SECTION IX
RECOMMENDATIONS

In developing this report, opportunities to better restore, sustain, and improve the MR&T System have been identified through the systematic assessment of its operational and structural performance during the 2011 Flood. This section provides both overarching recommendations and specific component team preliminary recommendations that should be seriously considered to address the System's immediate and future needs and vulnerabilities. The recommendations also identify opportunities that should be further analyzed to improve current MR&T processes and component functionality. Additional assessment, coordination, and potential combining of these recommendations will be necessary to advance them towards implementation.

Overarching MR&T System Recommendations

The PFR regional management team carefully considered the comprehensive listing of component team recommendations to identify key overarching recommendations for the MR&T System. These overarching recommendations capture the main themes of the many detailed recommendations developed through this effort:

- **Use the information from the PFR effort to inform repair of the MR&T System**
  Use 2011 MR&T System performance, damage, and risk assessment information developed through the PFR and other efforts to help establish appropriate repair processes. This includes efforts focused on improving levee resiliency, confirming level of protection, sharing best practices, and developing system repair plans using risk-informed decision making.

- **Use the information from the PFR effort to inform completion of the MR&T System**
  Information from the PFR effort should be used to aid in the development of a plan to complete the remaining 11 percent of the MR&T System not yet constructed. Information that would provide insights into this include MR&T performance, changing river hydraulics, improved levee engineering, economics and associated risks, environmental and other stakeholder considerations.

- **Update Operation Plans/Manuals, Communications Plans, and SOPs using information from this PFR, external inputs, AARs, etc.**
  Use information developed through the PFR effort, AARs, external inputs, and further studies to inform the update and enhancement of MR&T operation and flood fight plans/manuals, SOPs and regionally standardized communication plans. These efforts would focus on improving both internal and external MR&T related operations during major flood events and would involve refinement of existing processes and utilization of new technologies. Example efforts may include enhancing flood fight operations with newly developed tools and examining the potential need to update operations plans for key MR&T flood risk management structures.

- **Regionally standardize communication approaches and products with MR&T System floodway and backwater area stakeholders**
  Use feedback from stakeholders, lessons learned, best practices, and new technologies to develop regionally consistent communication approaches, tools and products to improve understanding, reduce impacts and improve collaboration during future floods. The IRTF offers great potential to make this a coordinated multi-agency effort.

- **Evaluate the need to conduct an updated flow line study for the MR&T System**
  Use 2011 hydraulic flood data and associated MR&T component performance to evaluate the need for an updated flow line study for the MR&T System. Physical and hydraulic changes in the river system and complex flow patterns at Morganza, Bonnet Carre, and ORCC should be examined to determine if a change in flow line data or water control plans is warranted.

- **Coordinate a regional "triage" effort to prioritize, refine and implement the recommendations identified in the MR&T System Post Flood Report**
  The next steps in advancing the preliminary MR&T recommendations in this report will utilize the existing regional program management structure and process to further screen, combine, prioritize, refine, and develop detailed scopes for recommendation implementation. This process is vitally important due to the need to establish coordinated MR&T improvement, regional priorities, and because there is limited funding available to accomplish these tasks.

These overarching recommendations are considered of significant importance as they would provide for structural/operational strengthening and benefit to the existing flood risk management system and improved efficiency and effectiveness in implementation of future MR&T construction and maintenance efforts. Many of the component team recommendations detailed in the remainder of this section would be nested within these overarching recommendations.

Recommendations with the greatest potential to improve the performance of the MR&T System components were identified and prioritized by each of the multi-District component teams working on the Post-Flood Report. These recommendations will require further refinement, scoping, and regional coordination prior to their implementation. The following sub-sections provide further description and justification of each component teams' prioritized recommendations:

A. Emergency Operations Plans
B. Reservoirs and Forecasting
C. Levees and Floodwalls Systems
D. Floodways
E. Backwaters
F. Interior Drainage
G. Channel Improvements
H. Channel Capacity
I. Environmental and Cultural Resources
J. Data Inventory and Management
K. Communications and Collaboration

The component team recommendations were further categorized as technical, operational, or strategic to help establish the most appropriate approach to advancing them. Technical recommendations (e.g., modify the design of a levee) will be evaluated, further refined and moved forward primarily by engineers and MR&T component experts. Operational recommendations (e.g., change operating plan) will be examined and implemented by MR&T component experts, managers/operators, flood fighters, and decisions makers. Strategic recommendations (e.g., consider the status of features outside of the MR&T during system operation) establish how the system may be enhanced beyond existing capabilities and authorities and will be advanced by senior leaders and decision makers.

A. EMERGENCY OPERATIONS PLANS

The following recommendations were developed based on lessons learned during the implementation of Emergency Operation Plans (EOP) by each District during the 2011 Flood. The highest priority EOP recommendations are listed first. The remaining recommendations are considered to be a lower priority because they are either a lower level of impact or they can be implemented without significant effort or coordination. These recommendations are categorized as operational. They were developed with input from all USACE Districts with MR&T components and may, at times, apply to some, but not all Districts.

1. Highest Priority Emergency Operations Plan Recommendations

- **Revisit the Chain of Command structure for Emergency Operation activities to ensure that decision makers have access to the most knowledgeable staff.** Emergency Managers in some Districts felt that they could have helped address and minimize some of the more controversial issues if they were in the field directly supporting the District Engineers during the decision making processes. Support offered by these staff would include providing and verifying information used by senior leaders to make critical decisions.

- **Assign MVD Representatives to Districts early on for regional flood events to assist with coordination**. The assignment of MVD Representatives to work directly with the Districts was a significant benefit to the District Emergency Operations activities. This should be considered as a standard practice for all regional flood events.

- **Take full advantage of Smartphone, FREEBOARD, & MICA Capabilities.** The tools were a significant benefit during the event and the expanding set of applications that are available should be continually exploited. ACE-IT does not currently allow Smartphones and steps should be taken to address this issue to improve the availability, distribution, and support of these devices. An organized and on-going effort to develop and apply these applications should be considered.

  - **Identify areas with limited cell phone coverage and work with appropriate entities to increase cell phone coverage in these areas. Update plans and identify and obtain equipment needed to ensure effective communication until cell phone coverage is expanded in these areas.** With the expanded use and reliance on cell phones, updates to all field-related plans should seek to identify areas without adequate cell phone reception. Once identified, the plans should identify alternative methods of communication and a means to provide it if radios or other equipment is needed. Also, consider working with cell phone service providers to expand coverage area if possible.

  - **Update pre-flood plans to better address new technologies (social media, Smartphones, etc.)** Many of the tools used during the 2011 Flood had not been utilized as extensively prior to the event. Consequently, decisions about how and when to use them were rushed, training was required, and some mistakes were made. To take complete advantage of these tools, pre-flood plans should thoughtfully incorporate them prior to the next event.

  - **Maintain sufficient supply of Smartphones for regional emergency use during a large event.** There was a shortage of Smartphones available at the beginning of the event. Additionally, there were process requirements that prevented efficient acquisition of more in a timely manner. An effort to maintain a sufficient supply of these valuable tools should be considered.

2. Additional Emergency Operations Plan Recommendations

- **Staff-up EOC and train early.** There was a shortage of trained staff to respond to the 2011 Flood. Districts should consider using the staff requirements needed to respond to the 2011 Flood as a basis for determining additional staffing and funding needs for future events and develop trained personnel accordingly.

- **Include public affairs section in EOC standard operation and EOP.** External Communications through coordination with the PAO was not consistently and effectively addressed in pre-flood plans. This adversely impacted some communications efforts. An effort to address that issue in future plan updates should be considered.

- **Coordinate early with non-Federal sponsors/stakeholders**. Some stakeholders expressed that early coordination would have alleviated many of their concerns and the lack of information presented problems for them. Districts should consider performing early coordination with key stakeholders and project sponsors to help initiate information sharing.

B. RESERVOIRS AND FORECASTING

The following recommendations were developed based on forecasting experience and the performance of Mississippi River Basin reservoirs during the 2011 Flood. The recommendations are considered primarily operational in their development and implementation. They are also considered strategic based on how they relate to operation of the Mississippi River Basin reservoirs as a system. A general strategic recommendation "Improve the overall operations of the Greater Mississippi River Basin reservoirs as a system" was developed based on operation of both MR&T and non-MR&T reservoirs during the 2011 Flood. A better understanding of operational impacts to the system, existing authorities, and the need to develop standard processes for operation and potential deviation directives would improve the operation of the greater Mississippi River Basin reservoirs as a system.

1. Reservoir and Forecasting Recommendations in Order of Priority

Priority 1. Improve NWS Forecasts and Communication Between the NWS and USACE Districts to Clarify Operational Requirements for MR&T Floodways. Steps should be taken to improve NWS forecasts and communication between the USACE Districts and NWS regarding MR&T floodway operation. Water control plans for the two floodways within MVN should incorporate the results of this effort and clearly lay out operational requirements based on NWS coordination and information. MVD Water Control offices should fully implement the Corps Water Management System.

Priority 2. Take Additional Steps To Improve the Accuracy of Forecasts. In spite of recent improvements in forecasting, several forecasting-related issues were highlighted and the public has expressed the need for additional improvement. To further improve the quality of river forecasting at all forecast offices within the Greater Mississippi River Basin, continue to implement the following initiatives/measures underway:

- Develop a HEC-RAS community model for the Mississippi River
- Continue tri-agency meetings to enhance collaboration
- Continue river forecaster's workshops to increase collaboration
- Utilize the Fusion Team as the primary coordinator of Tri-agency improvements in river forecasting

Priority 3. Develop a Standardized Deviation Directive Process. During the 2011 Flood, a Deviation Directive was given to several non-MR&T reservoirs. Reservoir Water Control Plans currently do not have a clear process for this nor were there standard processes in place to analyze conditions and communicate with upstream, downstream, environmental and local interests. If Deviation Directives continue to be an operational option, a process should be defined and incorporated into the Water Control Plans. Much of the uncertainty revolving around the use of these Directives involved the lack of an approved process. The process should be consistent with QMS and mirror the requirements for a major deviation that is presently defined. If applicable, as individual Water Control Manuals are updated, this process for Directives should be incorporated into the section of the manual that defines deviation processes. Furthermore, a process for deviation directives use/approval should be developed, reviewed, and codified in the appropriate ER and EM by the USACE water management community.

Priority 4. Incorporate Travel Time from Reservoirs and Document Associated Risk Considerations. When reservoirs were operated during the 2011 Flood, complete information related to travel times of flows/releases from the reservoirs was not readily available. This information should be developed and documented in advance so travel times from reservoirs can be used to make decisions and communicate impacts to stakeholders. Additionally, risk-based decisions should be documented and ensure that risk reduction at one location does not result in a net increase of risk within the river basin.

C. LEVEES AND FLOODWALLS SYSTEMS

The following recommendations were developed based on the performance of the MR&T System and the damages it sustained during the 2011 Flood. The levee and floodwall system recommendations are considered operational. Recommendation 1c is also considered technical in that analysis and redesign will need to be done to increase system resiliency and also strategic in implementation of its overarching goal.

1. Levee and Floodwall Recommendations in Order of Priority

Priority 1. All systems should be brought up to the minimally acceptable classification as quickly as funding allows.

- All FRAGO Classification 1 items are repaired or are in the process of being repaired.
- All FRAGO Classification 2 and 3 items will be repaired as quickly as funding allows.
- Some segments of the levee/floodwall systems were not tested in the 2011 event, but are believed to be deficient and should be further studied, and upgraded if required.
- Nearly 20 percent of the levee systems were rendered unacceptable by the 2011 Flood. This number is reasonable considering the magnitude and duration of the 2011 Flood. A level of damage is expected to occur due to significant flood events; as a goal the acceptable number of systems rendered unacceptable, should not exceed 20 percent to 30 percent. Increasing the resiliency of these systems will serve the dual purpose of minimizing the time and cost required to restore the systems following future events and will minimize the risk associated with subsequent events occurring before restoration efforts are complete.

Priority 2. The current Flood Fight Manual is from the early 1980s and should be updated to make the information more user friendly. The new manual, its use, and contents, should be communicated to all stakeholders through an organized outreach program,

emphasizing problems and solutions identified in the past. Problems with sand boils are a major concern. The fine points of ringing sand boils should be included in revised drawings showing the proper ringing technique and should be stressed in a revised manual.

Priority 3. Apply the recommendations in the Armoring Manual for the HSDRRS. Significant effort went into developing an Armoring Manual for HSDRRS (dated Nov. 2011). Much was learned in the aftermath of Katrina and subsequent testing of armoring materials, geometry, and techniques. Application of the recommendations contained therein should minimize future tie-in/erosion issues. An effort should be made to ensure this information is appropriately transmitted to the other Districts via an appropriate technology transfer program.

Priority 4. Develop and Implement a formalized information transfer program to assist the Districts in better managing and operating the MR&T. The revised Flood Fight Manual, Armoring Manual, and discussion of acceptable damage and risk (resiliency) will be important topics for this program. The program would promote communication and understanding of design techniques and assess problems and opportunities associated with each District's flood fighting methods. This in turn will allow Districts to more effectively support each other.

D. FLOODWAYS

1. Highest Priority Floodway Recommendations. Four high priority recommendations were developed based on the performance of MR&T floodway components during the 2011 Flood. They include:

- **BPNM. Evaluate possible alternative methods of placing the BPNM floodway into operation.** The Memphis District is proceeding with a study to examine this issue and will present the results to the Mississippi River Commission for consideration.

- **Morganza. Scour protection, additional height, or both may be needed at the south guide levee and curtain wall if future operations are expected to continue to occur at progressively higher river stages.** The ultimate cause of these issues is the apparent change in stage-discharge relationship along this reach of the Mississippi River, whereby equal discharges appear to be occurring at higher stages with each passing flood. A detailed technical review of the present flowline should be performed to assess these changes, determine whether a revised flowline is warranted, quantify the risk reduction the MR&T system can truly provide, and inform changes to operation of the Morganza Floodway and/or remedial actions such as river dredging to increase channel capacity, if needed.

- **ORCC. A comprehensive sediment management program for the ORCC should be implemented, including maintenance dredging of the channels as needed.**

- **Bonnet Carré. Deficient levee sections downstream of the Bonnet Carré Spillway should be brought up to design grade.** The Bonnet Carré Spillway performed as needed during the Flood of 2011, diverting more flow than its design discharge under Project Design Flood conditions in order to protect deficient levee sections on the Mississippi River. downstream. These levee sections should be brought up to design grade so that during future floods the Spillway will not have to divert as much water.

The recommendations are considered primarily operational in nature. There are also some technical recommendations related to the need for modeling and analysis. Significant changes to the operation of

floodways may also rise to the level of strategic recommendations due to required changes to current authorities to allow them happen. Additional details on the floodways and suggested enhancements to the system are as follows:

2. Additional Detail on Highest Priority Floodway Recommendations

- **BPNM Floodway.** The Flood of 2011 necessitated the first operation of the BPNM Floodway in 74 years, and the first under present operational procedures. This operation was not only a success, but it also provided the opportunity to capture lessons learned about how best to perform this operation in the future. The floodway crevasses are now being repaired to bring the floodway back to its pre-flood condition, so the system can function as it did before the operation. Under present policy, future operations of this floodway will be performed through artificial crevassing of the fuse plug levee sections, as was done in 2011. However, the MVM is moving forward with a study to evaluate possible alternative methods of placing the floodway into operation, to present to the MRC for consideration.

In addition to this study, relatively minor operational changes are needed to improve the efficiency of the existing floodway activation procedure. These include adjustments to the loading and travel timeline of transporting the explosive agent to the site, closer coordination with the Coast Guard, better weather protection for the explosive agents, and better strategies for quick procurement of critical materials. Twenty-nine of these recommendations have been captured in the MVM and ERDC AARs, which are included in Appendix E, *Communications/ Collaboration*, so they are not duplicated here.

- **Morganza Floodway.** The 2011 Flood required the operation of the Morganza Floodway for the first time since 1973. This operation was not only a success, but it also provided the opportunity to capture lessons learned about how best to perform this operation in the future. Among the most important lessons learned was the importance of a framework of operational criteria that is both specific enough to minimize problems resulting from the inevitable unfamiliarity of performing an operation that occurs about once per professional career, and flexible enough to stay useful as conditions change. During the Flood, river stages were so much higher than during previous floods that the top of the Morganza Structure was taken into account during the decision making process to operate the structure, as the river threatened to overtop the structure before the threshold flow of 1,500,000 cfs (which the Floodway is intended to prevent) was reached.

The damage at the Morganza Control Structure should be repaired and priorities should be established to identify the incremental steps required to effectively operate the structure within current capabilities to safely and effectively pass the project flood. Further, the challenges associated with the specified operational trigger, threat of structure overtopping at that trigger, potential for recurring stilling basin damage upon opening and potential threat to safe operations as scour occurs should be addressed.

The 2011 operation was within the guidelines of the water control manual, but a study should be conducted to assess whether the manual should be revised to add an explicit trigger for operation based on maintaining freeboard at the Morganza Structure as well as the levees downstream. This operational criterion could remain effective regardless of changes in Mississippi River channel capacity. Assessment of other potential changes to the Morganza Water Control Manual is also needed, including changing the gate opening sequence to reduce scouring in the tailbay, adding

more data to the pertinent data section, and revising and adding to the tables and charts to make them more useful.

The tailbay of the Morganza structure may require stronger scour protection and greater energy dissipation to prevent scour from approaching the structure, especially if it will continue to be opened at river stages higher than were anticipated when it was designed. Investigations into the best method(s) of providing this scour protection are ongoing. Scour protection, additional height, or both may also be needed at the south guide levee and curtain wall if future operations are expected to continue to occur at high river stages.

Assess the potential benefit of modifying the water control manual to contain plans to conduct surveys during a flood to determine and control scour progression during an operation. Additionally, a plan should be developed to study future system operational requirements. Analysis of the Morganza Structure, including the forebay, tailbay, and adjacent sections of the Mississippi River are needed to determine the performance of the structure for other extreme events. Models of the Morganza Floodway and Atchafalaya Basin should be developed to help inform Floodway operations and emergency preparedness.

- **ORCC.** The ORCC operation influences and is influenced by operation of the Morganza Floodway, and it shares some objectives with the Morganza Floodway and Bonnet Carré Spillway, so recommendations for this complex area follows:
    - The operational criteria at the Old River Overbank Structure should be re-evaluated. A fully functional Overbank Structure would permit closing portions of one of the other structures in the complex to conduct assessments, detect critical issues that could be rectified to prevent a failure. Additionally, gate hindrance or errant vessel impedance of flow could severely impact operations with little recourse without capability to redirect a portion of flow to the Overbank.
    - An engineering assessment followed by implementation of risk reduction measures with the goal of a fully functional overbank structure should be conducted. Potential actions include alterations to the gabion weir and stone blanket at the confluence of the Overbank and Low Sill outflow channels to eliminate the flow restriction and hydraulic jump concerns, providing needed flexibility for more severe or longer duration floods, and to provide flexibility to shift flows in response to unforeseen emergency situations.
    - The discharge computation procedures for the Mississippi River at Tarbert Landing, upon which the regulation of the ORCC is based, should be revisited to attempt to increase the accuracy degree of confidence of the results. Even under favorable conditions, discharge measurement in a large river may only be accurate to within 5 percent, so that a measurement of 1,500,000 cfs could be in error by 75,000 cfs or more. This is compounded by the apparent pulsing of flow that was observed in 2011, when multiple boats with high frequency acoustic instruments performed simultaneous discharge measurements, whereby flow increased and decreased sinusoidally by 300,000 cfs or more over the span of a few hours. The causes of this pulsing are now under study, but whatever the cause, it clearly increases uncertainty. These discharge measurements are used to create and adjust a stage-discharge rating curve at Red River Landing, which is then used to compute daily discharge and distribution of flow.

- A permanent discharge gage, with side-looking acoustic Doppler current profiler, data collection platform, and satellite antenna should be installed at the Tarbert Landing discharge range or suitable location nearby. This gage will provide near real-time discharge measurements to clarify operational decisions that are made on a daily basis at the ORCC. In addition it would provide information for risk-based decisions during future flood events, while also providing a wealth of data for examining the pulsing flow phenomenon.
- A comprehensive sediment management program for the ORCC should be implemented, including maintenance dredging of the channels as needed. The program should address excessive sediment that redirects flow, damages the channel banks, and causes overbank flow to occur at lower discharges, reducing access and visibility.

- **Bonnet Carré Spillway.** The Bonnet Carré Spillway performed as needed during the Flood of 2011, diverting more flow than its design discharge under PDF conditions in order to protect deficient levee sections on the Mississippi River downstream of the structure. These levee sections should be brought up to design grade so that during future floods the Spillway will not need to divert as much water. Additionally, Better computer models of the Spillway should be developed to help determine the maximum flow that can be diverted, without overtopping guide levees or creating dangerous scour. If linked to larger models of Lake Pontchartrain, these could also help address environmental concerns related to Spillway operation.

  US Highway 61 (Airline Highway) and most of the railway crossings at the Spillway guide levees are constructed below the height of the guide levees. This causes seepage through the railway ballast under the railroad tracks and can allow water to spill onto the highway. As a result, Spillway staff must build and maintain temporary embankments on the highway right-of-way to prevent water from flowing onto the road. Solutions such as raising the roadway, replacing the railway ballast, or a permanent barrier should be investigated.

- **West Atchafalaya Floodway. Public outreach on the possibility of operating the West Atchafalaya Floodway should be continued.** Because it was not operated in 2011, no new lessons learned regarding the West Atchafalaya Floodway were captured or used to form recommendations. However, the experiences of operating BPNM Floodway and the Morganza Floodway, both of which are less densely developed than the West Atchafalaya Floodway, provide important lessons learned on the potential risks for future development in this area. Public outreach on the possibility of operating the West Atchafalaya Floodway should be continued given the relatively large population living within it**.**

E. BACKWATERS

The following recommendations were developed based on the performance of MR&T backwater components during the 2011 Flood. Although backwater levees were not operated during the Flood, lessons learned and recommendations were still developed based on observations in these areas. Recommendations developed for the Yazoo River and Red River Backwater are considered the highest priority at this time. The recommendations are considered a combination of both operational (e.g., installation of new river gages) and technical (e.g., development of new hydraulic models).

1. Highest Priority Backwater Recommendations

- **Yazoo River Backwater Area. Additional river gages should be installed to aid in operation of the Yazoo Backwater Levee. Also create a hydraulic model to help inform future operation of the Yazoo Backwater Levee.** Although it was not operated during the Flood of 2011, river levels came within inches of putting the Yazoo River Backwater Area into operation, and flood fight operations were undertaken to minimize damage in the event of operation. Two major recommendations emerged from this experience.
    - To increase understanding of hydrodynamics in the vicinity of the Yazoo River Backwater Area and assist with future flood fight operations, two satellite-enabled gages should be installed near the intersection of the Mississippi River main line levee and the Yazoo Backwater Levee. One gage should be located upstream of the intersection along the mainline Mississippi River while the other should be located downstream of the intersection on the Yazoo Backwater Levee. These gages will be used to monitor the difference in water surface elevation as water flows over the spur dike at the intersection of the two levees. Knowledge of the complex water surface and how it changes at this location is integral to operation of the Yazoo Backwater area.
    - Additionally, a numerical hydraulic model should be created to help investigate the impacts to the Yazoo Backwater levee of a simultaneous Yazoo River headwater flood and a Mississippi River backwater flood. This model will be extremely helpful when preparing for future operation of the Yazoo Backwater Area.

- **Red River Backwater Area. Create a hydraulic model to help inform future operation of the Red River Backwater.** Although its fuse plug levee was not overtopped in 2011, significant backwater storage did occur in the overbank areas of the Red River, with both the Red and Black rivers flowing backward (northward) at times during the flood. This backwater effect creates uncertainty for flow computation, complicates operations at the ORCC, and prolongs the duration of flood conditions. To better understand this effect, a numerical hydraulic model of the lower Red River should be created to evaluate the effects of backwater from operation of the ORCC (and, potentially, the Morganza Floodway) on the Red River area. This model, if coupled to a model of the Mississippi River already under development, will aid in quantifying the effect of operation of the Morganza Floodway on stages in the Mississippi River as far upstream as Natchez and Vicksburg.

  During the flood, the NWS issued forecasts both with and without operation of the Morganza Floodway, with surprisingly large differences shown between the two on the gages at Vicksburg and Natchez. Numerically modeling this area with a calibrated hydraulic model will improve the accuracy of inundation mapping, improve forecasting accuracy, and help quantify the overall risk reduction provided by the Morganza Floodway, ORCC, and Red River Backwater Area.

F. INTERIOR DRAINAGE

The following recommendations were developed based on the performance of MR&T interior drainage components during the 2011 Flood. The following recommendations below are considered primarily operational in nature.

1. Highest Priority Interior Drainage Recommendations

- **St. Francis River Basin. Proceed with approved courses of action to repair the identified damages as provided by the 2012 Disaster Relief Act. Damages should be repaired during a time less likely to require pumping operations in order to minimize risk to protected areas.**

- **Bayou Chene. Perform a study to assess if on site pumping capability should be considered as part of emergency measure placed at this location during future events. A permanent structure has been proposed by the local sponsor near the location of the emergency measure and this should also be assessed to determine if it enhances flood risk management in this area.** Assessment of the structure should include allowing closure of the bayou for protection against flooding from the Atchafalaya floodway and storm surge. The addition of a pumping facility should also be assessed to allow for the drainage within the bayou when the proposed permanent structure is closed.

2. Additional Interior Drainage Recommendations

- **St. John's Bayou – New Madrid Floodway. Proceed with approved courses of action for the St. John's Bayou New Madrid Floodway Project with all critical repairs completed by the 2013 flood season.** Continue to use the St. John's Bayou Gravity Structure and the BPNM Floodway in accordance with existing project authorizations.

- **Yazoo River Area. Successful operation in 2011 showed that structures should continue to be operated as designed.**

- **Lake Chicot Pumping Plant. Successful operation in 2011 showed that structure should continue to be operated as designed.**

- **Upper Point Coupee Parish Loop. The gate seals on the Point Coupee Drainage Structure should be repaired to prevent leakage during events and further damage to the structure.** If a rain event occurs during a high river event, the Point Coupee Pumping Station should be operated in conjunction with the Point Coupee Drainage Structure. Local partners and landowners should maintain Johnson Bayou clear prior to high river season. Unrestricted use of the bayou for internal drainage will reduce the need to operate the pump station.

- **Bayou Courtableu Drainage Structure and Bayou Darbonne Drainage Structure. Plan should be developed to specifically address interior drainage when the Morganza Control Structure is operated.**

- **Hanson Canal, Franklin Canal, and Yellow Bayou. Additional drainage structure(s) should be installed as considered in the Atchafalaya project plan.**

G. CHANNEL IMPROVEMENTS

The utilization of the features of the Channel Improvement Project has been successful in resisting the erosive forces of the river in the vast majority of cases. Consequently, the design criteria by which the features are designed and constructed is proven. However, the 2011 Flood demonstrated that there are some inadequacies. Subject to economic considerations, the following recommendations should be considered.

The following channel improvement recommendations are listed in order of priority and are primarily considered operational.

1. Channel Improvement Recommendations in Order of Priority

Priority 1. Provide additional channel improvement measures in critical areas. In critical areas, such as in the immediate vicinity of a mainline levee, consideration should be given to providing additional channel improvement measures. These additional measures include dikes with flatter slopes, more scour protection where a dike intersects the bank, dragging the revetment higher up on the bank, providing toe protection for the levee, armoring the levee slope, planting tree screens, etc. The 2011 Flood pointed out that even though the Channel Improvement project was incredibly successful, there are still weaknesses with some Channel Improvement measures in various areas. For economic reasons, there will always be weaknesses that will require repair after major flood events, but we should make every effort to avoid having weaknesses that could result in a mainline levee being compromised.

Priority 2. The ACM sinking and grading units should receive major rehabilitation or be replaced. The Sinking Unit has been in use for several decades and has been repaired, modified, and upgraded on numerous occasions. Although the ACM has been very successful at maintaining the river bank alignment and configuration for flood risk management, navigation and environmental purposes for several decades, the 2011 Flood event demonstrated that major flood events will damage revetments. If left unrepaired, some damages would allow the river to change course. It is crucial to the Nation's economy that the river channel be maintained in its current location and alignment. To ensure that the Corps maintains the capability to construct new revetments and repair existing revetments after floods, the Sinking Unit must be maintained. Considering the age of the Sinking Unit and the importance of the river channel, it is recommended that the Sinking Unit be evaluated to determine its capability to perform the intended function in the future. Consideration should be given for major rehabilitation or replacement of the Sinking Unit to reduce the risk of a major malfunction which could adversely affect the Corps' ability to maintain the channel. For the Sinking Unit to perform its function properly, the river bank must be properly prepared to accept the ACM. This bank preparation is performed using the Grading Unit. Some of the equipment used by the Grading Unit has also been in operation for decades. Therefore, consideration should also be given for major rehabilitation or replacement of the equipment used by the Grading Unit.

Priority 3. Increase pace of implementation of channel improvement project features. The 2011 Flood demonstrated that major flood events will damage the channel and previously constructed channel improvement features. If the channel is exposed and damages left unrepaired, the river could change course and levees could be threatened. It is crucial to the Nation's economy that the river channel be maintained in its current location and alignment.

Priority 4. Incorporate tree screens at vulnerable top bank/overbank locations. Overbank flows generated a significantly greater amount of scour and damage where trees were sparse or not present. Consideration should be given to incorporating tree screens behind top bank at vulnerable locations. Developing design criteria to incorporate tree screens into the Channel Improvement Project is recommended.

Priority 5. Extend Articulated Concrete Mattress (ACM) revetment farther into the channel and higher up on the riverbank. Extending the revetment farther into the channel and higher up on the bank would likely have reduced the scour that occurred at the toe and the upper bank.

Another consideration for reducing the potential for upper bank erosion would be to increase the size and/or thickness of the stone currently being used.

Priority 6. Modify dikes to reduce damages caused by large flood events. Considering that some dikes sustained scour damage where the dike joins the bank, providing increased erosion protection on the downstream side of the dike could prevent some of that type of damage. In addition, increasing the dimensions of the root dike and key trench and/or extending the bankhead paving should be considered to provide a greater level of protection from flanking of the structure.

H. CHANNEL CAPACITY

The following recommendations were developed based on the operation and performance of the MR&T System during the 2011 Flood. All of the following channel capacity recommendations are considered primarily technical in nature.

1. Highest Priority Channel Capacity Recommendations

- **Assess effect of floodway operation, bedform changes, and secondary flow on overall flow**
- **Analyze the MR&T to identify areas within the system that may not be providing the authorized level of protection**
- **Analyze complex flow patterns at Morganza, Bonnet Carré, and ORCC**

2. Additional Channel Capacity Recommendations and Supporting Information. It is important to understand why, for higher flows on the Mississippi River in the MVN, ADCP measurements yield flows that are consistently lower than flows determined using conventional measurements. A change in measurement technique to ADCP methodology results in a higher stage for the same flow.

The quality control review of the ADCP measurements has resulted in the following recommendations.

- **Upgrade ADCP firmware used for overbank flow measurements**
- **Improve documentation of ADCP self tests and moving bed tests**
- **Upgrade GPS receivers used with ADCPs to have at least 2 decimal minute accuracy on position and velocity and provide data output at 2 Hz or faster.** Further conclusions and ADCP recommendations will be determined as the quality control review and assessment continue.
- **The effect of operation of the ORCC and Morganza Floodway, bedform changes, and secondary flow structure transitions on flow measurements should be assessed.** The analysis of discharge measurements should expand to other measurement sites within MVD. The MVN is pursuing funding to upgrade the Red River Landing gage with instruments to continually measure velocity; MVN should take additional measurements during future flood events to better define the pulsing phenomenon.
- **Analyze the ORCC and other areas of the MR&T System as recommended by the Committee on Channel Stabilization.** Channel capacity changes have been seen within the MVN; the extent of the changes outside the vicinity of the ORCC has yet to be determined. The Committee on Channel Stabilization reviewed the preliminary results of the ERDC study and concluded that operation of the ORCC has changed the base conditions and is in all likelihood contributing to geomorphic changes on the Red, Atchafalaya, and Mississippi

Rivers. The Committee recommended continued analysis of the system, including a determination if the levee system is providing the authorized level of protection.

- **Conduct further flow analyses.** The Districts within MVD have identified specific post flood study needs that include analysis of complex flow patterns at Morganza, Bonnet Carré, and ORCC; the effect of channel changes and future sedimentation trends on water surface profiles; analysis of the ORCC as recommended by the Committee on Channel Stabilization; and evaluation of operational procedures at Morganza, Bonnet Carré and ORCC. These studies will support the review to determine if a new flowline will be needed and provide information to update water control documents.

I. ENVIRONMENTAL AND CULTURAL RESOURCES

The environmental and cultural resources recommendations are largely centered on suggestions to standardize intra- and interagency coordination, study possible adjustments to the operation of the flood control system to enhance environmental and cultural resource protection, develop mechanisms to facilitate sampling and monitoring, and develop programs to enhance channel stability and riparian and aquatic habitat. Overall, the environmental and cultural resources recommendations are considered operational. There are also some technical aspects of these recommendations related to developing regional tools and processes (e.g., web-based database development). The need to incorporate more official environmental and cultural resource considerations in FRM may also be considered a strategic recommendation.

1. Highest Priority Environmental and Cultural Resource Recommendations in Order of Priority

Priority 1. Institutionalize both internal and external environmental and cultural resources regional response teams. Internal teams will include representatives from all of the affected Districts. External teams will include interested agencies and tribes. Define criteria for activating the teams and lay out plans for internal and external coordination of teams. Include these plans in emergency response plans or other documents for future utilization.

Priority 2. Investigate methods for slowly flooding floodways to allow for wildlife escape and to prevent scouring and erosion of cultural resource sites, as well as slowly closing floodways to facilitate rescue of fish species.

Priority 3. Investigate the feasibility of establishing a program to plant and rehabilitate tree screens along the river to stabilize banks and decrease scouring while also providing habitat and potentially shading a portion of the streamside.

Priority 4. Investigate the possibility of setting aside contingency emergency funding for environmental work and establishing advanced MOAs for monitoring, for example, with the USGS for water quality monitoring. Establish system-wide water quality monitoring protocols under these agreements.

Priority 5. Explore the advanced development of programmatic agreements such as Section 7 Consultation for T&E species with US F&W Service and pursue cultural resources programmatic agreements (36 CFR 800.14) and regional programmatic agreements for emergency Section 106 consultation.

2. Additional Pre-Flood Environmental and Cultural Resource Recommendations

- **Environmental.** The 2011 flood occurred just 3 years after the previous opening of the Bonnet Carré Spillway in 2008. Because of this, many agency personnel were able to leverage their experience managing the impacts of the 2008 flood to improve their flood management methods in 2011, which increased the efficiency and benefit of their actions. Accordingly, many recommendations focus on the need to codify the most successful activities that took place in the days leading up to and during the flood. These activities included:
    - **Establishing and publishing procedures for activating an internal, intra-divisional environmental team and instituting a meeting protocol for the team (Appendix F, Section I.)**
    - **Establishing and publishing procedures for activating an external, interagency environmental team and instituting meeting protocol (Appendix F, Section I.)**
    - **Developing consistent water-quality monitoring procedures and identifying rapid contracting mechanisms**
    - **Initiating emergency threatened and endangered species (T&E) consultation**
    - **Creating a web-based database or portal for standardized access to environmental data (e.g., water quality, fisheries, sediment, discharge, etc.)**
    - **Describing and cataloging invasive and nuisance species that may spread or otherwise be affected by flood conditions. Determine if any measures can be taken for managing invasive and native nuisance species during flood events.**

- **Cultural Resources.** Similarly, the observed need to utilize Corps and interagency communication channels during the early stages of a flooding event led to the following recommendations:
    - **Establish and publish procedures for activating an internal, intra-divisional environmental team and instituting a meeting protocol for the team** (Appendix F, *Environmental and Cultural Resources*)
    - **Establish and publish procedures for activating an external, interagency environmental team and instituting meeting protocol** (Appendix F)
    - **Notify culturally-affiliated tribes regarding possible floodway operations; mail draft protocols for the recovery and final dispositions of human remains should any be uncovered by soil erosion and scour**

3. Additional "During the Flood" Environmental and Cultural Resource Recommendations

- **Environmental.** Environmental data relating to spillway operation during floods is relatively time sensitive and must be collected immediately before the spillway activation and during its operation. To expedite response times and enhance readiness regarding environmental, the following tasks are recommended:
    - **Foster partnerships with others to quantify effects to oysters and other estuarine resources**
    - **Establish protocols and assign teams for the rescue of T&E species**

- **Maintain regular (weekly or more/less often depending on level of risk) communication with others, including Federal, state, local agencies, non-governmental organizations, and academics**
- **Coordinate with individuals and organizations collecting field data**
- **Develop a public communication plan on the status of Lake Pontchartrain and other waterbodies with high recreational use**
- **Consider gradual closure of Bonnet Carre Spillway, as was done in 2008 compared to the rapid closure in 2011, to prolong attraction flows for entrained pallid sturgeon to move upstream where they are more readily captured and rescued**

- **Cultural Resources.** During future floods, it is recommended that cultural resource specialists codify processes to:
  - **Update consulting and culturally-affiliated tribes using teleconferences and emails on a weekly basis**
  - **Based on tribal input, develop plans to revise protocols for the treatment and disposition of human remains uncovered by scouring.**

4. Additional Post-Flood Environmental and Cultural Resource Recommendations. Experience from the 2011 flood has shown that, as the floodwaters recede, 1) species which were trapped may require assistance; 2) aquatic areas flooded with nutrient-rich river waters may develop algal blooms; and 3) assessment of cultural resources damages must be initiated. These problems will likely occur during future floods and will need to be addressed.

- **Environmental.** The number of T&E species is likely to increase in the future due to new stresses initiated by anthropogenic development and climate change, enhancing the need to develop comprehensive yet easy-to-operate action plans. To quickly and more efficiently address these two problems, the following tasks are recommended:
  - **Establish the process for conducting T&E species rescue operations, funding mechanisms, and coordinating processes**
  - **Establish mechanisms to continue to identify, capture, and archive environmental data collected before, during, and after the flood**
  - **Continue interagency meetings/conference calls to summarize and share data**

- **Cultural Resources**. To increase the efficiency of our post-flood response in regards to cultural resource preservation, the following tasks are recommended:
  - **Conduct a LIDAR imagery evaluation in a GIS context as soon as flood waters recede to determine impacts to recorded cultural resources sites from scour**
  - **Consult with SHPO and affiliated tribes as required in programmatic agreement to mitigate adverse effects of floodway activation through site restoration or data recovery**

5. Additional Environmental and Cultural Resource Recommendations Related to Proactive Planning for Future Events. Previous flood reports paid little attention to management issues relating to environmental and cultural resources. However, because of increased public awareness and

new legislation, these issues play an increasingly important role in the Corps' flood fighting and management mission. This trend is expected to continue in the future. There are several recommendations that the Environmental and Cultural Resource teams developed which should be considered during non-flood years in preparation for the next significant food event:

- **Environmental**
  - **Re-evaluate the operations of floodways as a system and undertake the evaluation of the current operation plans**
  - **Evaluate options for changing the speed of both opening and closing the structures**
  - **Evaluate the order of operating the structures**
  - **Generate Environmental/Cultural Resource Operating Plans, similar to the Water Control Plans, which are linked to table top exercises, and undergo periodic reviews and updates**
  - **Investigate the possibility of setting aside contingency emergency funding for environmental work, perhaps within the EOC framework**
  - **Develop programmatic Section 7 Consultation for T&E species with the USFWS and establish mechanisms for periodic updates**
  - **In collaboration with channel improvement and bank stabilization efforts, explore the possibility of developing a tree screen establishment program**
  - **Investigate establishing advanced MOAs with USGS for water quality monitoring and other agencies to have agreements in place prior to emergency operations**

- **Cultural Resources**
  - **Develop programmatic agreements (36 CFR 800.14)**
  - **Complete cultural resources surveys in floodways as required by PAs or SHPOs (when PA has not been developed)**
  - **Develop regional programmatic agreement for emergency Section 106 consultation (1 year minimum)**
  - **Follow protocols approved by SHPOs and tribes for the treatment and disposition of human remains uncovered by scouring**

J. DATA INVENTORY AND MANAGEMENT

The following recommendations pertain to the handling and long-term viability of post flood data and envelop data gathering, handling, and preservation. The recommendations are considered both technical in their development and operational in their implementation. More detailed discussion of each recommendation is presented in Appendix H, *Data Management*.

1. Data Inventory and Management Recommendations in Order of Priority

Priority 1. Document control must be an assigned, dedicated function for the MR&T Project. Currently, document management practices vary widely across the Division reducing efficiency and

accuracy. For the Division to improve internal data handling practices, leadership must establish document management as a priority across the operational area of the MR&T system.

Priority 2. Create a Flood Data Center that compiles, preserves, and increases access, internally and with partners, for all regional Corps flood and post-flood information. The Center's scope would include historic and current flood information. The Center's mission would include capture and organization of historic data yet remain forward focused for new data sets using a combination of traditional archival techniques and state of the art data management and warehousing technologies.

Figure IX-1 outlines the basic structure of the Flood Data Center. The Center's objectives are to:

- complete comprehensive flood data sets for MVD and its partners;
- provide in-house reformatting of historic documents for better access;
- move to completely electronic circulation collection;
- preserve a safety copy of original documentation, maintaining original formats as required; and
- provide a single center to manage and serve all customer reference requests.

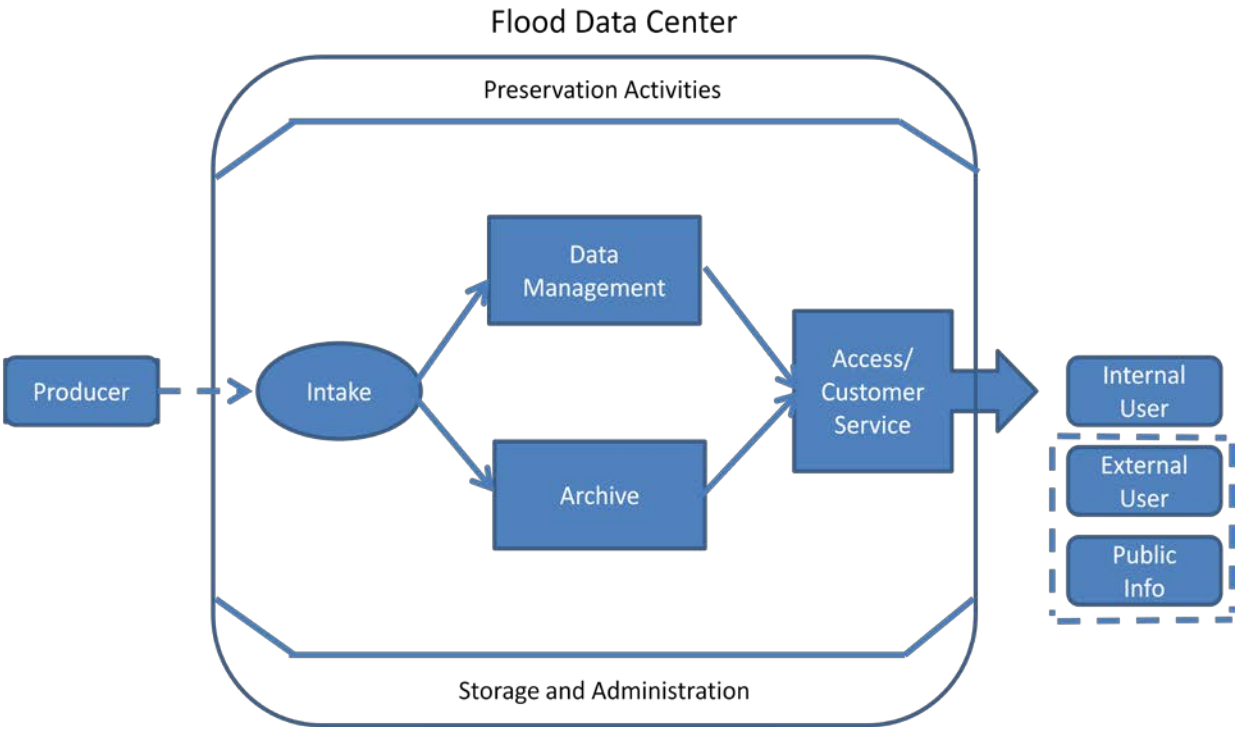

Figure IX-1. Flood Data Center Structure

Priority 3. Task archivists and records professionals to locate, inventory, and address MVD historic flood materials to have a complete spectrum of available flood related data. Use a simplified database with POC information for responsible entity for access.

Priority 4. Adopt a more centrally directed post-flood data capture and standardization process that stresses shared systems to mitigate the risk of potential loss of data and records due to

current ad hoc local storage practices, usage, and differences in handling. The continuation of the current system threatens Corps data and ability to respond efficiently and intelligently.

Priority 5. After data gathering has concluded, direct handlers throughout MVD to follow preservation activities outlined in the guidebook (Appendix I, *Data Management*) and provide resources in the coming years to revisit and perform preservation needs assessment at a designated Flood Data Center or at the local user level.

K. COMMUNICATIONS AND COLLABORATION

1. Highest Priority Communication Recommendations in Order of Priority. The following recommendations were developed through a process of public and stakeholder meetings, interviews, and intra- and interagency evaluations. All the communication recommendations are considered to be primarily operational in nature.

Priority 1. Provide mapping consistency between Districts, coordinate mapping sooner, and coordinate mapping with other agencies; provide mapping in multiple formats and allow the public to easily identify where they are on a map (pdf, Google Earth, etc.).

Priority 2. Send important information to other agencies (levee boards, etc) before releasing to the public, but continue use of social media for general information (similar to a press release).

Priority 3. Continue daily conference calls during emergency operations, ensuring that all necessary agencies are included.

Priority 4. Establish relationships and direct lines of communication with river industry decision makers; keep up these relationships between floods.

Priority 5. Involve environmental NGOs in recovery efforts consistent with policy and authorities.

Priority 6. Communicate recovery efforts to MR&T System Stakeholders.

Priority 7. Publicize and share results of PFRs with partner agencies.

2. Additional Internal USACE Communication Recommendations

- **Ensure that personnel are sufficiently equipped in accordance with their role, all equipment is operable, and employees know how to use equipment.**
- **Establish consistency between districts and other agencies in regards to modeling, mapping, reporting, briefings, and forecasts.**
- **Provide additional Emergency Operations training between flood events to partner agencies and stakeholders.**
- **Continue use of android phones to send locations of sand boils, etc back to the office.**
- **Keep the organization charts up to date.**
- **Educate Corps employees and flood workers on public affairs and making statements on behalf of the Corps.**

- **Expand the pool of potential LNOs and train prior to next event; provide with District tools and ensure they are included in necessary briefings/updates to ensure they remain fully informed/SA.**
- **Implement ProjectWise as a repository for gage data and all pertinent flood fight information.**
- **Use the chain of command so employees do not take action on behalf of the District without approval and without the proper authority.**
- **EOC should ensure requests for IT support are forwarded to ACE-IT at the District.**
- **One District/Division should take the lead with each state to provide "One Door to the Corps" and provide consistency Input will be provided by all districts/divisions.**
- **Improve internal information sharing.**
- **Include public affairs section in the EOC SOP; one POC be identified to oversee all public meetings, and emergency personnel be educated on procedures regarding public meetings.**

3. Additional Partner Agency and Organization Communication Recommendations

- **Work with the NWS through the fusion team to explore the potential for official NWS forecast to be released by NWS earlier in the day.**
- **Work between floods to establish relationships with other governmental and non-governmental agencies (i.e., River Industry Decision Makers, Environmental NGOs, Levee Boards, etc.) to ease the exchange of information and increase communication before, during, and after flood events (i.e., preparedness, response and recovery).**
- **Supply EOCs with multi-agency personnel, resulting in a major communication improvement.**
- **Provide a Corps member to represent Corps issues within the USCG Command Center.**
- **Actively participate in the Joint Information Center (and other state equivalents) during flood events, and inform public affairs and emergency management personnel of its purpose and capabilities for inclusion in their planning.**
- **Continue daily conference calls during emergency operations, ensuring that all necessary agencies are included.**
- **Establish consistency between districts and other agencies in regards to modeling, mapping, reporting, briefings, and forecasts.**
- **Update existing distribution lists prior to next event.**
- **Publicize and share results of the PFRs with our partner agencies.**

4. Additional Public Communication Recommendations

- **Continue communication with public but increase efforts to publicize public meetings.**
- **Involve PAO and security in public meetings.**

- **Continue use of social media for general information to the public (similar to a press release), but send important information to other agencies (levee boards, etc) before releasing to the public; coordinate with PAO and EOC prior to event.**
- **Use the time between flood events to educate the public on the risks of living in a floodway or behind a levee and how to understand gage readings (gage vs elevation).**
- **Make Corps websites more visible.**

L. MR&T SYSTEM RECOMMENDATIONS SUMMARY

A systemic assessment of the MR&T System's operational and structural performance during the 2011 flood was conducted to identify opportunities to better restore, sustain, and improve the system. Table IX-1 displays a comprehensive and prioritized set of recommendations that should be considered in addressing the System's weaknesses and vulnerabilities. The recommendations also identify opportunities that should be further analyzed to improve current MR&T processes and components.

The recommendations are divided into three main categories (i.e., strategic, operational, and technical) to help establish the most appropriate approach to advancing them. Technical recommendations (e.g., modify the design of a levee) will be evaluated and moved forward primarily by engineers and MR&T component experts. Operational recommendations (e.g., change operating plan) will be examined and implemented by MR&T component experts, managers/operators, flood fighters, and decisions makers. Strategic recommendations (e.g., consider the status of features outside of the MR&T during system operation) establish how the system may be enhanced beyond existing capabilities and authorities and will be advanced by senior leaders and decision makers.

The recommendations in table IX-1 are also organized by major MR&T System component type and sorted by an initial priority. The initial priority was assigned by the PFR team to help identify the recommendations with the greatest potential to improve the performance of the MR&T System. Priorities were established within each component group and were identified in rank order (e.g. 1-5) or by having a number of component recommendations identified as high priority (e.g., several Floodways recommendations ranked as 1). Lower priority recommendations were not assigned a numerical rank at this time. These priorities will likely change as evaluations of the recommendations are advanced and additional information becomes available. The rankings will also change and be further refined as decision makers and senior leaders establish final priorities across all component categories.

The "Component" column in table IX-1 identifies the primary MR&T System component group that developed the recommendations. Further details on these recommendations and the information used in developing them can be found in the component sub-sections of this and other major sections of the PFR. The recommendations presented here are considered preliminary and have not yet been fully scoped or vetted. The next steps in their advancement will include further screening, regional prioritization, refinement, detailed scoping, and analysis. Some of the recommendations provided are already moving forward (e.g., BPNM operation assessment, examination of river flow changes, etc.) and will continue to be advanced. The process of implementing the PFR recommendations will result in improved performance of the MR&T System and further reduce flood risks within the LMRV.

The following table presents a categorized list of high priority overarching system recommendations and preliminary component team recommendations for improving performance of the MR&T. The bolded overarching system recommendations capture the main themes of the many detailed component team recommendations which would be nested within them. The recommendations have been grouped into three main categories (strategic, operational, and technical) to help establish the most appropriate approach to advancing them. They are also listed by component in an initial priority order established by the PFR component teams. This allows the reader to quickly locate additional information about the development of key recommendations in this and other component sections of the PFR. The next steps in advancing these preliminary recommendations will include further screening, combining, regional prioritization, refinement and detailed scoping for implementation by a regional multi-district and division team.

Table IX-1. MR&T System Recommendations

Strategic Recommendations		
Priority	**Recommendation**	**Component**
1	**Use information from the PFR effort to inform repair of the MR&T System**	**Overarching System**
1	**Use information from the PFR effort to inform completion of the MR&T System**	**Overarching System**
1	**Coordinate regional "triage" effort to prioritize, refine and implement PFR recommendations**	**Overarching System**
1	Improve the overall operations of the greater Mississippi River Basin reservoirs as a system	Reservoirs/Forecasting
1	Increase levee resiliency so fewer levee systems are made unacceptable by major floods	Levees
1	Examine and implement operational changes to MR&T floodways to improve performance	Floodways
1	Explore ways to include environmental and cultural resource considerations in flood risk management	Environmental/Cultural

Operational Recommendations		
Priority	**Recommendation**	**Component**
1	**Update Operation Manuals, Communications Plans, and SOPs using PFR information**	**Overarching System**
1	**Regionally standardize communication with MR&T stakeholders and landowners**	**Overarching System**
1	Revisit Chain of Command for Emergencies/Emergency Managers accompany DEs in field	Emergency Ops Plans
1	Assign MVD Representatives to Districts early for regional flood events	Emergency Ops Plans
1	Take full advantage of Smartphone, FREEBOARD, & MICA Capabilities	Emergency Ops Plans
2	Identify areas with limited cell phone coverage and work to expand coverage and prepare accordingly	Emergency Ops Plans
2	Update Pre-flood plans to better address new technologies (social media, Smartphones, etc.)	Emergency Ops Plans
2	Maintain sufficient supply of Smartphones for regional emergency use	Emergency Ops Plans
	Staff-up EOC and train early	Emergency Ops Plans
	Include public affairs section in EOC standard operation and EOP	Emergency Ops Plans
	Coordinate early with Non-Federal sponsors/stakeholders	Emergency Ops Plans
1	Improve NWS forecast communication between the NWS & districts to improve floodway operation	Reservoirs/Forecasting
1	MVD Water Control offices fully implement Corps Water Management System	Reservoirs/Forecasting
2	Take additional steps to improve the accuracy of forecasts [1]	Reservoirs/Forecasting

[1] Responsibility for implementation of this recommendation would lie with the Fusion Team

Operational Recommendations (cont.)		
Priority	**Recommendation**	**Component**
2	Continue Tri-agency meetings to enhance collaboration on forecasting	Reservoirs/Forecasting
2	Continue river forecaster's workshops to increase collaboration	Reservoirs/Forecasting
2	Utilize the Fusion Team as primary coordinator of improvements in river forecasting	Reservoirs/Forecasting
3	Develop a standardized deviation directive process for reservoir operation	Reservoirs/Forecasting
4	Incorporate travel time information from reservoirs and document associated risk considerations	Reservoirs/Forecasting
1	Bring all levee systems up to a minimally acceptable rating as quickly as funding allows	Levees
2	The Flood Fight Manual should be updated and communicated through an outreach program	Levees
3	Apply the recommendations in the Armoring Manual for HSDRRS (dated Nov. 2011)	Levees
4	Develop and implement a formalized information transfer program	Levees
1	Scour protection, additional height, or both may be needed at the Morganza south guide levee	Floodways
1	A comprehensive sediment management program for the ORCC should be implemented	Floodways
1	Deficient levee sections downstream of Bonnet Carré should be brought up to design grade	Floodways
	A discharge gage should be installed at the Tarbert Landing to clarify ORCC operation	Floodways
	Public outreach on the possibility of operating the West Atchafalaya Floodway should be continued	Floodways
1	Additional river gages should be installed to aid in operation of the Yazoo Backwater Levee	Backwater
1	Proceed with approved courses of action to repair St. Francis River Basin damages	Interior Drainage
1	St. Francis River Basin repairs should occur during times less likely to require pumping	Interior Drainage
	Proceed with approved courses of action to repair St. Johns Bayou New Madrid Floodway	Interior Drainage
	Continue to use St. Johns Bayou Gravity Structure in accordance with project authorization	Interior Drainage
	Yazoo River Area structures should be operated as designed	Interior Drainage
	Lake Chicot Pumping Plant structure should be operated as designed	Interior Drainage
	Gate seals on the Point Coupee Drainage Structure should be repaired	Interior Drainage
	Point Coupee pumping station and drainage structure should be operated in conjunction	Interior Drainage
	Local partners and landowners should maintain Johnson Bayou prior to high river season [1]	Interior Drainage
	Bayou Courtableu and Darbonne structures: develop operating plan for Morganza operation	Interior Drainage
	Install additional structures at Hanson/Franklin Canals & Yellow Bayou per the Atchafalaya plan	Interior Drainage
1	Provide additional channel improvement features in critical areas	Channel Improvement
2	The ACM sinking and grading units should receive major rehabilitation or be replaced	Channel Improvement
3	Increase pace of implementation of the channel improvement project features	Channel Improvement
4	Incorporate tree screens at vulnerable top bank/overbank locations	Channel Improvement
5	Extend ACM revetment farther into the channel and higher up on the bank	Channel Improvement
6	Modify dikes to reduce damages caused by large flood events	Channel Improvement

[1] Responsibility for implementation of this recommendation would lie outside the Corps

Operational Recommendations (cont.)		
Priority	**Recommendation**	**Component**
	Take additional measurements during future floods to better define the pulsing phenomenon	Channel Capacity
1	Institutionalize environmental and cultural resources regional response teams	Environmental/Cultural
3	Establish a program to plant and rehabilitate tree screens along the river to stabilize banks	Environmental/Cultural
4	Investigate possibility of setting aside contingency emergency funding for environmental work	Environmental/Cultural
5	Explore the development of programmatic agreements for emergency environmental work	Environmental/Cultural
	Develop consistent water-quality monitoring procedures and identify rapid contracting	Environmental/Cultural
	Initiate emergency threatened and endangered species (T&E) consultation	Environmental/Cultural
	Describe and catalog invasive and nuisance species that may spread during a flood	Environmental/Cultural
	Notify culturally-affiliated tribes regarding possible floodway operations	Environmental/Cultural
	Foster partnerships with others to quantify effects to oysters and other estuarine resources	Environmental/Cultural
	Establish protocols and assign teams for the rescue of T&E species	Environmental/Cultural
	Maintain regular communication with partners/stakeholders to enhance response/recovery	Environmental/Cultural
	Coordinate with individuals and organizations collecting field data	Environmental/Cultural
	Develop public communication plan on status of Lake Pontchartrain and other water bodies	Environmental/Cultural
	Consider gradual closure of Bonnet Carre Spillway to improve pallid sturgeon recovery efforts	Environmental/Cultural
	Update (weekly) consulting and culturally affiliated tribes using teleconferences and emails	Environmental/Cultural
	Follow and revise protocols for the treatment and disposition of uncovered human remains	Environmental/Cultural
	Establishing mechanisms to identify, capture, and archive environmental data	Environmental/Cultural
	Conduct LIDAR evaluation to identify potential cultural resource sites impacted by scouring	Environmental/Cultural
	Conduct consultation with SHPO and affiliated tribes as required in programmatic agreements	Environmental/Cultural
	Generate Environmental/Cultural Resource Operating Plans	Environmental/Cultural
	Complete cultural resources surveys in floodways as required by PAs or SHPOs	Environmental/Cultural
1	Document control must be an assigned, dedicated function for the MR&T Project	Data Inventory and Mgmt
2	Create a Flood Data Center	Data Inventory and Mgmt
3	Locate and inventory all historic MVD flood data	Data Inventory and Mgmt
4	Adopt a more centrally directed post-flood data capture and standardization process	Data Inventory and Mgmt
5	After data gathering is complete follow preservation processes outlined in the guidebook	Data Inventory and Mgmt
1	Provide timely and consistent mapping between districts	Communication
2	Send important information to other agencies before releasing to the public	Communication
3	Continue daily conference calls with partner agencies during emergency operations	Communication
4	Establish relationships and direct lines of communication with river industry decision makers	Communication
5	Involve Environmental NGOs in recovery efforts	Communication
6	Communicate recovery efforts to stakeholders	Communication

Operational Recommendations (cont.)		
Priority	**Recommendation**	**Component**
7	Publicize and share results of PFRs with partner agencies	Communication
	Ensure that Corps personnel are sufficiently equipped in accordance with their role	Communication
	Establish consistency between districts and other agencies (e.g., forecasts, reporting, etc.)	Communication
	Provide additional Emergency Operations training between flood events	Communication
	Continue use of android phones to send locations of sand boils, etc back to the office	Communication
	Keep Corps organization charts up to date	Communication
	Educate Corps employees and flood workers on public affairs procedures	Communication
	Expand the pool of potential Corps LNOs and train prior to next event	Communication
	Implement ProjectWise as a repository for gauge data and all pertinent flood fight info	Communication
	Use appropriate Corps chain of command	Communication
	The EOC should ensure requests for IT support are forwarded to ACE-IT at the District	Communication
	One district/division should take the lead with each state to provide "One Door to the Corps"	Communication
	Improve internal Corps information sharing	Communication
	Include public affairs section in the EOC SOP; one POC to oversee all public meetings	Communication
	Work with NWS through fusion team to establish if official NWS forecast can be released earlier	Communication
	Work between floods to better establish relationships with other governmental and NGO agencies	Communication
	Supply EOCs with multi-agency personnel to improve communication	Communication
	A Corps employee should be stationed at the US Coast Guard Command Center	Communication
	Actively participate in the Joint Information Center (and other state equivalents) during flood	Communication
	Update existing distribution lists prior to next event	Communication
	Continue communication with public but increase efforts to publicize public meetings	Communication
	Involve Public Affairs Office and Security in public meetings	Communication
	Continue use of social media for general information to the public (similar to a press release)	Communication
	Use the time between flood events to educate the public on the risks of living in a floodway	Communication
	Make Corps websites more visible	Communication

Technical Recommendations		
Priority	**Recommendation**	**Component**
1	**Evaluate the need to conduct an updated flow line study for the MR&T System**	**Overarching System**
2	Develop a HEC-RAS community model for the Mississippi River to improve forecasting	Reservoirs
1	Levee systems should be designed to be more resilient during major floods	Levees
1	Evaluate possible alternative methods of placing the BPNM floodway into operation	Floodways
1	Conduct a flowline review to examine stage-discharge relationship at Morganza	Floodways

Technical Recommendations (cont.)		
Priority	**Recommendation**	**Component**
1	Assess potential operational improvements and water control manual updates for Morganza Floodway	Floodways
	Better models of the Morganza Floodway and Atchafalaya Basin should be developed	Floodways
	Better computer models of the Bonnet Carré Spillway should be developed	Floodways
	Investigate ways to permanently address railway crossing seepage at Bonnet Carré Spillway	Floodways
	Clarify computation of discharge upon which the regulation of the ORCC is based	Floodways
	Examine the pulsing flow phenomenon near ORCC	Floodways
	Operational criteria for the ORCC overbank structure should be examined to improve performance	Floodways
1	Create a hydraulic model to help inform future operation of the Yazoo Backwater	Backwaters
1	Create a hydraulic model to help inform future operation of the Red River Backwater	Backwaters
1	Perform study to assess effectiveness of onsite pumping capability at Bayou Chene	Interior Drainage
1	Assess if permanent structure proposed by Bayou Chene local sponsor enhances FRM	Interior Drainage
1	Assess effect of floodway operation, bedform changes, and secondary flow on overall flow	Channel Capacity
1	Analyze the MR&T to identify areas that may not be providing the authorized level of protection	Channel Capacity
1	Analyze complex flow patterns at Morganza, Bonnet Carré, and ORCC	Channel Capacity
	Upgrade ADCP firmware used for overbank flow measurements	Channel Capacity
	Improve documentation of ADCP self tests and moving bed tests	Channel Capacity
	Upgrade GPS receivers used with ADCPs to have at least 2 decimal minute accuracy	Channel Capacity
	Assess effect of floodway operation and bedform changes on flow measurements	Channel Capacity
	Analyze the ORCC and other areas as recommended by the Committee on Channel Stabilization	Channel Capacity
	Analyze effect of channel changes and future sedimentation trends on water surface profiles	Channel Capacity
2	Investigate methods to operate floodways that minimize environmental/cultural impacts	Environmental/Cultural
	Determine if any measures can be taken for managing nuisance species during flood events	Environmental/Cultural
	Create a web-based database or portal for standardized access to environmental data	Environmental/Cultural