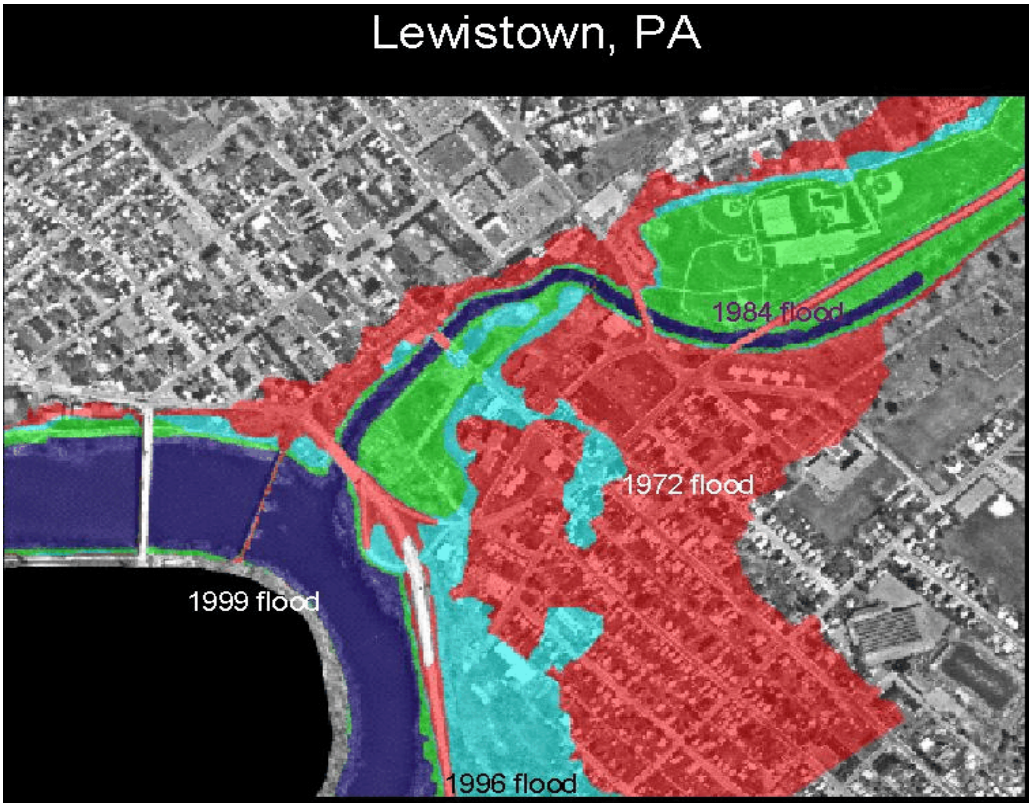


Figure 14. Prototype Flood Map

Implementation Approach

Our charge did not include the implementation of the core suite. However, the team recognizes the need to implement our recommendations in an efficient and cost effective manner. Our experience in defining the core suite provided some insight on implementation. The core suite recommendations will require significant Web development including development of an online database. A centralized server approach appears to be required to properly serve the data. Our view is these requirements point toward a centralized approach to supporting Web development, handling the required database, and supporting a Web farm for serving products.

The team recognizes that our recommendations for a core suite of AHPS graphical products are ambitious. The scope of our recommended products is extensive and varied. Our surveys showed us customers have a strong desire for information to meet their individual needs. Our recommendations meet this desire by providing customers with generic information and the capability to select more specific information through the use of interfaces. We have made these recommendations with a thorough understanding that our approach will add significant complexity to the task of implementation. While implementation is outside of the team's charge, we feel it is appropriate for us to offer our thoughts on how the complexity of our proposed core suite can be addressed. Our thoughts on implementation are based on our research in developing the core suite and our knowledge and experience in implementing existing consistent graphical products.

There are several key factors related to our recommendations that will have a significant bearing on implementation. The first of these is the amount of required Web development. Our recommendations are based on existing Web pages in a number of instances; however, in all of these cases we envision some significant changes. Furthermore, the sources of these existing Web pages are varied. They are written in different languages, and potentially significant work will be required to meld them into a cohesive unit. Other portions of our recommendations will need to be developed from scratch. All in all, the Web development to make these recommendations a reality will require effort on a scale significantly greater than any effort regarding product dissemination yet undertaken within the NWS hydrology program. Whether this development can be accomplished using existing field and headquarters resources is a real question in our minds. Consideration should be given to centralizing the Web development for our recommendations.

The second key factor relates to the informational content of our recommended core suite, especially providing customers with the capability of selecting the specific information they would like to see. This capability will require an online database. Such a database will require hardware, software, and human resources to implement and maintain. A conventional approach of having a database in each office may not be efficient or cost effective. Hardware and software costs alone may be prohibitive. Significant resources would be required to maintain such databases and ensure they were coordinated so that the information supplied remained consistent across the country. Again, a centralized approach of having a single database, with redundancy, of course, should be seriously investigated.

The final factor related to the implementation of our recommended core suite relates to how the core suite is accessed by customers. Past agency experience has shown that the deployment of consistent Web products at a large number of sites is difficult and resource intensive. Examples of this are the proliferation of the Central Region AHPS Web pages to other regions and the implementation of the corporate Web image. These efforts have yielded the desired results; however, they are on a much smaller scale than our proposed core suite. Thus, we would expect an increase in issues than occurred with these projects. After the deployment was complete, the issue of oversight to ensure a consistent approach was maintained would require resources at some level. Since consistency is a main goal of the development of the core suite, it would seem that the implementation should focus on making that happen in an efficient and effective manner. In our view, many of the deployment and oversight issues could be minimized if a centralized server, with redundancy, was employed to feed the Web pages.

In summary, we feel the successful implementation of the APIT recommendations in an efficient and cost effective manner may require an alternative approach to the presently used Internet dissemination process. The complexity of the core suite itself and the need for consistency throughout the development, deployment, and oversight indicate to us a centralized approach to implementation should seriously be considered.

Summary of Recommendations

The recommendations of the APIT are based on the premise the core suite will be information provided at an AHPS point/area in a nationally consistent format, and issued at every designated AHPS point/area all the time when the data are available. If the data are not available, then an explanation of why the information is not available, when it will be available, and other sources for similar information will be provided. A link to a contact to request additional information will also be included.

Much of the core suite is based loosely on existing graphical displays. Web development will be required to implement the recommendations, although with adequate resources the initial phases of this development should be able to be accomplished fairly quickly. However, there are several components of our recommendation which will require significant development work before the products can be produced and a format is determined. The team has formulated suggestions for the effective implementation of the core suite.

The core suite should be considered a baseline of AHPS graphical products. Many locations will have additional hydrologic information available to meet customer needs. The recommendations emphasize the need to make the core suite information understandable and useable to customers. Towards this end, descriptive information is to be included with all core suite graphics. The team recommends that a comprehensive customer survey be conducted for hydrologic services. Information from such a survey could be used to further refine the core suite. The team also envisions the core suite will evolve over time as technology and customer requirements change.

Core Suite

1) Hydrologic Conditions Information at Points and Areas

This graphic will depict the flood status and potential including uncertainty information. This graphic will provide information on river points and current or predicted conditions for areas. Clicking on river points will take the customer to information on that point (see 2 below). Clicking on an area will provide the customer with the ability to see the current text product covering that particular area. The product will allow the customer to select and zoom in and out of areas. The product will contain a link to precipitation information (see 5 below) at the same scale as the current display of the map.

2) Summary Information for a Point

This graphic will contain icons (picture with concise word description) depicting the daily river status over specific durations. The colors of the icons will be used to indicate the river status, using the same color scheme as in the conditions map in 1 (above). The icons will be derived from either the deterministic hydrograph or the ensemble.

This product will contain a simple hydrograph with five days of observed and five days of forecast stage (and toggle for flow) with uncertainty information when it becomes available. The flood stage or flow will be depicted, and the customer will be able to choose a variety of related information (flood of record, climate normals, USGS mean flow historical years, etc.) via toggle switches.

There will be a line of text in the graphic to provide a clear indication that the location has an active watch or warning in effect (with link to text product). Links will be provided to all other core suite products when they are available. Links will also be provided to allow customers to navigate to other points upstream or downstream and to obtain the information for all points within the same river basin.

3) Supportive (Static) Information for a Point

This graphic will include a forecast point location map, sufficiently detailed to provide visual clues about prominent structures, roads, railway lines, etc. Acknowledgment of the cooperating agencies will be displayed, along with links to all relevant cooperating agencies. The applicable flood stages – action, minor, moderate, major, flood of record – will be displayed against a depiction of the channel cross section, using a default shape when the cross section is not available. The gage datum will appear on the cross section in correct relative location with respect to the cross section. The impacts of various river levels along with high and low water marks (dates and heights) will be displayed via a staff gauge graphic and text. Finally, this section will contain links to annotated photos of the river.

4) Skill Information

The purpose of this member of the core suite is to provide customers with information about the skill of the NWS forecasts at this point so they may use the forecast more intelligently and effectively. The immaturity of the science and system do not allow us to provide an example graphic at this time. Significant scientific development is needed to develop meaningful methods of measuring the accuracy of NWS deterministic and probabilistic forecasts. Once we have such metrics, an effort will be required to determine a way to display them so that customers can understand them and use them effectively.

5) Precipitation Information

A wide variety of precipitation information will be available to customers through the selection of data types, times, etc. The default precipitation information graphic will consist of two displays. The first will be a 50-mile radius map of a location selected depicting the 24-hour accumulation from the multi-sensor precipitation on a 4 km grid, if available; otherwise, a map of rain gage amounts will be displayed. The second display will be the 24-hour quantitative precipitation forecast. These defaults will be static images, with looping in time being customer selectable.

Customers will be able to select a display of radar only estimates of precipitation. Rain gage measurements will be available geographically as an overlay on the default precipitation map or as a time series for an individual gage for a time scale that is not available at NCDC, i.e., the last 30 days. Links to graphics depicting the precipitation departure from the normal in the water resources section of the core suite (recommendation 6) and NCDC data will be provided on this display.

6) Water Resources Information

This display will include a graphic depicting the precipitation accumulation departure from normal displayed geographically. The default graphic will be an accumulation for the past 90 days. There will be the capability for customers to request departures from normal for other time periods ranging up to as long as a year.

Long-range forecast information for streamflow will be available in this display as well. A 30-day maximum (exceedance) or minimum (non-exceedance) stage distribution plot for the location selected will be the default display. An interface will be provided to allow customers to select the type of information, length of time (up to a year), etc. to produce probability graphics for criteria of interest. This "build-your-own" approach will allow customers to create graphics tailored to meet a wide variety of customer needs and desires.

This display will also feature a geographic display of a soil moisture indicator, which summarizes information for basin dry/wet moisture conditions. At the present time there is no consistent mechanism for producing such an indicator. Significant development work will be needed to produce information on which such an indicator can be based.

Finally, the display will contain links to other water resources information (NRCS, Drought Monitor, etc.)

7) Partnered Information Flood Mapping

Flood maps will be included in a consistent manner as part of the core suite where and when available. The flood maps may include information of inundation from past floods, current conditions, or forecast inundations based on expected river levels. At the present time, two issues prevent the establishment of a specific format for flood maps. The first issue concerns collaboration with partner agencies such as the USGS and FEMA. The role of each of these agencies in producing flood maps has yet to be finalized. The second issue is that the technology to produce flood maps operationally is too immature to define what our capabilities will be. Until we know for certain what we will be able to produce operationally, we cannot ask our customers how it can be displayed in the most understandable and effective way. The default look of the flood maps is an example of the output from the current prototype.

Appendix A — Initial List of Potential Graphic Products and Information

River Stages

- Hydrographs showing five days prior and latest forecast (if available) out to as many days as available including a label showing latest observation and time; also including probabilistic ranges with user-specified credible intervals
- Corresponding text products
- Plot (with zoom capability) of observed river stages in relationship to various thresholds such as low flow, in flood, above major flood, etc.
- Plot (with zoom capability) of forecast river stages in relationship to various thresholds such as low flow, in flood, above major flood, etc.
- Watch and Warnings associated with the point (I would like to see a map depicting areas with watches/warnings)
- Flood/Flash-Flood Threat Information (forecast), e.g., map depicting the ratio between Quantitative Precipitation Forecasts (QPF) and Flash Flood Guidance (FFG) ratio
- E-19 information including historical flooding, impacts, pictures, and a map of the area
- Flood inundation map where applicable or as it becomes available
- Extended probabilistic forecasts that actually make sense. We will have to go over details in the future.
- Link to Flood Potential Outlook
- Searchable historical data. Even if we could not provide this directly from our sites, then we could at least link to the USGS

Flash Flooding

- Graphical FFG by county/grid
- Text FFG by county
- Flash Flood Watches and Warnings on a graphic

Soil Conditions

- Soil Moisture map (computed/observed)
- Latent Moisture (observed snow pack map and Water Equivalents)

Precipitation

- QPF one-day totals, six-hour totals, and a complete total precipitation over the forecast period. We could also include this information with the River Forecasts
- Merged precipitation data for latest 1-, 3-, 6-, 12-, and 24-hour accumulations
- Merged precipitation data for six-hour totals on synoptic times
- Merged precipitation for 2-, 3-, 5-, 7-, 30-, 60-, 90-, and 180-day totals
- Mean Areal Precipitation data for the appropriate basin
- Mean absolute error of QPF with respect to merged precip (or similar case-by-case graphic comparing QPF with observed data)

Water Supply

- Forecasts of volume during the runoff season - includes most probable, probable max, and probable min
- Forecasts of peak flow, with timing - includes most probable, probable max, and probable min
- Comparison of volume and peak flow forecasts to 30-year averages
- Verification of water supply forecasts

Miscellaneous
- Historical exceedance probabilities, observed and forecasts
- Historical daily maxima stages, observed and forecasts
- Historical peak for location
- Comparison of observed versus simulated stages
- Freezing levels, observed and forecast
- Temperatures, observed and forecast
- Comparison of temperature, observed versus forecast
- Hydrometeorological discussions
- Stage definitions
- Evaporation Data
- Tide Tables
- V5 data

Seasonal
- River Ice Statement
- ESP Snowmelt
- Long-range Probabilistic Outlook
- Soil Temperature Map

Appendix B — Sample of Current Graphical Products and Information

Table B-1 Precipitation

WFOs/National Centers	RFCs
http://www.nwsla.noaa.gov/sbp1.gif	http://www.wrh.noaa.gov/cnrfc/prods/nca_24pcp12z.gif
http://www.wrh.noaa.gov/sandiego/or1hr_pcp.gif	http://www.wrh.noaa.gov/cnrfc/prods/nc_24pcp12z.gif
http://www.wrh.noaa.gov/Tucson/hydro/precipgraph.html	http://www.nwrfc.noaa.gov/res_prod/monthly.jpg
http://www.wrh.noaa.gov/cnrfc/prods/nv_pcp1.gif	http://aprfc.arh.noaa.gov/data/precip/akpmap_main.html
http://www.hpc.ncep.noaa.gov/qpf/94ewbg.gif	http://www.srh.noaa.gov/lmrfc/precip/stage3/hourly.shtml
	http://www.srh.noaa.gov/lmrfc/precip/stage3/hour_total_st3.shtml
	http://www.srh.noaa.gov/lmrfc/precip/stage3/day_total_st3.shtml
	http://www.srh.noaa.gov/lmrfc/precip/stage3/month_total_st3.shtml
	http://www.srh.noaa.gov/lmrfc/precip/stage3/todate.shtml
	http://www.srh.noaa.gov/lmrfc/precip/gage/index.shtml
	http://www.srh.noaa.gov/lmrfc/precip/gage/day_total_gage.shtml
	http://www.srh.noaa.gov/lmrfc/precip/gage/todate.shtml
	http://www.srh.noaa.gov/lmrfc/precip/map/index.shtml
	http://www.srh.noaa.gov/lmrfc/hmd/
	http://www.srh.noaa.gov/wgrfc/data/precipitation/daily/map/Sun/mainMap.html

Table B-2. QPF/QPE

WFOs/National Centers	RFCs
http://www.hpc.ncep.noaa.gov/qpf/95ep48iwbg.gif	http://www.crh.noaa.gov/mbrfc/radar/24hr12z.gif
http://www.hpc.ncep.noaa.gov/medr/95ewbg.gif	http://www.crh.noaa.gov/mbrfc/radar/24hr00z.gif
http://www.hpc.ncep.noaa.gov/qpf/99qwbg.gif	http://www.wrh.noaa.gov/cnrfc/qpf_images/point_day1_12z-18z.htm
http://www.hpc.ncep.noaa.gov/qpf/98qwbg.gif	http://www.wrh.noaa.gov/cnrfc/qpf_images/grid_day1_12z-12z_area2.htm
http://www.hpc.ncep.noaa.gov/qpf/94qwbg.gif	http://nimbo.wrh.noaa.gov/cnrfc/qpf_images/grid_day1to3.htm
	http://nimbo.wrh.noaa.gov/cnrfc/qpf_images/map_day1to3.htm
	http://nimbo.wrh.noaa.gov/cnrfc/qpf_images/point_day1to3.htm
	http://www.nwrfc.noaa.gov/forecast/qpf.html
	http://aprfc.arh.noaa.gov/data/precip/has_qpf24.html
	http://www.srh.noaa.gov/lmrfc/qpfpage.shtml

Table B-3. Seasonal Temperature and Precipitation

WFOs/National Centers	RFCs
http://www.prh.noaa.gov/pr/hnl/hydro/pages/kauai_02.gif	http://www.nwrfc.noaa.gov/res_prod/weekly.jpg
http://www.hpc.ncep.noaa.gov/medr/95Awbg.gif	http://www.nwrfc.noaa.gov/res_prod/seasonal.jpg
http://www.hpc.ncep.noaa.gov/medr/95Bwbg.gif	http://www.nwrfc.noaa.gov/res_prod/temperatures.jpg
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/1p.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/2p.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/3p.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/4p.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/5p.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/6p.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/7p.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/1t.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/2t.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/3t.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/4t.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/5t.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/6t.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/7t.html	
http://www.cpc.ncep.noaa.gov/pacdir/NFORdir/HUGEdir2/huo.html	

Table B-4. Extended River Forecasts

WFOs/National Centers	RFCs
http://www.crh.noaa.gov/cgi-bin-grr/ahps.cgi?id=eagm4&type=prob_stage	http://www.crh.noaa.gov/mbrfc/river_forecasts/long_term/GLGM8.QINE.exceed.gif
http://www.crh.noaa.gov/cgi-bin-grr/ahps.cgi?id=eagm4&type=prob_flow	http://www.crh.noaa.gov/mbrfc/river_forecasts/long_term/GLGM8.QINE.prob.weekint.gif
http://www.crh.noaa.gov/cgi-bin-grr/ahps.cgi?id=eagm4&type=prob_volume	http://www.crh.noaa.gov/mbrfc/river_forecasts/long_term/GLGM8.QINE.traces.gif
http://www.crh.noaa.gov/cgi-bin-grr/ahps.cgi?id=eagm4&type=exceed_stage	http://www.crh.noaa.gov/mbrfc/river_forecasts/long_term/GLGM8.SSTG.exceed.gif
http://www.crh.noaa.gov/cgi-bin-grr/ahps.cgi?id=eagm4&type=exceed_flow	http://www.crh.noaa.gov/mbrfc/river_forecasts/long_term/GLGM8.SSTG.prob.weekint.gif
	http://www.crh.noaa.gov/mbrfc/river_forecasts/long_term/GLGM8.volume.exceed.gif
	http://www.crh.noaa.gov/mbrfc/river_forecasts/long_term/GLGM8.volume.prob.weekint.gif
	http://nimbo.wrh.noaa.gov/cnrfc/prods/ahps/es01_SUSC1.5day_mnq.gif
	http://nimbo.wrh.noaa.gov/cnrfc/prods/ahps/es01_SUSC1.5day_vol.gif
	http://www.cbrfc.noaa.gov/ahps/project/espadpb.cgi
	http://www.srh.noaa.gov/lmrfc/forecast/riversummary/
	http://www.srh.noaa.gov/lmrfc/forecast/esp.shtml
	http://www.srh.noaa.gov/serfc/esp/html/sc.htm

Table B-5. Snowmelt, Runoff, and Snotel

WFOs/National Centers	RFCs
http://www.wrh.noaa.gov/Elko/snotel.html	http://www.cbrfc.noaa.gov/snow/snow.cgi
	http://www.cbrfc.noaa.gov/product/westwide/nrcs/2002/ms.html
	http://www.cbrfc.noaa.gov/product/westwide/nohrsc/2002/sc.html
	http://www.cbrfc.noaa.gov/product/peak/peak.cgi
	http://aprfc.arh.noaa.gov/sd_all_sites.html
	http://aprfc.arh.noaa.gov/data/snow/TUGA2.swe.shtml
	http://aprfc.arh.noaa.gov/data/snow/PAHO.swe.shtml
	http://www.crh.noaa.gov/mbrfc/snowmelt.htm

Table B-6. Hydrographs and Ratings

WFOs/National Centers	RFCs
http://www.wrh.noaa.gov/spokane/hydrology/outline/data/SPOW1.shtml	http://aprfc.arh.noaa.gov/data/river/COOA2.hg.shtml
http://www.wrh.noaa.gov/cgi-bin/Missoula/msoobs?site=STWM8&type=6%20	http://info.abrfc.noaa.gov/pub/FloodGraphs/
http://www.wrh.noaa.gov/Missoula/testhyd.html	
http://www.wrh.noaa.gov/Pocatello/rivers/rexi1.shtml	
http://www.wrh.noaa.gov/Medford/hydro/COQO3.html	
http://www.wrh.noaa.gov/Pendleton/hydrology/lgno3.shtml	
http://www.crh.noaa.gov/cgi-bin-grr/ahps.cgi?eagm4	
http://www.srh.noaa.gov/bmx/data/hydrograph/CRDA1.gif	
http://www.srh.noaa.gov/bna/images/FRAT1.gif	
http://www.wrh.noaa.gov/spokane/hydrology/outline/rating/SPOW1_rating.shtml	

Table B-7. Reservoir and Dams

WFOs/National Centers	RFCs
	http://www.nwrfc.noaa.gov/res_prod/esp_wk_plot.html
	http://www.nwrfc.noaa.gov/res_prod/esp_mon_plot.html
	http://www.cbrfc.noaa.gov/product/westwide/nrcs/2002/rs.html
	http://www.cbrfc.noaa.gov/dam2/dam2list.cgi?okey=d&skey=o2&lkey=p&out=1&ss=green%20
	http://www.srh.noaa.gov/lmrfc/ahps/esp.shtml

Table B-8. Water Supply/Drought

WFOs/National Centers	RFCs
http://www.cpc.ncep.noaa.gov/	http://nimbo.wrh.noaa.gov/cnrfc/water_supply.html
http://www.srh.noaa.gov/lmrfc/precip/drought.shtml	http://www.nwrfc.noaa.gov/cgi-bin/r_fcst
http://www.cpc.ncep.noaa.gov/products/expert_assessment/seasonal_drought.html	http://www.nwrfc.noaa.gov/cgi-bin/s_brief
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/palmer.gif	http://www.nwrfc.noaa.gov/cgi-bin/sx_brief
ftp://ftp.ncep.noaa.gov/pub/cpc/sabol/palmer/rpd07drs.gif	http://www.cbrfc.noaa.gov/rec/rec.cgi
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/addpcp.gif	http://www.srh.noaa.gov/serfc/wro/default.html
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/cmi.gif	http://info.abrfc.noaa.gov/pub/WaterSupply/

Table B-9. General Information

WFOs/National Centers	RFCs
http://www.wrh.noaa.gov/spokane/hydrology/outline/maps/SPOW1.map.htm	http://www.wrh.noaa.gov/cnrfc/fop.htm
http://www.wrh.noaa.gov/spokane/hydrology/outline/hsm/SPOW1.htm	http://nimbo.wrh.noaa.gov/cnrfc/wfo_hydro.html
http://www.boi.noaa.gov/hydro.htm	http://www.nwrfc.noaa.gov/fop.html
http://www.wrh.noaa.gov/Saltlake/projects/ifp/html/ffp.html	http://www.cbrfc.noaa.gov/product/short/fop/fop.cgi
http://www.wrh.noaa.gov/Saltlake/HydroSherrie/WeberFrameSet.htm	http://www.cbrfc.noaa.gov/product/short/oup.cgi?table?ffg?0%20
http://www.prh.noaa.gov/pr/hnl/hydro/pages/bigis_3mon_01.jpg	http://aprfc.arh.noaa.gov/data/maps/brkup_map.html
http://www.srh.noaa.gov/lub/wx/precip_freq/precip_index.htm	http://aprfc.arh.noaa.gov/data/maps/flood_pot.html
http://205.156.54.206/er/gsp/hydro/ahps/ashe19.htm	http://www.srh.noaa.gov/lmrfc/forecast/riversummary/archives.shtml
http://www.hpc.ncep.noaa.gov/rpp/images/HPC_FFGPROB6_F12.png	http://www.srh.noaa.gov/lmrfc/rfo/lmrfcrfo.shtml
http://www.hpc.ncep.noaa.gov/rpp/images/HPC_FFGPROB6_F18.png	http://www.srh.noaa.gov/lmrfc/fop/index.shtml
http://www.hpc.ncep.noaa.gov/rpp/images/HPC_FFGPROB6_F24.png	http://www.srh.noaa.gov/lmrfc/precip/ffg/
http://www.hpc.ncep.noaa.gov/rpp/images/HPC_FFGPROB6_F30.png	http://www.nws.noaa.gov/oh/hic/nho/index.shtml
http://www.hpc.ncep.noaa.gov/medr/DAY3_POP_wbg.gif	http://www.srh.noaa.gov/wgrfc/observation/basinList.html

Table B-10. River/Stream Conditions

WFOs/National Centers	RFCs
http://www.wrh.noaa.gov/spokane/hydro.htm	http://www.wrh.noaa.gov/cnrfc/prods/nc_stg1.gif
http://www.wrh.noaa.gov/spokane/hydrology/outline/SPO.html	http://www.cbrfc.noaa.gov/product/westwide/nrcs/2002/sssf.html
http://www.boi.noaa.gov/Hydro/Floodstage.htm	http://aprfc.arh.noaa.gov/hg_all_sites.html
http://www.wrh.noaa.gov/Missoula/nwsomso.hyd.html	http://www.srh.noaa.gov/lmrfc/forecast/rva.shtml
http://www.wrh.noaa.gov/Medford/hydro/	http://www.srh.noaa.gov/lmrfc/forecast/tributaries/
http://www.wrh.noaa.gov/Pendleton/hydrology/hydrologyIndex.shtml	http://www.srh.noaa.gov/serfc/
http://www.nwsla.noaa.gov/hydro/streamflow_w.html	http://www.srh.noaa.gov/ftproot/ffc/cgi-bin/rva.pl
http://www.wrh.noaa.gov/Elko/humflood.html	

Table B-11. NOHRSC

http://www.nohrsc.nws.gov/west/wur_new.gif
http://www.nohrsc.nws.gov/west/wuw_new.gif
http://www.nohrsc.nws.gov/west/wuz_new.gif
http://www.nohrsc.nws.gov/west/wuv_new.gif
http://www.nohrsc.nws.gov/west/wu8_new.gif
http://www.nohrsc.nws.gov/west/wu9_new.gif

Appendix C — The APIT Web Survey

This survey can be found at: http://www.srh.noaa.gov/lmrfc/ahpsteam/survey.php and is not included directly in this document due to length considerations and its availability on the web.

A link to the survey was distributed to a list of customers and partners that had agreed in the past to participate in future NWS surveys. A cover letter prepared by Gregg Rishel along with a link to the web survey was provided to Francis (Frank) Richards of OCWWS/HSD at the end of July 2002, who then emailed these to the list of participating customers and partners.

On September 16, 2002, an email was sent to all NWS employees asking for their participation in the survey. A copy of the email follows:

"Dear Fellow NWS Employee,

The National Weather Service Office of Climate Water and Weather Services (OCWWS) has chartered the Advanced Hydrologic Prediction Service (AHPS) Products and Information Team (APIT) to examine the agency's hydrologic services and recommend a consistent core suite of graphical hydrologic products and information for provision from field offices across the country. This core suite will support the full spectrum of hydrologic services from flash floods through extended-range river forecasts. AHPS is an initiative to modernize NWS hydrologic services and better serve our partners and customers through the infusion of science and technology.

The team's charter was coordinated with, and APIT membership includes representatives from, the NWS Regions, the Office of Hydrologic Development, the Office of Science and Technology, and OCWWS. Additional information on the APIT, including its Charter, can be found on the Team's web site at:

http://www.srh.noaa.gov/lmrfc/ahpsteam/

The team has prepared a survey to collect your comments and suggestions, as well as comments and suggestions from a spectrum of our partners and customers, on the types of hydrologic products and information the NWS should provide in a graphical format. The APIT will compile the internal and external feedback and utilize it to formulate recommendations for a consistent core suite of products. Your voluntary participation in this survey will provide the APIT with information critical to the team's success.

The APIT would appreciate your participation in the survey located at the following URL:

http://www.srh.noaa.gov/lmrfc/ahpsteam/survey.php

Please contact the APIT Leader Gregg Rishel, if you have any questions about the survey, at:

National Weather Service
125 S. State Street, Room 1311
Salt Lake City, UT 84138
Gregg.Rishel@noaa.gov
(801)524-5137 work
(801)524-3181 fax"

The web survey received many responses and comments from both groups. In order to analyze the data, Ethan Jolly wrote a web interface to extract and tabulate the responses in a detailed format. The results interface can be currently viewed at:
http://www.srh.noaa.gov/lmrfc/ahpsteam/results.php

Appendix D — Analysis of the Web Survey

The label "First Survey" identifies responses from those on the email list, and "NWS" and "non-NWS" to identify respondents after the NWS people were invited to respond. This may contain people from the "First Survey." The reason to include them for comparison here is to see if there is any difference between responses by people who have volunteered and those who responded to the request in the agency-wide mail. The categories were also combined to get a better feel for the responses. For example, the categories "*Very helpful*" and "*Helpful*" were combined as "*Positive*," similarly "*Strongly agree*" and "*Agree*" was combined as "*Positive*." The categories "*Strongly disagree*" and "*Disagree*" as well as "*Parts unclear*" and "*Not helpful*" were combined as "*Negative*." Responses under "*Average*," "*Not Sure*," and "*Not applicable*" were separated out because they do not provide any signal about the quality or merit of the data graphics. This survey can be found at the following URL: http://www.srh.noaa.gov/lmrfc/ahpsteam/survey.php.

No analysis of the sections on Reservoirs and Dams, Flash Flood Guidance, Extended QPF, Variations of QPF, and the Flood Threat graphic under General Information has been done.

River Conditions

The bar graphs tell the story. The respondents preferred Graphic A to either B or C on all the dimensions (such as, Ease of use, Grasping the situation, Visual assessment, and Meeting the needs) by a wide margin. On all dimensions the margin is between 2:1 and 5:1 in favor of Graphic A. It was interesting to note that when you compare the responses of the NWS *versus* non-NWS, the outsiders provide clearer opinions on these graphics. It is further reinforced by the fact that NWS respondents were indicating that they were not happy about any of the graphics while outsiders were fairly clear about their preferences.

When you read the comments with these responses, it seems that NWS people confound the issues with their local affinities, specific local needs, and their reticence to step back and look at the agency-wide picture. Here are some comments: " "Am I to understand that all this effort to which we are undergoing to develop an AHPS web page could be for naught? ...We, the SRH beta sites, are creating web pages like the CRH WFO page. Please get this decided before any more effort is undertaken that may not be used!" "As an NWS employee, I am not sure my response would be typical because I already know the offices with hydrologic responsibility for different areas and their products." "I like what CBRFC is doing which seems similar to Graphic B above." "I am not in favor of the Graphic A software. Have been involved in setting up, and it is NOT written well enough to be used NWS wide."

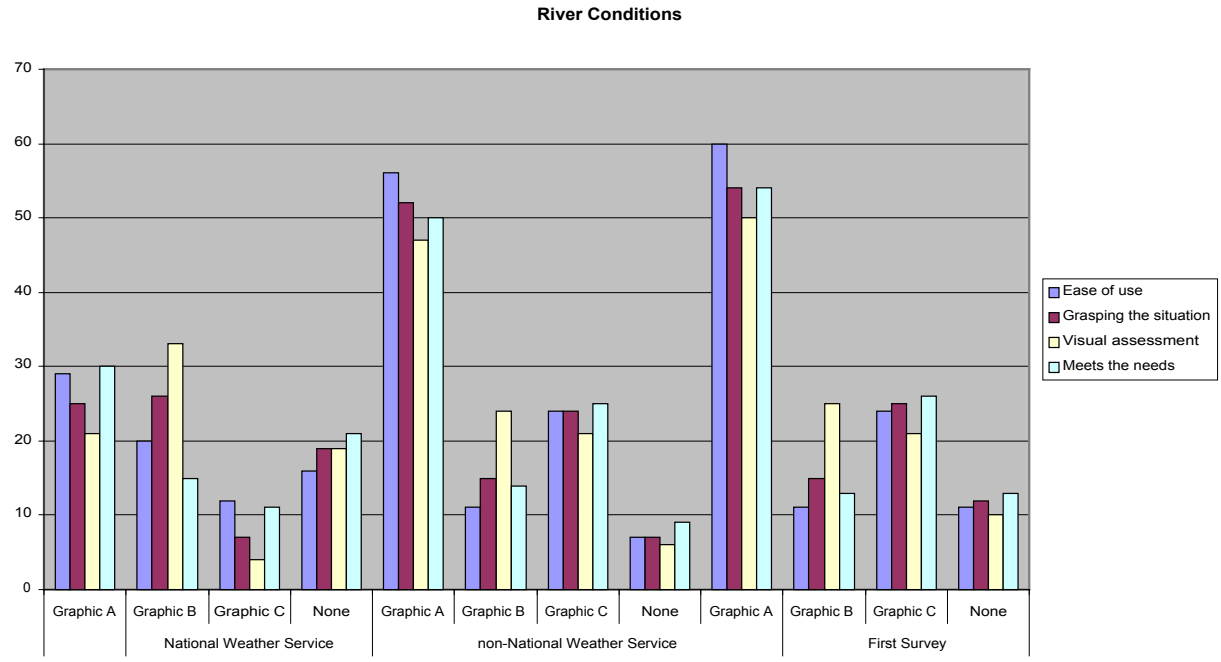


Figure 15. Responses to River Conditions

River Conditions											
National Weather Service				non-National Weather Service				First Survey			
Graphic A	Graphic B	Graphic C	None	Graphic A	Graphic B	Graphic C	None	Graphic A	Graphic B	Graphic C	None
29	20	12	16	56	11	24	7	60	11	24	11
25	26	7	19	52	15	24	7	54	15	25	12
21	33	4	19	47	24	21	6	50	25	21	10
30	15	11	21	50	14	25	9	54	13	26	13

There are some helpful comments, which should inform future graphics development: (1) Rivers need to be identified on the maps. It is commonly assumed that "a picture is worth a thousand words" and hence, to label, or use text in conjunction with graphics is seen as a heresy. However, those who have done research in data graphics and visual presentation of data tell us that it is more helpful to combine text with pictures. (2) Sensitivity in using colors, especially for those who are color blind. (3) If the information is for a large spatial area, there should be a function to let the user reach to the forecast point within three clicks. If it takes longer than that people are likely to say, "too many clicks for not enough information" (from one of the comments).

River Conditions (continued)

The graphics D and E depict national level pictures of river conditions, specifically floods. Graphic D shows current condition with color-coding for different categories of flooding used by NWS, while Graphic E shows long range forecast for flooding. From the responses to both the surveys, it is clear that there was preference for Graphic D over Graphic E in all categories. The preference is more pronounced with the external respondents than those within the NWS. However, what is noticeable about the internal respondents is that they show greater inclination

to reject both the graphics than do the outsiders. We can surmise the reasons from the comments: Instead of responding to the issue at hand, there was a tendency to what can be done with the graphic. "*Graphic D could hot link to RFCs...*", "*For graphic D, add a long list on right-hand side of graphic with many more colors to represent even more information...You can do both [current condition plus immediate future forecast] by using more colors*." "*I find the red pointer lines on graphic E confusing. Can lines be eliminated?*"

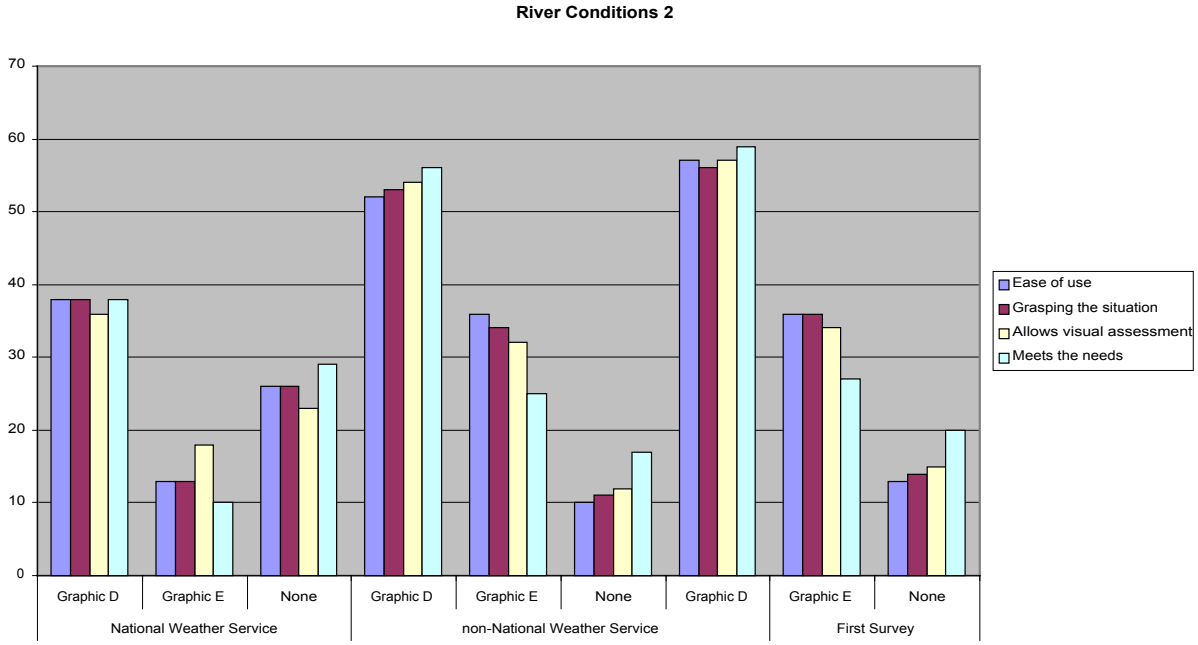


Figure 16. Responses to River Conditions

River Conditions								
National Weather Service			non-National Weather Service			First Survey		
Graphic D	Graphic E	None	Graphic D	Graphic E	None	Graphic D	Graphic E	None
38	13	26	52	36	10	57	36	13
38	13	26	53	34	11	56	36	14
36	18	23	54	32	12	57	34	15
38	10	29	56	25	17	59	27	20

There were some useful suggestions, such as, "*I need to see where it is flooding, what the peak will be, and some info about historical flooding would really be icing on the cake. Graphics without supporting data displayed and vice versa, are difficult to deal with*." "*The ability to select an individual state from graph D would be useful*." "*D could be worthwhile if it allowed clicking on the map to look at the current and forecast stages at particular points*."

What can we discern from the responses? The users would like to see clear labels, clear categories of information, supplementary information to enable the users to make a judgment, and easier navigation from the national picture to the actual point where a hydrologic event is taking place.

Drought

The graphics under this category actually present two different ways of presenting information about drought. Drought is a complex phenomenon and is not strictly defined in hydrologic terms by people who are not hydrologists. In general, there was a positive reaction to both the graphics on all the dimensions, namely, sufficiency of information to make informed decisions, ease of understanding, clarity of information, and sufficiency of information about water conditions. The internal respondents once again were either neutral or unsure compared to external respondents. The reasons are not clear from the comments available.

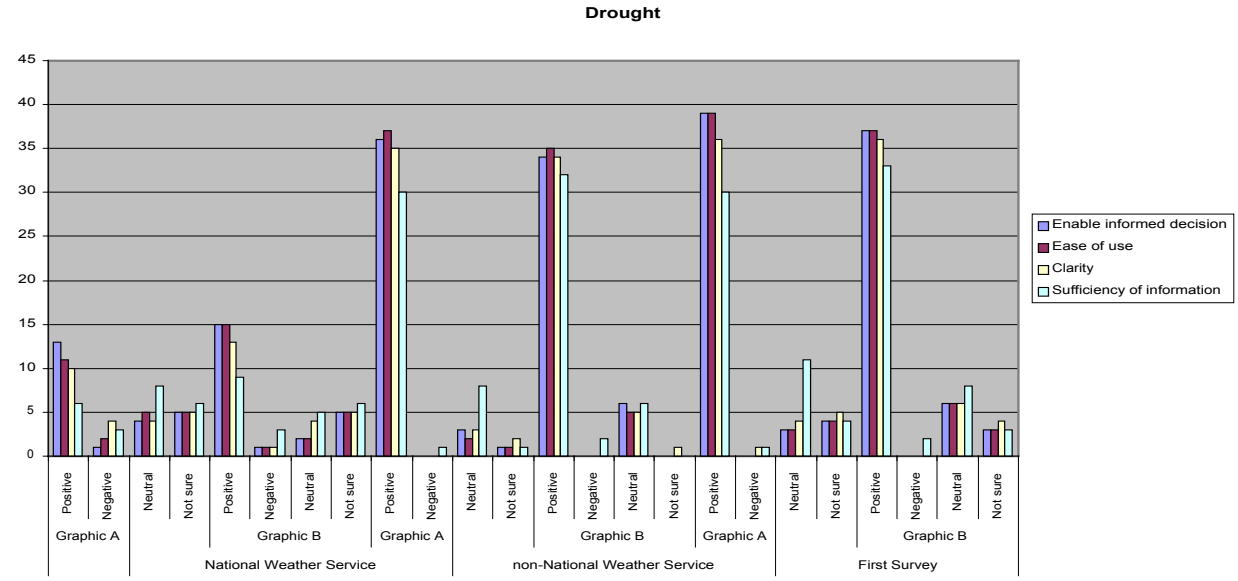


Figure 17. Responses to Drought

Drought														
National Weather Service								non-National Weather Service						
Graphic A				Graphic B				Graphic A				Graphic B		
Positive	Negative	Neutral	Not sure	Positive	Negative	Neutral	Not sure	Positive	Negative	Neutral	Not sure	Positive	Negative	Neutral
13	1	4	5	15	1	2	5	36	0	3	1	34	0	6
11	2	5	5	15	1	2	5	37	0	2	1	35	0	5
10	4	4	5	13	1	4	5	35	0	3	2	34	0	5
6	3	8	6	9	3	5	6	30	1	8	1	32	2	6

Snow

The two graphics for snow related information show a preference pattern similar to one mentioned above. The NWS respondents prefer Graphic A by a significant margin as do the non-NWS respondents, however, the negative votes from NWS respondents is much higher than the other set of respondents.

Some of the negative feedback actually points to the improvements necessary to make the graphics useful. For example, "*for Graphic A, on zooming the legend disappears*". It is necessary to have the legend explaining the colors or categories at all times. If it disappears on zooming, we need to make sure that the graphics are of a specific size. An observation: *It is a*

common occurrence on NWS sites that people do not pay attention to such basic elements as size of the graphic, explanations of colors or categories, explanations of abbreviations, proper titles for graphics, etc. It is assumed that since we understand, everybody outside the NWS will understand. Another comment, "*Both are hard to read and understand*," tells us that we do not have satisfactory graphic, even though Graphic A is preferred. A suggestion: *It will be worth reflecting on the fact that most of the graphics are screen-captures or are developed with very specific users in mind. This was probably all right when dissemination by means other than the Web was common because there were relatively few users and the exposure of the forecast documents was limited. The documents (text and graphic forecasts, watches, and warnings) are now visible 24 hours and anyone with access to the Web can look at it. This is good because it expands the fold, however, it also requires that we provide information in ways that are useful and usable to varied people.*

Here are some substantive criticisms: "*Neither adequately explains snow water equivalent very well,*" "*Snow depths need to show how old is the data*." Without that information it could be giving an erroneous picture, especially after a heavy snowstorm. It suggests that we need to think of how to combine information in a graphic so that it provides water equivalent, date when the graphic was generated, and the amount of snow in one data graphic.

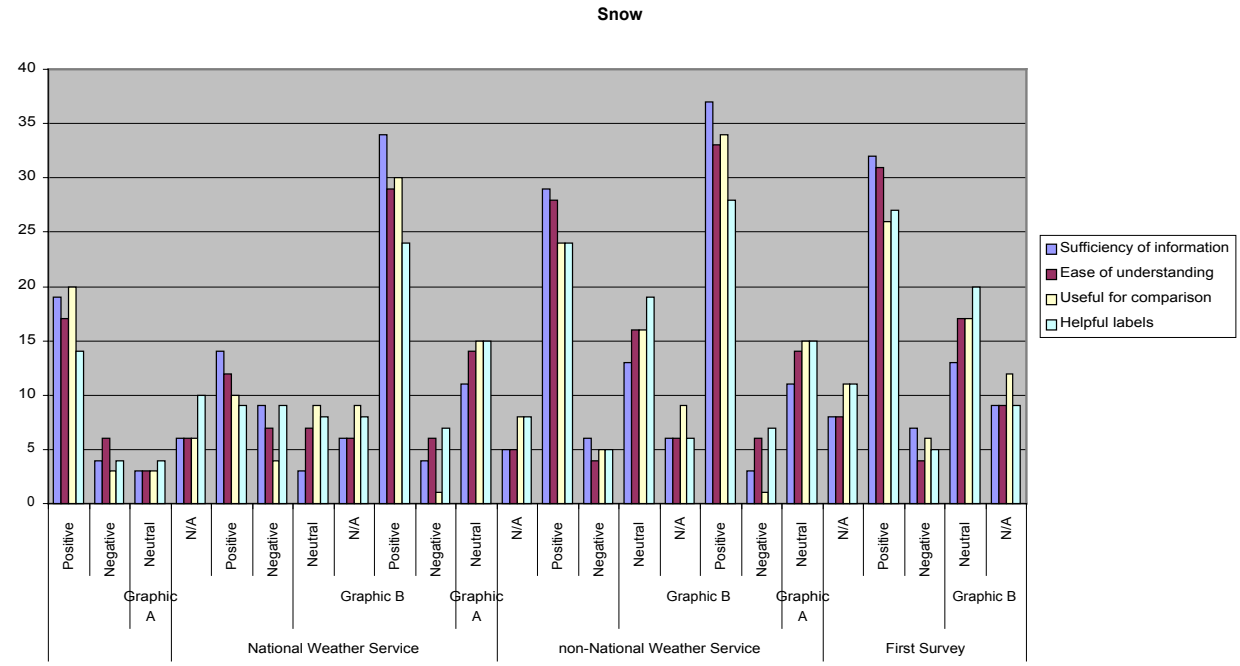


Figure 18. Responses to Snow

Snow																
National Weather Service								non-National Weather Service								
Graphic A				Graphic B				Graphic A				Graphic B				
Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A	
19	4	3	6	14	9	3	6	34	4	11	5	29	6	13	6	
17	6	3	6	12	7	7	6	29	6	14	5	28	4	16	6	
0	3	3	6	10	4	9	9	30	1	15	8	24	5	16	9	
14	4	4	10	9	9	8	8	24	7	15	8	24	5	19	6	

First Survey							
Graphic A				Graphic B			
Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A
37	3	11	8	32	7	13	9
33	6	14	8	31	4	17	9
34	1	15	11	26	6	17	12
28	7	15	11	27	5	20	9

Snow Water Equivalent

Responses to the two graphics for snow water equivalent show that Graphic B is preferred to Graphic A. The number of neutral or "not applicable" votes indicates problems with that graphic. In the first survey, proportion of positive responses to negative were in favor of Graphic B but it also showed that many respondents either were neutral or did not care for it. Once again, when we look at the second iteration of the survey, it shows that the NWS respondents were evenly divided between the two and the external respondents preferred Graphic B. The five dimensions on which the questions were asked respondents were not getting good usable information. It is helpful to look at the number of responses for each dimension and read the comments.

The respondents were reacting to many aspects: Floridians were unwilling to offer comments about a snow graphic; data presentation in graphical instead of numerical format; and inability to evaluate graphics in the absence of data (no snow on the ground). The more serious comment once again draws attention to the fact that "neither graphic provides information required to make necessary decisions leading up to required actions prior to potential spring snow melt flooding." This leads to reiteration of the comment made in the context of snow graphic, namely, there is an urgent need to reconstruct graphics to provide useful and usable information for the customer. An observation: It would be important to step outside the shell, *if we think it is useful, it must be useful for others* or *if we understand it, others will understand it too*, to develop better data graphics.

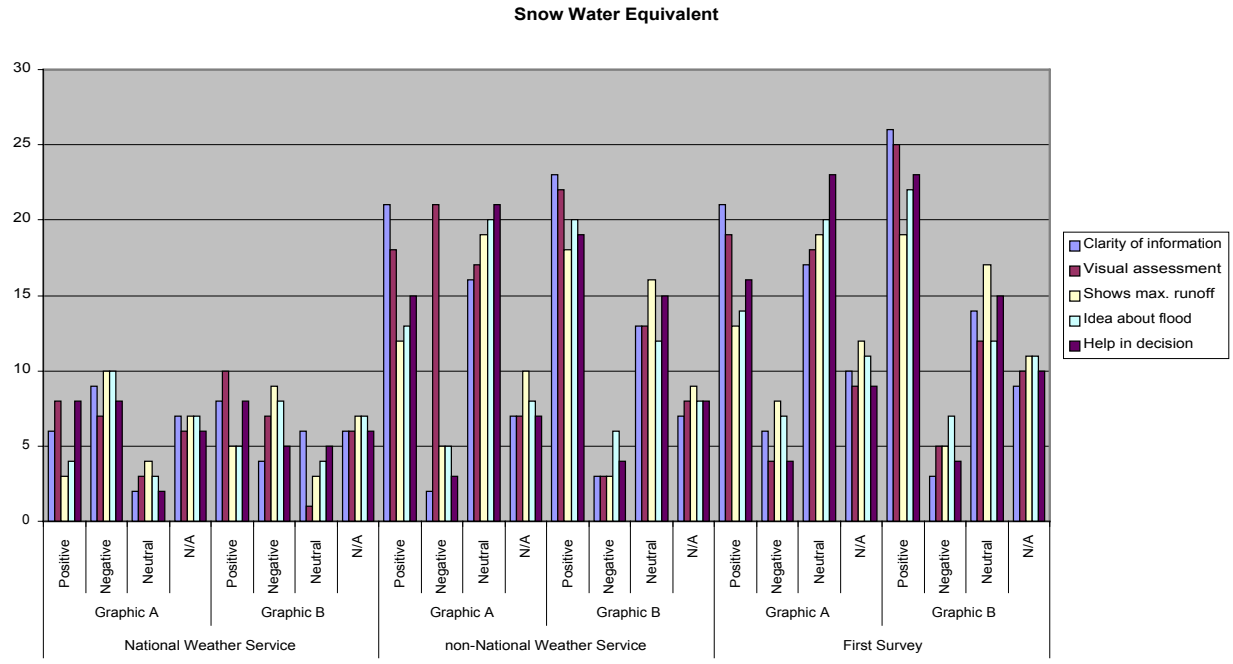


Figure 19. Responses to Snow Water Equivalent

Snow Water Equivalent															
National Weather Service								non-National Weather Service							
Graphic A				Graphic B				Graphic A				Graphic B			
Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A
6	9	2	7	8	4	6	6	21	2	16	7	23	3	13	7
8	7	3	6	10	7	1	6	18	21	17	7	22	3	13	8
3	10	4	7	5	9	3	7	12	5	19	10	18	3	16	9
4	10	3	7	5	8	4	7	13	5	20	8	20	6	12	8
8	8	2	6	8	5	5	6	15	3	21	7	19	4	15	8

Snow Water Equivalent							
First Survey							
Graphic A				Graphic B			
Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A
21	6	17	10	26	3	14	9
19	4	18	9	25	5	12	10
13	8	19	12	19	5	17	11
14	7	20	11	22	7	12	11
16	4	23	9	23	4	15	10

Water Supply

The three graphics offered in this section received some interesting reactions to the structure and dissemination of hydrologic information. In the initial survey and in its reiteration, Graphic C is a clear favorite on all dimensions, namely, useful information for decision-making, ease of understanding, indication of forecast uncertainty, and helpful labels. Graphic C provides far less neutral or negative responses compared to other graphics. Respondents are not interested in Graphic A or B.

The comments are interesting for two reasons: (1) Those who are not commonly working with water supply issues do not want to offer their views on what they thought about the graphics. *This*, to me, *indicates* that either (a) our graphics are not intelligible or clear and hence, the reactions, "not useful", "*I do not work with Water Supply*" or "*These graphics are useful for water supply areas*". This allows the respondent to steer away from information; or (b) The information we provide through these graphics is for professionals only and it alienates the general public from it. For example, here is a comment: "There [are] two distinct audiences here: Professionals in hydrology, and the public. The public needs much more of an explanation to understand why their reservoir/lake is not full or overflowing". A comment: *It implies that NWS needs to make a conscious attempt to provide information in formats that will help the general public to understand it. If NWS takes the elitist view that if you don't understand it, we don't want to dumb it down, then there is a risk of private vendors taking the same information and providing it in forms that some non-specialists can understand. The general public will have no reason to look at NWS for weather information. It has consequences for the organization and they are clear to anyone who wants to see in that direction.*

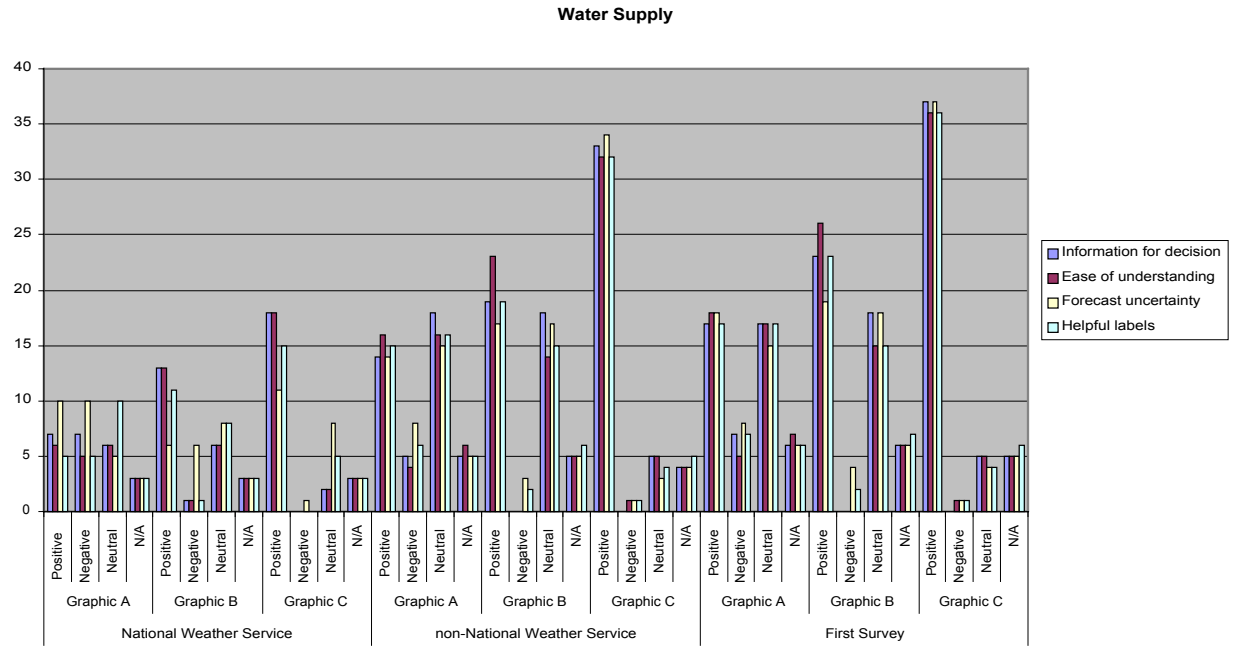


Figure 20. Responses to Water Supply

Water Supply															
National Weather Service								non-National Weather Service							
Graphic A				Graphic B				Graphic A				Graphic B			
Positive	Negative	Neutral	Not sure	Positive	Negative	Neutral	Not sure	Positive	Negative	Neutral	Not sure	Positive	Negative	Neutral	Not sure
13	1	4	5	15	1	2	5	36	0	3	1	34	0	6	0
11	2	5	5	15	1	2	5	37	0	2	1	35	0	5	0
10	4	4	5	13	1	4	5	35	0	3	2	34	0	5	1
6	3	8	6	9	3	5	6	30	1	8	1	32	2	6	0

Water Supply							
First Survey							
Graphic A				Graphic B			
Positive	Negative	Neutral	Not sure	Positive	Negative	Neutral	Not sure
39	0	3	4	37	0	6	3
39	0	3	4	37	0	6	3
36	1	4	5	36	0	6	4
30	1	11	4	33	2	8	3

Hydrograph

Among all the graphics included in the survey, hydrographs are the most commonly used graphics used by the professional and casual users of hydrologic information. *From the feedback We have seen on the Central Region Web pages received from the users it is clear that users like it because they understand it and use it effectively.* Hence, this is a graphic we can look at closely.

In the first survey Graphic B received most favorable responses from the users (proportion of positive and negative responses). We had asked questions on different dimensions relating to the information and users provided helpful feedback. Graphic A received favorable responses for clarity of information, flood indication, and sufficiency of information. It did not do so well on other dimensions, information about gauge location, information about flow and tabular format. The question about tabular format was included because many users wanted to know more precise information about both stage and flow but it is not easy to get it from the graphic. *Such information, users had told us can be printed and circulated easily for meetings or discussions.* The neutral or negative responses to both Graphic A and C are high indicating some weaknesses in those graphics. For example, in Graphic C respondents found the clarity of information about flood level to be weak, a similar weakness relating to flow was seen in the responses to Graphic A.

In the second survey, Graphic B was preferred over others by both the internal and external respondents. The internal respondents gave Graphic A high marks for clarity, but Graphic B was rated high on all dimensions. Graphic C was rated the lowest on all dimensions.

The comments indicated the preferences of the respondents for one graphic or another, but did not offer any helpful information to improve the data graphics.

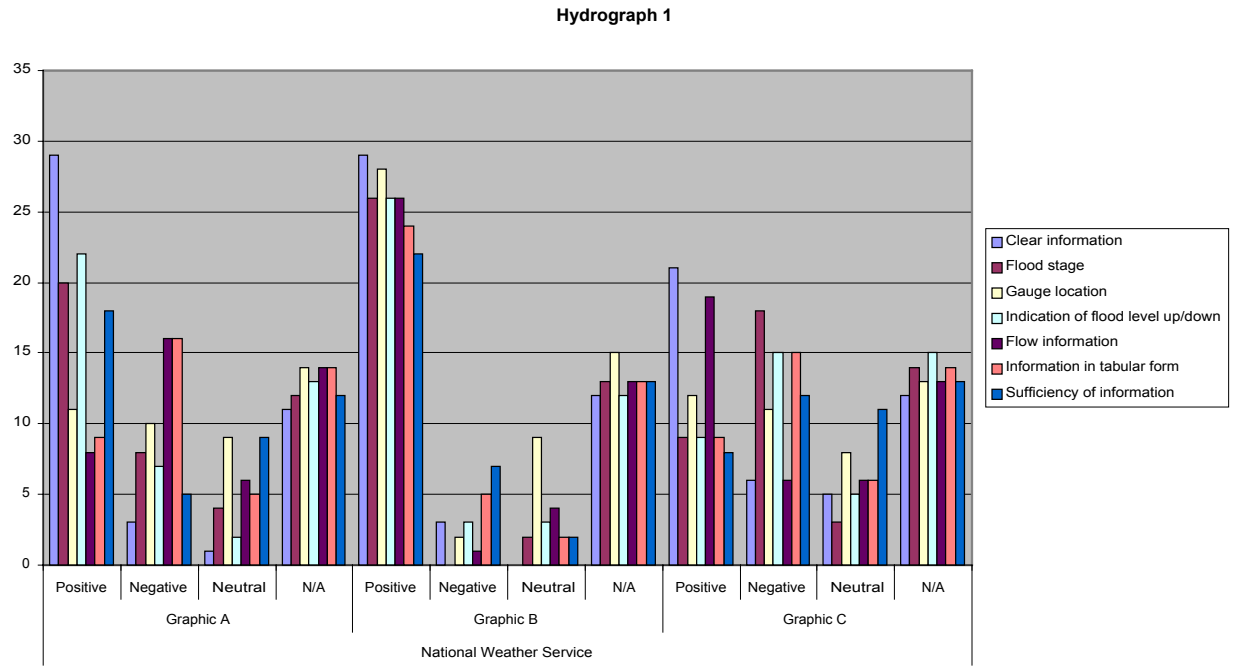


Figure 21. Responses to Hydrograph 1

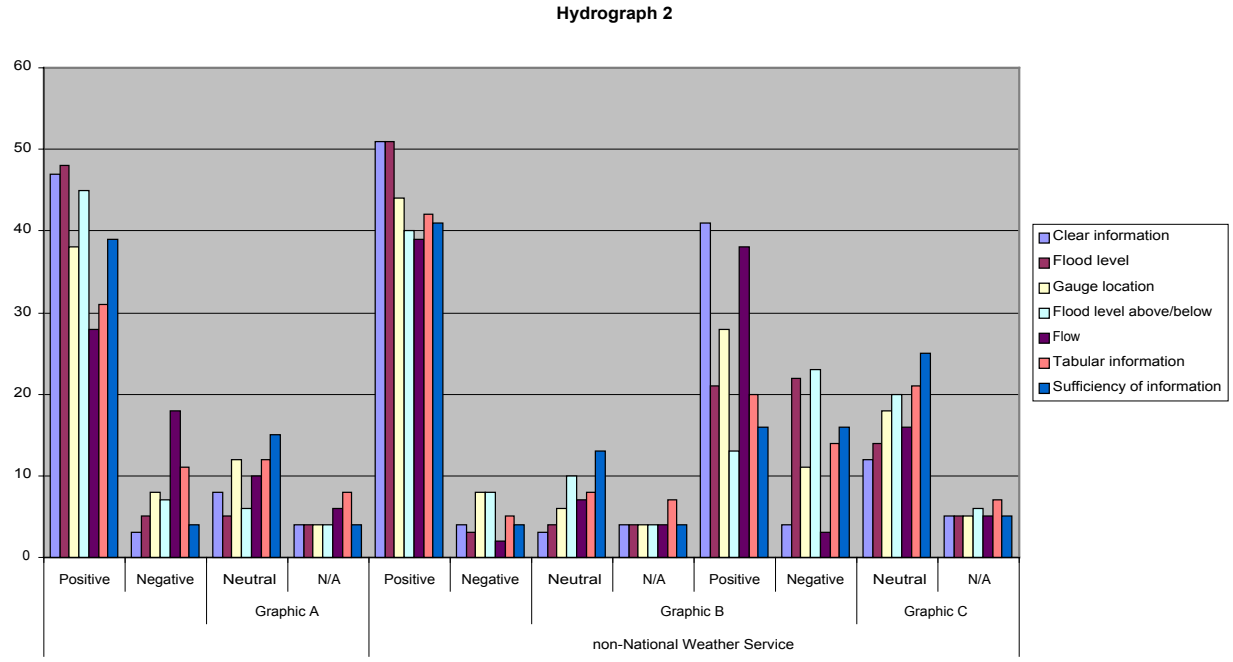


Figure 22. Responses to Hydrograph 2

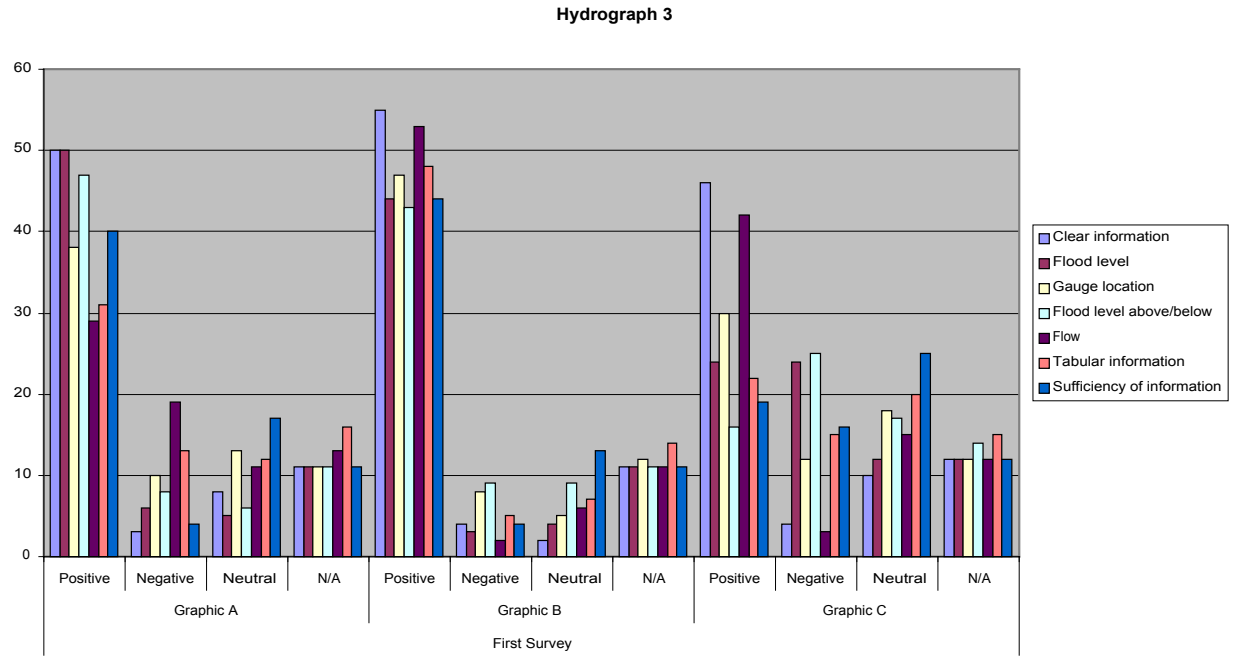


Figure 23. Responses to Hydrograph 3

National Weather Service											
Graphic A				Graphic B				Graphic C			
Positive	Negative	Average	Not sure	Positive	Negative	Average	Not sure	Positive	Negative	Average	Not sure
19	18	8	14	37	3	4	15	22	11	12	14
25	12	8	14	27	7	7	18	22	9	10	18
16	15	14	14	31	7	6	15	17	13	15	14
20	14	10	15	36	4	4	15	19	16	10	14
8	17	7	27	14	9	7	29	15	12	7	25

non-National Weather Service											
Graphic A				Graphic B				Graphic C			
Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A
47	3	8	4	51	4	3	4	41	4	12	5
48	5	5	4	51	3	4	4	21	22	14	5
38	8	12	4	44	8	6	4	28	11	18	5
45	7	6	4	40	8	10	4	13	23	20	6
28	18	10	6	39	2	7	4	38	3	16	5
31	11	12	8	42	5	8	7	20	14	21	7
39	4	15	4	41	4	13	4	16	16	25	5

First Survey											
Graphic A				Graphic B				Graphic C			
Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A
50	3	8	11	55	4	2	11	46	4	10	12
50	6	5	11	44	3	4	11	24	24	12	12
38	10	13	11	47	8	5	12	30	12	18	12
47	8	6	11	43	9	9	11	16	25	17	14
29	19	11	13	53	2	6	11	42	3	15	12
31	13	12	16	48	5	7	14	22	15	20	15
40	4	17	11	44	4	13	11	19	16	25	12

Extended River Conditions

The three graphics indicate extended river conditions in three different formats, namely, weekly probability of exceedance, short-term probability of exceedance, and 90-day probability of exceedance. These graphics are not comparable because they present different temporal frames and formats. The questions we had asked required the users to indicate their evaluation of information, use of colors to indicate categories of information, appropriate labeling, facility of the graphic to enable visual assessment, and provision of supplementary tools to make an informed decision. *The concepts of probabilistic forecasting have been introduced in NWS forecasts in last three years and hence, users have difficulty in understanding them, let alone using them. We have seen feedback from the users in Central Region.* We need to be very careful in evaluating the responses to assess the propriety of these graphics for a core suite.

The responses in two surveys we conducted tell us that respondents are unsure of what the graphics communicate. The number of responses under "Average" and "Not sure" are fairly high. For example in the first survey, total responses under these two categories are higher than under either positive or negative responses for all the graphics. This indicates the need for better explanation of these graphics if users are going to find them useful or usable. If we look at positive and negative responses, then graphics B and C fare better than Graphic A. It is useful to see the comments about these graphics. Graphic C was favored for density of information and supplementary tools that could be used for planning. Graphic C was also preferred by one respondents for its colors, "I am color blind (red-green) Graphic C was by far the least problematic for me." We need to pay close attention to these considerations as part of our service to the general public.

The tenor of comments was not very different in the second survey. The NWS and non-NWS respondents also indicate their unease and unfamiliarity to these graphics through high number of "Average " and "Not sure" responses. This high proportion deserves greater attention to ensure that NWS devotes more attention to explaining the data graphics to internal and external users. The respondents indicate their preference for Graphic B followed by Graphic C. The comments reflect "unease," "unfamiliarity," and "dislike" for "probabilistic forecasts". One comment is worth noting, "*Remember we will be providing this material for ALL users, not just statisticians*." It is a comment from an internal respondent. A comment: *If NWS employees are telling us what is not helpful, then how will external users receive it. The outreach is better if only the messenger is comfortable about the message. It is important to remember that it is better to familiarize the staff about new statistical tools for forecasting before they are disseminated or else they will stand no chance of success.*

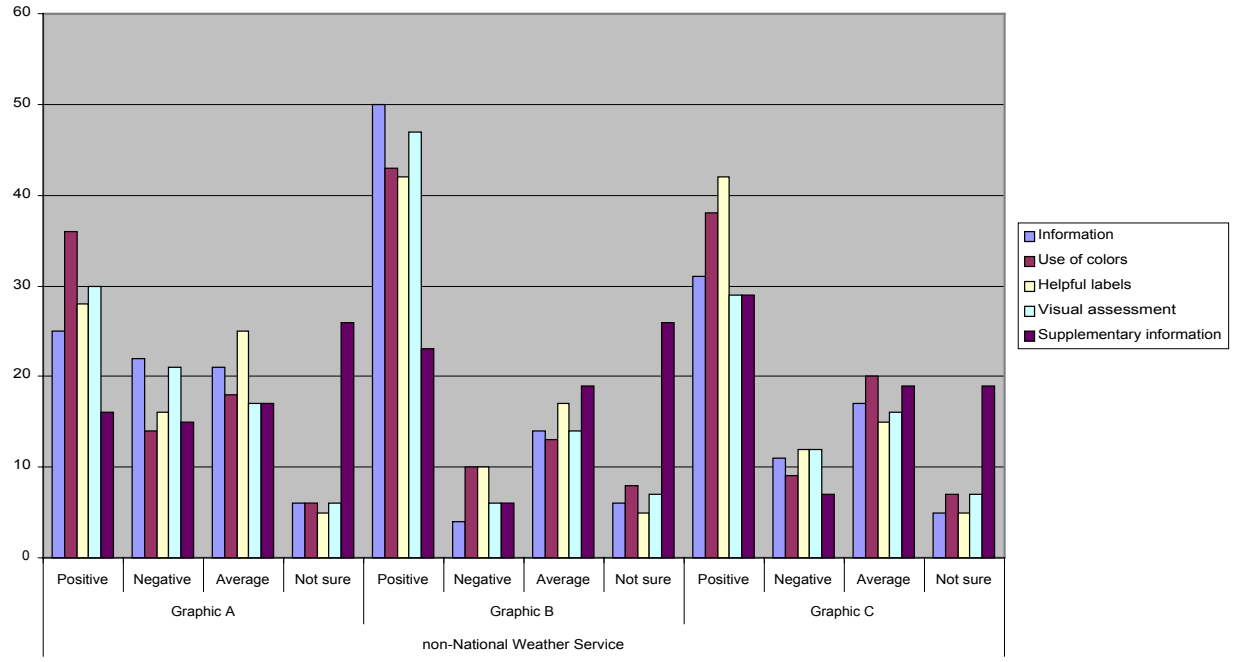


Figure 24. Responses to Extended River Conditions 1

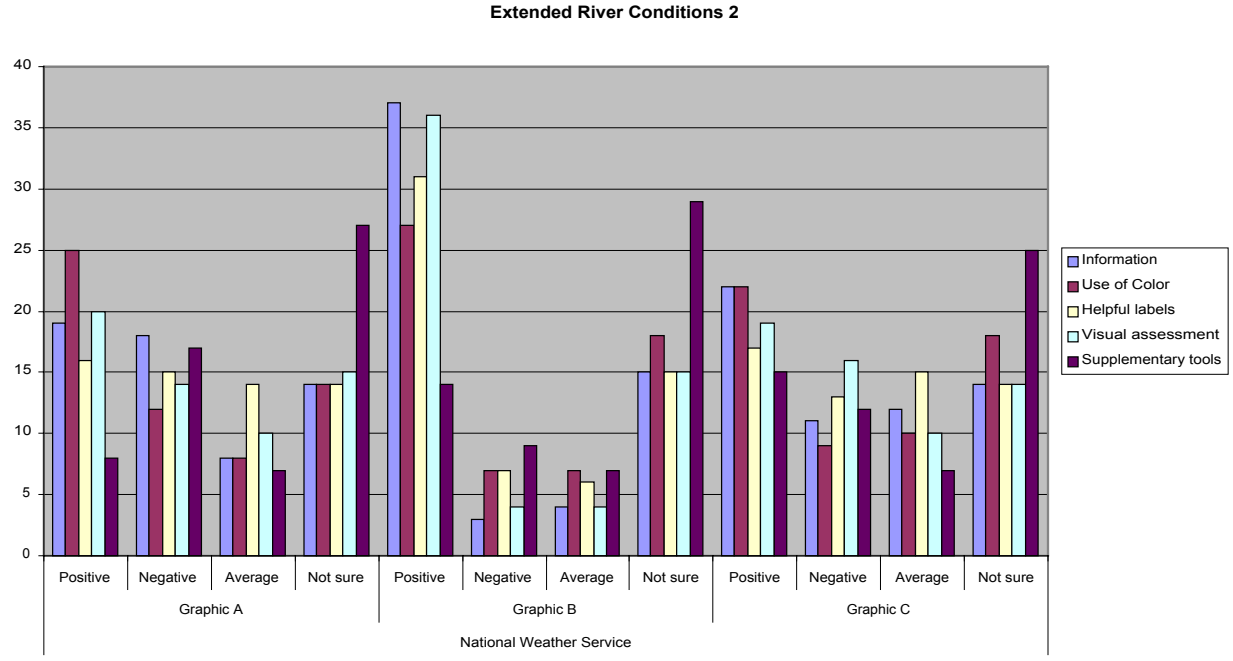


Figure 25. Responses to Extended River Conditions 2

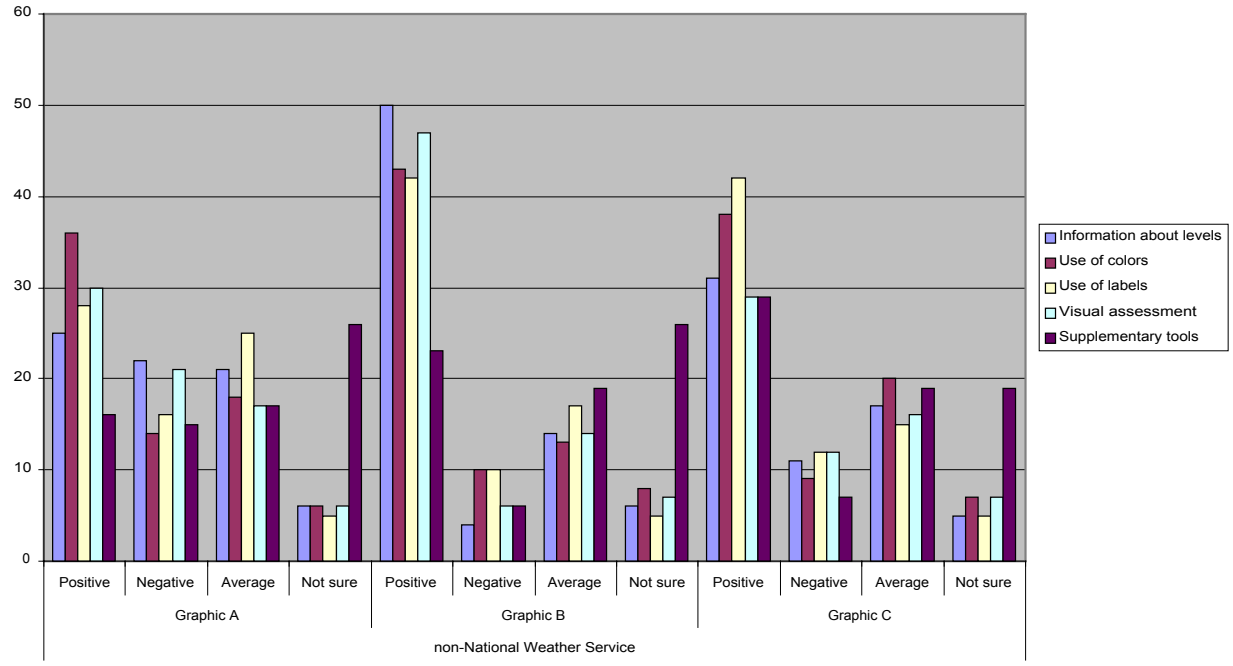


Figure 26. Responses to Extended River Conditions 3

National Weather Service											
Graphic A				Graphic B				Graphic C			
Positive	Negative	Average	Not sure	Positive	Negative	Average	Not sure	Positive	Negative	Average	Not sure
19	18	8	14	37	3	4	15	22	11	12	14
25	12	8	14	27	7	7	18	22	9	10	18
16	15	14	14	31	7	6	15	17	13	15	14
20	14	10	15	36	4	4	15	19	16	10	14
8	17	7	27	14	9	7	29	15	12	7	25

non-National Weather Service											
Graphic A				Graphic B				Graphic C			
Positive	Negative	Average	Not sure	Positive	Negative	Average	Not sure	Positive	Negative	Average	Not sure
25	22	21	6	50	4	14	6	31	11	17	5
36	14	18	6	43	10	13	8	38	9	20	7
28	16	25	5	42	10	17	5	42	12	15	5
30	21	17	6	47	6	14	7	29	12	16	7
16	15	17	26	23	6	19	26	29	7	19	19

First Survey											
Graphic A				Graphic B				Graphic C			
Positive	Negative	Average	Not sure	Positive	Negative	Average	Not sure	Positive	Negative	Average	Not sure
25	25	22	12	56	4	12	12	44	11	18	11
39	14	19	12	47	11	12	14	40	9	22	13
30	18	25	11	48	10	15	11	45	11	17	11
32	22	18	12	53	6	12	13	43	12	16	13
17	17	17	33	31	8	20	25	31	8	20	25

Precipitation

It is difficult to explain the responses received for this set of graphics. We had arrayed six graphics relating to precipitation and asked the respondents to state their preferences and comments. The graphics varied by spatial coverage (grid, region, etc.), sources of data (radar, gauge, etc.), and time intervals (24-hour, monthly, etc.). The questions related to data sources, color codes, preferred time intervals, and data needs. There was little interest in point data, monthly data, or gauge data among both categories of respondents. The internal users did not care for daily data either. The preference was for data for short time interval, explicit values, color-coding, comparative data, precipitation amounts, gauge plus radar, and data in grid format. This pattern is true for both the surveys.

There were comments indicating that attention should be paid to the needs of the users implying these graphics are what NWS people like and are not appropriate for general public outside. A suggestion to the effect that the graphics need to be oriented toward the needs of the users is worth using as a guide for our considerations. Respondents have given their preferences for one graphic or another, and some preferred a cluster of them, but it is not apparent which one would help.

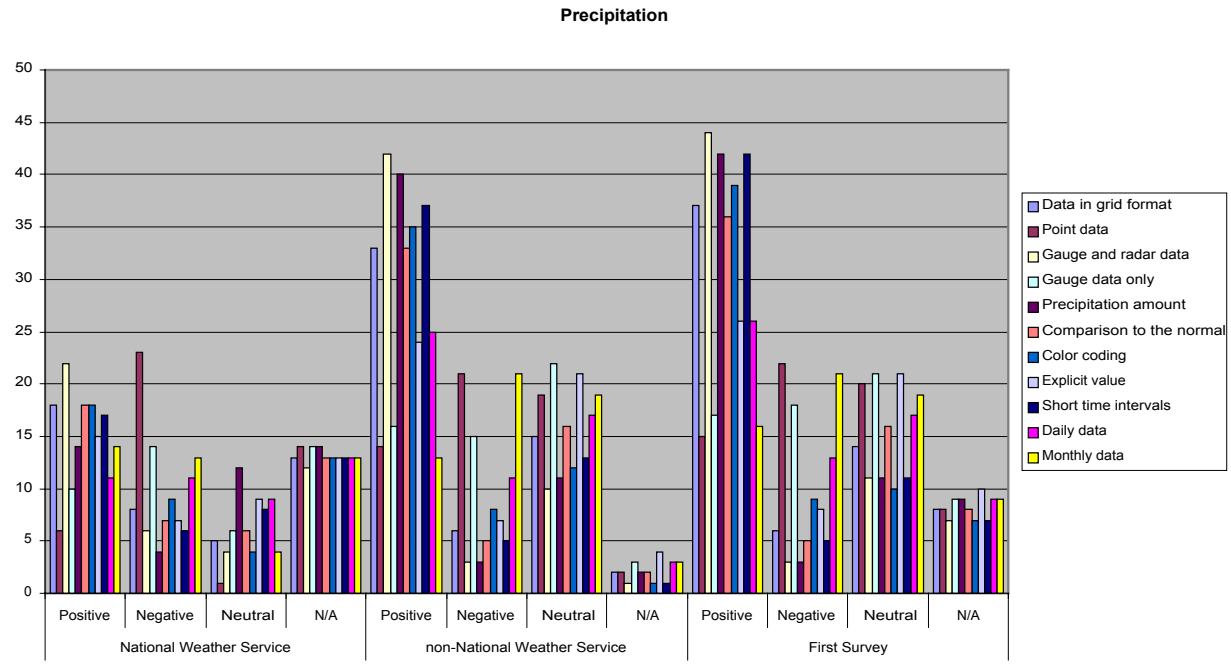


Figure 27. Responses to Precipitation

Precipitation											
National Weather Service				non-National Weather Service				First Survey			
Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A	Positive	Negative	Neutral	N/A
18	8	5	13	33	6	15	2	37	6	14	8
6	23	1	14	14	21	19	2	15	22	20	8
22	6	4	12	42	3	10	1	44	3	11	7
10	14	6	14	16	15	22	3	17	18	21	9
14	4	12	14	40	3	11	2	42	3	11	9
18	7	6	13	33	5	16	2	36	5	16	8
18	9	4	13	35	8	12	1	39	9	10	7
15	7	9	13	24	7	21	4	26	8	21	10
17	6	8	13	37	5	13	1	42	5	11	7
11	11	9	13	25	11	17	3	26	13	17	9
14	13	4	13	13	21	19	3	16	21	19	9

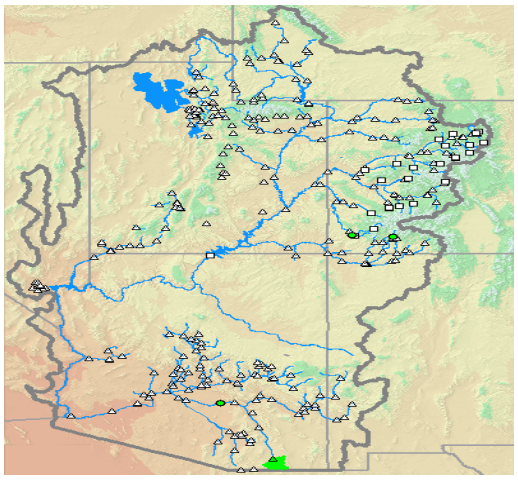
Appendix E — Hydrologic Program Manager's Survey

The APIT made a survey available to all of the attendees at the NWS Hydrologic Program Manager's Conference in December 2002. The hard copy survey was abbreviated when compared to the Web survey conducted by the team. This survey included thumbnail graphics, description of the information displayed, and a comments section. There were approximately 50 respondents (depicted as a small colored square on each chart) to this survey. This appendix contains the survey and a summary of the responses.

The Survey

River Conditions

Graphic A



Graphic B

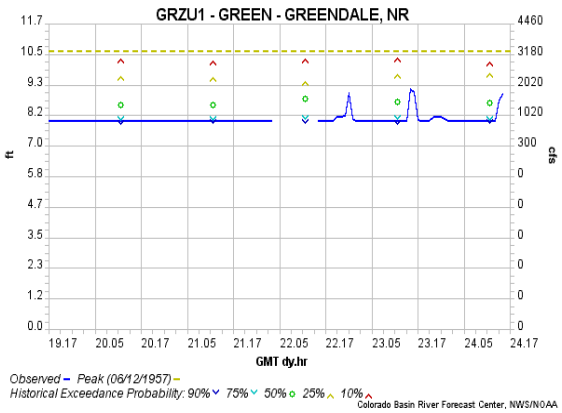
The two graphics above provide "clickable" maps of the forecast points in specific area of responsibility of a NWS office. This graphic is the first graphic that you would see on the web page. It provides a quick overview of the hydrologic conditions and for navigating to the location/s of interest. By clicking on a point on the map, you can view the current observed and forecast level and flow information for that location.

Graphic A allows you to see parts of the river basins with the facility to navigate along the streams to see the conditions up and down stream. It also provides color-coding for current river conditions of below, near flood stage, or above flood stage.
Graphic B provides river conditions for entire river basins. Color-coding is provided for locations and river basins for normal conditions, significant rises, near bankfull, above bankfull, and above flood stage. Please provide your response to the following statements.

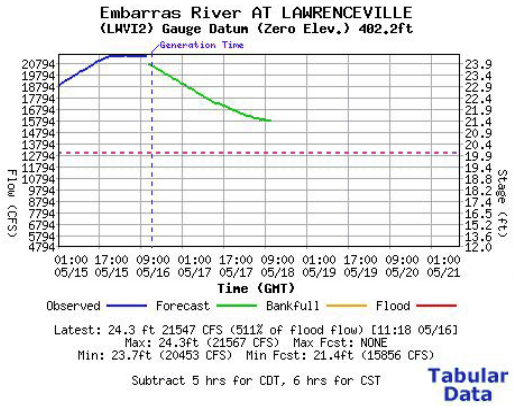
1. Graph A allows me to get the information most easily.	Yes	No
2. Graph B allows me to get the information most easily.	Yes	No
3. Graph A presents the information better to help me to understand the situation.	Yes	No
4. Graph B presents the information better to help me to understand the situation.	Yes	No
5. Graph A provides more of the information I need.	Yes	No
6. Graph B provides more of the information I need.	Yes	No

Please provide any additional comments, suggestions, or ideas that you feel would enhance the above graphics or services (optional):

Hydrograph



Graphic A



Graphic B

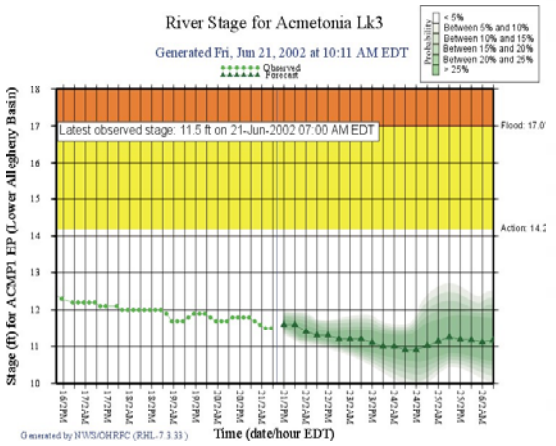
A hydrograph shows how the river level changes over time at a specific location. Observed and/or forecast hydrographs are provided at locations where data are available. Graphic A shows the observed hydrograph and historical information such as exceedance probabilities and historical peak flow. Graphic B shows the observed and five-day forecast hydrograph.

Please provide your response to the following statements.

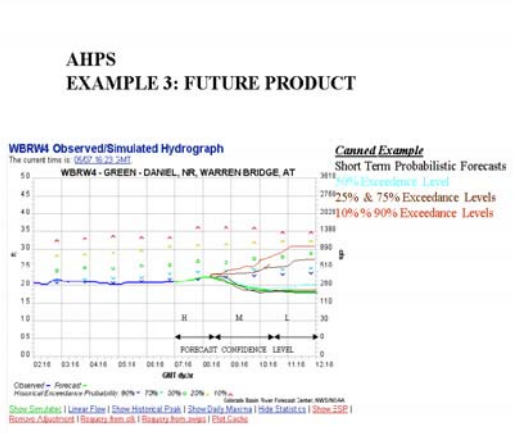
1. Graphic A provides the observed water level information I need.	Yes	No
2. Graphic B provides the observed water level information I need.	Yes	No
3. Graphic A provides the flow information I need.	Yes	No
4. Graphic B provides the flow information I need.	Yes	No
5. Graphic A could show me if and when the river may go above or below flood stage.	Yes	No
6. Graphic B could show me if and when the river may go above or below flood stage.	Yes	No
7. Graphic A provides me with sufficient information to make informed decisions.	Yes	No
8. Graphic B provides me with sufficient information to make informed decisions.	Yes	No

Please provide any additional comments, suggestions, or ideas that you feel would enhance the above graphics or services (optional):

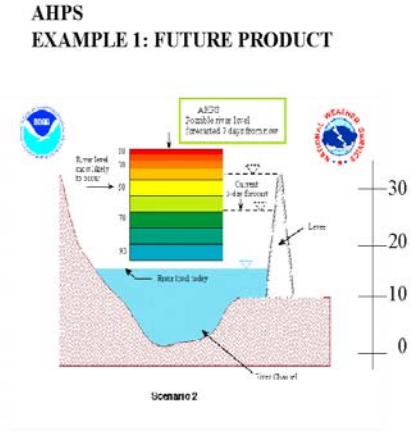
Hydrographs (cont.)



Graphic C



Graphic D



Graphic E

The three graphics above are examples of potential data graphics depicting short-term (five days or more) forecast information with uncertainty. The intent is to provide some measure of the extent of uncertainty inherent in the forecast of water levels. Graphics C and D provide observed hydrographs with information about flood stage and forecast for five days or more.

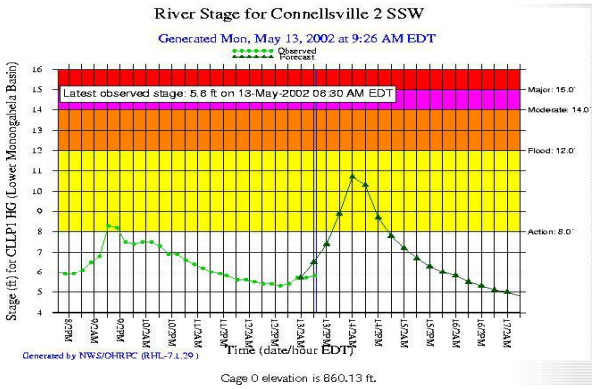
Graphic C provides the deterministic forecast hydrograph and has different probabilities in gray shading about this line.
Graphic D provides separate forecast hydrographs for various exceedance probabilities to indicate a range of probable scenarios.
Graphic E provides information about the probability that the water level will reach certain heights. It also provides other supplementary information.

Please provide your response to the following statements.

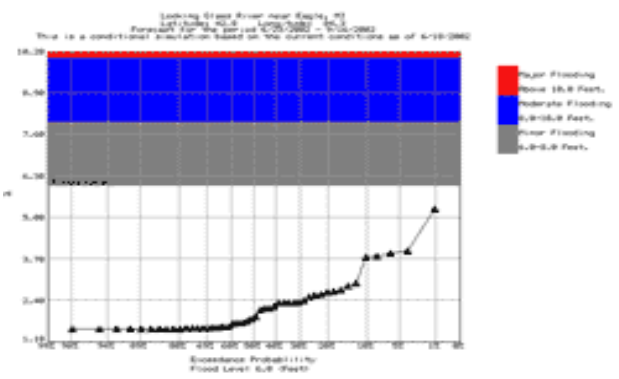
1. Uncertainty information on forecasts out to five days or so is important to me.	Yes	No
2. Graphic C provides the forecast uncertainty information in a useable format.	Yes	No
3. Graphic D provides the forecast uncertainty information in a useable format.	Yes	No
4. Graphic E provides the forecast uncertainty information in a useable format.	Yes	No
5. Graphic C provides me with information to make informed decisions.	Yes	No
6. Graphic D provides me with information to make informed decisions.	Yes	No
7. Graphic E provides me with information to make informed decisions.	Yes	No
8. I prefer the presentation in graphic C to that of Graphic C and/or D.	Yes	No

Please provide any additional comments, suggestions, or ideas that you feel would enhance the above graphics or services (optional):

Extended River Forecasts



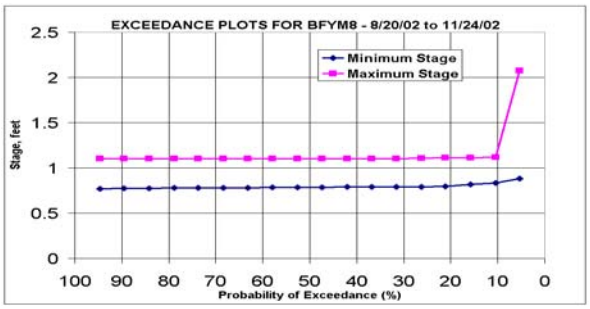
Graphic A



Graphic B

Mountain Products

Need a product to deal with areas influenced by snow. Can we do better?



Graphic C

These graphics provide forecasts of water levels for a location on a river for an extended period of time. The period of time can be determined by customer requirements and the hydrologic condition of that particular location. Graphic A provides a deterministic forecast while Graphics B and C provide forecasts that include uncertainty information.

Graphic A shows observed levels and a forecast hydrograph for the next four days. [**Note**: *This*

is just an example, the length of time could be extended beyond four days for many locations.] The levels at which flood risks increase are indicated on the graph.

Graphic B shows the probability of river exceeding a certain level during the next 90 days. This graphic also indicates the level of flood risk by color bands marking the thresholds of different flood categories. [**Note**: *The period of forecast for flooding (5, 10, or 90 days) depends on the location and history of the river floods*.]

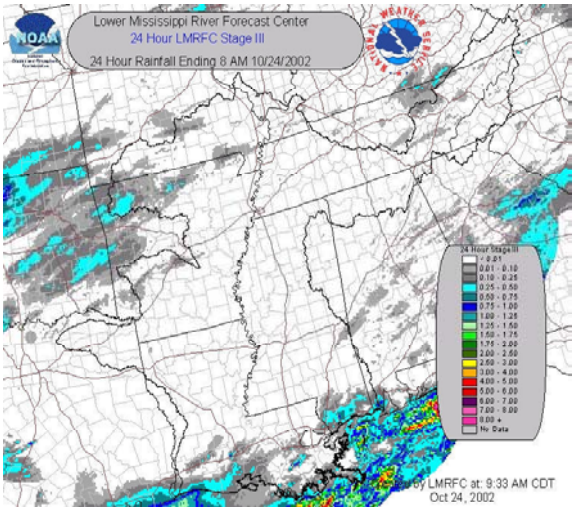
Graphic C provides exceedance probability information for a long time period (90 days). It provides information on both the maximum and the minimum water levels during that period.

Please provide your response to the following statements:

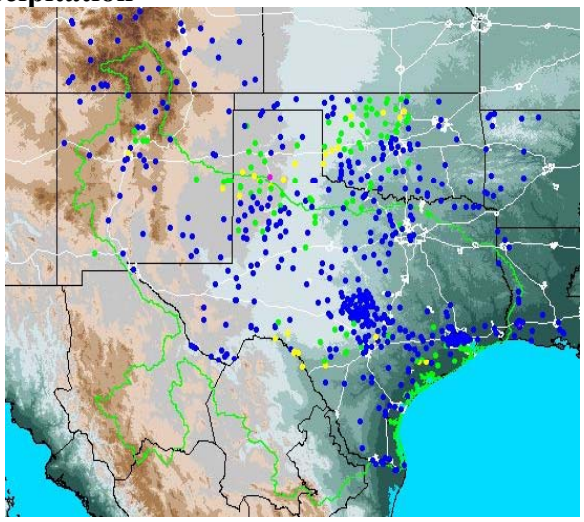
1. Graphic A provides water level information I need.	Yes	No
2. Graphic B provides water level information I need.	Yes	No
3. Graphic C provides water level information I need.	Yes	No
4. Graphic A provides information in a format that is understandable	Yes	No
5. Graphic B provides information in a format that is understandable	Yes	No
6. Graphic C provides information in a format that is understandable	Yes	No
7. Graphic A provides me with sufficient information to make informed decisions.	Yes	No
8. Graphic B provides me with sufficient information to make informed decisions.	Yes	No
9. Graphic C provides me with sufficient information to make informed decisions.	Yes	No
10. Information about the maximum and minimum water levels is important to me.	Yes	No

Please provide any additional comments, suggestions, or ideas that you feel would enhance the above graphics or services (optional):

Precipitation



Graphic A



Graphic B

Precipitation information can be provided in several ways. The data can be provided as a grid or a point. Data in grid format depicts estimated precipitation over an area. It can be based either on gauge data or on gauge reports and radar estimates. Some examples of precipitation graphics are shown above.

Graphic A depicts precipitation amounts in grid format for a 24-hour period for a region of the country. It is based on gauge and radar data.
Graphic B displays point precipitation data for a 24-hour period for a region of the country. The data are displayed as a color coded range.

Please provide your responses to the following statements:

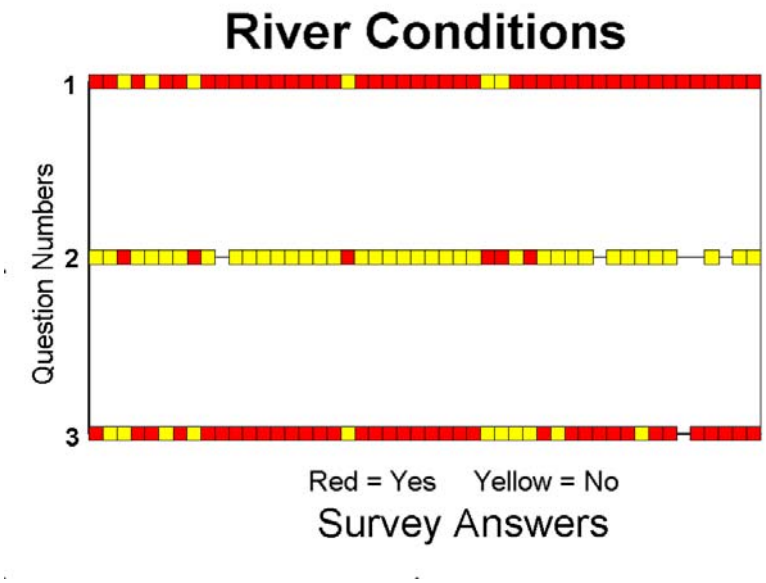
1. I prefer precipitation data in grid format	Yes	No
2. I prefer precipitation data for points	Yes	No
3. I prefer precipitation data from gauge reports and radar estimates	Yes	No
4. I prefer precipitation data from gauge reports only	Yes	No
5. I prefer precipitation data presented as actual precipitation amounts	Yes	No
6. I prefer precipitation data represented as color coded range	Yes	No
7. I use 24-hour precipitation data	Yes	No
8. I use monthly precipitation data	Yes	No

Please provide any additional comments, suggestions, or ideas that you feel would enhance the above graphics or services (optional):

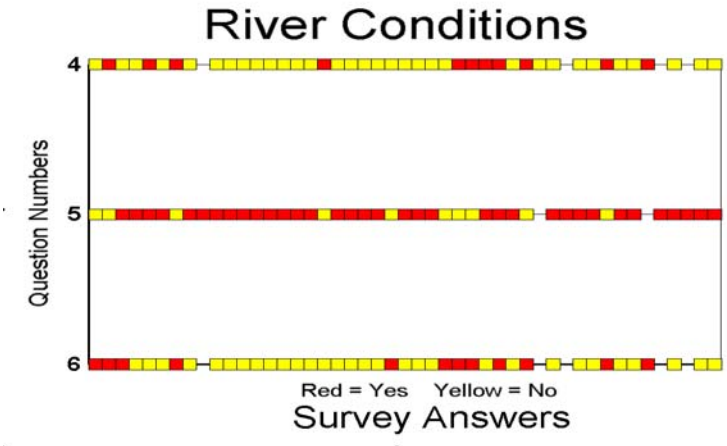
Appendix F — Analysis of HPM Survey Results

1. River Conditions

1. Graph A allows me to get the information most easily.	Yes	No
2. Graph B allows me to get the information most easily.	Yes	No
3. Graph A presents the information better to help me to understand the situation.	Yes	No



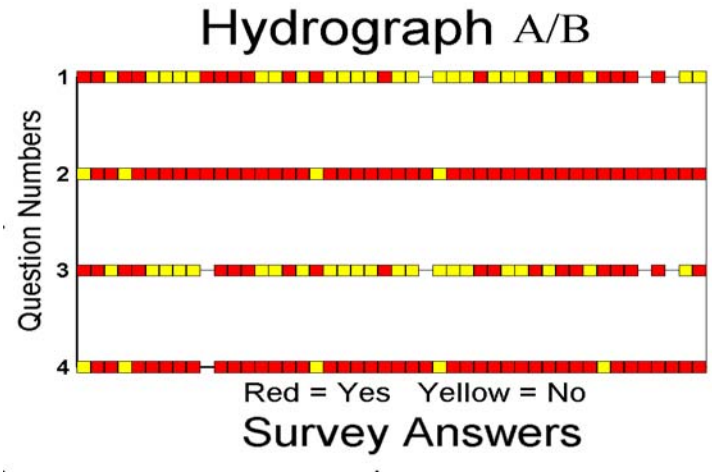
4. Graph B presents the information better to help me to understand the situation.	Yes	No
5. Graph A provides more of the information I need.	Yes	No
6. Graph B provides more of the information I need.	Yes	No



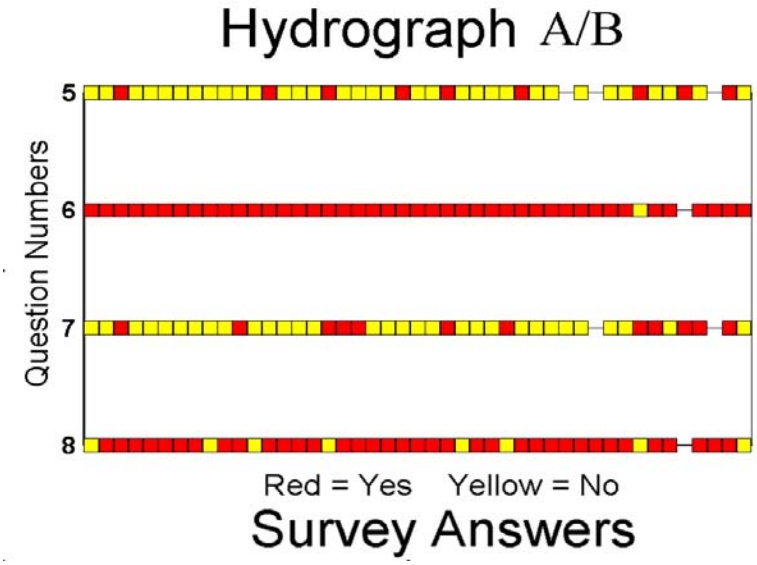
2. Hydrographs A and B

1. Graphic A provides the observed water level information I need.	Yes	No
2. Graphic B provides the observed water level information I need.	Yes	No
3. Graphic A provides the flow information I need.	Yes	No

4. Graphic B provides the flow information I need. Yes No

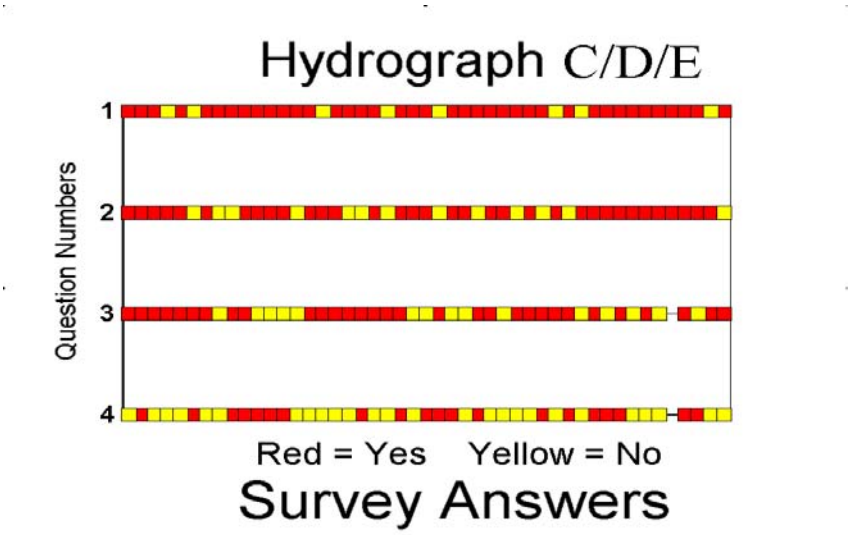


5. Graphic A could show me if and when the river may go above or below flood stage. Yes No
6. Graphic B could show me if and when the river may go above or below flood stage. Yes No
7. Graphic A provides me with sufficient information to make informed decisions. Yes No
8. Graphic B provides me with sufficient information to make informed decisions. Yes No

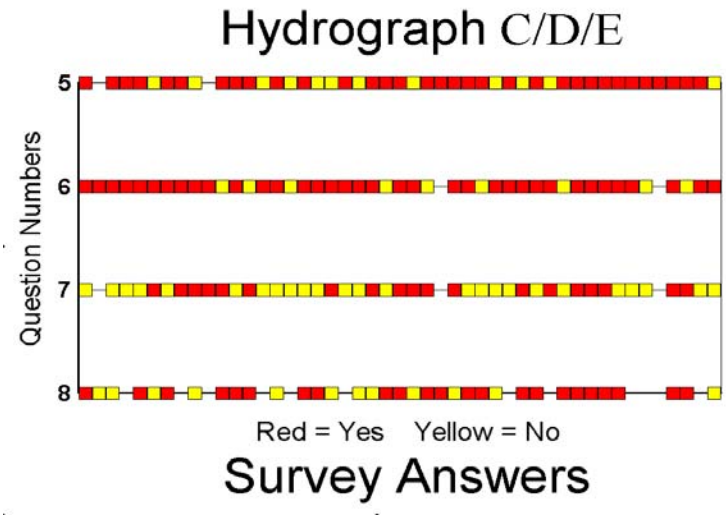


3. Hydrographs C, D, and E

1. Uncertainty information on forecasts out to five days or so is important to me. Yes No
2. Graphic C provides the forecast uncertainty information in a useable format. Yes No
3. Graphic D provides the forecast uncertainty information in a useable format. Yes No
4. Graphic E provides the forecast uncertainty information in a useable format. Yes No

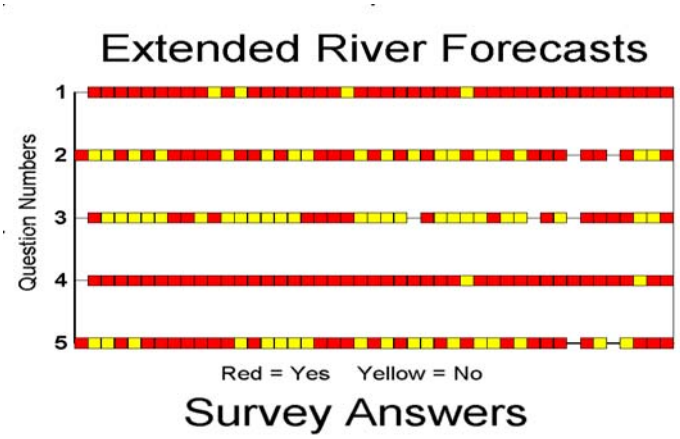


5. Graphic C provides me with information to make informed decisions.	Yes	No
6. Graphic D provides me with information to make informed decisions.	Yes	No
7. Graphic E provides me with information to make informed decisions.	Yes	No
8. I prefer the presentation in graphic C to that of Graphic C and/or D.	Yes	No

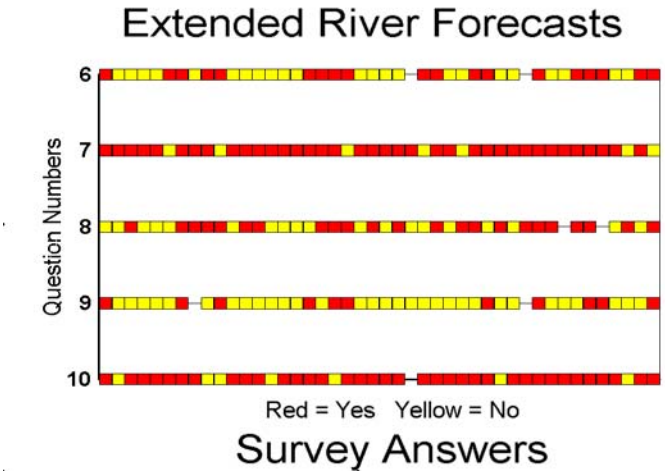


4. Extended River Forecasts

1. Graphic A provides water level information I need.	Yes	No
2. Graphic B provides water level information I need.	Yes	No
3. Graphic C provides water level information I need.	Yes	No
4. Graphic A provides information in a format that is understandable.	Yes	No
5. Graphic B provides information in a format that is understandable.	Yes	No

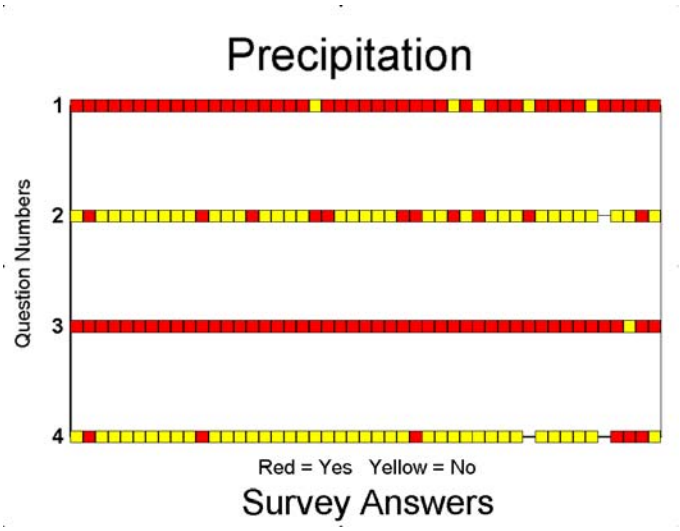


6. Graphic C provides information in a format that is understandable.	Yes	No
7. Graphic A provides me with sufficient information to make informed decisions.	Yes	No
8. Graphic B provides me with sufficient information to make informed decisions.	Yes	No
9. Graphic C provides me with sufficient information to make informed decisions.	Yes	No
10. Information about the maximum and minimum water levels is important to me.	Yes	No

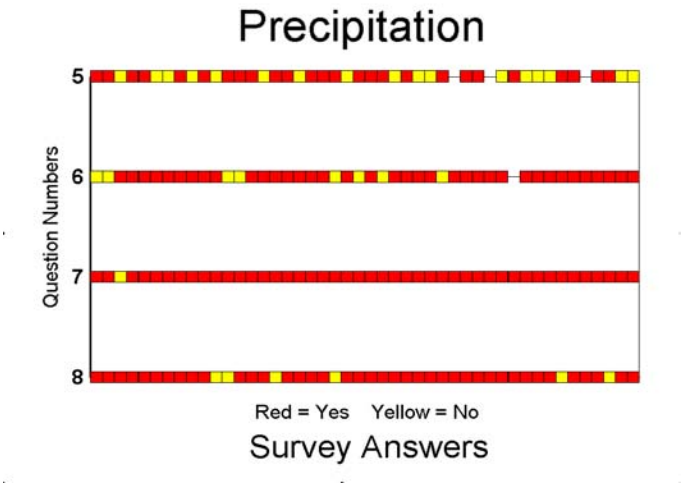


5. Precipitation

1. I prefer precipitation data in grid format.	Yes	No
2. I prefer precipitation data for points.	Yes	No
3. I prefer precipitation data from gauge reports and radar estimates.	Yes	No
4. I prefer precipitation data from gauge reports only.	Yes	No



5. I prefer precipitation data presented as actual precipitation amounts.	Yes	No
6. I prefer precipitation data represented as color-coded range.	Yes	No
7. I use 24-hour precipitation data.	Yes	No
8. I use monthly precipitation data.	Yes	No



Appendix G — Information Not Included in the Core Suite

A sizable amount of hydrologic information was ingested and analyzed by the APIT. Some of this information was deemed useful by the surveys but was determined not to be included in the AHPS core suite for one reason or another. As mentioned in the Introduction to Recommendations section of this report, this does not mean that the team felt this information was not important. Instead, it is recommended this additional information be assessed for individual NWS offices to include as a supplement to the core suite products.

A brief description of each category and explanation of why is was not included as part of the core suite follows:

Velocity Information – Exhibits actual movement of a river/stream which is not correlated to stage at a particular forecast point. We have already recommended Stage (ft) and Flow (cfs) information on a hydrograph. It also requires more real-time data, and direct measurements are generally not readily available.

Vegetation – Description of vegetation along both banks of stream which is contained in the E-19 information. This type of information does not have a strong relation to the NWS mission. Also, this information is not available consistently across the country.

River Bed Composition – Again, this is part of the E-19 information describing makeup of the river/stream bed. This type of information does not have a strong relation to the NWS mission. In addition, this information is not available consistently across the country.

Snow Water Equivalent (SWE) – National Operational Hydrologic Remote Sensing Center (NOHRSC) map which would also include the areal extent of snow cover across the United States. Through the Airborne Snow Survey Program and ground-based observations, the SWE is measured and displayed. Although very helpful for water supply and runoff, the SWE is a seasonal product. Additionally, much of the southern part of the country would not find much usefulness in this information due to the climate.

Snow Depth – More seasonal information from the NOHRSC, which has a format similar to the SWE product. It is valuable for snowmelt runoff and the spring flood potential outlook. This is not in demand by NWS customers year around, and the southern parts of the country would rarely utilize such information due to the climate.

RFC Hydrometeorological Discussion – The possibility of including the Hydrometeorological Discussion text message to validate excessive rainfall areas, QPF, flash flood potential, hydrologic conditions, etc. It was questioned whether all RFCs make this information accessible to the public. Also, not all RFCs issue this text product on a routine basis. For example, the Southeast RFC will only issue it during significant or widespread river flooding events.

Depth of Dryness/Wetness in Soil – This would be a measurement of current soil moisture

conditions for a given area. An example is an icon that displays areas of extreme wetness or drought due to soil moisture content at a predetermined depth. There were several reasons the team excluded this information from the core suite.

1. We have no (or very few) direct measurements of soil moisture.
2. Our soil moisture modeling is an empirical approach aimed at calculating realistic values for basin runoff. It is not directed to actually estimate soil moisture values.
3. On the same lines, the specific values we could provide from our models for simulate soil moisture conditions (such as API, values in SAC-SMA, etc.) have no real world meaning.
4. There is no single standard method used in the RFCs across the country for soil moisture modeling.

Queries from a gridded precipitation map to produce the M.A.P. for a region/basin of interest – A user could query precipitation information. A GUI, for instance, could combine grids from precipitation data, gages, and radar into mean areal precipitation (MAP). This may come from the RFC or WFO and cover large regions over a number of time intervals.

The team determined that although user selectable grids are acceptable, there are enough precipitation products/information already suggested for the core suite, including the capability to build a precipitation accumulation map.

Appendix H — List of Acronyms

AHPS	Advanced Hydrologic Prediction Service
APIT	AHPS Products and Information Team
APRFC	Alaska-Pacific River Forecast Center
CRH	Central Region Headquarters
FEMA	Federal Emergency Management Agency
HL	Hydrologic Laboratory
HSD	Hydrologic Services Division
LMRFC	Lower Mississippi River Forecast Center
NCEP	National Centers for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
OCWWS	Office of Climate, Water, and Weather Services
OHD	Office of Hydrologic Development
OHRFC	Ohio River Forecast Center
OMB	Office of Management and Budget
OST	Office of Science and Technology
RFC	River Forecast Center
USGS	U.S. Geological Survey
WFO	Weather Forecast Office
WRH	Western Region Headquarters