



DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

CECW-EC

JUN 12 2018

MEMORANDUM FOR RECORD

SUBJECT: Response to 2016 Independent External Peer Review (IEPR) of the U.S. Army Corps of Engineers Dam Safety Program

1. References:

a. Response to 2016 Independent External Peer Review (IEPR) of the U.S. Army Corps of Engineers Dam Safety Program, 23 March 2018

b. EC 1165-2-214, Civil Works Review, 15 December 2012.

c. Office of Management and Budget, Final Information Quality Bulletin for Peer Review, 2004.

d. Federal Emergency Management Agency, 1979 (Jul), "Federal Guidelines for Dam Safety," FEMA 93, Washington, DC.

e. Final report, 2016 Independent External Peer Review (IEPR), U.S. Army Corps of Engineers' Dam Safety Program, Contract No. W912QR-16-D-004, dated August 1, 2017.

2. An Independent External Peer Review (IEPR) was conducted for the U.S. Army Corps of Engineers (USACE) Dam Safety program in accordance with Civil Works Review policy EC 1165-2-214, and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review. This program review was conducted at USACE discretion and was not related to any statutory mandate. USACE contracted with Schnabel-HDR Joint Venture (Schnabel-HDR) to perform an IEPR of the USACE Dam Safety Program. The primary objectives of the IEPR were to examine how well USACE is implementing the Federal Guidelines for Dam Safety and executing its stated mission. The review provided an independent external view of the policies, procedures, and performance of the USACE Dam Safety Program.

3. I approve the final written responses to the IEPR in the enclosed document. The IEPR Report and USACE responses will be posted on the internet to share lessons learned with other dam owners.

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Army Corps of Engineers Dam Safety Program

4. The point of contact for this action is John P. Bianco, HQUSACE, Special Assistant for Dam Safety who can be reached at John.P.Bianco@usace.army.mil or at (732) 675-8742.

A handwritten signature in black ink, appearing to read "J. Dalton", with a stylized flourish at the end.

JAMES C. DALTON, P.E.
Director of Civil Works

Encl



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

CECW-EC

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MEMORANDUM FOR DIRECTOR OF CIVIL WORKS

SUBJECT: Response to 2016 Independent External Peer Review (IEPR) of the U.S. Army Corps of Engineers Dam Safety Program

1. References:

- a. EC 1165-2-214, Civil Works Review, 15 Dec 2012.
- b. Office of Management and Budget, Final Information Quality Bulletin for Peer Review, 2004.
- c. Federal Emergency Management Agency, 1979 (Jul), "Federal Guidelines for Dam Safety," FEMA 93, Washington, DC.
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3. The USACE Dam Safety Program uses a risk-informed decision management approach to oversee its portfolio of 715 dams, with public safety paramount and highest priority. This risk-informed approach was adopted to improve our understanding of the safety of our dams, to better communicate the risks and benefits of the dams, and to enhance dam safety management decisions. The Dam Safety Program seeks to ensure that USACE owned and operated dams do not present unacceptable risks to people, property, or the environment.

4. Selection of expert reviewers for IEPR efforts was in accordance with the National Academy of Science (NAS) Policy on Committee Composition and Balance and Conflicts of Interest. The Panel conducted its review of the Dam Safety Program between August 2016 and July 2017. The review encompassed routine and non-routine dam safety activities being performed by Headquarters (HQ), the Dam Senior Oversight Group (DSOG), the Risk Management Center (RMC), Dam Safety Production Centers (DSPC), the Dam Safety Modification Mandatory Center of Expertise (DSMMCX), the Modeling, Mapping, and Consequence Center (MMCC), Divisions (MSCs), Districts and selected project locations.

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5. Schnabel-HDR issued the final IEPR report on August 1, 2017 (referenced 1.d.) with fourteen (14) findings and thirty-five (35) recommendations. The IEPR team initially rated their 14 Findings as either Category A – Critical, Category B – Urgent or Category C – Important. Definitions of these categories follow:

a. Critical: The recommendation has the potential to significantly degrade or undermine the Dam Safety Program, or otherwise can lead to dramatic negative consequences. Includes “must do” recommendations.

b. Urgent: The recommendation is of significant importance to the program and can provide substantial dam safety benefits.

c. Important: The recommendation is worthy of implementation and would likely provide a definitive return on investment. Timeline for implementation could be long.

Subsequent to the release of the Final report, the USACE dam safety team and the IEPR Panel further coordinated agreement upon the rating for each recommendation. Discussions were held and agreement was reached to ensure that emphasis, as envisioned by the IEPR Panel, would be properly placed on each of their recommendations. Work plan development, analysis and/or studies are categorically prioritized for scheduling and implementation, as funding permits, based on these ratings.

6. The USACE responses to individual IEPR comments are provided in the attached Enclosure. USACE Dam Safety team endorses twenty-three (23) of the panel recommendations (includes two panel recommendations combined into 1 response), partially endorses six (6), does not concur with four (4), and has determined one (1) required no further action. Many of our subsequent actions will be phased to include the updating of guidance first, then revising associated procedures, followed by the development of training tools to aid in field implementation.

7. Agency responses, within the attached enclosure, were coordinated with the 2016 IEPR Panel members. Request your approval of the IEPR report and our agency responses to the panel findings and recommendations.

8. The point of contact for this action is John P. Bianco, HQUSACE, Special Assistant for Dam Safety who can be reached via email at John.P.Bianco@usace.army.mil or telephonically at (732) 675-8742.



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ERIC C. HALPIN, P.E.
Corps Deputy Dam Safety Officer (DDSO)
Directorate of Civil Works

Enclosure
USACE Response to the 2016 IEPR Review of the USACE Dam Safety Program

USACE Responses to the 14 Independent External Peer Review (IEPR)
Findings containing 35 Recommendations on the Dam Safety Program.

Notes:

- (1) A USACE lead organization has been assigned for each recommendation. Entities include: Headquarters (HQ); Dam Senior Oversight Group (DSOG); Dam Safety Steering Committee (DSSC); Districts; Institute of Water Resources (IWR), Risk Management Center (RMC); Mapping, Modeling and Consequence production Center (MMC) and the Dam Safety Modification Mandatory Center of Expertise (DSMMCX).
- (2) The IEPR team initially rated their 14 findings. Subsequent to delivery of the Final Report, USACE and the IEPR panel coordinated and reached agreement on the ratings for each of their 35 recommendations. Each finding and recommendation was assigned a rating as: Category A - Critical, Category B- Urgent or Category C - Important.

1. IEPR Finding: 2016-A-01 - Emergency Preparedness. The implementation of EAPs continues to be a concern (reference IEPR Finding/Recommendation 2013-A-17). The IEPR Team believes there is still a lack of national oversight of the EAP program. The development of EC 1110-2-212 (now EC 1110-2-6074) is an important step toward improvement, but without national oversight (i.e., central management), there are still concerns with regard to the quality and consistency of EAPs and emergency management, and consistent implementation across the USACE. Coordination between the Dam Safety and Emergency Management groups at the District level is inconsistent and appears to be lacking at some locations. Further, the role of Emergency Management staff and their interface with Dam safety may not be adequately defined. Eight (8) recommendations follow:

Recommendation 2016-A-01.a. Given the nature of this IEPR and the scale of the USACE Dam Safety Program, this peer review is not considered a detailed review of this one aspect of the program. USACE should consider a separate peer review of the policies, procedures, and implementation of all aspects of the program that relate to emergency preparedness.

Recommendation Rating: CRITICAL

USACE Lead Organization: HQ

Concur. HQUSACE will perform a review of current policies, procedures and implementation practices of the DS Program. USACE had noted to IEPR panel members that ER 1110-2-1156 will be under review and revised in the near future. A peer review of the proposed ER will be considered, in particular as it relates to emergency preparedness activities documented within the revised guidance. Peer review feedback can be incorporated into future revisions of ER 1110-2-1156 and/or EC 1110-2-6074 as appropriate.

Recommendation 2016-A-01.b. Develop a national, centrally managed, group of EAP facilitators/coordinators to schedule and facilitate EAP exercises and assist in maintaining effective EAPs. This group would coordinate with District dam safety and emergency management staff. Lessons learned from the exercises would be collected and disseminated from a single source.

Recommendation Rating: CRITICAL

USACE Lead Organization: MMC

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Non-concur. The recommended approach would limit incentives for districts to develop this expertise locally. However, USACE agrees with the recommendation to seek overall improvement in consistency & effectiveness of EAPs. To accomplish this USACE will develop an Agency wide list of EAP specialists to assist Districts as requested. These specialists will maintain a compilation of best practices and communicate them throughout USACE. Best practices will be reviewed for incorporation into future EAP guidance updates.

Recommendation 2016-A-01.c. Establish a dam safety/emergency management oversight group that would have responsibility for technical review and oversight (i.e., have audit responsibilities) of district and project emergency preparedness.

Recommendation Rating: CRITICAL

USACE Lead Organization: MMC

Non-concur. Establishment of a dam safety/emergency management technical review and oversight group would add further burden and extend internal review processes with limited improvement realized. However, USACE does agree that district dam safety and emergency management experts should work closely together to enhance project emergency preparedness at the local level. USACE will consider adding emergency management representation on the Dam Safety Steering Committee (DSSC) to incorporate emergency management improvements into the dam safety program. Subsequent responses to 2016-A-01.d and 2016-A-01.e further address how this will be encouraged.

Recommendation 2016-A-01.d. EAPs should be the responsibility of the emergency management staff, given their qualifications and experience with emergency management procedures. This staff would keep the plan updated, notify plan holders of any changes, and arrange logistics and invitations for exercises. Educating downstream communities on risks and interfacing with local emergency responders would be a significant component of their responsibilities. Dam safety staff would provide technical input into the EAP.

Recommendation Rating: CRITICAL

USACE Lead Organization: MMC

Non-concur. Dam Safety (district level) will maintain the lead role in EAP preparation, updating, internal coordination and developing exercises. Although USACE is somewhat unique as an agency that both operates dams and has an emergency management function, keeping EAP responsibilities with the dam safety function is consistent with federal guidelines. Furthermore, USACE emergency management resources are insufficient to take responsibility as recommended above. However, USACE does agree with the recommendation that more emergency management involvement and closer coordination between emergency management and dam safety is necessary. USACE also notes that many districts rely upon operations staff at the projects to perform many of the functions of this recommendation. USACE guidance will be updated to recommend that district emergency management and/or operations staff should be actively involved or leading external coordination with EMAs, communities, county and state representatives. USACE EAP guidance, draft EC 1110-2-6074, clarifies the role of the emergency managers and operations project managers in incident response and clarifies EAP, exercise and incident response funding sources.

Recommendation 2016-A-01.e. EAPs should include specific references to surveillance and monitoring plans, including instrument threshold limits, which can be incorporated as warnings in the determination of emergency levels in the EAP.

Recommendation Rating: URGENT

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USACE Lead Organization: MMC

Partially concur. Concur that revisions and/or updates will be made as necessary to existing ER/EM guidance. Consideration will be given in future EAP guidance updates to provide reference to a model EAP and/or EAP template. USACE notes that internal review of EAPs performed during development of draft EC 1110-2-6074, found that many EAPs are lengthy as identified in the IEPR findings, specifically because they include many surveillance and monitoring plan elements and essentially serve these functions in addition to EAP functions. USACE does acknowledge that unusual instrumentation readings should trigger verification actions such as visual observation of the instrument (for potential damage or dam distress), increased monitoring and notification to dam safety specialists, the District DSPgM and the District DSO.

However, USACE non-concurs with the implicit use of instrumentation readings. Instrumentation readings alone should not be used to trigger evacuations.

Recommendation 2016-A-01.f. The effectiveness of an EAP should be a unit of measure when developing consequences during the Periodic Assessment. The only time the EAP was mentioned in the Barren River Dam Consequence Assessment Report (2015) was in a table that showed that a plan existed. An effective EAP should be a positive consideration when developing consequences and if ineffective, uncertainties might be increased.

Recommendation Rating: URGENT

USACE Lead Organization: MMC

Partially concur (see details below).

Non-concur. Currently, within our decision-driven approach to risk management, we do not require a high level of accuracy for consequence estimates during a Periodic Assessment (PA). It should be noted that the goal of a consequence estimate in support of a PA, is to bracket the potential consequences (max/min). Assessing the effectiveness of an EAP, in terms of evacuation phase activities related to large or emergency spillway releases or even breach flow conditions in support of a PA would not be an effective use of resources as other uncertainties in the consequence estimate would outweigh the relatively small reduction in uncertainty gained. For the more detailed risk assessments (Issue Evaluation Studies (IESs) and other higher level studies), additional in-depth consequence studies are performed and we do look at the effectiveness of the EAP in reducing the uncertainty in the consequence assessment.

Concur. USACE recognizes that the Periodic Assessment (PA) process could be revised to include a cursory evaluation of the evacuation effectiveness as part of intervention.

Recommendation 2016-A-01.g. O&M funding should be prioritized for the development and implementation of EAPs. Risks related to ineffective EAPs should be captured in this prioritization. This would likely help in elevating the importance of the EAP, particularly for dams with very high consequences, where coordination with local EMAs is complex and time consuming.

Recommendation Rating: URGENT

USACE Lead Organization: Districts as appropriate.

Concur. USACE will assess revising the Budget EC to consider life loss risk and the degree of consequences. In addition, as EAP's are determined to be ineffective, they will be prioritized based on the estimated consequences within available O&M funds.

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Recommendation 2016-A-01.h. District Commanders should be engaged in the EAP processes and emphasize the importance of emergency preparedness to all branches in the District.

Recommendation Rating: URGENT

USACE Lead Organization: Districts as appropriate.

Concur. District Commanders will be invited to participate during EAP emergency exercise(s). EAP guidance will be modified to reflect the inclusion of District Commanders.

2. IEPR Finding: 2016-A-03 - Instrumentation and Monitoring. The 2013 IEPR included a critical finding (2013-A-19) related to surveillance and instrumentation. The 2015 and 2016 USACE internal peer reviews confirmed the concerns noted in the 2013 IEPR. The IEPR Team concurs with the internal peer review findings and believes that the recommended improvements should be a priority of the dam safety program, given the importance of monitoring dams as it relates to potential failure modes. Two (2) recommendations follow:

Recommendation 2016-A-03.a. Prioritizing the completion and approval of EM 1110-2-1908. Review should be accelerated to implement the latest technology and practices in the field.

Recommendation Rating: CRITICAL

USACE Lead Organization: RMC

Concur. USACE is revising EM1110-2-1908 to focus strictly on Instrumentation for embankment dams and levees and the EM will be renamed accordingly - Instrumentation of Embankment Dams and Levees. Monitoring content of the EM will focus on how and when to acquire data from instrumentation. Enhancements will be made to the guidance so that the risk-informed process related to instrumentation is clear and that it aligns with the USACE Risk Framework. Inspection guidance will be removed from the EM. Levee inspection guidance will be contained in an upcoming ECB and ultimately be included in a new ETL/EM. Sufficient dam inspection guidance is currently contained in ER 1110-2-1156, "Dam Safety Program - Policies and Procedures", dated 31 March 2014.

Recommendation 2016-A-03.b. Instrumentation training through the PROSPECT or other courses should be mandatory for staff responsible for surveillance and instrumentation at a dam.

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Concur. Mandatory PROSPECT Instrumentation training will be included on Individual Development Plans (IDPs) with regard to those responsible for surveillance and instrumentation at a USACE dam(s). HQ will prepare a Guidance Memorandum to be issued by either USACE's Deputy Dam Safety Officer (DDSO) or Dam Safety Officer (DSO) that advocates this requirement throughout USACE.

3. IEPR Finding: 2016-A-04 - Strategy to Complete and Assess "Fundamental Dam Safety Activities" for All Projects. There is a need for an overall assessment of the development of fundamental dam safety activities in a qualitative manner, including a clear definition of a baseline objective regardless of the type of project. Such a baseline should enable a defensible quantitative risk analysis for all dams in the portfolio. One (1) recommendation follows:

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Recommendation 2016-A-04. A guideline and a roadmap (including timing) for baseline completion of fundamental dam safety activities and studies should be developed, together with an approach to continuously and qualitatively assess these activities. These "fundamentals" should allow defensible quantitative risk analysis and explicit consideration of uncertainties at any level of assessment within the USACE Dam Safety Program.

Recommendation Rating: CRITICAL

USACE Lead Organization: RMC

Partially-concur. USACE concurs with the development of guidelines and an overarching roadmap for fundamental dam safety activities, however, we do not concur that this activity warrants reprogramming for immediate implementation this FY. USACE may elect to include the fundamental data requirements as part of our mid-term Periodic Inspections (PI) and may also include this as part of the scope of MSC/HQ audits.

4. IEPR Finding: 2016-B-02 - Risk-Informed Emergency Preparedness. The interface between the risk analyses (i.e., Periodic Assessments, Issue Evaluation Studies) that are performed for USACE dams and dam safety program activities in general is an important part of the program. ER 1110-2-1156 specifically calls for EAPs to be risk-informed. The IEPR Team did not observe clear evidence that EAPs are risk-informed and that those responsible for the EAPs have a clear understanding of the risk profile for a project. One (1) recommendation follows:

Recommendation 2016-B-02. While ER 1110-2-1156 makes it clear that EAPs should be risk-informed, it is not obvious this implementation has taken place. It is recommended that the RMC conduct a programmatic review to assess whether and how risk-informed information is being integrated into dam safety program activities, particularly routine activities, including EAPs. This review should be followed by the development of guidelines and training (likely integrated into existing training course) as to how risk information can be in the development of EAPs, instrumentation programs, etc.

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Concur. USACE will utilize our improved understanding of our dams from risk assessments to better focus our routine dam safety program to:

- a) modify inspection checklists to highlight significant potential failure mode (PFM) observation points,
- b) identify instruments that monitor significant PFMs for priority during routine data reviews and develop monitoring thresholds for them,
- c) assure significant PFMs and associated indicators of distress, and actions to take are covered in dam safety training and emergency actions plans.

Management Controls will be updated to include these actions and be included in MSC reviews. USACE internal Dam Safety training courses will be updated to emphasize these points.

5. IEPR Finding: 2016-B-05 - Integration of Design and Construction. Regarding the charge question: "What is the panel's evaluation of how USACE has integrated design and construction?" The IEPR Team believes there is appropriate USACE guidance to integrate engineering and construction; however, implementation and accountability have been a challenge. This is evident through discussions with staff at all levels. Another issue related to

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construction is the lack of construction staff with experience specific to dams. Training and developmental assignments are not sufficient for current project needs. Six (6) recommendations follow:

Recommendation 2016-B-05.a. Provide training of construction staff and include developmental assignments to dam projects under supervision of construction staff experienced in dam construction.

Recommendation Rating: URGENT

USACE Lead Organization: DSMMCX

Concur. USACE will enhance DSAC University's enrollment of construction support personnel. HQ's to issue guidance to encourage construction staff participation within the program.

Recommendation 2016-B-05.b. DSMMCX should take a more active role in tracking construction projects and perform periodic interviews with the construction and design staff to enhance the level of cooperation.

Recommendation Rating: URGENT

USACE Lead Organization: DSMMCX

Concur. DSMMCX will explore avenues to increase active feedback from design/construction teams on DS projects.

Recommendation 2016-B-05.c. HQUSACE and Commanders must stress the importance of collaboration to the Engineering and Construction Branch chiefs.

Recommendation Rating: URGENT

USACE Lead Organization: DSMMCX & HQ

Concur. An ECB will be developed and issued to field operating offices to address this concern.

Recommendation 2016-B-05.d. Each Project Management Plan should require a pre-construction meeting between engineering and construction staff to discuss critical phases of construction and involvement from the design team. The design team needs to provide clear guidance on what the critical tasks are with an explanation on why they require extra oversight by use of a detailed Engineering Considerations and Instructions for Field Personnel document.

Recommendation Rating: URGENT

USACE Lead Organization: HQ Construction

Concur. While PMPs should reflect these requirements, future Design Construction Evaluations (DCEs) will determine if these meetings are occurring and the effectiveness of designers and/or design teams in bringing key issues to the attention of the construction team during project startup and subsequent meetings.

Recommendation 2016-B-05.e. Construction staff should be included early in the design process, to ensure constructability concerns are addressed.

Recommendation Rating: URGENT

USACE Lead Organization: HQ Construction

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Concur. This is already a USACE requirement. USACE will evaluate, during DCEs or MSC Quality Assurance (QA) visits how soon the Districts are integrating their construction staff into the design effort.

Recommendation 2016-B-05.f. A Design Construction Evaluation team, similar to the one used on mega projects, should be used on all construction projects to assist in making design and construction staff accountable to implementation of USACE guidance with regard to integration of design and construction.

Recommendation Rating: URGENT

USACE Lead Organization: HQ Construction

Concur. USACE will evaluate what types of Dam Safety projects and funding thresholds may require this type of intensity for upward reporting and outside MSC multi-discipline team assessments.

6. IEPR Finding: 2016-B-06 - Sharing and Implementing Lessons Learned. The Dam Safety Program has not established a programmatic effort to identify and share lessons and experiences on dam performance and overall dam safety activities (EAP exercises, management practices, etc.). Six (6) recommendations follow:

Recommendation 2016-B-06.a. Define a vision and a mission for learning from experience that supports the advancement and improvement of dam engineering and safety, and maintaining and growing institutional knowledge.

Recommendation Rating: URGENT

USACE Lead Organization: HQ

Concur. USACE has recognized the need for a knowledge based vision and system in the past. An Agency wide eLL (Enterprise Lessons Learned) website was previously developed but that system is currently non-functional. However, others - namely the Military Programs Directorate, has issued guidance to the field as recently as July 2017 mandating the capturing of "AARs" and "LLs" into a knowledge based system. DS specialist will collaborate with Military Programs on their current system and determine what, if anything, may be beneficial in response to this recommendation. Furthermore, DS will also inquiry if a new Corporate-wide knowledge based system is under consideration.

In 2011 USACE implemented the Periodic Assessment (PA) program that requires all dam and levee safety projects to undergo a risk assessment on a 10-year cycle in perpetuity. PA's include a 10-day risk assessment of a dam or levee safety project performed by district personnel and guided by an experienced facilitator as provided by the RMC. The PA program has allowed district personnel to gain a better understanding (by analyzing these systems from a failure mode perspective) of their projects and ranking them accordingly to aid in effective risk reduction. This process also encourages USACE personnel to appreciate the relevance of historical performance of these structures and maintain an ongoing familiarity of case histories of past incidents and failures thus learning from past experiences.

In 2013 USACE formed 15 dam and levee safety risk assessment cadres to more effectively assess the risk associated with flood control projects within the USACE dam and levee portfolios. The cadres are multi-disciplinary groups of between 5 to 8 district employees responsible to perform risk assessments. USACE has invested considerable resources by both training and developing the cadre members into dam safety technical experts within their respective disciplines. Cadre membership and training opportunities are open to all viable

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technical assets at USACE Districts which aids in advancing improvements to the Agency and dam safety community at large.

The RMC has also trained approximately 40 dam and levee safety professionals to be risk assessment facilitators specifically for the PA program. This ensures that a standard set of best practices are being adhered to, provides programmatic and technical consistency across the PA program and ensures that learning is institutionalized thru knowledge transfer.

Recommendation 2016-B-06.b. Identify 'significant events' (incidents, experiences, practices, etc.) that would/may locally and/or broadly (across the USACE) offer lessons that would support the dam safety mission.

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Concur. In 2012, the RMC began sponsoring a monthly case history webinar (1- 2 hour presentations) discussing past dam and levee safety incidents and failures. The webinars provides participants with background information with regard to the specific structure/facility, evaluates the events around the specific incident or failure being described, and attempts to characterize the specific cause or causes of the incident or failure based on current state of engineering practice.

Initially the Case History Webinar had limited participation but now incorporates the entire Dam and Levee Safety Community of Practice within USACE. Invites are distributed to the Dam and Levee Safety Project Managers (DSPMs and LSPMs) of each district, members of the Dam and Levee Safety Risk Assessment Cadres, Periodic Assessment facilitators, and others. Furthermore, the case history webinars are now more broadly shared and attended across the Federal community with participation and presentations made by representatives from USACE, Bureau of Reclamation (BoR), Federal Energy Regulatory Commission (FERC), Tennessee Valley Authority (TVA) and the National Resources Conservation Service (NRCS).

Recommendation 2016-B-06.c. Evaluate the significant events to derive lessons (are there lessons to be learned and if so what are they).

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Concur. Lessons learned from recent events/incidents are being incorporated into assessments for USACE dams and levee projects as they become available. As an example, recent events at Oroville Dam in California have USACE re-examining its portfolio of dams that contain steep, high-velocity concrete spillways. Any USACE dam identified will be assessed to ascertain if the structure will perform as intended (designed) for various loading conditions which it may be subjected to. The Oroville event also provided and informative case history on warning issuance and large scale evacuation success which are being integrated into a database of past performance to enhance our methodologies when estimating consequences.

Recommendation 2016-B-06.d. Record and distribute information on significant events and lessons.

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Concur. Lessons learned will be developed & disseminated throughout the organization. Currently, significant events are presented and discussed at "Case History Webinars" spanning

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multiple federal agencies as noted above (see response to 2016-B-06.b.). This information will be included in the knowledge management system.

Each "Case History Webinar" presentation is recorded and posted for future viewing by USACE personnel. Also to encourage broader participation, PDH's have been provided to employees attending these technical lectures. Lastly, these presentations are incorporated into RMC training workshops where discussions are held to distill these valuable lessons learned such that implications are better understood by USACE dam and levee safety practitioners.

Recommendation 2016-B-06.e. Establish mechanisms with training programs and other organizational opportunities to ensure that lessons are learned.

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Concur. Dam Safety training as well as organization training workshops (DSO, LSO and USACE wide Infrastructure Conferences) will include technical forums to identify, discuss and disseminate this type of information.

USACE technical personnel are being actively encouraged to participate in professional trade organizations through membership, authoring papers and presenting papers. This has led to a renewed focus on Profession Registration across USACE.

A key RMC mission is to develop training resources for members of the risk cadres, district personnel and dam/levee safety specialists. Training opportunities include well documented courses that have been repeatedly taught to different groups of students. Classes are continually updated based upon comments received from students and further development in the state of the practice. RMC courses include:

- Best Practices in Dam and Levee Safety Engineering, a four-day class used by the USACE, BoR, FERC, and FEMA;
- Mechanics of Internal Erosion Workshop;
- Hydrologic Hazards Workshop;
- Seismic Analysis of Embankments;
- Seismic Evaluation of Concrete Gravity Dams and Related Water Retention Structures;
- Site Characterization for Dam and Levee Safety, Parts 1 and 2;
- Estimating Consequences for Dam and Levee Failures Workshop;
- Seminal Papers in Risk Analysis for Civil Engineering;
- Seminal Papers in Internal Erosion of Dams and Levees;
- Estimating Risk of Internal Erosion Failure Modes (planned);
- Risk Analysis Tools Including DAMRAE, @Risk (planned); and
- Risk Portrayal (planned).

Recommendation 2016-B-06.f. Establish mechanisms to ensure that learned lessons become a part of dam safety practices.

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Concur. Policy and guidance requirements for the dissemination, storage and corporate retrieval processes for accessing lessons learned are actively being developed by others within

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USACE. Those processes will be incorporated into the dam and levee safety programs. Dam Safety training (PROSPECT, Webinars and Training Workshops) as well as key organizational sessions (DSO, LSO, Infrastructure Conferences) will also include technical forums to identify, discuss and disseminate this type of information to the field. The HQ Dam Safety team will periodically review developed policy and guidance to ensure that the Enterprise Lessons Learned (ELLs) methods and procedures are being utilized thus incorporating the value added from these past experiences. Guidance will emphasize the need to review appropriate ELLs during project startup and at key transitional points during the life of the project. Furthermore, since USACE has implemented a risk-informed decision-making framework and that framework embedded the decision to continually assess our entire dam and levee portfolio predominately by using internal (in-house) resources. This internal focus has resulted in our practitioners becoming more cognizant/aware of developing lessons learned and the need to rapidly share that information across the Agency. Numerous training classes, workshops and other technical forums have been developed, assembled and provided to the USACE dam safety community to expedite the rapid transfer of knowledge to include lessons learned. The RMC has also established a case history library (via monthly webinars) which is actively being maintained and available electronically to the USACE dam and levee safety community of practice as well as other agencies.

7. IEPR Finding: 2016-B-07 - Centrally Managed – Locally Executed. Discussions with USACE District and Division staff during the course of this IEPR have highlighted mixed implementation of the central management-local execution concept. For example, RMC is responsible for development of risk analysis methodologies and to varying degrees their implementation. The implementation of risk analysis (e.g., Periodic Assessments, Issue Evaluation Studies) is an example of central management (by RMC, DSOG) integrated with local execution (teams include District, Division, and Centers). Alternatively, USACE has recently developed new guidance for emergency action plans (**EC 1110-2-6074**); however, there is no clearly defined central oversight of EAPs, potentially compromising USACE readiness for managing emergencies at dams. Similarly, dam safety modifications are centrally prioritized and funded; however, major maintenance packages (e.g., spillway gate replacements) are locally prioritized and executed. One (1) recommendation follows:

Recommendation 2016-B-07. The IEPR Team recommends an enterprise-wide review (a task force of internal and possibly external members) to systematically evaluate where, to what level, and by what means central management can be more effectively implemented. The task force would be charged with evaluating how dam safety activities are implemented throughout the organization and approaches to achieving technical quality, consistency, effectiveness, and efficiency (timeliness). This assurance is achievable with a greater level of oversight (central management) of all dam safety activities. In addition, the task force should be charged with developing and recommending specific organizational changes that would improve the effectiveness (in the sense of reducing/eliminating the potential for discontinuities) of a centrally managed-locally executed framework.

Recommendation Rating: URGENT

USACE Lead Organization: HQ.

Action. N/A. USACE response to this recommendation will be included within IEPR Comment 2016-B-08 below (see next comment).

8. IEPR Finding: 2016-B-08 - Locally Executed. Districts are given the autonomy to establish staff organizational structures and management practices they find to best suit their needs. While local factors are clearly a reasonable consideration, the IEPR Team has observed

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USACE Response to the 2016 IEPR Review of the USACE Dam Safety Program

organization and management approaches that appear to be more effective and efficient for the USACE Dam Safety Program. These instances have been observed in areas such as design and construction interface, dam safety and emergency management, and project operations and maintenance funding. One (1) recommendation follows:

Recommendation 2016-B-08. The Dam Safety Program should undertake an enterprise review of District engineering and dam safety management structures and practices. This review should identify those practices that provide improved effectiveness and efficiency in carrying out dam safety responsibilities. Once these 'best practices' are vetted, Districts should be subject to a comprehensive review, and as locally and generally appropriate, HQUSACE should recommend changes that should be implemented. [*The IEPR Team notes this recommendation could be combined with recommendation 2016-B-07 (Centrally Managed – Locally Executed).*]

Recommendation Rating: URGENT

USACE Lead Organization: HQ

Concur. USACE will review, analyze and evaluate current District process, procedures and methodologies when executing their dam safety programs. A dam safety team, led by a HQ's senior representative, will identify "Best Practices" for potential implementation across the agency to achieve and/or enhance technical quality, consistency, effectiveness, and efficiency (timeliness). HQ's will also consider and evaluate driving that change through top down directives as well as encouraging Districts to accept and adopt recognized "Best Practices" in their programs. Following the national review, USACE will implement periodic audits at selected Districts for compliance. These dam safety audits will be similar to our Design Construction Evaluations (DCEs) and leverage senior representatives from HQ's, the RMC and the local MSC when performing these reviews.

9. IEPR Finding: 2016-B-09- Hydrologic Analysis. In the natural hazards field, it is standard practice to incorporate a formal, structured approach to identify and evaluate aleatory and epistemic uncertainty in a hazards analysis. Further, the quantification of the hazard involves a segregated propagation of aleatory and epistemic uncertainties, sensitivity analysis, and analysis of variance assessments that identify the contribution of different sources of uncertainty to the total uncertainty in the hazard. One (1) recommendation follows:

Recommendation 2016-B-09. The IEPR Team recommends the HHT undertake an effort to establish a formal approach and implementation plan for the assessment of hydrologic hazards that include a framework for the identification and evaluation of sources of aleatory and epistemic uncertainty, a structured approach for evaluation and integration of sources of epistemic uncertainties, and quantification methods for the propagation of uncertainties. Initially, this may include the development of a conceptual hydrologic hazards analysis framework that describes an uncertainty framework, the physical events (e.g., extra-tropical storms) that are being modeled, an initial aleatory model(s), and an initial identification of the sources of aleatory and epistemic uncertainty. Once the conceptual framework is prepared, a project plan that identifies methods, tasks, and schedule can be prepared.

Recommendation Rating: URGENT

USACE Lead Organization: HQ

Concur. Overarching USACE guidance stipulates that uncertainty must be accounted for within all projects/programs as part of the risk-based framework. USACE numerical modeling tools (HEC-WAT and RMC-RFA) are capable of assessing uncertainty in such a manner, however, more formalized guidance needs to be developed for specific application of

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USACE Response to the 2016 IEPR Review of the USACE Dam Safety Program

uncertainty analyses across the enterprise. USACE will develop a Hydrologic Hazards "Best Practices" guidance document to address aleatory and epistemic uncertainty. The document will address technical procedures and consolidate references from existing USACE Engineering Regulations, Engineering Circulars, Technical Reports, and numerical modeling software.

10. IEPR Finding: 2016-B-10 - Hydrologic Risk Analysis. Integration of sufficient number of hydrologic events with gate reliability analysis, operating rules assessment, concurrent probabilities of "spillway related" failure modes, and characterization of pool level prior to the flood needs a formal approach through every level of risk analysis within the Program, as well as clear identification of all contributors to the existing uncertainties. One (1) recommendation follows:

Recommendation 2016-B-10. The "loading" component of hydrologic risk analysis for all studies (e.g., Periodic Assessments, Issue Evaluation Studies, etc.) should be centrally managed, following the example of the consequence analysis. This should be a priority and the approach should be formalized in a manner that enables quantitative risk analysis and clear accountability of uncertainties at any level of assessment (including Periodic Assessments). A formal approach to addressing hydrologic risk should be developed, with its particular features, for the design of dam safety modifications.

Recommendation Rating: URGENT

USACE Lead Organization: HQ

Partially-concur (see actions identified below). Non-concur with above comment as routine activities, including Periodic Assessments, are managed and executed by the local District. The RMC provides guidance documents, training, help desk support, and consistency review support to achieve a formal and consistent flood hazard assessment approach. Non-routine activities, including Issue Evaluation Studies (IESs), are managed and led by the RMC. The RMC provides a formal and consistent approach through centralized program management and technical oversight. Resources across USACE are utilized for execution of the work based on the requirements and needs of the particular study.

USACE does concur that actions could be taken to potentially improve the overall process and could include:

- Developing and/or hiring additional senior level H&H advisors;
- Fully integrating senior level H&H advisors within the IES team; and
- Developing guidance for addressing hydrologic risk in the design of a dam safety modification.

11. IEPR Finding: 2016-B-11 - Seismic Hazard Analysis. At this time, an approach to formally evaluate seismic hazards at USACE projects has not been developed. Efforts have been initiated, but there does not yet exist a program plan and schedule to define how and when this issue will be addressed. One (1) recommendation follows:

Recommendation 2016-B-11. As a first step, a plan should be developed to establish the steps and schedule for how the probabilistic assessment of seismic hazards will be evaluated at USACE dams. The plan should include the development of guidance for how PSHAs are performed, the level of analysis that is required, which will vary depending on the risk analysis being supported and the consequences of an uncontrolled release, among other possible factors.

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USACE Response to the 2016 IEPR Review of the USACE Dam Safety Program

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Non-Concur. Non-Concur that a new seismic hazard analysis program is needed as seismic hazards are being systematically evaluated for USACE dams. USACE has screened all its projects using seismic hazard zones to determine if there are any structures in areas of high seismic risk that should be evaluated before the next scheduled PA. During periodic assessments, teams use USGS hazard information to estimate seismic hazards and use existing information to assess if enough information exists to characterize the seismic hazard. If these conservative analyses indicate seismic hazard and associated risks are high, detailed state-of-the-art analyses are completed for seismic failure modes. This is currently on-going for many of our structures and has been completed on several facilities in Idaho, Oregon, Washington, and California, and additional analyses are being planned in the New Madrid Seismic Zone and other seismic zones in the central and eastern United States. It is acknowledged that the existing program could be updated to (a) include a portfolio-wide screening that could be used directly by District personnel in PA/SQRA level assessments, and (b) ensure that guidance for higher-level seismic hazard analyses (i.e., EM-1110-2-6000) is updated and better understood by District / Cadre assessment teams.

12. IEPR Finding: 2016-B-12 - Seismic Risk Analysis for Dam Systems. There is no information to indicate that USACE has given much attention to the seismic risk of their portfolio of dams. Further, given Finding 2016-B-11, it is not apparent there is a clear understanding of the issues and unique aspects associated with seismic risks. For example, in the Midwest, the USACE has dams that are located in proximity to the New Madrid seismic zone and the Wabash Valley seismic zone. At the District level there seems to be a lack of awareness of the potential seismic risks, which could result in inadequate consideration of potential seismic failure modes, impacts to approaches for emergency management, etc. One (1) recommendation follows:

Recommendation 2016-B-12. It is recommended that a systematic seismic risk analysis program be established that includes the range of evaluation methods that is required to support the dam safety program; risk-informed screening analysis through to full-scope probabilistic seismic risk analysis that is consistent with the state-of-practice in earthquake engineering. This program should consider all elements of the risk analysis for a dam system, the assessment of downstream consequences, and the integration of the results into project monitoring, post-event inspection, and emergency preparedness both on and off site.

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Partially concur. Do not concur with the Finding statement above suggesting that USACE has not given much attention to the seismic risk of their portfolio of dams. USACE has screened all its projects using seismic hazard zones to determine if there are any structures in areas of high seismic risk that should be evaluated before the next scheduled PA. During periodic assessments, teams are using USGS hazard information to evaluate seismic hazards and existing information to determine if they have enough information to characterize seismic risks. If these conservative analyses indicate seismic risks are high, detailed state-of-the-art analyses are completed for those failure modes. This is currently on-going for many of our structures and has been completed on several high consequence facilities in Idaho, Oregon, Washington, and California. Therefore, USACE non-concurs that a new seismic risk analysis program is needed as seismic risks are already being systematically evaluated for USACE dams.

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USACE Response to the 2016 IEPR Review of the USACE Dam Safety Program

However, USACE does concur that when significant seismic risks are identified, then project monitoring, post-event inspection procedures, and emergency preparedness should be updated.

Lastly, prioritizing seismic hazard above other hazards is not a risk-informed approach.

13. IEPR Finding: 2016-B-13 - Update Role, Scope and Contents of Periodic

Assessments. As the USACE Dam Safety Program matures and high-risk projects are modified to meet USACE Tolerable Risk Guidelines, potential concerns are emerging from the fact that risk analysis has also been used to prioritize the completion of more "fundamental" dam safety studies for all dams. The first round of Periodic Assessments (e.g., Brea Dam, Periodic Assessment No. 01) not only serves to estimate and assess existing risks, but are also the means to identify and recommend actions such as updating hydrologic analysis, performing seismic studies, developing instrumentation monitoring plans, or conducting emergency exercises, which are fundamental activities of any modern dam safety program. The current scope of risk assessment, which has served well for portfolio management, particularly given the urgency driven by "legacy" projects and other critical, extreme or very high risk projects, may not serve as well for prioritizing the completion of "fundamental" dam safety activities. This concern is internally recognized (i.e., Bluestone Dam Hydrologic Hazard Document Supplement 2016, with regard to hydrologic analysis). Four (4) recommendations follow:

Recommendation 2016-B-13.a. Perform a systematic analysis of all projects that have been through quantitative risk assessment to evaluate the implications in terms of risk characterization and resulting actions of the different levels of analysis. (e.g., Are there quantifiable trends when comparing the results of risk analyses performed through Periodic Assessment versus Issue Evaluation Study?).

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Concur. USACE currently performs and will continue to perform annual systematic analyses of risk assessment results from PA's and quantitative risk assessments (IES) to identify any trends that would suggest improvements to the risk analysis methodology utilized for Periodic Assessments or quantitative risk assessments. The overall goal is to improve the reliability and confidence in the PA process, and determine the highest priority projects that demand a quantitative risk analysis in order to provide the necessary input for a decision. The analytics currently performed identify outlier risk estimates for specific PFMs or those with high uncertainty to allow for the entire portfolio to be compared to other projects with similar risks, and to make inherent corrections when appropriate to the methodology to estimate risk or the actual risk estimates.

Recommendation 2016-B-13.b. Perform a systematic review of all findings and recommendations from Periodic Assessments with regard to performing "fundamental" dam safety activities and studies, so that a qualitative assessment of such fundamentals can be performed. (This could supplement quantitative results of the DSPMT scorecard.)

Recommendation Rating: URGENT

USACE Lead Organization: RMC

Concur. USACE will explore conducting a yearly review of Periodic Assessment findings and associated recommendations (by District or Division) to assess what recommendations have been implemented, how long it takes to implement recommendations, and how effective

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USACE Response to the 2016 IEPR Review of the USACE Dam Safety Program

the recommendations are in reducing the risks associated with projects. This will help ensure USACE is conducting dam safety activities in a timely manner to reduce the overall risk of the portfolio.

Recommendation 2016-B-13.c. Develop a detailed plan to centrally track and support O&M recommendations (including dam safety studies) from the Periodic Assessment program.

Recommendation Rating: URGENT

USACE Lead Organization: DSSC

Concur. A detailed methodology/process to centrally track & support O&M recommendations via PA's will be further developed. This may require mandatory updating of DSPMT following DSOG approved PAs when identifying, tracking and funding resulting O&M recommendations.

Recommendation 2016-B-13.d. Develop a vision for the future scope of risk analysis at the Periodic Assessment level to ensure that the "second round" of Periodic Assessments will reduce the potential for: (1) a lack of fundamental dam safety activities and/or studies, resulting in an unsound basis for a full quantitative risk analysis (including explicit consideration of uncertainties), and (2) risk analysis providing an overconfident outcome in terms of need and urgency of actions.

Recommendation Rating: IMPORTANT

USACE Lead Organization: RMC

Partially Concur. Concur with regard to the routine portion of USACE's dam safety program. The fundamental routine data collection and evaluation issues will be addressed through the actions previously described in our response to 2016-A-04. The USACE Periodic Assessment methodology, which is currently state-of-the-art, is updated annually.

Non-concur that an overarching objective for a periodic assessment is to improve the characterization of uncertainty and to separate uncertainty from sensitivity. It is noted that there are technological and financial challenges to the approaches. First, there are no broadly accepted consistent methods to characterize uncertainty. There are no industry best practices to rely upon, so USACE would be developing those from the ground up. The return on investment for that is very low, as USACE has not observed significant variations in uncertainty between projects. Second, funding for Periodic Assessments is essentially fixed. Any improvements in methods would have to essentially be neutral in terms of effort on the part of the teams doing the assessment. Improving the characterization of uncertainty, which is a secondary consideration in the decision process, is less effective than improving other aspects of the PA process. It would be more valuable for teams to spend their time attempting to reduce uncertainty rather than improve their characterization of uncertainty. A second overarching objective for periodic assessments is to move towards more numeric characterization of risks. As this approach becomes more mature, we expect to be able to more systematically characterize uncertainty. However, the two issues of methodology and level of effort will still limit the effectiveness and value of any approach.

14. IEPR Finding: 2016-C-14 - Consideration of Consequences Beyond Life Loss in Risk Reduction Indicators. Exclusive consideration of life safety risk in the management of the USACE diverse portfolio of dams, particularly moving forward as high risk issues are addressed, could be limiting with regard to leveraging new opportunities within the USACE (other business lines) and externally (in terms of funding fundamentally). One recommendation follows:

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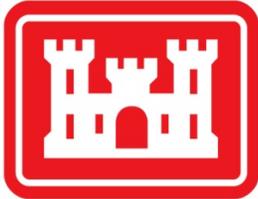
USACE Response to the 2016 IEPR Review of the USACE Dam Safety Program

Recommendation 2016-C-14. While this finding does not warrant a specific action, given the limited number of projects where life-safety risk is not the main driver, the IEPR Team suggests that this “boundary” of the program deserves an updated evaluation. Some of the benefits could come from comparing options related to prioritization of actions, enabling more direct comparisons with other business lines, and/or, assisting in identifying unique funding opportunities. We also understand this “boundary” intersects with current policy, as only life safety risk and cost-to-save-a-statistical life are included in ER 1110-2-1156 as risk reduction indicators.

Recommendation Rating: IMPORTANT

USACE Lead Organization: RMC

Comment is noted - no specific action is warranted. However, USACE will further consider this recommendation, particularly on low head navigation projects. USACE DS specialists will also clarify how other business lines are incorporating benefit streams into their decision making processes.



**FINAL REPORT
2016 INDEPENDENT EXTERNAL PEER
REVIEW (IEPR)**

**US Army Corps of Engineers' Dam Safety Program
Contract No. W912QR-16-D-0004
Task Order 0002**

August 1, 2017

Schnabel HDR Joint Venture

Schnabel HDR Joint Venture

August 1, 2017

Mr. James Dalton, PE, HQUSACE Dam Safety Officer
Mr. Eric Halpin, PE, HQUSACE Deputy Dam Safety Officer
U.S. Army Corps of Engineers
441 G Street, NW
Washington, DC 20314-0001

Subject: FINAL REPORT, 2016 Independent External Peer Review (IEPR) of the USACE Dam Safety Program, W912QR-16-D-0004 TO 0002 (LRL) (Schnabel Reference 16C35002.09)

Dear Mr. Dalton and Mr. Halpin:

SCHNABEL-HDR JOINT VENTURE is pleased to submit this **Final Report** for our 2016 Independent External Peer Review (IEPR) of the USACE Dam Safety Program. This peer review was performed in accordance with our contract dated June 29, 2016, modified on January 24 and May 25, 2017.

The IEPR was performed between August 2016 and March 2017, with a draft report issued on March 14, 2017. Minor edits to the report were reflected in a revised draft issued on March 20, 2017. The IEPR Team attended a briefing meeting on March 31, 2017. Following that meeting, USACE added to the scope of work. A revised draft report was issued on July 1, 2017, and included the additional scope. Additional edits were made and are included in this final report.

We appreciate the opportunity to be of service for this project. Please contact me if you have any questions regarding this report.

Sincerely,

SCHNABEL-HDR JOINT VENTURE



Gregory S. Paxson, PE, D.WRE
Project Manager

GSP:RPB:IEB:MWM:hcf

**W912QR-16-D-0004 TO 0002 (LRL) – IEPR, USACE Dam Safety Program
Final Report**

Distribution

**FINAL REPORT
2016 INDEPENDENT EXTERNAL PEER REVIEW
USACE DAM SAFETY PROGRAM**

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LIST OF ACRONYMS USED IN THIS REPORT

ASDSO	Association of State Dam Safety Officials
CIPR	Critical Infrastructure Protection & Resilience
COI	Conflicts of Interest
CoP	Community of Practice
CRM-D	Common Risk Model for Dams
CTS	Consequence-Based Top Screen
DCE	Design and Construction Evaluations
DDR	Design Documentation Reports
DHS	Department of Homeland Security
DSAC	Dam Safety Action Classification
DSAT	Dams Sector Analysis Tool
DSM	Dam Safety Modification
DSMR	Dam Safety Modification Reports
DSMMCX	Dam Safety Modification Mandatory Center of Expertise
DSO	Dam Safety Officers
DSOG	Dam Safety Oversight Group
DSPC	Dam Safety Production Centers

**W912QR-16-D-0004 TO 0002 (LRL) – IEPR, USACE Dam Safety Program
Final Report**

DSPCSC	Dam Safety Production Center Steering Committee
DSPM	Dam Safety Program Manager
DSPMT	Dam Safety Program Management Tools
DSSC	Dam Safety Steering Committee
EAP	Emergency Action Plan
EMA	Emergency Management Agency
FEMA	Federal Emergency Management Agency
HHT	Hydrologic Hazards Team
HQ	Headquarters
HQUSACE	Headquarters US Army Corps of Engineers
IEPR	Independent External Peer Review
IES	Issue Evaluation Studies
IRRM	Interim Risk Reduction Measures
LRD	Lakes and Rivers Division
LRL	Louisville District
LSO	Deputy Levee Safety Officer
MMC	Mapping Modeling and Consequences Production Center
MSC	Major Subordinate Commands
MVD	Mississippi Valley Division
MVS	St. Louis District
NAS	National Academy of Sciences
O&M	Operation and Maintenance
PA	Periodic Assessments
PDT	Project Delivery Team
PI	Periodic Inspections
PRQCP	Peer Review Quality Control Plan
PSHA	Probabilistic Seismic Hazard Analysis
RMC	Risk Management Center
SOW	Statement of Work
SPD	South Pacific Division
SPL	Los Angeles District
SQRA	Semi-Quantitative Risk Assessment
USACE	United States Army Corps of Engineers

1.0 ACKNOWLEDGEMENTS

This report provides the results of the 2016 Peer Review of the US Army Corps of Engineers' (USACE) Dam Safety Program by an Independent External Peer Review (IEPR) Team.

The IEPR Team acknowledges the significant amount of time, effort, and support provided by USACE personnel who contributed to making this review meaningful. The candid participation of representatives from LRD, LRL, MVD, MVS, SPD, SPL, RMC, DSMMCX, MMC, and HQUSACE is gratefully acknowledged, along with the efforts of individuals from across USACE who supported this project with thoughtful survey responses and discussions with the IEPR Team. In particular, the IEPR Team acknowledges the support of John Bianco (HQ) and Travis Tutka (RMC) in managing and supporting the IEPR for USACE. In addition to responding promptly to requests for additional information, they provided valuable information regarding the organization and workings of the USACE and its Dam Safety program.

Respectfully submitted,

Randall Bass, PE, Principal, Schnabel Engineering

Ignacio Escuder-Bueno, PE, PhD, Founding Partner, iPresas

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Gregory Paxson, PE, D.WRE, Principal, Schnabel Engineering

2.0 EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE) contracted with Schnabel-HDR Joint Venture to perform an Independent External Peer Review (IEPR) of the USACE Dam Safety Program. This report summarizes the results of the IEPR, performed between August 2016 and July 2017.

As described in the Statement of Work (SOW), the objective of this IEPR is to “examine how well the USACE is implementing the federal guidelines for dam safety and executing its stated mission.” The SOW also included the following “charge” questions to be answered by the IEPR:

- Is the direction of the program appropriate?
- Has USACE overlooked any critical items?
- What is the panel's evaluation of how USACE has integrated design and construction?
- Does the panel have recommendations regarding improvement in methodologies or approaches to implementation?
- Does the panel have any other observations to add?

In addition, USACE specifically requested that the IEPR Team “Evaluate and make a recommendation whether the Critical Infrastructure Program should be incorporated into the HQUSACE dam safety organization.”

The IEPR Team consists of a Project Manager and panel of three experts in dam safety, dam engineering, and management of a dam safety program. The project manager and two of the panel members served on the IEPR Team for the 2013 IEPR of the Dam Safety Program.

USACE provided numerous documents to the IEPR Team as part of the review, and several additional documents were provided upon request. In addition, the IEPR Team participated in an orientation briefing at Headquarters (HQ), and participated in three trips, each including a visit to a Division, District, and Project. The IEPR Team also participated in the 2017 Dam Safety Community of Practice meeting. In addition, the IEPR developed a survey questionnaire that was distributed to various organizations within USACE (Districts, Divisions, Centers, etc.). The results of this survey were used to inform the IEPR Team.

The USACE Dam Safety Program is the largest in the United States, and USACE owns and regulates hundreds of high and significant hazard dams, with the majority constructed between 1930 and 1980. This period of construction was followed by the current period of dam safety assessments and modifications to identify and address deficiencies at existing dams.

There have been two previous peer reviews (2001 and 2013) of the USACE Dam Safety Program. In 2001, the Association of State Dam Safety Officials (ASDSO) conducted a peer review, with the following major finding:

[USACE] is currently considered to have a minimally acceptable Dam Safety Program and any further reductions in their Program will endanger their dams and the lives and property they protect.

This finding, coupled with other events such as the levee failures resulting from Hurricane Katrina, motivated a series of significant changes in the USACE Dam Safety Program, most notably the adoption of a risk-informed approach for dam safety portfolio management and decision making.

In 2013, the USACE requested that Schnabel Engineering establish an IEPR Team (including subconsultants). This IEPR identified and acknowledged the progress of the USACE program since 2001, noting the following:

The implementation of a risk-informed approach for dam safety portfolio management and decision making is a great improvement in the program and the program continues to mature. USACE should be commended for the positive changes made in the past decade.

The 2016 IEPR built upon the 2013 IEPR findings and recommendations. As a preface to answering the “charge” and discussion of specific IEPR findings and recommendations, it is worth noting the progress and positive steps of the program, both in the past 15 years and since the 2013 IEPR.

- The 2016 IEPR Team noted broad acceptance of the risk-informed approaches across all staff levels. This is a significant achievement, even since the 2013 IEPR.
- RMC, DSMMCX, and MMC continue to grow and add capabilities. The IEPR Team observed significant advances in collaboration between the Centers and other levels of the USACE Dam Safety Program.
- USACE recognizes the value and importance of education and training of the staff, resulting in the ongoing development of training programs in risk analysis methods and facilitation, surveillance, and instrumentation, etc.
- The dam safety program has established and is implementing an effective programmatic structure for managing risk for its dams.
- Since the 2013 IEPR, USACE has implemented several new initiatives and developed guidance documents, some related to findings/recommendations of the 2013 IEPR. Notable examples of these initiatives are documented in the report.

The implementation of risk-informed management has been extremely positive. The changes in the program have been successful and should continue with the full support of USACE leadership.

With regard to the SOW objective that the IEPR evaluation of how well USACE is implementing the federal guidelines for dam safety:

- As noted in the 2013 IEPR, the “Federal Guidelines for Dam Safety” were found to be a limited metric for evaluating the USACE Dam Safety Program. These guidelines, developed nearly 40 years ago, are considered outdated. A number of elements of the guidelines do not provide

reasonable guidance or a standard for evaluating and measuring the adequacy of a dam safety program.

- Additional federal guidance for dam safety has been developed since the “Federal Guidelines for Dam Safety,” particularly the “Federal Guidelines for Dam Safety Risk Management” (FEMA 2015). These guidelines are considered relevant and USACE provided significant input into the guidelines. The IEPR Team believes that USACE is implementing risk management in general accordance with these guidelines.

With regard to the “charge” questions:

- ***Is the direction of the program appropriate?*** The IEPR Team believes the direction of the program is clearly appropriate and positive, as was also noted in the 2013 IEPR. The changes of the past 10+ years are benefitting the program and the safety of USACE dams. Since 2013, USACE has continued with initiatives to improve the program, further indicating that the direction is appropriate.
- ***Has USACE overlooked any critical items?*** The IEPR Team has identified three findings as “critical” according to the definitions provided herein. Two findings were also included in the 2013 IEPR (related to Emergency Preparedness and Instrumentation). The “critical” category is partially related to how important these activities are to an effective dam safety program. It would not be appropriate to state that USACE has “overlooked” these items, rather it is the IEPR Team's assessment that not enough emphasis in continued development and/or implementation has been placed on these issues.
- ***What is the panel's evaluation of how USACE has integrated design and construction?*** IEPR Finding 2016-B-05 describes this evaluation, noting the IEPR Team believes there is appropriate guidance to integrate engineering and construction; however, implementation and accountability have been a challenge.
- ***Does the panel have recommendations regarding improvement in methodologies or approaches to implementation?*** The 2016 IEPR findings specifically reference potential improvements in methodologies and implementation related to “fundamental” dam safety activities (surveillance and instrumentation, emergency preparedness, etc.) and hydrologic and seismic risk analysis.
- ***Does the panel have any other observations to add?*** Many of the findings and recommendations presented herein are considered to fall into this category. One additional observation is that USACE has addressed many issues that have become critical in many other dam safety organizations, including the items below. In this sense, USACE is unique with regard to its approach to risk governance in the field of dam safety.
 - Defining risk in a way that allows handling inherent complexity, uncertainty, and ambiguity
 - Adopting quantitative tolerable risk guidelines
 - Using risk for internal and external communication
 - Building personnel competencies in risk and making risk-informed decisions

During the 2016 IEPR, USACE provided input on their activities in response to each finding and recommendation from the 2013 IEPR. The IEPR Team generally concurred with the approaches being implemented by USACE. A number of actions proposed to address the 2013 findings have not yet matured to the point of being fully implemented. Therefore, many of the 2013 IEPR findings and recommendations still apply.

Many of the 2016 IEPR findings and recommendations reference issues that were identified as part of the 2013 IEPR. The 2016 findings/recommendations specifically reference the 2013 findings/recommendations where appropriate. The report includes a table to cross-reference the 2016 findings/recommendations to those from the 2013 IEPR.

Given the various missions of USACE, the size of the agency, its geographic coverage, and the number and diversity of the dams within the portfolio, the USACE Dam Safety Program is a unique organization presented with unique challenges in executing its mission. The report includes the following “broad perspectives” to characterize some of these features and challenges.

- **Self-Regulation.** USACE is a “self-regulated” agency with regard to dam safety. This is one paradigm for dam safety, with the other being that of an entity (typically a government agency) providing independent regulatory oversight of compliance with defined standards related to dam design, operation and maintenance, and emergency management. Self-regulation is inherently challenging from a risk governance and quality assurance and oversight perspective.
- **Potential Program Discontinuities.** Given the diversity of activities and responsibilities that are inherent to a dam safety program, coupled with the central management-local execution philosophy of USACE, the IEPR Team identified several potential programmatic “discontinuities.”
- **Complacency and/or Overconfidence.** These can occur at a number of levels in an organization. Certainly, if these occur at the highest management levels, they will trickle down to middle management and staff. Alternatively, complacency and/or overconfidence may occur at staff levels, and should be identified and addressed by supervisors and management.

These “broad perspectives” were not included as specific findings, but provide context for the specific IEPR findings and recommendations and, where appropriate, are referenced by individual findings.

The IEPR Team developed 14 findings and recommendations, with three “critical” findings (denoted with “A”), 10 “urgent” findings (denoted with “B”) and one “important” finding (denoted with “C”). The categories (critical, urgent, important, other) are defined in the report. The findings were:

- 2016-A-01: Emergency Preparedness
- 2016-B-02: Risk-Informed Emergency Preparedness
- 2016-A-03: Instrumentation and Monitoring
- 2016-A-04: Strategy to Complete and Assess “Fundamental Dam Safety Activities” for All Projects
- 2016-B-05: Integration of Design and Construction

- 2016-B-06: Sharing and Implementing Lessons Learned
- 2016-B-07: Centrally Managed – Locally Executed
- 2016-B-08: Locally Executed
- 2016-B-09: Hydrologic Analysis
- 2016-B-10: Hydrologic Risk Analysis
- 2016-B-11: Seismic Hazard Analysis
- 2016-B-12: Seismic Risk Analysis for Dam Systems
- 2016-B-13: Update Role, Scope and Contents of Periodic Assessments
- 2016-C-14: Consideration of Consequences Beyond Life Loss in Risk Reduction Indicators

The report includes a detailed and summarized description of each finding, along with a recommendation.

During the briefing of IEPR findings and recommendations, USACE requested the IEPR Team's opinion related to the CIPR Program and its relationship to the dam safety program. The IEPR SOW was revised to include the following: "Evaluate and make a recommendation whether the Critical Infrastructure Program should be incorporated into the HQUSACE dam safety organization."

The IEPR Team reviewed documentation related to the CIPR Program and interviewed the CIPR Program Manager and leadership from the Dam Safety Program regarding this "integration" of dam safety and dam security (CIPR).

It is the IEPR Team's view that **integration** of the dam safety and security programs would have limited benefits to dam safety (the focus of this IEPR). While there appear to be synergies that could provide benefits, these are inherently limited due to the limited overlap of the dam safety and security program responsibilities. It is the IEPR Team's assessment that potential benefits could be achieved through close **coordination** between the programs, which is desirable. The IEPR Team identified a list of concerns herein that should be considered as the USACE considers integration of these programs.

As with the 2013 IEPR, a Maturity Matrix approach was developed to provide an aggregate assessment of various elements of the USACE Dam Safety Program. The approach to the Maturity Matrix differed from the approach used during the 2013 IEPR. In this review, the IEPR Team generally followed an industry approach developed by CEATI, with some notable differences.

Finally, the IEPR included several "lessons learned" through the IEPR process that should be considered in future peer reviews.

3.0 INTRODUCTION

3.1 Purpose and Scope of Independent External Peer Review (IEPR)

As described in the Statement of Work (SOW) for this project (included in Appendix A), the objective of this IEPR is to “examine how well the USACE is implementing the federal guidelines for dam safety and executing its stated mission.” The IEPR “shall provide an external review of the policies, procedures, and performance of the USACE Dam Safety Program” with the intent of providing USACE “with an external examination of its internal workings, with external ideas to improve performance, and assess USACE in comparison to industry dam safety practices.” The IEPR “should also provide a level of transparency for USACE and the public that will determine if the USACE is effectively and efficiently managing risks for its dams.”

According to the SOW, the IEPR should answer the following general questions (referred to as the “Charge”) regarding the overall USACE Dam Safety Program:

- Is the direction of the program appropriate?
- Has USACE overlooked any critical items?
- What is the panel's evaluation of how USACE has integrated design and construction?
- Does the panel have recommendations regarding improvement in methodologies or approaches to implementation?
- Does the panel have any other observations to add?

In addition to these “Charge” questions, during the briefing on March 31, USACE requested additional evaluation by the IEPR Team. The SOW was revised to include the following:

- Evaluate and make a recommendation whether the Critical Infrastructure Program should be incorporated into the HQUSACE dam safety organization.

The SOW included a list of several documents to be reviewed as part of the IEPR. During the course of the review, numerous additional documents were identified as relevant to the IEPR. A list of documents provided by USACE is included in Appendix B.

The objective of the IEPR is to perform a review of the USACE Dam Safety Program, with a focus on addressing the charge questions. The IEPR is considered a programmatic review, as opposed to a detailed technical review of methods, procedures, and processes. In this context, the IEPR does not include a detailed review of ER 1110-2-1156, the technical methodology it describes or references, or the policy content. The IEPR also excludes detailed review of the methods, calculations, and other details of the documents provided by USACE. Documents were reviewed to provide the IEPR Team context regarding the policies and implementation of the USACE Dam Safety Program.

In this context, the IEPR addressed programmatic elements of the dam safety program and is not and should not be interpreted as a technical endorsement of methodologies, procedures, and policies of the program.

The general inclusions and limitations of the IEPR described above are intended to conceptually define the bounds or limits of the review. In spite of the limitations, it goes without saying the IEPR Team was

exposed directly or indirectly to various technical elements of the USACE Dam Safety Program and its implementation. If a technical issue was observed, a finding and recommendation are included. These technical observations should not be interpreted to be a result of a thorough technical review.

In addition to review of selected documents provided by USACE, the IEPR Team visited the following USACE offices, facilities and events:

- Headquarters (HQ), Orientation Briefing, August 18-19, 2016
- Lakes and Rivers Division (LRD), Louisville District (LRL), and Rough River Dam, September 19-21, 2016.
- Mississippi Valley Division (MVD), St. Louis District (MVS), and Lock and Dam No. 25, November 7-10, 2016.
- South Pacific Division (SPD), Los Angeles District (SPL), and Whittier Narrows Dam, November 14-17, 2016.
- 2017 Dam Safety Community of Practice (CoP) Workshop, Galveston, TX, February 6-8, 2017.

The IEPR Team interprets the purpose of these visits as a means to obtain a general understanding of the organization and operations of the entire USACE Dam Safety Program, and obtain a sampling of observations and views of USACE staff regarding the program and its processes and procedures. The visits are not considered evaluations or “audits” of the individual Districts or Divisions. Appendix C includes information regarding each visit, including the agenda, attendee list, and a memorandum with discussion topics prepared by the IEPR Team in advance of the visits. In addition to these visits, the IEPR Team interviewed numerous other staff involved in the USACE Dam Safety Program by telephone and during the CoP Workshop. A listing of those interviewed outside of the visits is also included in Appendix C.

This report summarizes the IEPR of the USACE Dam Safety Program. The only other deliverable for this project is the Peer Review Quality Control Plan (PRQCP) dated August 5, 2016. The original schedule for the project is included in the SOW in Appendix A. The revised schedule is also included in Appendix A.

3.2 IEPR Team

The IEPR Team includes a project manager and review panel of experts. The project manager and eight potential candidates were selected by the Schnabel-HDR Joint Venture Management Team and Technical Advisory Panel. The eight candidates were submitted to USACE, who selected the three-member panel. The IEPR Team includes:

Project Manager:

- Mr. Gregory (Greg) S. Paxson, PE, D.WRE, Schnabel Engineering, West Chester, PA

Panel:

- Mr. Randall (Randy) P. Bass, PE, Schnabel Engineering, Alpharetta, GA
- Mr. Ignacio Escuder-Bueno, PE, PhD, iPresas, Valencia, Spain
- Mr. Martin (Marty) W. McCann, Jr., PhD, Jack R. Benjamin & Associates, Menlo Park, CA

Summaries of the IEPR Team members' experience and qualifications are included in Appendix F. The IEPR panel was selected in accordance with the National Academy of Sciences (NAS) Policy on Committee Composition and Balance and Conflicts of Interest (COI). Full resumes, along with signed NAS COI forms, were included with the PRQCP.

3.3 Federal Guidelines for Dam Safety

As noted in Section 3.1, an objective of the IEPR is to evaluate how USACE is implementing the federal guidelines for dam safety. These guidelines were developed by the Interagency Committee on Dam Safety and are included in the Federal Emergency Management Agency (FEMA) document "Federal Guidelines for Dam Safety" (reprinted April 2004). The guidelines, originally published in 1979, are summarized as follows (FEMA, 2004):

These guidelines apply to management practices for dam safety of all Federal agencies responsible for the planning, design, construction, operation, or regulation of dams. They are not intended as guidelines or standards for the technology of dams. The basic principles of the guidelines apply to all dams. However, reasonable judgments need to be made in their application commensurate with each dam's size, complexity, and hazard.

The Federal agencies have a good record and generally sound practices on dam safety. These guidelines are intended to promote management control of dam safety and a common approach to dam safety practices by all the agencies. Although the guidelines are intended for and applicable to all agencies, it is recognized that the methods of the degree of application will vary depending on the agency mission and functions.

As noted in the 2013 IEPR, the "Federal Guidelines for Dam Safety" were found to be a limited metric for evaluating the USACE Dam Safety Program. These guidelines, developed nearly 40 years ago, are considered outdated. The IEPR Team understands that the guidelines are undergoing significant revisions. In addition, a number of elements of the guidelines do not provide reasonable guidance or standard for evaluating and measuring the adequacy of a dam safety program.

3.4 Risk-Informed Management for Dam Safety

The 2013 IEPR included a history and overview of the implementation of risk-informed management for dam safety in the United States. Since the 2013 IEPR, FEMA (2015) issued the "Federal Guidelines for Dam Safety Risk Management," with significant contributions from USACE and other federal agencies involved in dam safety. FEMA (2015) includes the following statement, highlighting the value of risk-informed management for dam safety:

...entities that analyze, evaluate, and manage risks have found that risk provides a rigorous, systematic, and thorough process that improves the quality of and support for safety decisions.

USACE ER 1110-2-1156, "Safety of Dams – Policy and Procedures" (May 2013 draft) includes the following statement (Section 1.10), which demonstrates USACE commitment to the application of risk for dam safety management:

USACE has moved from a solely standards-based approach for its dam safety program to a dam safety portfolio risk management approach. The standards-based or essential guidelines approach is included in the risk-informed approach to the dam safety program and dam safety program decisions will now be risk informed.

4.0 USACE DAM SAFETY PROGRAM

4.1 Mission of the Dam Safety Program

As noted in the SOW, this IEPR is to evaluate how USACE is “executing its stated mission.” The dam safety program is part of the USACE Civil Works program, which has the following stated mission and vision (<http://www.usace.army.mil/Missions/Civil-Works/>):

Dedicated to providing quality, responsive service to the nation in peace and war. The Directorate of Civil Works is a major component of the U.S. Army Corps of Engineers. The Civil Works programs include water resource development activities including flood risk management, navigation, recreation, and infrastructure and environmental stewardship. Our mission also includes emergency response.

According to Section 1.8 of ER 1110-2-1156 (Safety of Dams – Policy and Procedures):

The purposes of a dam safety program are to protect life, property, lifelines, and the environment by ensuring that all dams are designed, constructed, regulated, operated, and maintained as safely and effectively as is reasonably practicable.

In addition, Section 1.11 includes the following:

Principles for Dam Safety Program Management. The following guiding principles, which represented a paradigm shift for USACE, have been established for the USACE Dam Safety Program Management process:

Public Safety. *A key mission of the USACE dam safety program is to achieve an equitable and reasonably low level of risk to the public from its dams. USACE executes its project purposes guided by its commitment and responsibility to public safety. Since "Life Safety is Paramount", it is not appropriate to refer to balancing or trading off public safety with other project benefits. Instead, it is after tolerable risk guidelines are met that other purposes and objectives will be considered. Dam Safety Officers (DSO) are the designated advisors and advocates for life safety decisions.*

Do No Harm. *The principle of 'Do No Harm' must underpin all actions intended to reduce dam safety risk.*

USACE will ensure that USACE dams are designed and operated in a way that during a flood the spillway flow will not, at any time during the event, result in downstream flooding more severe than that which would have been the circumstance had the dam not existed. Herein is the basic principle upon which dam safety programs are based as regards to managing flows in excess of the authorized purposes; this 'non-breach' situation of flow past the dam is not to result in greater flood hazard than that which would have occurred without the dam in place.

USACE will implement Interim Risk Reduction Measures (IRRM) while long-term solutions are pursued. USACE will ensure that proposed IRRM implementation, emergency or permanent construction, or a temporary or permanent change in regulation

plans will not result in the increased risk of unsatisfactory performance of the dam, adjacent structures, and other basin/system components or operations over existing risk at any time.

Risk-Informed Corporate Approach. *The USACE dam safety program will be managed from a risk-informed USACE-wide portfolio perspective applied to all features of all dams on a continuing basis. Decisions are risk-informed, not risk-based. Risk-informed decisions integrate traditional engineering analyses with numerical risk estimations of risk through the critical foundation of experience-based engineering judgment. "Risk-based" can imply that life-safety decisions can be reduced to simple, numerical solutions.*

Congressional Authorizations. *USACE projects have specific Congressional authorizations and legal responsibilities that often cover a broad array of purposes and objectives. Because of the complexity of these authorities, the public safety responsibility is critical to informing how we implement these statutory responsibilities. The public safety responsibility requires USACE to assure projects are adequately safe from catastrophic failure that results in uncontrolled release of the water in the reservoir. USACE has specific public safety responsibility, when a project has known safety issues, to take appropriate interim risk reduction measures - including reservoir operating restrictions - to assure safety of the project and to protect the public. USACE statutory responsibilities do not give authority to operate dams in a manner that increases the project's probabilities of failure when there are known issues with the integrity of the project.*

Manage Flood Waters. *USACE manages risks of flood waters--it does not control them. USACE projects do not have unlimited operational capacity to control extreme floods. Outlet works have limited capacity to release flows in a controlled manner, and thus all properly designed projects have a capacity above which the inflow is passed through without attenuation. These are very large releases that may cause damage downstream of the dam but not to a greater degree than would have occurred under pre-project conditions. Decision makers must understand these limitations and operational constraints.*

Unique Dynamics over Time. *All projects have unique geographic, physical, social, and economic aspects that are subject to dynamics over time. Decision making within Interim Risk Reduction Measure Plans should not be overly prescriptive because of these complexities.*

Tension between Loss of Life and Economic Damage. *The operations of a very high, high or moderate risk dam during flood conditions can create a dynamic tension between the potential for loss of life and economic damage resulting from an uncontrolled release due to failure and the surety of economic damages resulting from operational release to prevent failure. Operational releases can be accompanied with planning, advanced warnings, and evacuations with the goal of avoiding loss of life. Economic impacts may be incurred and options for mitigating these impacts can be explored. The advanced planning and execution of mitigating measures is far more effective with planned, controlled release of the pool than with the case of unplanned, uncontrolled release resulting from failure of the project.*

Urgency of Dam Safety Actions. *The urgency of actions, including funding, to reduce risks in the short term (i.e., Interim Risk Reduction Measures) and in the long term (i.e., Dam Safety*

Modifications) will be commensurate with the level of risk based on current knowledge. This may require first addressing only those failure modes that contribute significantly to the overall risk.

Risk Communication. *USACE will provide risk information to internal and external stakeholders. An informed and engaged public is an empowered public that understands risk, can contribute to the evaluation of risk-reduction options and can take some degree of responsibility for its safety. USACE will assess and communicate the breach and 'non-breach' risk in all level of dam safety studies to internal and external stakeholders.*

Prioritization of Studies and Investigations. *Studies and investigations will be scoped with the goal of confirming dam safety issues and prioritized to reduce knowledge uncertainties and risk across the portfolio of dams in a cost effective and timely manner.*

Formulation and Prioritization of Risk Management Measures. *Where practical, risk-management measures will be formulated as separable measures and these will be prioritized to achieve tolerable risk as quickly as practicable and in a cost-effective manner across the portfolio of dams.*

Level of Detail of Risk Assessments. *The level of effort and scope of risk assessments will be scaled to provide an appropriate level of confidence considering the purpose of the risk management decision.*

Routine Dam Safety Activities. *Execution of inspections, instrumentation, monitoring, Periodic Assessments, operations and maintenance, emergency action planning, training, and other routine dam safety activities are an essential part of effective dam safety risk management for all USACE dams.*

Risk Reporting. *The current level of risk for USACE dams will be documented and routinely reported. The basis for decisions will be formally documented.*

4.2 Overview of the USACE Dam Safety Program

According to the USACE Dam Safety Program website (<http://www.usace.army.mil/Missions/Civil-Works/Dam-Safety-Program/>), the USACE operates and maintains approximately 700 dams nationwide and in Puerto Rico. The previous (2013) IEPR Report includes an overview of the dams owned and maintained by USACE, along with a history of the dam safety program, summarized below:

- Dam safety has been a key component of the USACE since it began to construct dams in the 1840s.
- USACE went through a period of significant construction of dams between 1930 and 1980.
- Between 1980 and 2000, USACE dam safety modifications were primarily focused on standards-based evaluations of existing structures, primarily focused on hydrologic and seismic modifications to protect against extreme events.
- In 2001, an Association of State Dam Safety Officials (ASDSO) Peer Review was completed, noting that USACE was considered to have a “minimally acceptable Dam Safety Program.”
- Changes to the program subsequent to the ASDSO peer review included the establishment of a Special Assistant for Dam Safety (2002), implementation of the Dam Safety Program

Management Tools (DSPMT), and movement toward a risk-informed approach to evaluating the inventory of USACE dams.

- Since 2005, the USACE Dam Safety Program has performed a complete Screening Portfolio Risk Assessment of the inventory of USACE dams and established:
 - The Risk Management Center (2009)
 - The Modeling Mapping and Consequences Production Center (2009)
 - The Dam Safety Modifications Mandatory Center of Expertise (2012)
 - The Dam Safety Production Centers at the Division level
- In 2013, an IEPR of the USACE Dam Safety Program was performed and included 26 findings and recommendations. Many of these recommendations are being implemented, as summarized in this report.

4.3 Safety of Dams – Policy and Procedures (ER 1110-2-1156)

This regulation is intended to include most aspects of the USACE Dam Safety Program, including “guiding principles, policy, organization, and procedures for implementation of a risk-informed dam safety program and a dam safety portfolio risk management process.” As with the overall program, ER 1110-2-1156 has undergone several revisions in the past decade, as USACE has incorporated risk as a guiding principle in program implementation.

This regulation serves as the basis for organization and implementation of the dam safety program and is considered integral to this IEPR. The copy of ER 1110-2-1156 provided to the IEPR Team and referenced herein is dated March 31, 2014.

Based on discussions with USACE, the IEPR Team understands that ER 1110-2-1156 will be undergoing a significant revision as early as 2017.

4.4 Organization

USACE maintains a three-level decentralized organization, including Headquarters (HQ), Major Subordinate Commands (MSC) or Divisions, and Districts. According to the USACE website (<http://www.usace.army.mil/Locations.aspx>), there are eight Divisions within the United States; and within each Division, there are between four and seven Districts; giving a total of 38 Districts within the United States. A map of the Divisions and Districts is provided as Figure 4.1.



Figure 4.1: USACE Divisions and Districts (from <http://www.usace.army.mil/Locations.aspx>)

Section 4.2 of ER-1110-2-1156 includes the following statements with regard to responsibility for the USACE Dam Safety Program:

The Commanders at each level of USACE have the ultimate responsibility for dam safety within their commands. Each District Commander having responsibility for dams shall ensure that the organization has a dam safety program which complies with USACE policy and criteria, assuring compliance with the “Federal Guidelines for Dam Safety” (reference A.71). Commanders exercise this responsibility through officially designated (appointed) Dam Safety Officers (DSO) at each level. Although the DSO is located in the technical element of each organizational level, dam safety crosses all business lines and office elements, and the DSO must coordinate dam safety issues and activities with the leaders of those business lines and office elements as they manage the dam safety activities in their areas of responsibility. This includes coordination between the district office and the project field offices (that serve as the first line of defense for dam safety) concerning such issues as emergency action plans, dam safety training, and control of project documentation.

All of the Divisions and 35 Districts have dam safety responsibilities. Each of the three levels of the organization (HQ, Divisions, and District) includes staff with dam safety experience and responsibilities. This includes a DSO and a Dam Safety Program Manager (DSPM). In addition to these levels, the dam safety program includes the Risk Management Center (RMC), the Dam Safety Modification Mandatory Center of Expertise (DSMMCX), the Mapping Modeling and Consequences Production Center (MMC), and several Dam Safety Production Centers (DSPC). Each of these national and regional Centers supports implementation of the dam safety program.

While the three levels are decentralized, representatives participate in and coordinate national dam safety activities. Modifications to address dam safety deficiencies are prioritized nationally using risk-informed procedures, and HQ manages budgeting for non-routine dam safety studies and modifications. The Dam Safety Steering Committee (DSSC), Dam Safety Production Center Steering Committee (DSPCSC), and the Dam Safety Oversight Group (DSOG) all provide national oversight of the dam safety program. These organizations include representatives from HQ, Divisions, Districts, and Centers.

As noted above, HQ dam safety staff includes a DSO and DSPM. In addition, HQ includes the Special Assistant for Dam and Levee Safety (Special Assistant), who reports directly to the HQ DSO. The HQ DSO, DSPM, and Special Assistant qualifications, roles, and responsibilities are described in Section 4.3.2 of ER 1110-2-1156, as follows:

*As the **USACE DSO**, this individual is responsible directly to the Chief of Engineers for all dam safety activities and shall be appointed by written order of the Chief of Engineers. The USACE DSO coordinates dam safety activities with the various elements of the Directorate of Civil Works and informs the Director concerning the condition of USACE dams. The USACE DSO is responsible for ensuring that USACE maintains a proactive dam safety program, implementing all practices and procedures outlined in the 'Federal Guidelines for Dam Safety' ...*

*The **Special Assistant** acts for the USACE DSO in the execution of daily program activities and serves as Chairman of the DSSC and the DSOG [note that the Special Assistant no longer serves as DSOG Chairman]... The Special Assistant provides operational direction to the director of the RMC. The Special Assistant represents the USACE DSO in the development of the budget submission, working with the appropriate Business Line Managers to ensure that dam safety priorities are addressed...*

*The **USACE DSPM**... works in coordination with the Special Assistant for Dam and Levee Safety. The USACE DSPM conducts the daily activities of the overall dam safety program. The USACE DSPM coordinates the HQ review of dam safety reports and prepares USACE-wide dam safety budget submissions in coordination with the DSSC and the RMC.*

While not yet documented in ER 1110-2-1156, recent changes at the HQUSACE include the establishment of the "Deputy DSO" role. Eric Halpin, PE was assigned to this position. Mr. Halpin was also designated as the Deputy Levee Safety Officer (LSO). The Deputy DSO/LSO reports to the HQ DSO/LSO. James Dalton, PE, Director of Civil Works, currently serves as the HQ DSO and LSO. The Special Assistant for Dam Safety and Special Assistant for Levee Safety each report to the Deputy DSO/LSO.

The DSOG assists HQ in the overall management of the dam safety program and according to ER 1110-2-1156:

*The **[DSOG]** is the surrogate for the HQUSACE Dam Safety Committee. The DSOG coordinates with the MSC's and presents the resulting proposed items to the DSO for concurrence and decision...The DSOG reviews the DSAC of existing dams, dams safety risk assessment reports and other decision documents, and dam safety work priorities based on portfolio risk findings. DSOG makes recommendations on dam safety modifications to the Special Assistant for Dam and Levee Safety and the USACE DSO.*

The chairman of the DSOG is Nate Snorteland, PE, who also serves as the RMC Director.

Divisions (MSCs) include a DSO, DSPM, and a Division Dam Safety Committee. At the Division Level, the DSO and DSPM have the following general responsibilities, according to ER 1110-2-1156 Section 4.4:

*The **MSC DSO** should be the SES or MSC technical lead who is responsible for the engineering elements of the organization...The MSC DSO is responsible for quality assurance, coordination, and implementation of the MSC dam safety program. In this capacity the MSC DSO must establish procedures to ensure that the MSC DSO is fully advised on dam safety issues.*

*The **MSC DSPM** conducts the daily activities for the MSC dam safety program, coordinates the review of dam safety reports, and provides support to districts within the MSC. The MSC DSPM works with the programs budget managers to ensure that dam safety requirements are included and properly prioritized in budget submissions.*

While not yet staffed at every location, a Dam Safety Production Center (DSPC) is proposed for each Continental United States Division, each with a DSPC Director. The DSPC is responsible for developing Dam Safety Modification Reports (DSMR), Design Documentation Reports (DDR), and construction documents in coordination with staff of the District where the dam is located.

According to Section 4.4.1.5 of ER 1110-2-1156, each modification project will have a Dam Safety Modification (DSM) Lead Engineer, who “must be assigned by the Director of the DSPC in consultation with the district DSO.”

*The **DSM Lead Engineer** must provide the general oversight and have primary control and responsibility for the technical development of all engineering products produced by the PDT and for engineering support during construction. The DSM Lead Engineer will work in close coordination with the DSM Project Manager for the development of project schedules and funding requests.*

Each District with dam safety responsibilities includes a DSO, DSPM, and a Dam Safety Committee. The DSO and DSPM roles and responsibilities are provided in Section 4.5 of ER 1110-2-1156 and generally include the following:

*The **District DSO** should generally be the chief of the engineering organization...The District DSO is responsible for ensuring that the dam safety program is fully implemented and documented, in accordance with the District Dam Safety Program Management Plan.*

*The **District DSPM** conducts the daily activities for the District dam safety program and coordinates the review of dam safety reports. The District DSPM works with the programs budget managers to ensure that dam safety requirements are included and properly prioritized in budget submissions.*

In addition, each dam modification project will have a DSM Project Manager, assigned by the Chief of the District Project Management Branch or Division, in coordination with the district DSO. Section 4.5.1.4 of ER 1110-2-1156 describes the responsibilities of the DSM Project Manager.

The general roles and responsibilities of each of the Centers that are integral to the USACE Dam Safety Program are described in Section 4.3 of ER 1110-2-1156:

*In order to realize the full benefits of risk-informed program management, the **RMC** has been established to provide technical expertise and advisory services to assist in managing and facilitating the USACE-wide dam safety program. The RMC is a support organization, partially project funded, and located within the Institute of Water Resources (IWR). The director of the RMC reports through the IWR Director to the Director of Civil Works. The RMC has close ties to the DSO and to the Special Assistant for Dam and Levee Safety. The RMC assists the Special Assistant in implementation of dam safety policy using a combination of centralized staff as well as other national, regional, and district resources.*

*The **DSMMCX** is responsible for assisting HQUSACE with the overall coordination and oversight of the dam safety modification mission. The DSMMCX conducts sufficient reviews and coordination of the DSPCs to ensure consistency in product development and continual improvement through lessons learned. The DSMMCX promotes the development of technical competencies and facilitates coordination between the DSPCs to align resources with project needs and agency priorities.*

*The **MMC** supports both the USACE Dam Safety and Critical Infrastructure Protection & Resilience (CIPR) Programs. In support of HQUSACE management of the dam safety program, the MMC performs hydraulic modeling, mapping, and consequences analysis for USACE dams in support of the Dam Safety and CIPR programs ... The MMC leverages H&H modeling, consequences analysis, and GIS mapping capabilities and resources via close coordination with USACE RMC to accomplish national mapping, hydraulic analysis, and consequences requirements for the Dam Safety and CIPR Programs.*

4.5 Processes

The processes for inspection, assessment, evaluation, and modification of dams are described in detail in ER 1110-2-1156. The overall “Dam Safety Portfolio Risk Management Process” (reference ER 1110-2-1156 Figure 2.6) generally includes the following activities:

- 'Routine' Operation and Maintenance (O&M) and Annual Inspections
- PI: Periodic Inspections (maximum 5-year intervals)
- PA: Periodic Assessments (maximum 10-year intervals, in conjunction with a PI)
- IRRM: Implementation of Interim Risk Reduction Measures (when dam safety issues are identified)
- IES: Issue Evaluation Studies (when dam safety issues are identified)
- DSM: Dam Safety Modification Studies/Reports (when warranted based upon IES)

Dam Safety Action Classification (DSAC) reviews are conducted as part of various processes. In addition, Risk Assessments and Analyses are integral to several of these processes.

Development of Design Documentation Reports (DDR) and construction contract documents (plans and specifications) for modifications occur following approval of the DSMR. The DSM Lead Engineer and DSM Project Engineer are responsible for developing these documents.

Construction of dam safety modifications is discussed in Chapter 22 of ER 1110-2-1156, which includes guidance specific to dam safety projects; there are other USACE regulations that provide general processes related to construction. ER 1110-2-1156 includes the following:

During construction, the entire project team (particularly the on-site construction staff) is responsible for assuring that the design is compatible with field conditions. Inspection and quality assurance are required to prevent deficiencies in materials and construction practices. This is particularly important when working on dam safety projects as these projects often have significant life and economic loss implications.

Involvement of construction expertise in the design phase of a project is vital to assure the constructability of the proposed project.

In order to provide the best opportunity for project success, a district should always strive to build a cohesive team built upon the principles in ER 5-1-11. This entire team must be involved in the project from planning, design, and through completion of construction. This includes not only the technical elements within a district and the DSPC (planners, designers, constructors, PMs, etc. ...) but also the involvement of vertical elements such as the regional/HQ staff, the RMC, and the DSMMCX. While the day-to-day execution of a project remains the responsibility of a district, the RMC and DSMMCX are able to bring an agency-wide perspective to the project to ensure uniformity and adoption of best practices from across USACE. The RMC and DSMMCX fill a vital part of the overall QA function for HQ in dam safety modification projects. Their early and continual involvement as part of the PDT is essential.

Similar to the importance of having construction personnel involved in the planning and design phases of a project, it is equally vital that the design team remain integrally involved and integrated throughout the entire construction period. This is consistent with ER 5-1-11 and ER 1110-1-12.

USACE guidance with regard to review of Civil Works products (i.e., design reports, drawings, etc.) is included in EC 1165-2-214, "Civil Works Review." The official version of this EC expired in December 2014 and based on discussions with USACE during the course of this IEPR, the IEPR Team understands that an updated version of this guidance document is nearly complete.

Other critical activities, processes, and responsibilities of the USACE Dam Safety Program include:

- Surveillance and Instrumentation
- Emergency Action Plans
- Operation of Water Control Systems

4.6 Risk Analysis as Applied to Dam Safety

ER 1110-2-1156 formally addresses how people, policies, and procedures interact to build a practical risk governance infrastructure for dam safety management. Risk governance goes beyond the analysis of risks (International Risk Governance Council, 2005):

[Risk governance] includes the totality of actors, rules, conventions, processes, and mechanisms concerned with how relevant risk information is collected, analyzed and communicated and management decisions are taken.

In this context, USACE has established a risk-informed culture as the cornerstone of the dam safety program that is broadly accepted at all levels within the organizations.

Beginning with the Screening Portfolio Risk Assessment Process, the USACE has developed and implemented a range of risk analysis methods to meet various needs of the dam safety program (from prioritization of dam safety fundamental activities to dam safety modification decision making).

4.7 Previous Peer Reviews

Peer reviews of the USACE Dam Safety Program were performed in 2001 and 2013.

4.7.1 2001 Peer Review (Association of State Dam Safety Officials)

In 2001, ASDSO established a four-member panel to perform a Peer Review of the USACE Dam Safety Program. The report documenting this review is dated September 30, 2001, and included the following statement in the Executive Summary:

Based on the collective experience and judgment of the Peer Review Team, the Corps of Engineers in consideration of its available resources, is currently considered to have a minimally acceptable Dam Safety Program and any further reductions in their Program will endanger their dams and the lives and property they protect.

The report included 11 specific findings and 17 specific recommendations.

4.7.2 2013 IEPR (Schnabel Engineering)

In 2013, through Contract W912QR-10-D-0031, Schnabel Engineering established a four-member panel and project manager to perform an IEPR of the USACE Dam Safety Program. The final report was issued on November 22, 2013. This IEPR identified and acknowledged the progress of the USACE program since 2001, noting the following with regard to the first “charge” question:

Is the direction of the program appropriate? The answer to this question is clearly “yes.” The implementation of a risk-informed approach for dam safety portfolio management and decision making is a great improvement in the program and the program continues to mature. USACE should be commended for the positive changes made in the past decade.

The IEPR identified 26 findings, with a recommendation for each. The Executive Summary of the 2013 IEPR Report is included in Appendix D. USACE responded to the findings and recommendations by memorandum, which is also included in Appendix D.

The 2013 IEPR findings are referenced herein, both in Section 5.0 and in the current findings and recommendations, where appropriate.

4.8 2016 Survey Questionnaire

As part of the 2013 IEPR, HQUSACE and RMC developed a Survey Questionnaire that was distributed to various organizations across the USACE Dam Safety Program. The results of this survey were used to inform the IEPR Team.

USACE proposed to conduct a similar survey as part of the 2016 IEPR; however, after discussions during the Orientation Briefing, USACE and the IEPR Team elected to have the IEPR Team develop the survey, which was distributed to Districts, Divisions, and Centers; 42 responses were received. The survey included a request for quantitative ratings and supporting discussion related to various aspects of the USACE Dam Safety Program. The results of the survey ratings of broad subject areas are presented in Figure 4.2. The thick gray lines represent one standard deviation above and below the mean; the black “whiskers” represent the minimum and maximum ratings received. A blank survey form and selected results are included in Appendix E. Where appropriate, the findings presented herein reference USACE responses to the survey questions.

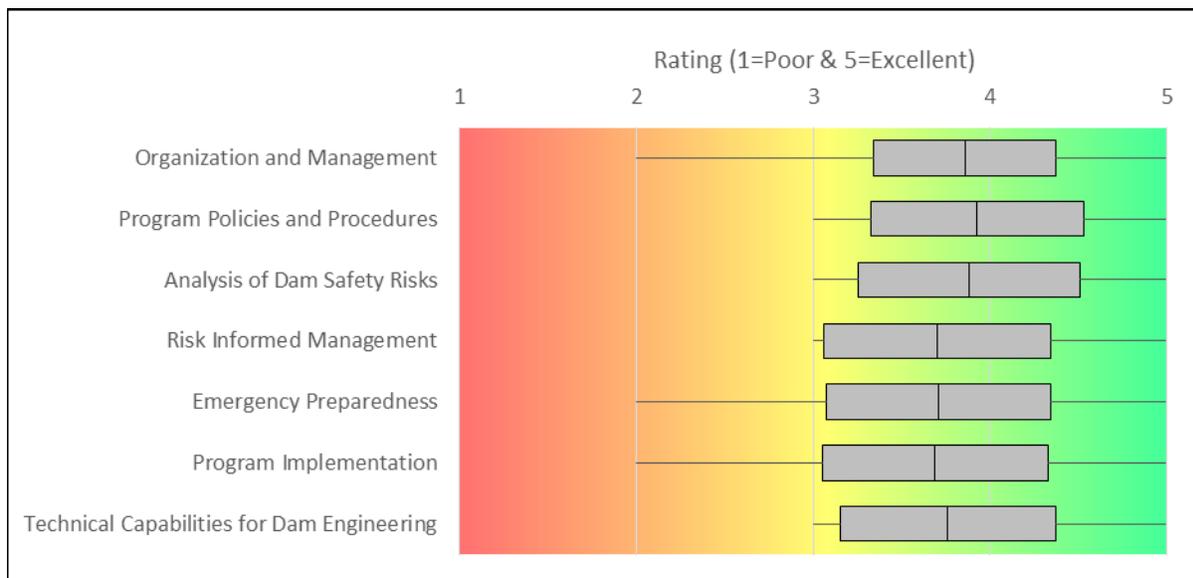


Figure 4.2: Survey Questionnaire – USACE Responses/Ratings

5.0 EVALUATION OF USACE RESPONSE TO THE 2013 IEPR

The 2013 IEPR included 26 findings and recommendations. During the course of the 2016 IEPR, USACE provided input on their activities in response to each finding and recommendation. The IEPR Team generally concurred with the approaches being implemented by USACE in response to the 2013 IEPR. A number of actions proposed to address the 2013 findings have not yet matured to the point of being fully implemented. Therefore, from the perspective of current practice (what is being done by staff or in the field), many of the 2013 IEPR findings and recommendations still apply.

Several of the 2016 IEPR findings and recommendations reference issues that were identified as part of the 2013 IEPR. This was done both to illustrate the IEPR Team’s opinion regarding the urgency and/or critical nature of these 2013 findings/recommendations and to expand upon or clarify the previous findings/recommendations. The 2016 findings/recommendations specifically reference the 2013 findings/recommendations where appropriate. Table 5-1 cross-references the IEPR Team 2016 findings/recommendations to those from the 2013 IEPR.

Table 5.1: Cross Reference 2013 to 2016 IEPR Findings/Recommendations

2013 Comment Reference and Title		Relevant 2016 Comment Reference and Title	
2013-B-01	Full Time Position in HQUSACE Dedicated to the Dam Safety Program Leadership and Management		
2013-B-02	HQUSACE Oversight and Strategic Leadership of the Dam Safety Program		
2013-C-03	Dam Safety Team Unity	2016-B-08	Locally Executed
2013-C-04	Adaptation to Change		
2013-B-05	Peer Review of ER 1110-2-1156		
2013-B-06	USACE Engineering Manuals and Regulations		
2013-D-07	General Direction of Program with Regard to Risk Management		
2013-C-08	Complying with OMB Guidance	2016-C-14	Consideration of Consequences beyond Life Loss in Risk Reduction Indicators
2013-B-09	Frequency of Flooding and Use of the PMF Standard	2016-B-09	Hydrologic Analysis
		2016-B-10	Hydrologic Risk Analysis
2013-C-10	Consistency/Quality of Risk Cadres	2016-B-07	Centrally Managed – Locally Executed

2013 Comment Reference and Title		Relevant 2016 Comment Reference and Title	
2013-C-11	Risk Analyses Performed as Part of Periodic Assessments	2016-B-07	Centrally Managed – Locally Executed
		2016-B-13	Update Role, Scope and Contents of Periodic Assessments
2013-B-12	Operational Risks	2016-B-10	Hydrologic Risk Analysis
2013-C-13	Broad-Based Application of Risk-Informed Management	2016-B-02	Risk-Informed Emergency Preparedness
		2016-B-13	Update Role, Scope, and Contents of Periodic Assessments
		2016-C-14	Consideration of Consequences beyond Life Loss in Risk Reduction Indicators
2013-B-14	Evaluation of Uncertainties in Risk Analysis	2016-B-09	Hydrologic Analysis
		2016-B-10	Hydrologic Risk Analysis
		2016-B-12	Seismic Risk Analysis for Dam Systems
2013-B-15	Systems-Based Risk Evaluation	2016-B-11	Seismic Hazard Analysis
		2016-B-12	Seismic Risk Analysis for Dam Systems
		2016-B-10	Hydrologic Risk Analysis
2013-B-16	Seismic Hazard Analysis	2016-B-11	Seismic Hazard Analysis
		2016-B-12	Seismic Risk Analysis for Dam Systems
2013-A-17	Emergency Management Procedures Oversight and Implementation	2016-A-01	Emergency Preparedness
		2016-B-07	Centrally Managed – Locally Executed
2013-A-18	Decision-Making for Time-Critical Emergencies	2016-A-01	Emergency Preparedness

2013 Comment Reference and Title		Relevant 2016 Comment Reference and Title	
2013-A-19	Surveillance and Instrumentation	2016-A-03	Instrumentation and Monitoring
		2016-B-07	Centrally Managed – Locally Executed
2013-B-20	Data Management	2016-A-04	Strategy to Complete and Assess “Fundamental Dam Safety Activities” for All Projects
		2016-B-07	Centrally Managed – Locally Executed
2013-C-21	Budgeting for 'Routine' Activities	2016-A-04	Strategy to Complete and Assess “Fundamental Dam Safety Activities” for All Projects
		2016-B-07	Centrally Managed – Locally Executed
		2016-B-08	Locally Executed
2013-C-22	Roles of RMC, DSMMCX, and DSPCs	2016-B-05	Integration of Design and Construction
		2016-B-07	Centrally Managed – Locally Executed
2013-B-23	Technical Review Processes	2016-B-07	Centrally Managed – Locally Executed
2013-C-24	Project Design and Construction Costs		
2013-C-25	IRRM Financial Impacts		
2013-B-26	Resources and Expertise	2016-B-05	Integration of Design and Construction
		2016-B-06	Sharing and Implementing Lessons Learned

As a practical matter, the IEPR Team recognizes that implementing the 2013 recommendations takes time and resources. For many of the recommendations, the three-year period since the last IEPR was simply not enough time to formulate, implement, and measure the performance of new methods and practices.

Two notable examples of 2013 findings that were discussed with USACE staff at various levels during the 2016 IEPR, but not reflected in new findings/recommendations, are 2013-B-20 (Data Management) and 2013-B-23 (Technical Review Processes). Data management continues to be a challenge and the IEPR Team heard examples of poor management of digital files, risk models, etc. However, USACE has begun implementation of file and data management processes. With regard to technical review processes, a

new version of EC 1165-2-214 (Civil Works Review) has been drafted and is under review. It is noted that this policy is applied across the entire USACE Civil Works program, not just dam safety. The IEPR Team understands that gaining approval of the policy across Civil Works has been time consuming.

6.0 FINDINGS AND RECOMMENDATIONS

As noted in the 2013 IEPR, the USACE Dam Safety Program has undergone significant changes over the past 10 to 15 years, most notably the shift to risk-informed management for prioritization of program activities, decision-making, and funding of dam safety modifications across the USACE portfolio of dams. The changes in the program have been dramatic and the program continues to evolve. As preface to presenting the IEPR findings and answers to the “charge,” it is worth noting the progress and positive steps of the program, both in the past 15 years and since the 2013 IEPR. The USACE has made a commitment to risk-informed management in the dam safety program. Specific advances and achievements include:

- The 2016 IEPR Team noted broad acceptance of the risk-informed approaches across all staff levels. This is a significant achievement, even since the 2013 IEPR.
- RMC, DSMMCX, and MMC continue to grow and add capabilities. The IEPR Team observed significant advances in collaboration between the Centers and other levels of the USACE Dam Safety Program.
- USACE recognizes the value and importance of education and training of the staff, resulting in the ongoing development of training programs in risk analysis methods and facilitation, surveillance, and instrumentation, etc.
- The dam safety program has established and is implementing an effective programmatic structure for managing risk for its dams.
- Since the draft 2013 IEPR, USACE has implemented several new initiatives and developed guidance documents, some related to findings/recommendations of the 2013 IEPR. Notable examples of these initiatives include:
 - The establishment of the Hydrologic Hazards Team
 - Development of the draft EC 1110-2-212, “Guidance for Emergency Action Plans, Incident Reporting, and Inundation Maps for Dams and Levee Systems”
 - Publication of “A Guide to Public Alerts and Warnings for Dam and Levee Emergencies”
 - Completing an internal peer review of instrumentation and monitoring, which resulted in significant revisions to EM 1110-2-1908, “Instrumentation and Monitoring of Embankment Dams and Levees,” and the development of a training program related to instrumentation and monitoring
 - Continuing to improve the consistency and quality of inundation mapping provided by the MMC
 - Development and implementation of more rigorous methods in estimating life-safety consequences for risk analyses
 - Completing several Design and Construction Evaluations (DCE) for mega projects
 - Initiating implementation of the O&M 20/20 study to utilize risk-informed approaches for budgeting of O&M activities across all Business Lines
 - Ongoing participation in the development of the update to the “Civil Works Review” EC
 - Issuing periodic (quarterly to semi-annual) “Dam Safety Officer Update” newsletters to communicate ongoing activities of the USACE Dam Safety Program

The USACE implementation of risk-informed management has been extremely positive. The changes in the program have been successful and should continue with the full support of USACE leadership.

6.1 Broad Perspectives Related to the USACE Dam Safety Program

Given the various missions of USACE, the size of the agency, its geographic coverage, and the number and diversity of the dams within the portfolio, the USACE Dam Safety Program is a unique organization presented with unique challenges in executing its mission. The following sections summarize some of these features and challenges. These sections were not included as specific findings with recommendations. These topics provide context for the specific findings and recommendations and, where appropriate, these are referenced by individual findings.

6.1.1 Self-Regulation

In the dam safety industry, the USACE is typically referred to as being self-regulated. The concept of self-regulation is but one paradigm for dam safety, with the other being that of an entity (typically a government agency) providing independent regulatory oversight of compliance with defined standards related to dam design, operation and maintenance, and emergency management. The former approach (self-regulation) is practiced by agencies of the federal government, while the latter is typical of state and federal regulation of industry and in the case of states, other state agencies that operate dams. The majority of dams in the United States fall under the independent regulatory framework. There are positive attributes associated with each paradigm. An obvious attribute of the independent regulatory approach is the independence of the regulator from all management, technical, and fiscal aspects of dam operations and safety. In addition, an independent governmental regulatory body serves in the interest of public safety without potential competing interests that an owner may face/consider. The self-regulated structure can be effective and efficient with respect to decision making, allocation of resources, and in establishing and improving methodologies. Whereas dam owners in an independent regulatory framework may focus on compliance rather than in developing and implementing approaches that ultimately would benefit dam safety, the USACE has transformed itself by developing methods and a governance structure that is risk informed.

However, without the attributes fundamental to an independent regulator paradigm, there is the potential for competing interests at multiple levels within a self-regulated organization to compromise the effective management of an owner's dam safety responsibilities, in the interests of expediency.

An integral part of the USACE dam safety program is the multiple levels of review imposed on dam safety activities. While these reviews are not 'independent' in the sense of an independent regulatory structure (reviewers are USACE employees or consultants who are selected and compensated by USACE), they provide technical reviews that are independent of specific projects.

None of the above is intended to imply that USACE or other federal dam owners should have regulatory oversight by an independent entity. Nonetheless, it is an obvious alternate perspective (given that independent regulatory oversight is common to most industries, even within state and federal government and that most dams in the United States fall within the independent regulatory framework) that allows one to consider whether there are attributes of the independent regulatory structure that could benefit the USACE dam safety program. For instance, there appears to be a lack of technical oversight and accountability of some of the elements of the USACE dam safety program. For example, at this time there appears to be little oversight regarding the quality and effectiveness of emergency preparedness, and

more generally emergency management across the portfolio of dams (see Finding 2016-A-01). This lack of oversight has the potential to compromise the effectiveness of the dam safety program and impact public safety. This example, in and of itself, does not lead to a conclusion that an independent regulator is needed. Rather it simply points to an area where an oversight role is not being carried out for an important part of the dam safety program.

In general, the USACE Dam Safety Program takes on the responsibilities of policy and methodology development, analyst, designer, reviewer, decision maker, and emergency manager (at least in part). In carrying out all these roles, the division of responsibilities may at best be blurred. In the worst case, areas of clear importance or areas of interface may not be given the attention they deserve (e.g., design and construction). With some level of independent oversight, the potential for such shortcomings could be reduced in likelihood and scale.

As noted herein, there are multiple levels of review within the USACE Dam Safety Program. This IEPR of the overall program is one example. Arguably, this IEPR serves as a form of independent oversight. At the same time, however, its structure is limiting in terms of the depth and breadth to which the review can be conducted, given the scale of the USACE Dam Safety Program.

6.1.2 Potential Program Discontinuities

ER 1110-2-1156 defines USACE Dam Safety Policy, a risk governance framework, and the program management. Given the diversity of activities and responsibilities that are inherent to a dam safety program, coupled with the central management-local execution philosophy, there is the potential for programmatic “discontinuities” in the following areas:

- Central management versus de-central execution
- Routine versus non-routine activities
- WEDGE versus O&M funding
- Project versus system funding
- Life safety versus non-life safety investments
- Dam safety versus water control
- Dam safety versus asset management
- Risk analysis versus dam safety “fundamentals”
- Project specific findings versus portfolio analysis of findings
- Guidance versus implementation

To the extent these areas of potential disconnect may impact how “dam safety fundamental” are being implemented, or how risk governance is being applied, these “discontinuities” are identified in our diagnosis, findings and recommendations.

Of particular note is the path from guidance to program implementation. In the framework of an organization that depends on local execution, implementation of guidance and methodologies can be inconsistent and difficult to evaluate. Several of the findings included herein note that USACE has developed strong guidance documents and procedures, but implementation is the responsibility of a

subset of the organization, increasing the potential for inconsistencies. In addition, some guidance has been developed recently, and implementation is continuing to improve.

6.1.3 Complacency and/or Overconfidence

Organizations (public or private) that have a public safety responsibility have a unique role in society. On one hand, they typically provide a public service (water, power, transportation, emergency services, medical services, etc.). At the same time, an error or simply a rare event that results in a system failure can have significant public health impacts (fatalities, injuries, lost services, and disruption of the quality of life), potentially on catastrophic scales.

Complacency and/or over-confidence can occur at a number of levels in an organization. Certainly, if these occur at the highest management levels, this will trickle down to middle management and staff. Alternatively, complacency and/or overconfidence may occur at staff levels, and should be identified and addressed by supervisors and management.

With regard to dam safety, the potential for complacency or overconfidence may occur in a number of ways, including:

- A belief that experience in conducting potential failure modes and risk analyses leads one to conclude they have a complete understanding of a dam and its vulnerabilities
- A failure to recognize what is not known or understood
- A failure to recognize the sources of epistemic uncertainties and the potential impact on risk analysis results
- An assumption that the multiple levels of review will catch one's mistakes

The IEPR Team has not observed any clear examples of overconfidence or complacency. Rather, these concerns exist in any organization and there are numerous examples throughout the history of dam safety where overconfidence and/or complacency has led to significant incidents or failures. During some IEPR Team discussions with USACE staff, we heard views that were erroneously put forth as fact. These circumstances are likely the result of a lack of expertise or experience. Alternatively, they may be a by-product of over-confidence. The statements that were made may be a function of a number of factors, including the individuals interviewed, their experience or level of training, etc. Nonetheless, the occurrence of these events leads the panel to suggest there may be a need to be wary of potential overconfidence that could contribute to complacency in carrying out dam safety responsibilities.

In the course of its review, the IEPR Team noted that District and Division staff have an appetite for learning, beyond the scope of training activities. This provides an opportunity to address the threat of overconfidence and complacency if the organization is vigilant in considering this issue at every level of responsibility.

6.2 The Charge

The IEPR was charged with addressing the following questions regarding the USACE Dam Safety Program, which are presented along with the IEPR general finding for each question:

Is the direction of the program appropriate? The IEPR Team believes the direction of the program is clearly appropriate and positive, as was also noted in the 2013 IEPR. The changes of the past 10+ years are benefitting the program and the safety of USACE dams. Since 2013, USACE has continued with initiatives to improve the program, further indicating that the direction is appropriate.

One element of the program that the IEPR Team believes is essential to USACE effective management of dam safety risks is the flexibility achieved through the centrally managed WEDGE fund. This fund allows HQUSACE and RMC to reallocate resources as high risk issues are identified.

Has USACE overlooked any critical items? The IEPR Team has identified three findings as “critical” according to the definitions provided herein. These findings are:

- 2016-A-01: Emergency Preparedness
- 2016-A-03: Instrumentation and Monitoring
- 2016-A-04: Strategy to Complete and Assess “Fundamental Dam Safety Activities” for All Projects

It should be noted that the first two findings were also included in the 2013 IEPR and the “critical” category is partially related to how important these activities are to an effective dam safety program.

As noted in 2013, it may not be appropriate to state that USACE has “overlooked” these items, but rather not placed enough emphasis on or made enough of a priority of the issue.

What is the panel’s evaluation of how USACE has integrated design and construction? IEPR Finding 2016-B-05 describes this evaluation, noting that the IEPR Team believes there is appropriate USACE guidance to integrate engineering and construction; however, implementation and accountability have been a challenge. This is evident through discussions with staff at all levels.

Does the panel have recommendations regarding improvement in methodologies or approaches to implementation? The 2013 IEPR included several findings and recommendations related to improvements in methodologies and approaches to implementation. USACE has several initiatives related to these recommendations.

With regard to the 2016 IEPR, the findings presented herein specifically reference potential improvements in methodologies and implementation related to:

- “Fundamental” dam safety activities, including, but not limited to surveillance and instrumentation, emergency preparedness, hydrologic analysis, seismic evaluation, etc.
- Hydrologic and seismic risk analysis, including consideration of “systems” and uncertainties

Does the panel have any other observations to add? Many of the findings and recommendations presented herein are considered to fall into this category.

As a final observation, USACE has addressed issues that have become critical in many other dam safety organizations, throughout the world including:

- Defining risk in a way that allows handling inherent complexity, uncertainty, and ambiguity
- Adopting quantitative tolerable risk guidelines

- Using risk for internal and external communication
- Building personnel competencies in risk and making risk-informed decisions

In this sense USACE is unique. There is no equivalent publicly available policy with such a formal and comprehensive approach to risk governance in the field of dam safety.

6.3 Specific Findings and Recommendations

The specific findings and recommendations of this IEPR are presented in this section. Each finding has been assigned one of four categories, in accordance with the SOW:

- Category A – Critical
- Category B – Urgent
- Category C – Important
- Category D – Other

The IEPR Team developed the following definitions for these categories, which are the same as those used for the 2013 IEPR.

Critical: The issue has the potential to significantly degrade or undermine the dam safety program, or otherwise can lead to dramatic negative consequences. Includes “must do” recommendations.

Urgent: The finding is of significant importance to the program and can provide substantial dam safety benefits.

Important: The recommendation is worthy of implementation and would likely provide a definitive return on investment. Timeline for implementation could be long.

Other: Observations, considerations, and perspectives worthy of USACE review regarding its dam safety program.

Findings and recommendations have been numbered in accordance with the SOW, with the following format: Year-Category-Number (2016-[A to D]-[01 to XX]).

It should be noted that unless otherwise stated, specific approaches described within the IEPR recommendations should only be considered possible solutions to address the findings. USACE should develop approaches best suited to its organization, its strategic direction, and its policies and procedures.

6.3.1 2016-A-01: Emergency Preparedness

Emergency preparedness should be a priority for an effective dam safety program. Communities have an expectation that dams will be safely maintained and operated and that the USACE is vigilant in maintaining effective Emergency Action Plans (EAPs) and in coordinating with other emergency management agencies with responsibilities in implementing EAPs.

The 2013 IEPR identified two critical findings (2013-A-17 and 2013-A-18) related to emergency preparedness. Finding 2013-A-17 noted:

There appears to be no USACE management or oversight above the District office level to drive consistent, quality implementation of EAPs, including the importance of a strong and collaborative relationship between USACE and the local EMAs...

Since the 2013 IEPR, the USACE has implemented improvements to the EAP program, most notably the development of the draft EC 1110-2-212, "Guidance for Emergency Action Plans, Incident Reporting, and Inundation Maps for Dams and Levee Systems." EC 1110-2-212 was reviewed by the EAP workgroup of the National Dam Safety Review Board and is currently awaiting approval by HQUSACE. This document should improve consistency across Districts and provide direction in implementing processes for better coordination with local emergency management agencies. Community outreach programs and orientation seminars for EAP plan holders are important steps being implemented by USACE with partners in downstream communities. The EAP training course in the PROSPECT program has reportedly been updated to reflect the guidance provided in EC 1110-2-212.

The USACE has a dedicated and motivated dam safety staff that takes its obligations seriously. While dam safety functions are a responsibility of the engineering branch of a District, other branches, notably emergency management and public relations, serve key roles related to emergency preparedness. Coordination between dam safety and emergency management is vital to the success of the EAP implementation.

Based on USACE responses to the 2016 Survey Questionnaire, discussions during the 2016 IEPR visits, and subsequent phone interviews, the IEPR Team identified ongoing concerns at least in some Districts with regard to emergency preparedness:

- Insufficient O&M funding and resources to maintain effective EAPs
- Lack of consistency of EAPs and exercises
- Lack of training in conducting exercises
- Poor communication between dam safety and emergency management staff
- Lack of agency oversight across the portfolio
- Lack of technical review as to the quality of USACE emergency management practices (i.e., EAPs, dam safety and emergency management coordination, community relations and coordination, etc.)

Based on a review of the Dam Safety Program Management Tools (DSPMT), the IEPR Team noted one District with 41% of projects behind on EAP exercises, and 47% of EAPs lacked updates of emergency contact information.

The DSPMT scorecard serves as a high-order 'check-the-box' metric, but does not appear to be an adequate measure of EAP effectiveness and emergency management effectiveness. Metrics that more closely measure effectiveness are reportedly being considered for future scorecard updates.

Inconsistencies between Districts were identified in the development and implementation of EAPs, including coordinating with local emergency management agencies, as illustrated by the following survey responses:

The level of exercises and what those exercise goals are is unclear in the guidance. More national guidance and training in EAPs and Emergency Exercises is needed.

Keeping EAPs current, accurate and complete remains a challenge. Communication systems within USACE and local EMAs also need improvement.

Format and content of EAPs not consistent throughout the Corps...

The regulation references FEMA 64 but does not offer specific directions to standardize EAPs across the USACE. As a result, EAPs vary significantly and many districts are publishing extremely voluminous documents...

Some Districts place the responsibility with the project engineer for a given dam. Other Districts have a dam safety coordinator who is responsible for several (say 3 to 6) dams. LRL has an EAP coordinator who is responsible for all EAPs within the District, which the IEPR Team observed to be an effective approach. Engineers who support the dam safety program have other significant dam safety responsibilities and it has been observed, not just in USACE, that many dam engineers are not well versed in emergency management and may lack a “passion” for this aspect of dam safety.

Coordination between Dam Safety and Emergency Management staff appears to be an issue and concern, as indicated by the following survey responses:

The dam safety program and emergency management programs have some overlap but often different focus. Complementary activities often occur separately.

It seems that many Districts have something of a disconnect between Dam Safety and Emergency management staff.

Establish responsibilities for Readiness Branch regarding Dam safety emergency preparedness.

Clearer guidance on EM's role in dam safety would be beneficial. EMs only contribution to the latest [District] emergency exercise was to attend...

Based on these survey responses and selected discussions, communication and collaboration between Dam Safety and Emergency Management Branches require improvement, and Emergency Management needs to play a more significant role in developing and updating EAPs.

Finding: The implementation of EAPs continues to be a concern (reference IEPR Finding/ Recommendation 2013-A-17). The IEPR Team believes there is still a lack of national oversight of the EAP program. The development of EC 1110-2-212 is an important step toward improvement, but without national oversight (i.e., central management), there are still concerns with regard to the quality and consistency of EAPs and emergency management, and consistent implementation across the USACE. Coordination between the Dam Safety and Emergency Management groups at the District level is inconsistent and appears to be lacking at some locations. Further, the role of Emergency Management staff and their interface with Dam safety may not be adequately defined.

Recommendation: The importance of emergency preparedness cannot be overstated. With regard to emergency preparedness, USACE should consider the following recommendations:

- Given the nature of this IEPR and the scale of the USACE Dam Safety Program, this peer review is not considered a detailed review of this one aspect of the program. USACE should consider a separate peer review of the policies, procedures, and implementation of all aspects of the program that relate to emergency preparedness.
- Develop a national, centrally managed, group of EAP facilitators/coordinators to schedule and facilitate EAP exercises and assist in maintaining effective EAPs. This group would coordinate with District dam safety and emergency management staff. Lessons learned from the exercises would be collected and disseminated from a single source.
- Establish a dam safety/emergency management oversight group that would have responsibility for technical review and oversight (i.e., have audit responsibilities) of district and project emergency preparedness.
- EAPs should be the responsibility of the emergency management staff, given their qualifications and experience with emergency management procedures. This staff would keep the plan updated, notify plan holders of any changes, and arrange logistics and invitations for exercises. Educating downstream communities on risks and interfacing with local emergency responders would be a significant component of their responsibilities. Dam safety staff would provide technical input into the EAP.
- EAPs should include specific references to surveillance and monitoring plans, including instrument threshold limits, which can be incorporated as warnings in the determination of emergency levels in the EAP.
- The effectiveness of an EAP should be a unit of measure when developing consequences during the Periodic Assessment. The only time the EAP was mentioned in the Barren River Dam Consequence Assessment Report (2015) was in a table that showed that a plan existed. An effective EAP should be a positive consideration when developing consequences and if ineffective, uncertainties might be increased.
- O&M funding should be prioritized for the development and implementation of EAPs. Risks related to ineffective EAPs should be captured in this prioritization. This would likely help in elevating the importance of the EAP, particularly for dams with very high consequences, where coordination with local EMAs is complex and time consuming.
- District Commanders should be engaged in the EAP processes and emphasize the importance of emergency preparedness to all branches in the District.

6.3.2 2016-B-02: Risk-Informed Emergency Preparedness

A major tenant of the Dam Safety Program is to use risk information (or risk-informed concepts) to inform all dam safety program activities and responsibilities. Chapter 16 of ER 1110-2-1156 notes the following:

For this reason every EAP must be tailored to site-specific risks/conditions and failure modes yet should remain simplistic enough to encourage its use. This should include the full range of failure scenarios (including upstream landslide failures, if appropriate) as well as different detection times for the incident.

During the course of this IEPR, there has not been a clear indication that risk analysis information is explicitly integrated into the development of EAPs and in EAP exercises. Rather, there have been indicators that risk information is NOT incorporated into EAPs or exercises.

Finding: The interface between the risk analyses (i.e., Periodic Assessments, Issue Evaluation Studies) that are performed for USACE dams and dam safety program activities in general is an important part of the program. ER 1110-2-1156 specifically calls for EAPs to be risk-informed. The IEPR Team did not observe clear evidence that EAPs are risk-informed and that those responsible for the EAPs have a clear understanding of the risk profile for a project.

Recommendation: While ER 1110-2-1156 makes it clear that EAPs should be risk-informed, it is not obvious this implementation has taken place. It is recommended that the RMC conduct a programmatic review to assess whether and how risk-informed information is being integrated into dam safety program activities, particularly routine activities, including EAPs. This review should be followed by the development of guidelines and training (likely integrated into existing training course) as to how risk information can be in the development of EAPs, instrumentation programs, etc.

6.3.3 2016-A-03: Instrumentation and Monitoring

The 2013 IEPR identified a critical finding (2013-A-19) related to surveillance and instrumentation, stating:

The failure to collect, interpret, and report findings in a timely manner is an urgent shortcoming.

The finding noted that while data collection is adequate, there were concerns with timely review and evaluation of the collected data by experienced engineers. The application of threshold levels indicating potential concerns was not standard practice.

Since the 2013 IEPR, USACE has implemented several initiatives to improve their instrumentation and monitoring program, which is documented in the “2015 USACE Instrumentation and Monitoring Program Internal Peer Review” (November 2015), provided to the IEPR Team. As noted in this document, USACE has implemented three actions, including:

- Finalized updates to EM 1110-2-1908, “Instrumentation and Monitoring of Embankment Dams and Levees”
- Developed and implemented a training course for instrumentation and monitoring
- Performed an in-depth peer review of a sampling of dams at several districts

The IEPR Team understands the updates to EM 1110-2-1908 under HQUSACE review. The training course has been developed and will be offered as part of the PROSPECT program. An instrumentation webinar was also developed. The first peer review was performed in 2015 and was performed on Districts that had the lowest DSPMT score within six of the MSCs (seven districts were selected, but funding only permitted reviews of six districts). In 2016, eight districts were selected for peer review, including the remaining district from 2015 and the seven districts with the highest DSPMT scores in each Division. The USACE internal peer review findings found significant deficiencies across all the districts reviewed, including analyzing data and lack of warning threshold establishment. These findings illustrated that the DSPMT results are not necessarily indicative of the quality of the instrumentation program. One year after the peer review, USACE sends a follow up survey to each of the Districts.

Similar to emergency preparedness (see Finding 2016-A-01), the implementation of surveillance and instrumentation activities is the responsibility of the Districts; Districts handle this differently. For example, some Districts have a single person responsible for several dams while other Districts have distributed responsibilities differently.

The annual Instrumentation Report (2015) for Patoka Lake Dam was reviewed. The data was well presented and easy to understand. However, the report lacked established threshold values and not all recommendations discussed in the report were carried forward to the Recommendations section. Due to the high number of recommendations, the most critical recommendations should be prioritized and addressed according to this prioritization.

Finding: The 2013 IEPR included a critical finding (2013-A-19) related to surveillance and instrumentation. The 2015 and 2016 USACE internal peer reviews confirmed the concerns noted in the 2013 IEPR. The IEPR Team concurs with the internal peer review findings and believes that the recommended improvements should be a priority of the dam safety program, given the importance of monitoring dams as it relates to potential failure modes.

Recommendation: The IEPR Team recommends that USACE continue with the activities in response to IEPR Finding 2013-A-19, along with the recommendations provided in “2015 USACE Instrumentation and Monitoring Program Internal Peer Review” (November 2015). In addition, the IEPR Team specifically recommends:

- Prioritizing the completion and approval of EM 1110-2-1908. Review should be accelerated to implement the latest technology and practices in the field.
- Instrumentation training through the PROSPECT or other courses should be mandatory for staff responsible for surveillance and instrumentation at a dam.

6.3.4 2016-A-04: Strategy to Complete and Assess “Fundamental Dam Safety Activities” for All Projects

In risk-informed management for dam safety, all fundamental dam safety activities provide inputs for risk analysis, assessment, and management. At the same time, these activities can be designed, shaped and prioritized using risk information, insights, and principles. An objective of the USACE Dam Safety Program is to make all program activities (all types of analyses, surveillance, instrumentation, site explorations, emergency planning, etc.) risk-informed.

As noted in 2013 IEPR Finding 2013-C-21, the USACE Dam Safety Program has two primary funding classifications:

- ‘Routine’ activities are funded through the District’s operation and maintenance budgeting process. Routine activities include the operation and maintenance (O&M) along with PIs and PAs for dam projects.
- ‘Non-routine’ activities are generally funded by HQ through project-specific funding channels.

With regard to “routine activities,” central management is provided through training and policies and tracked using DSPMT. It is under the broad heading of “routine activities” where “fundamental dam safety activities” are completed.

Responses to the 2016 Survey Questionnaire indicate a concern related to the O&M funding of fundamental dam safety activities and studies.

Funding for routine activities at the district O&M level has always been low. Our level of funding and resources has grown with the risk informed program but there is still more improvement to right size the O&M routine funding and resources to the ER requirements.

Based on a review of ER 1110-2-1156 Figure 3.1, it is the understanding of the IEPR Team that all dams, regardless of DSAC, will eventually go through an IES type of study, which utilizes centrally managed WEDGE funds. Today, despite the constant pace in completing IES plans, the majority of DSAC 2, 3, and 4 dams have been or will be first evaluated under the scope of a Periodic Assessment (de-centrally funded and with a more limited scope related to risk analysis).

An example of using fundamental dam safety activities to inform risk assessments is considering EAP effectiveness in consequences. While the IEPR Team noted that this is considered at the IES, DSMS or other level where quantitative risk analysis is being performed, it does not appear to be used when estimating consequences during Periodic Assessments. The only time the EAP was mentioned in the Barren River Dam Consequence Assessment Report (2015) was in a table showing that the EAP exists.

Finding: There is a need for an overall assessment of the development of fundamental dam safety activities in a qualitative manner, including a clear definition of a baseline objective regardless of the type of project. Such a baseline should enable a defensible quantitative risk analysis for all dams in the portfolio.

Recommendation: A guideline and a roadmap (including timing) for baseline completion of fundamental dam safety activities and studies should be developed, together with an approach to continuously and qualitatively assess these activities. These “fundamentals” should allow defensible quantitative risk analysis and explicit consideration of uncertainties at any level of assessment within the USACE Dam Safety Program.

6.3.5 2016-B-05: Integration of Design and Construction

Recognizing the importance of the integration of design and construction, USACE included a charge question specific to this issue in the SOW for the 2016 IEPR. A cohesive project team is essential to ensure that the design assumptions are validated during construction of modifications for a project.

During the visit to Rough River Dam, which was in construction, the IEPR Team observed the DSM lead engineer and the construction PM exhibited a strong relationship with good communication, noting that they spoke nearly every day. However, during other discussions with USACE staff at all levels, the IEPR Team identified concerns with relationships between design and construction groups. The IEPR Team heard the phrase “turf wars” as it relates to the design and construction staff and phases of projects. Many Districts have separate engineering and construction branches. While both branches may be represented on the Dam Safety Committee, there may still be issues with communication.

Roles and responsibilities of the different levels within USACE are documented in several guidance documents. ER 1110-2-1156 states that the DSM Lead Engineer be actively involved with confirmation of design assumptions during construction. It also notes the RMC, DSMMCX, and the Division (MSC) are integral members of the vertical team, to be updated throughout the construction progress. ER 1110-2-112 specifically requires visits to construction sites by design personnel. ER 1110-2-1150, “Engineering and Design for Civil Works Projects” states that design visits shall verify that site conditions match design assumptions. ER 10-1-51 establishes the roles and responsibilities of the DSMMCX, which has the

responsibility for the overall coordination and oversight of the national dam safety modification mission. The DSMMCX provides a Construction Liaison which supplements the DSM Lead Engineer in the oversight of quality management activities. ECB 2016-28 “Benchmarking of Design during Construction” provides guidance on developing costs and budgets for design personnel during the construction phase. While including all levels of the organization in the design and construction process provides significant benefit, the IEPR Team did hear of issues with timely decisions, given the number of staff who need to agree on a particular decision during construction. This can slow construction and frustrate contractors; however, it is also important to get to the right answer.

The IEPR Team was also provided three “HQUSACE Led Mega Design and Construction Evaluation Reports” (DCE). The DCE reports include roles of the Designer of Record, requires an Engineering Considerations and Instruction for Field Personnel document, a Quality Assurance Plan signed by the Design Branch section chief, and states that the Division is tasked with tracking design during construction. These DCE Reports provide a stable metric to monitoring the collaboration between design and construction. The provided DCE reports note that the DSM Lead Engineer is engaged, and documented regular interaction across the PDT. One significant weakness noted in the DCE reports is that the enterprise system remains non-functional, and while the project(s) provides a good “lessons learned” database, it is not effectively shared outside of the project’s district.

Another weakness identified through discussions with USACE staff at several levels is the lack of available construction staff with experience specific to dam construction. Training and developmental assignments are not sufficient to meet the current and anticipated staffing needs. This lack of dam safety experience further justifies the need for integration of design staff with the construction team.

During the 2017 Dam Safety CoP Workshop, the IEPR Team learned more related to concerns regarding integration of design and construction. The audience was asked to answer a live poll question that essentially stated the IEPR charge question: What is your evaluation of how USACE has integrated design and construction? Roughly 30 percent of the responses were “poor” and nearly 50 percent were “fair.” Another poll question asked: Are you satisfied with the current state of relations and communication between engineering and construction communities of practice? This resulted in 76 percent “No” responses. One comment during the SWOT meetings noted that “better synergy is needed between engineering and construction.”

Finding: Regarding the charge question: “What is the panel’s evaluation of how USACE has integrated design and construction?” The IEPR Team believes there is appropriate USACE guidance to integrate engineering and construction; however, implementation and accountability have been a challenge. This is evident through discussions with staff at all levels.

Another issue related to construction is the lack of construction staff with experience specific to dams. Training and developmental assignments are not sufficient for current project needs.

Recommendation: With regard to integration of design and construction, the IEPR Team recommends continued and increased vigilance regarding the implementation of existing guidance documents and policies, including ER 1110-2-1156, ER 1110-2-112, ER 1110-2-1150, ER 10-1-51, ECB 2016-28, and the DCE report recommendations. Those not following guidance should be held accountable. Additional suggestions include the following:

- Provide training of construction staff and include developmental assignments to dam projects under supervision of construction staff experienced in dam construction.
- DSMMCX should take a more active role in tracking construction projects and perform periodic interviews with the construction and design staff to enhance the level of cooperation.
- HQUSACE and Commanders must stress the importance of collaboration to the Engineering and Construction Branch chiefs.
- Each Project Management Plan should require a pre-construction meeting between engineering and construction staff to discuss critical phases of construction and involvement from the design team. The design team needs to provide clear guidance on what the critical tasks are with an explanation on why they require extra oversight by use of a detailed Engineering Considerations and Instructions for Field Personnel document.
- Construction staff should be included early in the design process, to ensure constructability concerns are addressed.
- A Design Construction Evaluation team, similar to the one used on mega projects, should be used on all construction projects to assist in making design and construction staff accountable to implementation of USACE guidance with regard to integration of design and construction.

Improvement in communication across all levels is a step toward addressing concerns with timely decisions during construction.

6.3.6 2016-B-06: Sharing and Implementing Lessons Learned

In the course of this IEPR, the subject of sharing lessons learned was discussed during meetings and interviews. It is clear that during risk analysis and facilitator training, lessons and experiences with respect to conducting risk studies or PFMAs are shared. However, when the subject of sharing lessons from construction experience, dam incidents (including water control issues), EAP exercises or implementations, etc. was discussed, it was clear there is not a systematic effort to ensure that lessons are captured and shared within the organization. At best, it appears this is only done in an ad hoc manner. As noted in Finding 2016-B-05, the enterprise system used to track lessons learned is no longer used.

The concept of lessons learned is mentioned a number of times in ER-1110-2-1156, including Section 11.2 (Institutional Knowledge and Technical Expertise). In most instances, these references appear to be limited to learning lessons at the local level. For instance, Chapter 16 (Emergency Action Plans) states:

Note that actual emergency events may be substituted for the appropriate exercise provided they are properly documented and the lessons learned from that event are incorporated into the updated EAP.

This statement suggests that lessons identified may only be shared and implemented locally. While it is certainly likely in many instances that lessons at a District will have local importance (an impact on the EAP for a specific dam), it is also likely there are broader benefits and lessons that could be shared across the program. However, the regulation does not suggest or require that these lessons be shared.

Finding: The Dam Safety Program has not established a programmatic effort to identify and share lessons and experiences on dam performance and overall dam safety activities (EAP exercises, management practices, etc.).

Recommendation: A programmatic effort should be developed to capture, share, and implement lessons that are learned across the spectrum of dam design, operation, and safety practices. This effort should:

- Define a vision and a mission for learning from experience that supports the advancement and improvement of dam engineering and safety, and maintaining and growing institutional knowledge.
- Identify 'significant events' (incidents, experiences, practices, etc.) that would/may locally and/or broadly (across the USACE) offer lessons that would support the dam safety mission.
- Evaluate the significant events to derive lessons (are there lessons to be learned and if so what are they).
- Record and distribute information on significant events and lessons.
- Establish mechanisms with training programs and other organizational opportunities to ensure that lessons are learned.
- Establish mechanisms to ensure that learned lessons become a part of dam safety practices.

6.3.7 2016-B-07: Centrally Managed – Locally Executed

A basic element of the USACE Dam Safety Program is central management with local execution of dam safety responsibilities. While the concept of central management and local execution is pragmatic for a number of reasons (e.g., portfolio size and complexity), implementation is complicated by the diversity of the organization, frequent changes in leadership (Commanders), and wide ranging responsibilities required of a dam safety program.

Finding: Discussions with USACE District and Division staff during the course of this IEPR have highlighted mixed implementation of the central management-local execution concept. For example, RMC is responsible for development of risk analysis methodologies and to varying degrees their implementation. The implementation of risk analysis (e.g., Periodic Assessments, Issue Evaluation Studies) is an example of central management (by RMC, DSOG) integrated with local execution (teams include District, Division, and Centers). Alternatively, USACE has recently developed new guidance for emergency action plans (EC 1110-2-212); however, there is no clearly defined central oversight of EAPs, potentially compromising USACE readiness for managing emergencies at dams. Similarly, dam safety modifications are centrally prioritized and funded; however, major maintenance packages (e.g., spillway gate replacements) are locally prioritized and executed.

Recommendation: The IEPR Team recommends an enterprise-wide review (a task force of internal and possibly external members) to systematically evaluate where, to what level, and by what means central management can be more effectively implemented. The task force would be charged with evaluating how dam safety activities are implemented throughout the organization and approaches to achieving technical quality, consistency, effectiveness, and efficiency (timeliness). This assurance is achievable with a greater level of oversight (central management) of all dam safety activities. In addition, the task force should be charged with developing and recommending specific organizational changes that would

improve the effectiveness (in the sense of reducing/eliminating the potential for discontinuities) of a centrally managed-locally executed framework.

6.3.8 2016-B-08: Locally Executed

In the course of both the 2013 and 2016 IEPR, it was apparent that Districts are given a level of autonomy with respect to local management and staff structure and responsibilities (i.e., local execution). At the same time, it is clear that certain approaches or local organizational structures work better than others. It would seem a responsibility of HQUSACE would be to provide oversight or recommendations regarding how Districts manage staff and workload, dictating when changes are needed and/or stepping in when a more effective approach has been demonstrated in another District. The IEPR Team notes that in a number of technical areas, specific organizational structures appear to work well, but the same structure is not used in other Districts. At the same time, the IEPR Team recognizes there are differences between Districts and that for various reasons a common approach may not work everywhere.

Finding: Districts are given the autonomy to establish staff organizational structures and management practices they find to best suit their needs. While local factors are clearly a reasonable consideration, the IEPR Team has observed organization and management approaches that appear to be more effective and efficient for the USACE Dam Safety Program. These instances have been observed in areas such as design and construction interface, dam safety and emergency management, and project operations and maintenance funding.

Recommendation: The Dam Safety Program should undertake an enterprise review of District engineering and dam safety management structures and practices. This review should identify those practices that provide improved effectiveness and efficiency in carrying out dam safety responsibilities. Once these 'best practices' are vetted, Districts should be subject to a comprehensive review, and as locally and generally appropriate, HQUSACE should recommend changes that should be implemented.

The IEPR Team notes this recommendation could be combined with recommendation 2016-B-07 (Centrally Managed – Locally Executed).

6.3.9 2016-B-09: Hydrologic Analysis

The 2013 IEPR Finding 2013-B-09 noted:

The current practice to estimating extreme inflows...does not take into account modern methods of statistical analysis, hydrologic and stochastic modeling methods and uncertainty analysis.

Since the 2013 IEPR, USACE has established the Hydrologic Hazards Team (HHT), which is part of the RMC. The HHT has done considerable work to develop a modern approach to the assessment of the frequency of occurrence of inflow flood hazards (flood hydrographs) at dams for frequent as well as extreme events. The work of the HHT has already provided technical support and input for project-specific risk analysis studies. This development in a short-period of time is to be commended.

The IEPR team has identified two issues with regard to the assessment of hydrologic inputs to risk analysis studies. The first, which is rather pragmatic, is that the HHT effort is not yet providing enough support to the Districts. This appears to be simply due to the high demand that cannot be met by the HHT at this time. The severity of this issue is illustrated by selected survey responses:

Estimating extreme loading conditions remains a challenge, especially for rare seismic and hydrologic events. USACE is attempting to build our expertise, but we're not there yet.

Hydrologic methods are inadequate to confidently quantify likelihood over most of the range of the risk matrix.

Assessment of USACE dams for hydrologic adequacy is undergoing significant change. Hydrologic guidance needs to be finalized.

It appears inadequate hydrologic studies are impacting the inputs to risk analyses, compromising the quality of the risk results.

The second issue is more technical. Based on discussions with HHT members, there does not appear to be a formal approach (framework) to the identification and evaluation of epistemic uncertainties.

Finding: In the natural hazards field, it is standard practice to incorporate a formal, structured approach to identify and evaluate aleatory and epistemic uncertainty in a hazards analysis. Further, the quantification of the hazard involves a segregated propagation of aleatory and epistemic uncertainties, sensitivity analysis, and analysis of variance assessments that identify the contribution of different sources of uncertainty to the total uncertainty in the hazard.

Recommendation: The IEPR Team recommends the HHT undertake an effort to establish a formal approach and implementation plan for the assessment of hydrologic hazards that include a framework for the identification and evaluation of sources of aleatory and epistemic uncertainty, a structured approach for evaluation and integration of sources of epistemic uncertainties, and quantification methods for the propagation of uncertainties. Initially, this may include the development of a conceptual hydrologic hazards analysis framework that describes an uncertainty framework, the physical events (e.g., extra-tropical storms) that are being modeled, an initial aleatory model(s), and an initial identification of the sources of aleatory and epistemic uncertainty. Once the conceptual framework is prepared, a project plan that identifies methods, tasks, and schedule can be prepared.

6.3.10 2016-B-10: Hydrologic Risk Analysis

The analysis of hydrologic risks involves a number of fundamental activities that include:

- Probabilistic characterization of inflow flood events (a sufficient number of hydrographs covering a wide range of annual probabilities of exceedance) and, as noted in the previous finding, the current state of the art includes explicitly accounting for aleatory and epistemic uncertainties
- Evaluation of electro-mechanical equipment reliability (i.e., functionality)
- Evaluation of operator actions
- Systems analysis
- Defining explicit operating rules for gates and outlets in case of flooding
- Assessing the hydraulic behavior and structural stability of spillways

In addition to these individual areas, there are “interfaces” of “hydrologic events-water management-operational response-maintenance” that should be addressed (integrated into the analysis), including consideration of all contributors to the existing uncertainties.

Finding: Integration of sufficient number of hydrologic events with gate reliability analysis, operating rules assessment, concurrent probabilities of “spillway related” failure modes, and characterization of pool level prior to the flood needs a formal approach through every level of risk analysis within the Program, as well as clear identification of all contributors to the existing uncertainties.

Recommendation: According to the finding, we recommend the following:

- The “loading” component of hydrologic risk analysis for all studies (e.g., Periodic Assessments, Issue Evaluation Studies, etc.) should be centrally managed, following the example of the consequence analysis.
- This should be a priority and the approach should be formalized in a manner that enables quantitative risk analysis and clear accountability of uncertainties at any level of assessment (including Periodic Assessments).
- A formal approach to addressing hydrologic risk should be developed, with its particular features, for the design of dam safety modifications.

6.3.11 2016-B-11: Seismic Hazard Analysis

IEPR Finding 2013-B-16 noted:

Experience in comparing the USGS probabilistic seismic hazard analysis (PSHA) results to those of full-scope PSHAs in the central and eastern U.S. and the western U.S. suggests they may be conservative or non-conservative. As a consequence, they cannot be generally considered a reliable basis to estimate the seismic risk of USACE dams.

In response to this finding, the USACE has taken steps to improve the evaluation of ground motion hazards at USACE dams. At the time of this IEPR, a seismic hazard screening evaluation has been performed to rank USACE dam sites. In addition, two site-specific PSHAs have been performed and two others are underway. The site-specific PSHAs are performed as Senior Seismic Hazard Analysis Committee Level 2 studies (NRC, 2012). Despite these steps, the attention given to the assessment of seismic hazards and seismic risk in general has been limited and informal.

Discussions with District staff during the IEPR visits suggest that deterministic methods are still used to assess whether there is a hazard and, by implication, a seismic risk at USACE projects. This approach is certainly counter to a risk-informed approach and potentially erroneous (depending on the site-specific circumstances).

Finding: At this time, an approach to formally evaluate seismic hazards at USACE projects has not been developed. Efforts have been initiated, but there does not yet exist a program plan and schedule to define how and when this issue will be addressed.

Recommendation: As a first step, a plan should be developed to establish the steps and schedule for how the probabilistic assessment of seismic hazards will be evaluated at USACE dams. The plan should include the development of guidance for how PSHAs are performed, the level of analysis that is required, which will vary depending on the risk analysis being supported and the consequences of an uncontrolled release, among other possible factors.

6.3.12 2016-B-12: Seismic Risk Analysis for Dam Systems

The USACE is unique with respect to the seismic risk of its portfolio of dams. From a seismic hazard perspective, there are projects in the western United States that may be exposed to potentially high seismic hazards (e.g., Magnitude 9+ earthquakes in the Pacific Northwest and large magnitude events in California). At the other extreme, the USACE has dams located in the central and eastern United States where the seismic hazard is lower (in terms of the annual frequency of occurrence), yet the potential for high ground motions due to moderate or large magnitude earthquakes is similar to that in the western United States. The portfolio is also varied in the sense that many USACE dams are flood control structures and are typically 'dry' (e.g., Whittier Narrows Dam in California). However, there are a number of dams across the country that do have a 'full' reservoir. These conditions contribute to a varied seismic risk portfolio.

While work has been initiated with respect to the evaluation of seismic hazards following the 2013 IEPR (see Finding 2016-B-11), the subject of seismic risk analysis for dam systems seems to have been given less attention.

Finding: There is no information to indicate that USACE has given much attention to the seismic risk of their portfolio of dams. Further, given Finding 2016-B-11, it is not apparent there is a clear understanding of the issues and unique aspects associated with seismic risks. For example, in the Midwest, the USACE has dams that are located in proximity to the New Madrid seismic zone and the Wabash Valley seismic zone. At the District level there seems to be a lack of awareness of the potential seismic risks, which could result in inadequate consideration of potential seismic failure modes, impacts to approaches for emergency management, etc.

Even for dams with a small to moderate population-at-risk (life-loss estimates on the order of 10), the seismic frequency of an uncontrolled release of the reservoir must be quite low, less than 10^{-5} per year to satisfy the USACE tolerable risk guidance. Even in the central and eastern United States, where the rate of occurrence of earthquakes is lower than in the west, the seismic capacity of a dam must be fairly high in order to achieve an acceptable probability of uncontrolled reservoir release.

There are other unique aspects to seismic risk, including the potential seismic failure modes a structure may experience, system seismic reliability during a seismic event, including vulnerability of off-site power and on-site emergency power sources, potential complications associated with implementation of EAPs and downstream mobilization and evacuation, the post-seismic vulnerability of a project, etc.

Recommendation: It is recommended that a systematic seismic risk analysis program be established that includes the range of evaluation methods that is required to support the dam safety program; risk-informed screening analysis through to full-scope probabilistic seismic risk analysis that is consistent with the state-of-practice in earthquake engineering. This program should consider all elements of the risk analysis for a dam system, the assessment of downstream consequences, and the integration of the results into project monitoring, post-event inspection, and emergency preparedness both on and off site.

6.3.13 2016-B-13: Update Role, Scope, and Contents of Periodic Assessments

Based on a review of ER 1110-2-1156 and Figure 3.1, it is the understanding of the IEPR Team that all dams, regardless of their DSAC rating, will eventually go through an IES type of study, which is considered to be a more robust risk assessment than performed for a Periodic Assessment. However,

those studies, which are centrally funded through the WEDGE, are currently only applied to selected DSAC 2 dams.

Consequently, while the “resource queue” makes progress in scheduling IES types of analysis, some DSAC 2 and many DSAC 3 and 4 dams advance directly from Screening Portfolio Risk Assessment to a Periodic Assessment (semi-quantitative risk assessment). This, combined with the fact that very high risk projects have been or are being modified, raises questions regarding the suitability of the current role and scope of Periodic Assessments.

IEPR Finding 2013-C-11 included the following finding/recommendation:

Periodic Assessments are a core element of the dam safety program and risk analyses are performed as part of the [Periodic Assessment]. In this context, the quality and consistency of [Periodic Assessments] are important to the quality of the USACE risk management program... [USACE] should assess the root causes of risk analyses that have failed to meet its quality and consistency standards and, as appropriate, provide more and better training, make changes to procedures, modify the role of risk cadres, clarify the role and responsibilities of facilitators, and provide uniform guidance to district staff.

Finding 2013-C-13 recommended:

The USACE should plan for and evolve to the utilization of risk-informed approaches to support all elements of the dam safety program and asset management.

Finding 2013-B-14 noted:

PAs are based on approximate or limited quantitative evaluations (hydrologic frequency analysis, seismic hazard analysis, etc.). Given these attributes, the risk analyses performed as part of PAs are judged to provide a relative measure of risk, which is useful to support the USACE DSAC process, but the results cannot be directly compared to the tolerable risk criteria.

Since the 2013 IEPR, the USACE has improved the quality and consistency of PAs, is working on improving both hydrologic and seismic analysis methods, and is conceptually addressing how uncertainties are considered.

Based on discussions during the 2016 IEPR visits and phone interviews, several issues were identified with respect to the impact of Periodic Assessments on the overall program, given their current role and scope:

- The basis of the analysis performed under Periodic Assessments is not quantitative, being that the “loading” part of the risk equation is less developed in relative terms to the “system response” and “consequences” parts of the equation.
- Periodic Assessments are used, among other things, for prioritizing the completion of “fundamental” dam safety studies (e.g., need for hydrologic or seismic analysis, additional site investigations or installation of instrumentation, updated emergency preparedness procedures). These “fundamental dam safety activities” will, in principle, also be used to properly feed the risk analyses.

- The potential threat to the program is that, as projects may go through Periodic Assessment before more detailed qualitative risk analysis, dam safety “fundamentals” may not be properly feeding the risk estimates, and these estimates may not be robust enough to support or prioritize actions.
- The fact that Periodic Assessments are executed by Districts, with senior oversight provided by RMC, together with potential for complacency with the overall dam safety program process, may add some overconfidence to the Periodic Assessment outcomes.
- The IEPR Team did not identify evidence of any formal or centralized analytical evaluation of the risk assessment results from the first round of Periodic Assessments. This could include evaluation of projects that have advanced through additional levels of risk analysis (e.g., Issue Evaluation Study) and a comparison of the resulting risk estimates. This would provide, in a systematic manner, lessons learned to evaluate adjustments to the Periodic Assessment processes, if needed.

As a matter of fact, in the USACE response to the 2016 Survey, “analysis of dam safety risks” scored higher than “program implementation.” Furthermore, several of the responses to questions related to “analysis of dam safety risks,” indicate a relatively high degree of comfort is found on semi-quantitative risk analysis, as well as with regard to the adequacy of current risk analysis tools:

There is good consistency of the processes used in the SQRA and PA analyses due to experienced RMC and district personnel and a well-vetted methodology.

The risks are being properly rated. The Periodic Assessment is one of the best tools we have.

The PA program provides an excellent opportunity to define risk at a manageable district level product.

Use of consistent risk estimate processes is now part of the agency culture. This MSC has a much greater awareness of risks posed by our infrastructure, which influences work priorities and other actions.

However, there were some potential weaknesses noted in the responses:

There needs to be more work on defining the level of uncertainty in the program.

The efficacy of the approach is dependent on how individual team members assess the likelihood of failure modes occurring. The characterization and likelihood of failure modes can be more intuitive than scientific. Uncertainty is not adequately taken into account.

Approaches are technically sound; sometimes seems lacking in SQRA. May be opportunities for more technical basis of evaluations.

The more quantitative the analysis, the lower the risk imposed by the projects (at least in my region), and the lower the likelihood of the project advancing to a Modification study.

Finding: As the USACE Dam Safety Program matures and high-risk projects are modified to meet USACE Tolerable Risk Guidelines, potential concerns are emerging from the fact that risk analysis has also been used to prioritize the completion of more “fundamental” dam safety studies for all dams. The

first round of Periodic Assessments (e.g., Brea Dam, Periodic Assessment No. 01) not only serves to estimate and assess existing risks, but are also the means to identify and recommend actions such as updating hydrologic analysis, performing seismic studies, developing instrumentation monitoring plans, or conducting emergency exercises, which are fundamental activities of any modern dam safety program.

The current scope of risk assessment, which has served well for portfolio management, particularly given the urgency driven by "legacy" projects and other critical, extreme or very high risk projects, may not serve as well for prioritizing the completion of "fundamental" dam safety activities. This concern is internally recognized (i.e., Bluestone Dam Hydrologic Hazard Document Supplement 2016, with regard to hydrologic analysis).

Recommendation: The IEPR Team recommends the following:

- Perform a systematic analysis of all projects that have been through quantitative risk assessment to evaluate the implications in terms of risk characterization and resulting actions of the different levels of analysis. (e.g., Are there quantifiable trends when comparing the results of risk analyses performed through Periodic Assessment versus Issue Evaluation Study?)
- Perform a systematic review of all findings and recommendations from Periodic Assessments with regard to performing "fundamental" dam safety activities and studies, so that a qualitative assessment of such fundamentals can be performed. (This could supplement quantitative results of the DSPMT scorecard.)
- Develop a detailed plan to centrally track and support O&M recommendations (including dam safety studies) from the Periodic Assessment program.
- Develop a vision for the future scope of risk analysis at the Periodic Assessment level to ensure that the "second round" of Periodic Assessments will reduce the potential for:
 - A lack of "fundamental" dam safety activities and/or studies, resulting in an unsound basis for a full quantitative risk analysis (including explicit consideration of uncertainties)
 - Risk analysis providing an overconfident outcome in terms of need and urgency of actions

6.3.14 2016-C-14: Consideration of Consequences Beyond Life Loss in Risk Reduction Indicators

According to ER 1110-2-1156 Chapter 3 (Table 3.1), DSAC Classification accounts for life safety, economic and environmental risks, though statements attached to each category in terms of acceptability and/or tolerability of risks are formulated solely in terms of life-risk. Section 6.3.2 further suggests the consideration of life-risk as the main driver for urgency of actions, as follows:

- Section 5.3.8.2.2 considers the issue of cost-effectiveness of incremental risk reduction measures, which plays a role (i.e., through risk indicators as "cost-to-save-a-statistical life" compared to the "value-of-statistical-life" provided by the United States Department of Transportation) but only after tolerability guidelines are met.
- Consequently, projects that involve potential for life losses are likely "dominating" decisions on both prioritization of studies and actions, and it is difficult to see how this can change in the coming years. (In practice, it will be impossible to demonstrate that every project meets current Tolerability Guidelines.)

Finding 2013-C-08 notes:

A focus on public safety is clearly appropriate for dams that may have significant consequences in the event of uncontrolled release of the reservoir. However, it is not clear that the current focus is consistent with the broad agency responsibility of managing a critical part of the nation's infrastructure.

The IEPR Team believes that, in order to do better informed and more consistent management with limited resources, it is desirable to use risk reduction principle/indicators which include assigning an economic value to the loss of life. This can be compatible with the principle of “life safety is paramount” by assigning a very large economic value to the loss of life, but it is not necessary to make this value “infinite” in practice.

Based on discussions during visits and several individual phone interviews, and acknowledging that there may be very few projects with no life safety risk, The IEPR Team believes that:

- Current prioritization principles in the USACE Dam Safety Program may not account for the fact that very high economic risks may need to be competing better in terms of urgency.
- Though it may not result in direct loss of life, dam failures or incidents have the potential to dramatically impact the quality of life, result in indirect loss of life, and create other substantial issues for large communities.

As a matter of fact, responses collected in several of the 2016 survey questions keep focusing on a perceived disadvantage of navigation projects in terms of prioritization of studies and actions. This concern has been highlighted mainly with regard to policies and procedures, but also with regard to the analysis of dam safety risks through a significant number of comments.

Finding: Exclusive consideration of life safety risk in the management of the USACE diverse portfolio of dams, particularly moving forward as high risk issues are addressed, could be limiting with regard to leveraging new opportunities within the USACE (other business lines) and externally (in terms of funding fundamentally).

Recommendation: While this finding does not warrant a specific action, given the limited number of projects where life-safety risk is not the main driver, the IEPR Team suggests that this “boundary” of the program deserves an updated evaluation. Some of the benefits could come from comparing options related to prioritization of actions, enabling more direct comparisons with other business lines, and/or, assisting in identifying unique funding opportunities. We also understand this “boundary” intersects with current policy, as only life safety risk and cost-to-save-a-statistical life are included in ER 1110-2-1156 as risk reduction indicators.

6.4 Critical Infrastructure Protection and Resilience (CIPR) Program

During the March 31, 2017, meeting to brief USACE on the IEPR findings and recommendation, USACE requested the IEPR Team's opinion related to the CIPR Program and its relationship to the dam safety program. Subsequently, the SOW was revised to include the following:

- Evaluate and make a recommendation whether the Critical Infrastructure Program should be incorporated into the HQUSACE dam safety organization.

As a preface to our evaluation and recommendation, the IEPR Team notes that prior to the March briefing, dam security and the CIPR Program did not come up formally or informally during the 2013 or the 2016 IEPRs in discussions with USACE staff at any level. This suggests, as a minimum, the subject of dam security from a programmatic or a project-specific level is an area of limited concern of dam safety management or staff in fulfilling their responsibilities.

6.4.1 Background on CIPR and Dam Safety Programs

The IEPR Team was provided with several documents summarizing the CIPR Program and spoke with Yazmin Seda-Sanabria, CIPR Program Manager along with leadership of the Dam Safety Program (HQ – Eric Halpin and John Bianco and RMC – Nate Snorteland and Travis Tutka).

ER 1110-2-1156 contains background in Chapter 23 – Critical Infrastructure Protection and Resilience. Chapter 23 of ER 1110-2-1156 includes the following:

This chapter sets forth policy, guidance, and procedures for the implementation of a comprehensive security risk assessment and management framework supporting the effective implementation of critical infrastructure protection efforts across USACE Civil Works portfolio of projects (conventional dams, navigation locks, and appurtenant structures).

[HQUSACE Office of Homeland Security CIPR Program] security risk assessment framework is fully aligned with national policy (defined by Presidential Policy Directives and Executive Orders).

With regard to procedures for security portfolio prioritization, Chapter 23 of ER 110-2-1156 prescribes the Consequence-Based Top Screen (CTS) methodology. CTS screening and prioritization are supported by MMC.

Section 23.7 of ER 1110-2-1156 includes a requirement to conduct a security risk assessment at a minimum of “every five years in conjunction with the project’s periodic inspection or periodic assessment.” The USACE Common Risk Model for Dams (CRM-D) risk assessment methodology is used to conduct security risk assessments.

Finally, Section 23.8 of ER 1110-2-1156 includes a description of available training to support CIPR Program activities. This training is coordinated with and/or developed by the Department of Homeland Security and FEMA.

It is the understanding of the IEPR Team that the CIPR Program has no formal governance structure, community-of-practice, or full-time staff other than the Program Manager.

6.4.2 IEPR Assessment of the CIPR Program Implementation and Methodology

The IEPR Team was not charged with reviewing the CIPR Program; however, some background on the program and its degree of implementation are necessary to evaluate the concept of “incorporating” the CIPR Program into the USACE Dam Safety Program.

Based on review of documents and discussions with the CIPR Program Manager and leadership of the USACE Dam Safety Program, the IEPR Team understands the following with regard to the CIPR Program:

- The CTS methodology was fully developed and centrally funded. CTS screening and prioritization have been completed with the support of the MMC who performed dam breach and consequence assessments.
- The CRM-D methodology is fully developed but efforts to conduct security risk assessment are not adequately funded; implementation has been slow. Security risk assessments are rarely completed every five years; they are generally not carried out as part of a Periodic Inspection or Assessment. (As noted above, the subject of security assessments was never raised during discussions between USACE and the IEPR Team, let alone those that focused specifically on PAs.)
- A number of training activities, in coordination with the Department of Homeland Security, have been completed over the last decade.
- The CIPR Program lacks an established “governance structure,” community-of-practice, or full-time staff, other than the CIPR Program Manager.
- Districts and Divisions have separate staff for dam safety and security. The efforts of these staff are not well coordinated or integrated.

Overall, the IEPR Team notes the implementation of the CIPR Program appears to be considerably less “mature” than that of the Dam Safety Program.

The Department of Homeland Security (DHS) first developed the Dams Sector Analysis Tool (DSAT) to provide Dam Sector agents with secure access to a series of modules and applications. Developed in collaboration with USACE, the DSAT serves as a web-based tool to integrate available information on dam critical infrastructure facilities. Among the DSAT tools is the Common Risk Model for Dams (CRM-D), developed by the Institute for Defense Analyses. CRM-D assists in quantifying vulnerabilities based on standard security configuration attributes and pre-selected attack vectors (Kirpichevsky, Y., Seda-Sanabria, Y., Matheu, E.E., Dechant, J.A., Fainberg, M.A., Morgeson, J.D., Utgoff, V.A. (2013): *The Common Risk Model for Dams: A Portfolio Approach to Security Risk Assessments*, Report NSD-4943, Institute for Defense Analyses (IDA), Alexandria, Virginia).

With regard to the CRM-D methodology, which is the core of the CIPR Program approach to performing security risk assessments, the IEPR Team notes the following:

- CRM-D provides a systematic approach for evaluating and comparing risks from terrorist attacks, though it cannot be considered a fully quantitative tool to characterize security risks.
- The analysis of man-made threats has encountered a number of unsolved challenges, such as the estimation of the probability of an attack performed by goal-oriented and intelligent adversaries. The panel is not aware of any fully quantitative security risk assessment tool being applied in the dam industry worldwide.

6.4.3 IEPR Assessment of the Integration of Dam Safety and Security Risk Management

Integrated dam safety and security risk management is a major challenge for the dams community worldwide. The application of risk analysis to support dam safety decision making is increasing; however, security analyses still remain generally disconnected from decision making by owners, operators, and regulators.

As a practical matter, issues of security for dams go well beyond the perimeter of a dam project. For instance, efforts to mitigate actions against critical infrastructure are addressed through cyber security and intelligence efforts. In both of these examples, efforts are handled in part (if not largely) outside of the USACE by other agencies (let alone the dam safety program itself). As a practical matter, there is limited overlap between dam safety program activities and dam security issues. On-site, security issues are likely to deal with issues such as site access, protection of control systems, etc.

In current practice, only conditional security risk outcomes from defined attack scenarios are estimated by the suite of existing tools (i.e., CRM-D), making it impossible to directly compare with risk results from current dam safety applications. A further complication with comparing risk results is the fact that security risk methods tend to involve index measures, rather than quantitative probabilistic risk estimates.

On balance, it would seem there are limited areas of common ground between the elements of the dam safety program and the responsibilities of the CIPR Program. While the notion of risk appears to be common, there is little regarding the analysis of risks the two programs share or need to share. This said, there are some common needs – for instance both programs require a measure of the consequences of a dam incident (release of the reservoir), which is now centrally addressed by the MMC.

Considering potential benefits to integrating these programs, there may be synergies, including:

- Efficient use of selected resources in performing dam safety and security risk assessments (e.g., MMC consequence estimates).
- Programmatic coordination of dam safety and security measures (i.e., Interim Risk Reduction Measures, or Dam Safety Modifications) that are submitted for funding.
- Coordination between dam safety and security for a given project reduces the potential for conflicting recommendations and inappropriate prioritization of actions.
- Improvement of risk methodologies as applied to dam security assessments and in the training and development of risk specialists.
- Incorporating security provisions in EAPs, as is referenced in the latest draft of EC 1110-2-212.

Based on discussions with USACE CIPR and Dam Safety Program leadership and review of information provided, the IEPR Team identified potential challenges in integrating the programs:

- The CIPR Program is “fully aligned with national policy” (defined by Presidential Policy Directives and Executive Orders), potentially impacting control and direction of the dam safety program if the programs were integrated.
- The classified nature of security programs could impact the dam safety program, where transparency is important in the evaluation of risks and where communication with stakeholders is vitally important with respect to the effectiveness of flood warnings (warning issuance and diffusion) and public mobilization (taking protective action in a timely manner).
- The “less mature” nature of the CIPR Program implementation could impact the progress of implementation of the Dam Safety Program. Funding or resources could be directed toward “maturing” the CIPR Program.
- The dam safety program staff, including RMC, has a significant backlog of work. Adding CIPR program responsibilities could burden the dam safety program with additional responsibilities, potentially diluting attention on dam safety and compromising their effectiveness.

This IEPR is focused on the USACE dam safety program. With this perspective in mind, the IEPR Team did not read or hear during this or the 2013 IEPR anything related to benefits of integration of the dam safety program with the CIPR program or any issues related to impacts of the lack of integration with regard to the dam safety program. Based on this observation, the benefits of integrating the programs are believed to be somewhat limited with regard to dam safety. This is likely due in part to the limited overlap of the areas of interest of the two programs and the very different nature of their responsibilities and solutions to the unique risks they are each charged with evaluating and managing.

One issue of concern is the USACE responsibility to the public with respect to sharing emergency preparedness information. At the start of the 2013 IEPR, the USACE had policies in place (ECB 2008-10, Interim USACE Policy on Release of Inundation Maps) that limited the sharing of inundation maps with the public and even local government entities in some cases. Coincidentally, during the course of the 2013 IEPR, this policy was revised to be less restrictive in providing information to the public (reference EC 1165-2-215, Use and Dissemination of Dam and Levee Inundation Map Data) and is further revised in a draft policy (reference Appendix D of EC 1165-2-215). This recent history is indicative of the potential for security concerns to compromise aspects of dam safety by limiting the sharing of information that is important to emergency readiness of communities or for the evaluation of dam safety risks.

In general, the IEPR Team offers the following observations relative to potential integration of the dam safety and security programs:

- The benefits of integrating the two programs seems to be somewhat one-sided; limited benefit for the dam safety program and greater potential benefits for dam security.
- To the extent the RMC and District staffs have a full agenda of dam safety responsibilities to meet, adding dam security to their responsibilities represents a potential threat to dam safety.
- The overlap between the responsibilities of the two programs is limited, and therefore the benefits of program integration are inherently limited.
- There are areas of common interest/need and therefore close coordination of these needs and use of USACE resources (e.g., MMC) is beneficial.
- Coordination would align with the draft EAP guidance (EC 1110-2-212) in developing an EAP that considers failure modes and impacts related to both dam safety and dam security.
- Coordination could facilitate project site inspections by security staff with a presence from the dam safety program, to better educate security teams on project features and potential failure modes and vulnerabilities.

In light of the foregoing, it is the IEPR Team's view that from a technical perspective, *integration* of the dam safety and security programs would have limited benefits to dam safety (the focus of this IEPR). While there appear to be synergies that could provide benefits, these could be achieved through close *coordination* between the programs, which is desirable. The IEPR Team has identified a list of concerns herein that should be carefully considered as the USACE considers integration.

6.5 IEPR Panel Consensus

The SOW notes the following regarding the panel findings:

The team panel lead shall be responsible for insuring [sic] that comments represent the group, be non-attributable to individuals, and where there is a lack of consensus, note the non-concurrence and why.

As part of the development of the findings and recommendations presented in this report, the IEPR project manager solicited opinions from the panel regarding each finding and recommendation. During the development of this report, there were differences in opinions regarding either the emphasis or specific wording of selected findings and recommendations. In addition, members of the panel did not initially agree on the categories (critical, urgent, etc.) of every finding. However, it is the opinion of the IEPR Team that there is general consensus for all of the findings and recommendations presented herein, and the categories that have been assigned. It should be noted that, based on expertise and/or commitment to lead a finding/recommendation, each panel member focused, in part, on certain aspects of the program. Therefore, to some extent, other panel members relied on a given individual’s interpretation of the review of various documents and elements of the program.

Initially, there was a lack of consensus among the IEPR Team regarding integration of the CIPR Program into the Dam Safety Program. The panel discussed the issue and the recommendations and potential concerns were revised. The language presented herein reflects general consensus of the panel.

6.6 Summarizing the State of the USACE Dam Safety Program – The Maturity Matrix

The previous sections of this report have identified findings and recommendations related to various aspects of the dam safety program. As part of the 2013 IEPR, the IEPR Team used a “high level” application of the maturity matrix approach to provide an aggregate assessment of the state of each program subject area (Organization and Management, Dam Safety Policies and Procedures, Risk-Informed Management, Emergency Preparedness, Dam Safety Program Implementation, and Technical Capabilities for Dam Engineering). The 2013 Maturity Matrix is shown in Figure 6.1:

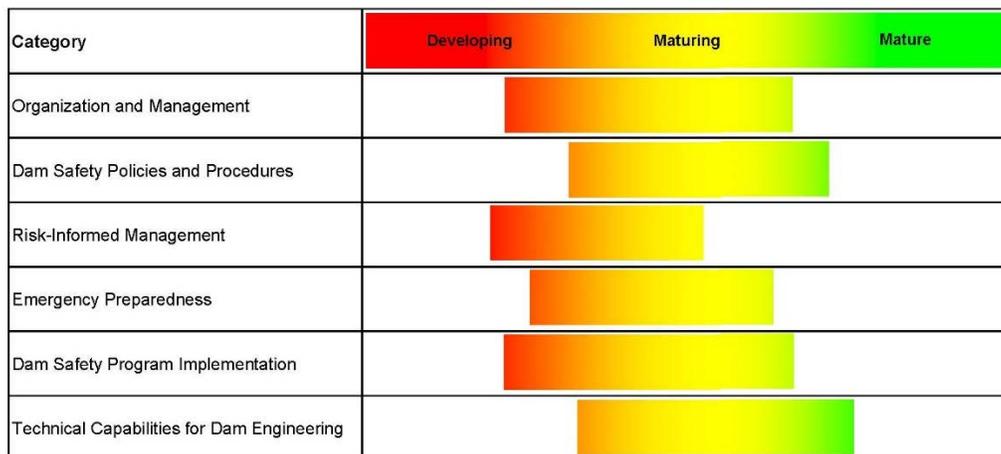


Figure 6.1: 2013 IEPR Maturity Matrix

As a baseline for summarizing the state of the USACE Dam Safety Program, the IEPR Team (3 members and project manager) rated the program using the survey that was distributed to USACE. The USACE and IEPR Team responses are summarized in Figure 6.2. The USACE survey results are provided as gray bars and lines. The gray bars show the ± one standard deviation range, and the gray lines define the

minimum and maximum responses. The IEPR Team mean ratings are shown as black diamonds and the minimum and maximum ratings are represented by the heavy black line:

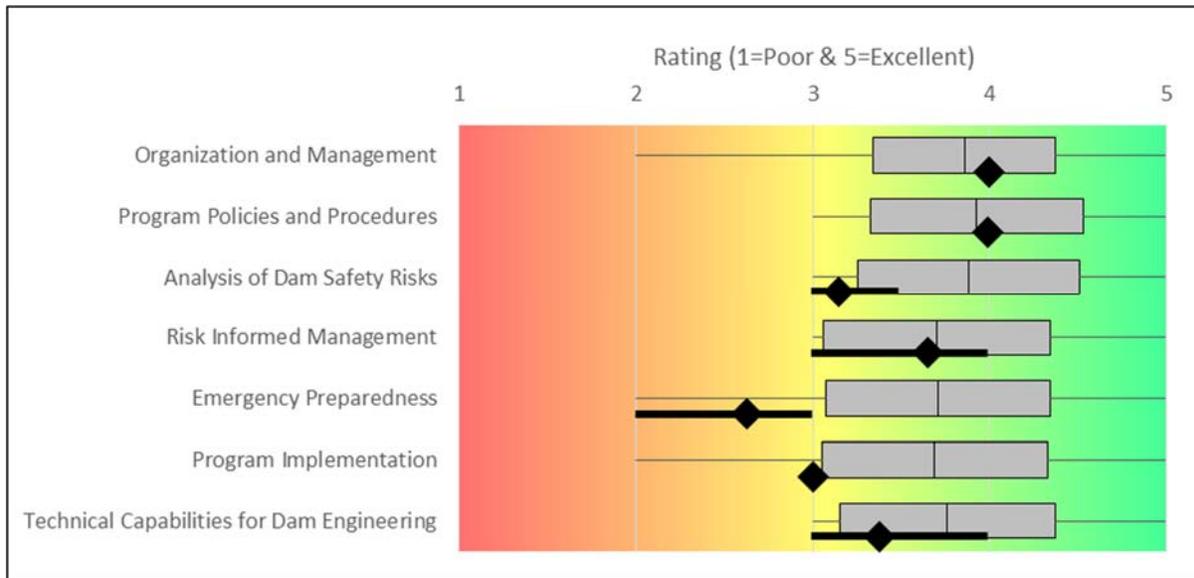


Figure 6.2: 2016 Survey Responses (USACE and IEPR Team)

Development of the maturity matrix was not included in the 2013 or the original 2016 SOW; however, during the March 2016 briefing of the IEPR Draft Report, USACE requested that the IEPR Team utilize the maturity matrix, and the SOW was subsequently revised.

For the 2016 IEPR, an approach was selected that is generally consistent (albeit less detailed or rigorous), with that described in “Using Maturity Matrices to Evaluate Dam Safety Programs – User Manual” (CEATI International, January 2015), which was provided to the IEPR Team by USACE for use on this project, which includes the following abstract:

Maturity matrices are a powerful tool to evaluate how well-developed a process or program is. The maturity matrices described in this manual have been developed for owners to assess the effectiveness of a dam safety program against industry practice.

In this maturity matrix, the current state of development (or maturity) of a dam safety program can be evaluated. If required, improvements to the program can be subsequently developed, prioritized & planned and then the process can be repeated at a later date to determine if progress has been made.

The primary benefit from using the maturity matrix is expected to be the improved understanding of the dam safety program across the whole range of activities that influence its effectiveness.

The maturity matrix is a two axis chart with “maturity level” on the horizontal axis and typical activities of a dam safety program (referred to as “elements”) on the vertical axis. Sub-matrices (with “sub-elements”) are used to perform the evaluations. Individual “line items” are used to evaluate the maturity of each sub-element.

For this application, the IEPR Team reviewed the elements suggested in CEATI (2015) and found several elements to be applicable to the USACE Dam Safety Program; however, some elements were not considered relevant or important enough to be considered “elements.” Table 6.1 lists the elements included in CEATI, along with the IEPR element or the IEPR Team comment on applicability of each element.

Table 6.1: Maturity Matrix Elements

CEATI (2015) Element	2016 IEPR Element (bold) or Comment on Applicability (italics)
Surveillance	Surveillance
Flow Control Equipment	<i>Not considered significant enough to include as an element</i>
Reservoir Operations and Public Safety	Responsibilities at least partially outside the Dam Safety Program
Emergency Preparedness	Emergency Preparedness
Dam and Water Control Structure Maintenance	<i>Not considered significant enough to include as an element</i>
Managing Dam Safety Issues	<i>Adjusted concept to</i> Managing Dam Safety Issues (aka Dam Safety Program Implementation)
Audits and Reviews	<i>Considered to be part of Managing Dam Safety Issues</i>
Training and Education	Training and Education
Information Management	Information Management
Governance	Governance
	<i>Additional Element:</i> Risk Informed Management

The selected elements were re-ordered and sub-elements developed (Table 6.2), using CEATI sub-elements where considered appropriate and applicable.

Table 6.2: IEPR Maturity Matrix Elements and Sub-elements

Element	Sub-elements
Governance	<ul style="list-style-type: none"> a. Organization and Management b. Dam Safety Policies, Goals and Values, and Procedures c. Delegated Roles and Responsibilities d. Internal and External Communication e. Resourcing
Risk Informed Management	<ul style="list-style-type: none"> a. Risk Analysis Methods and Practices b. Risk Management Practices c. Risk-Informed Decision Making d. Integration of Project Information into Risk Analysis e. Portfolio Prioritization
Surveillance	<ul style="list-style-type: none"> a. Surveillance Program b. Dam Inspections c. Instrumentation and Data d. Dam Safety Assessment (Data Review and Evaluation)
Emergency Preparedness	<ul style="list-style-type: none"> a. Hazard and Consequence Identification b. Emergency Preparedness Plans c. Relationships with Community and External Agencies d. Test and Exercises
Information Management	<ul style="list-style-type: none"> a. Standards, Policies, Plans, and Procedures b. Information on the Physical Infrastructure c. Operational and Surveillance Data Management d. Management of Study Documentation (PI, PA, IES, DSMR, Plans, Specifications, etc.)
Training and Education	<ul style="list-style-type: none"> a. Dam Safety Training b. Dam Engineering Fundamentals c. Incident and Emergency Preparedness Training and Education d. Risk Analysis and Management Training e. Project Operations
Managing Dam Safety Issues (aka Dam Safety Program Implementation)	<ul style="list-style-type: none"> a. Timeliness and Effectiveness of Inspections and Assessments b. Consistency of Reporting (studies, etc.) c. Addressing and Managing Dam Safety Deficiencies d. Availability of Resources to Address Time-Sensitive Dam Safety Issues e. Effectiveness and Efficiency of Program Activities such as Design and Construction f. Quality and Consistency of Implementation of Regulations (ER 1110-2-1156)

The maturity levels (1 through 5) also generally followed those presented in CEATI (2015) and are defined in Table 6.3.

Table 6.3: Maturity Level Descriptions and Characteristics

Maturity Level	Maturity Level Description	Typical Characteristics
1. Needing Development	Lacks conformance to applicable guidelines, standards, and typical practice.	Poorly organized, unplanned, unstructured, improvised, makeshift, one-off, poorly understood, non-conforming.
2. Intermediate	Conforms to applicable guidelines, standards, and good practice in some areas.	Partial conformance, basic level of understanding/planning/structure/ approach incomplete.
3. Good Practice	Generally conforms to applicable guidelines, standards, and good practice.	Generally conforms, organized, planned, structured, generally complete, good level of understanding.
4. Best Practice	High degree of understanding and conformance with applicable guidelines, standards, and good practice.	Comprehensive (not easy to improve on). Thorough. High degree of conformance and completeness. High level of understanding, organization, and planning. Well structured.
5. Leading Edge	Generally meeting best practice level and also developing, trialing, and implementing new technology, methods, and systems.	Meets all characteristics of Level 4 and includes development and implementation of new methods, techniques, etc.

The IEPR team provided three ratings for each sub-element: (1) a “central tendency” to reflect the IEPR Team member’s opinion of the overall USACE maturity level, (2) a “minimum” which is the member’s opinion of the lowest maturity level at which USACE is performing, and (3) which is the member’s opinion of the highest maturity level at which USACE is performing. The average of each of these ratings was computed and is presented in Figure 6.3. This presentation of the Maturity Matrix differs from that presented in CEATI (2015) by including a central tendency and a width representing the range in maturity level. The width of the bars could represent the consistency at which USACE is performing; possibly a reflection of differing maturity levels across different locations or organizations within the dam safety program.

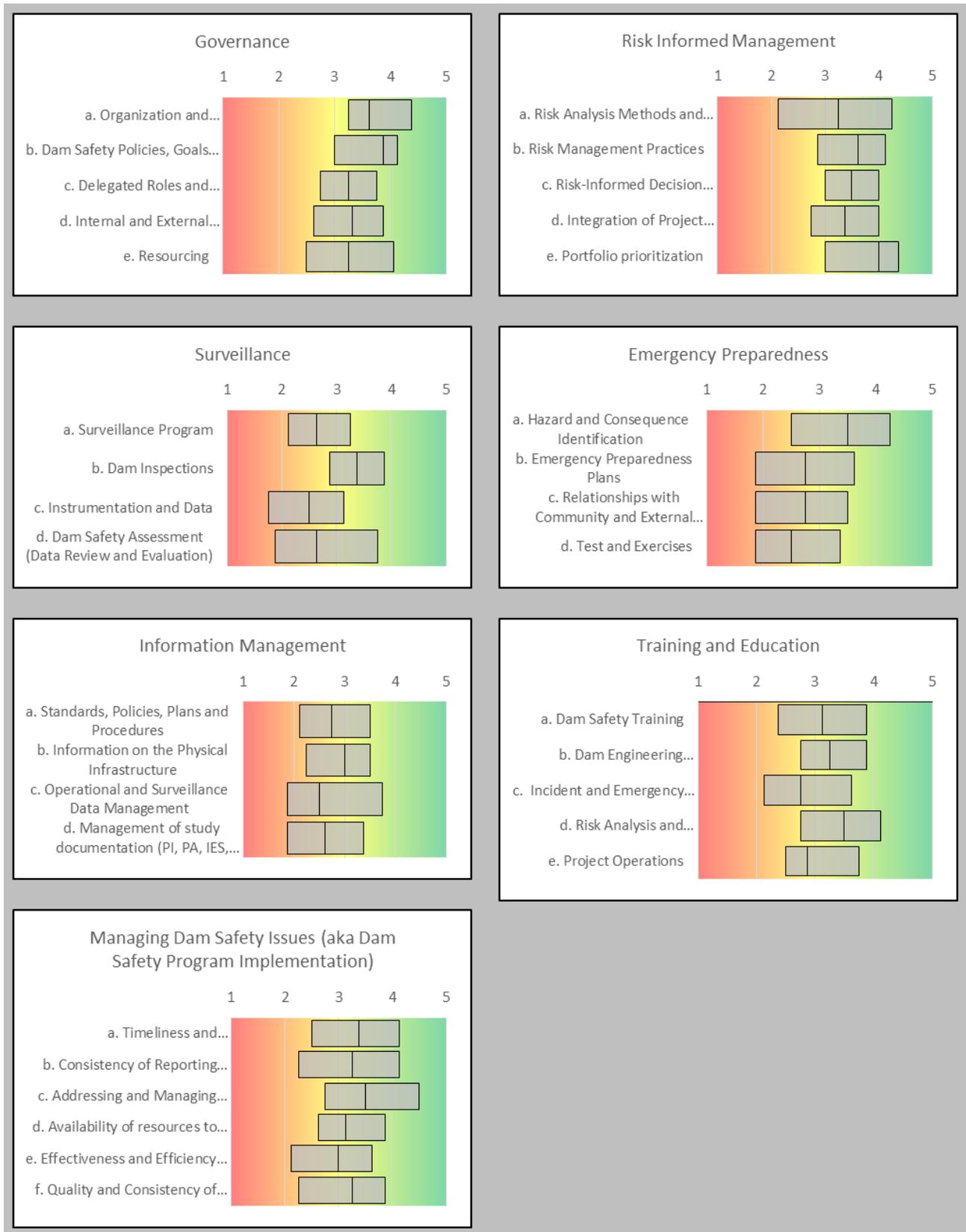


Figure 6.3: 2016 IEPR Maturity Matrix Summary

6.7 Summary and Follow Up

The findings and recommendations included herein vary in nature and with regard to ease of implementation by USACE. It should be noted that some recommendations are considered to be long term improvements and may take many years to fully implement. The categories (critical, urgent, important, and other) are one way for the USACE to plan for implementation of the recommendations.

To maximize the benefit of the 2016 IEPR, within 90 days of the final IEPR report, USACE should develop and provide to USACE Leadership a response to the findings and recommendations included in this report, which includes:

- Proposed approach to implementing the recommendation.
- Proposed schedule for implementing the recommendation.

Unless otherwise stated, specific approaches described within the IEPR recommendations should only be considered possible solutions to address the findings. USACE should develop approaches best suited to its organization, its strategic direction and its policies and procedures.

7.0 IEPR LESSONS LEARNED

Based on our experience with this peer review, the IEPR Team has developed the following “lessons learned” and recommendations for future peer reviews.

IEPR Scope and Charge: The 2013 IEPR included three “charge” questions, general in nature with regard to the scope of the peer review. The 2016 IEPR included the same three questions, but also included a more specific question related to the integration of design and construction. The IEPR Team believes that inclusion of more focused question(s) is a good idea.

In general, the size, scope, and complexity of the USACE Dam Safety Program make it difficult to “drill down” into individual topical areas or to address specific issues in adequate detail. For example, finding/recommendation 2016-A-01 (Emergency Preparedness) was developed based on results of the survey and limited discussions during the three District/Division visits and the Galveston CoP meeting. One recommendation of 2016-A-01 is to perform a more focused review of the Emergency Preparedness activities of the Dam Safety Program. The IEPR Team believes the scope should still include a high level review of the overall program, but it may be possible to include a more focused review of certain aspects of the program with each review, similar to the inclusion of the “design and construction” question.

If it is desired to include a more focused review of aspect(s) of the program, the scope could be revised to replace the more “general” visits to District/Division/Project with observation of a given aspect of the program. For example, if the IEPR included a focused review on the Periodic Assessment process, one of the IEPR visits could include observation of a project Periodic Assessment, in part or whole.

Maturity Matrix: As part of its report and evaluation, the 2013 IEPR developed a Maturity Matrix (not included in scope) as a means of presenting a summary of the IEPR. The desire on the part of the USACE to have a Maturity Matrix assessment in the 2016 was not included in the SOW and was not included in the initial draft report. USACE subsequently indicated their desire to have the Maturity Matrix developed and added it to the SOW. Aside from the obvious lesson to include the requirement to develop the Maturity Matrix in the SOW, there is a more specific lesson with regard to the Maturity Matrix – its content, and how it is implemented as a part of a peer review. For example, are the elements and sub-elements defined by CEATI (2015) appropriate for the USACE? Another question relates to implementation of the Maturity Matrix concept by the IEPR Team in the context of a program as large and complex as the USACE Dam Safety Program. It is possible the application of the Maturity Matrix could include an effort that is considerably more involved than presented in the 2013 or 2016 IEPR. The lesson is simply the need to evaluate approaches to apply the Maturity Matrix to support the IEPR and meet the needs of the USACE Dam Safety Program.

IEPR Survey: The 2013 survey questionnaire was developed and distributed by USACE at the start of the project. Per a 2013 lesson learned, the scope of the 2016 IEPR included participation from the IEPR in development of the survey. Based on initial discussions during the orientation briefing, USACE and the IEPR Team decided it best to have the IEPR Team develop the survey. We believe the scope of future IEPRs should include the development of the survey by the IEPR Team. Also, in hindsight, the IEPR Team believes that a question or questions should have been included related to the charge question of design and construction.

APPENDIX A

USACE STATEMENT OF WORK AND PROJECT SCHEDULE

Section C - Descriptions and Specifications

SCOPE OF WORK

24 May 2016 (Revised 15 June 2016)

**CONTRACT APPENDIX A
PROJECT DESCRIPTION AND SCOPE OF WORK**

PROJECT NAME: Assessment, Analysis, and Evaluation of the USACE Dam Safety Program Review.

LOCATION: Various Sites

P2#: 326042

STATEMENT OF WORK**1. TITLE.**

Assessment, Analysis, and Evaluation of the USACE Dam Safety Program Review.

2. GENERAL.

The task order for which this Statement of Work (SOW) applies will be issued under IDIQ Contract W912QR -16-D-0004. Provisions of the IDIQ Contract are applicable to this task order unless otherwise indicated. This SOW and attached or referenced exhibits provide specific instructions for this project and, in the case of conflicts, take precedence over the requirements of the IDIQ.

3. OBJECTIVE.

The objective of this work is to examine how well the USACE is implementing the federal guidelines for dam safety and executing its stated mission through a process known as Type II Independent External Peer Review (IEPR) Safety Assurance Review (SAR) for the USACE' Dam Safety Program in accordance with the Water Resources Development Act (WRDA) 2007 (Public Law 110-114), Section 2035. The SAR shall provide an external view of the policies, procedures, and performance of the USACE' dam safety program. This should provide the USACE with an external examination of its internal workings, with external ideas to improve performance, and assess USACE in comparison to industry dam safety practices. The review should also provide a level of transparency for the USACE and the public that will determine if the USACE is effectively and efficiently managing risks for its dams.

The review panel shall focus on answering the general questions listed in Appendix B. The review will encompass dam safety activities being done by HQUSACE, the Risk Management Center (RMC), Dam Safety Production Centers (DSPC), the Modeling, Mapping, and Consequence Center (MMCC), Divisions (MSC's), and Districts.

USACE officials may attend panel meetings. USACE is not a voting member of the group. USACE officials must refrain from participating in the development of any reports or final work product of the group.

The following documents will be provided by the USACE for review:

- ER 1110-2-1156, Safety of Dams – Policy and Procedures
- 3 recent Periodic Inspection Reports (PI)
- 3 recent Periodic Assessment Reports (PA)
- 2 recent Issue Evaluation Reports (IES)
- 2 recent Dam Safety Modification Reports (DSMR)
- The most recent scorecard from the Dam Safety Program Management Tool (DSPMT)
- A compilation of the results of a survey given to each USACE District and Division Office.

The following supporting documents will be provided by the USACE:

- Federal Guidelines for Dam Safety

The following references to USACE regulations shall be followed in conducting the IEPR. The most recent Engineering Regulation (ER) documents shall be used and are available at <http://www.publications.usace.army.mil/>. The IEPR Contractor shall recommend any additional references or criteria not listed below to the COR for a determination of adding them to the scope of work.

IEPR teams are not expected to be knowledgeable of Army and administration policies, nor are they expected to address such concerns. However, an IEPR team should be given the flexibility to bring important issues to the attention of decision makers

General

- 2013 Independent External Peer Review Report and USACE response
- EC 1165-2-214, Water Resources Policies and Authorities, Civil Works Review Policy, 15 December 2012
- ER 1110-1-12, Engineering and Design, Quality Management, 30 September 2006;
- ER 1110-1-8159, Engineering and Design, DrChecks, 10 May 2001.
- ER 1110-2-1150, Engineering and Design, Engineering and Design for Civil Works Projects, 31 August 1999

Cost Engineering

- ER 1110-1-1300 - Cost Engineering Policy and General Requirements, 26 March 1993
- ER 1110-2-1302 - Civil Works Cost Engineering, 15 September 2008

Geotechnical Engineering

- EM 1110-2-1902, Engineering and Design, Slope Stability, 31 October 2003
- EM 1110-2-2502, Engineering and Design, Retaining and Flood Walls, 29 September 1989
- EM 1110-2-1901, Engineering and Design, Seepage Analysis and Control for Dams, 30 September 1986
- EM 1110-2-1908, Engineering and Design, Instrumentation of Embankment Dams and Levees, 30 June 1995

Structural Engineering

- EM 1110-2-2100, Engineering and Design, Stability Analysis of Concrete Structures, 1 December 2005
- EM 1110-2-2104, Engineering and Design, Strength Design for Reinforced-Concrete Hydraulic Structures, 20 August 2003
- EM 1110-2-2200, Engineering and Design, Gravity Dam Design, 30 June 1995
- EM 1110-2-2502, Engineering and Design, Retaining and Flood Walls, 29 September 1989

Hydraulic Engineering

- [EM 1110-2-1602](#), Engineering and Design, Hydraulic Design of Reservoir Outlet Works, 15 October 1980
- [EM 1110-2-1603](#), Engineering and Design, Hydraulic Design of Spillways, 16 January 1990
- EM 1110-2-3600 (<http://140.194.76.129/publications/eng-manuals/em1110-2-3600/toc.htm>) Engineering and Design - Management of Water Control Systems

Mechanical Engineering

- EM 1110-2-2105, Engineering and Design, Design of Hydraulic Steel Structures, 31 May 1994
- EM 1110-2-2701, Engineering and Design, Vertical Lift Gates, 30 November 1997

Materials Engineering

- EM 1110-2-2000, Engineering and Design, Standard Practice for Concrete for Civil Works Structures, 31 March 2001
- EM 1110-2-2302, Engineering and Design, Construction with Large Stone, 24 October 1990

Engineering Geology

- EM 1110-1-2908, Engineering and Design, Rock Foundations, 30 November 1994
- EM 1110-2-2100, Engineering and Design, Stability Analysis of Concrete Structures, 1 December 2005
- EM 1110-2-2200, Engineering and Design, Gravity Dam Design, 30 June 1995

4. SPECIFIC TASKS.

The IEPR contractor shall perform reviews and site visits in accordance with milestones identified in this scope. The IEPR panel may recommend to HQUSACE additional or alternate milestones. After consulting with USACE Technical Representative, the KO may approve these recommendations and modify the task order when they are warranted and reasonable. The SAR is a strategic level review.

The following general tasks shall be performed independent of government supervision, direction or control to fulfill independence criteria of an IEPR:

Task 1. Peer Review Quality Control Plan: The IEPR Contractor shall prepare a draft and final peer review quality control plan (PRQCP) for the work covered under this task order. The IEPR Contractor shall conduct the IEPR in accordance with this PRQCP to assure that all services are performed, evaluated, reviewed and provided in a manner that meets professional engineering quality standards. The PRQCP shall include a Communications Plan (All communication to the Dam Safety Program Review team will come through Travis Tutka, Senior Dam Safety Program Manager, RMC) and any required safety plans related to site visits in accordance with EM 385-1-1.

The IEPR Contractor shall establish processes to maintain independence and individuality of each expert reviewer's respective discipline, comments, assessments, evaluations, and reports associated with design criteria and project components inherent and related to their respective professional design/engineering and construction discipline to ensure the integrity of the safety assurance review criteria.

Task 2. Identify Type II Independent External Peer Review (IEPR) Panel: The peer review panel should take the form of a panel of consultants. The peer review can work concurrent with on-going work, be interactive as needed, and provide real time over the shoulder input.

The IEPR Contractor shall identify 3 experts at dam safety, dam engineering, and management of a dam safety program from the list of disciplines below to serve on the IEPR Panel. At least 1 of the 3 panel members must have served on the panel for the 2013 USACE Dam Safety Program IEPR. The IEPR contractor shall submit a diverse list of at least 8 names of individuals that meet the discipline qualifications below and also are available for the duration of this task order. USACE will select the 3 reviewers from this proposed list. It is also preferred that at least 2 of the 8 individuals proposed have participated on the IEPR panel for the 2013 USACE Dam Safety program review. **For proposal purposes the AE will assume that the panel will consist of a Geotechnical Engineer – Level 3, a Hydraulic Engineer – Level 3 and a Seismologist – Level 3.** The experts will also be referenced as expert reviewers. Selection will be based on availability, technical credentials, and absence of perceived or actual conflict of interest (expert reviewers selected are preferred to fully support subsequent Type II IEPRs for the Dam Safety Program Review in order to ensure consistency for review). The IEPR Contractor or Panel shall not have any financial or litigation association with the USACE. The IEPR Panel shall fully disclose any known or potential conflict of interest that may arise from the performance of the work. Areas of conflict may include current employment by the Federal or State governments and paid or unpaid participation in litigation against the USACE.

Selection of expert reviewers for IEPR efforts will adhere to the National Academy of Science (NAS) Policy on Committee Composition and Balance and Conflicts of Interest. Prior to submitting the IEPR panel for approval, the IEPR Contractor shall obtain a statement from each of the panel members indicating willingness to participate and the absence of a conflict of interest. The IEPR Contractor will be required to submit the NAS COI form for all reviewers with the proposed list of panel members. The following website provides academy guidance for assessing composition and the appropriate forms (also available in Appendix C) for prospective panel members in General Scientific and Technical Studies:

<http://www.nationalacademies.org/coi/index.html> . The contractor shall also develop criteria for determining if review panels are properly balanced, as defined by criteria in the contract, both in terms of professional expertise as well as in points of view on the study or project at hand. If necessary, the contractor shall remove and replace panel members with approval from the USACE Technical Representative during a review if a conflict arises. All potential reviewers carry professional and personal biases, and it is important that these biases be disclosed when reviewers are considered and selected. The contractor leading the review shall determine which biases, if any, will disqualify prospective reviewers.

The IEPR Contractor will provide the USACE with the final independent external expert reviewer list, including their credentials and NAS forms, for approval. Expert reviewers shall be industry leaders in their required field of review stated below and have experience in design and construction of projects similar in scope to the Dam Safety Program Review. Expert reviewers shall be registered professionals in their discipline in the United States, or similarly credentialed in their home country. The expert reviewers must also have a college degree in their discipline. A graduate degree in engineering is preferable, but not required, as hands-on relevant engineering experience in the listed disciplines is more important. Expert reviewers included in the proposal for selection of the base contract shall be submitted first. If the expert reviewer submitted for selection of the base contract is unavailable or if the IEPR Contractor believes another individual not originally submitted has equal or better credentials and meets all of the minimum requirements for the level of reviewer required, that individual can be submitted for approval.

For all disciplines required for the IEPR described below, the following experience level requirements apply: Level 1 reviewers shall have a minimum of 7 years of general experience in their field; Level 2 reviewers shall have a minimum of 10 years of specialized experience in their field; Level 3 reviewers shall have a minimum of 15 years of specialized experience and are considered to be a recognized expert in their field. Level 2 and Level 3 reviewers shall also have relevant dam and levee experience (except for the Cost Engineers) and experience in failure mode analysis and risk assessment of large complex systems with emphasis on dam and levee safety issues.

Geotechnical Engineer (Level 3) shall have experience in the field of geotechnical engineering, analysis, design, and construction of embankment dams and levees. The Geotechnical engineers shall have experience in subsurface investigations, soil

mechanics, retaining wall design, seepage & piping, slope stability evaluations, erosion protection design, and earthwork construction. The Geotechnical engineers shall have knowledge and experience in the forensic investigation of seepage, settlement, stability, and deformation problems associated with embankments constructed on karst, weathered rock, alluvial soils, glacial outwash, and other geological formations.

Instrumentation Engineer (Level 3) shall demonstrate extensive experience in installing, maintaining and monitoring instruments for geotechnical and structural engineering purposes. First-hand knowledge of dam safety instruments, including but not limited to piezometers, inclinometers, tiltmeters, inverted pendulums, movement indicators, survey monuments, strain gages, flow meters, automated instrumentation, automated data acquisition systems, as well as the collection / reduction / presentation / evaluation of instrumentation data from these type instruments is critical to the position.

Hydraulic Engineer (Level 3) shall have experience in hydraulic engineering with an emphasis on large public works projects, or be a professor from academia with extensive background in hydraulic theory and practice, with a minimum MS degree or higher in engineering. The Hydraulic Engineers shall have experience in the analysis and design of hydraulic structures related to flood control reservoirs including the design of hydraulic structures including spillways, outlet works, and stilling basins. The Hydraulic Engineers must demonstrate knowledge and experience with physical modeling and the application of data from physical model testing to the design of stilling basins and scour protection, and in the ability to coordinate, interpret, and explain testing results with other engineering disciplines, particularly structural engineers, geotechnical engineers, and geologists. In regard to hydrologic analysis, the Hydraulic Engineers must demonstrate knowledge and experience with the routing of inflow hydrographs through multipurpose flood control reservoirs utilizing multiple discharge devices, including gated sluiceways and gated spillways. The Hydraulic Engineers shall be familiar with USACE application of risk and uncertainty analyses in flood damage reduction studies and also have a familiarity with standard USACE hydrologic and hydraulic computer models used in drawdown studies, dam break inundation studies, hydrologic modeling and analysis for dam safety investigations.

Engineering Geologist (Level 3) shall have extensive experience in the type of work being performed. The Engineering Geologists shall be proficient in assessing seepage and piping through and beneath dams constructed on or within various geologic environments, including but not limited to karstic and solution prone rock formations, fractured & faulted rock, as well as glacial materials. The Engineering Geologists shall be familiar with identification of geological hazards, exploration techniques, field & laboratory testing, and instrumentation. The Engineering Geologists shall be experienced in the design of grout curtains & cutoff walls and must be knowledgeable in grout rheology, concrete mix designs, and other materials used in foundation seepage barriers. When assessing a concrete gravity structure, the Geologists must possess additional proficiency in uplift pressures, rock mechanics, rock strength parameters development, and specialized techniques specific to grouting in galleries.

Civil Engineer (Level 3) shall have extensive experience in the design, layout, and construction of flood control structures including dams and levees. The Civil Engineers shall have demonstrated knowledge regarding hydraulic structures, erosion control, earthwork, concrete placement, design of access roads, and relocation of underground utilities.

Structural Engineer (Level 3) shall have extensive experience and be proficient in performing stability analysis using limit equilibrium analysis, in the design of post tensioned high strength steel anchors to stabilize mass concrete gravity dams and structures, in the stability analysis and structural design of mass concrete scour protection and stilling features including the design of baffles, end sills, and training walls.

Seismologist (Level 3) shall have extensive experience in seismic design of flood control structures including dams and levees. The seismologist shall have extensive experience in seismic hazard analysis and evaluations of flood control structures, dynamic analysis of soil structure interaction, seismic response of foundation soils and foundation liquefaction, probabilistic and deterministic seismic hazard analysis, and an understanding of how ground motions affect flood control structures.

In addition, the IEPR Contractor shall provide a Project manager to lead the IEPR Panel. The Project Manager shall be a registered engineer or geologist with a minimum of 5 years project management experience related to the above discipline descriptions.

The expert review panel responsibilities shall include, but not limited to, the following:

- a. Conduct the review for the USACE Dam Safety Program in a timely manner in accordance with the schedule defined in this task order;
- b. Follow the General Charge Guidance (Appendix B), but when deemed appropriate by the team lead, request other products relevant to the project and the purpose of the review;
- c. Receive from USACE any survey responses from USACE districts, divisions, HQUSACE, RMC, or any other USACE organization with Dam Safety responsibilities or functions;
- d. Provide timely written and oral comments throughout the duration of the review as requested;
- e. Assure the review focuses on the questions in the General Charge Guidance (Appendix B), but the panel can recommend additional questions for consideration. The IEPR Contractor may recommend to the USACE Technical Representative additional or alternate questions;
- f. Offer any lessons learned to improve the review process;
- g. Submit reports in accordance with the milestones;

h. The team panel lead shall be responsible for insuring that comments represent the group, be non-attributable to individuals, and where there is lack of consensus, note the non-concurrence and why.

Task 3. Orientation Briefing: The IEPR Contractor Project Manager and the 3 Expert Reviewers will participate in a one-day orientation briefing conducted by the USACE. Briefing materials will be provided by the USACE one (1) week prior to the briefing. The briefing will take place at HQUSACE.

Task 4. *Monthly* E-mail Updates and Conference Call Discussions/Updates: *Monthly* e-mail updates of progress and status shall be sent to Travis Tutka, Senior Dam Safety Program Manager, USACE Technical Representative, Chris Hogan, USACE Alternate Technical Representative, and Erich Hoehler, Task Order Manager. The *monthly* e-mail updates will include progress conducted during the previous *month* period, planned progress for the next *month*, and any problems encountered. A 2-hour monthly conference call will be required to maintain and convey progress and to collect/exchange critical information by all parties pertinent to the respective subject matter.

Task 5. Survey Form Review: Each USACE District Office will have completed a short survey. **The panel will provide input into the development of the questions, the panel will be provided with the completed forms and will be expected to review these prior to the Orientation Briefing.** The Project Manager for the IEPR panel will also be required to compile the results to the survey questions and provide the survey results in a consolidated format to HQUSACE during the Orientation Briefing.

Task 6. LRD Site Visit: The panel will visit the Great Lakes and Ohio River Division office and interview managers and staff selected by the LRD Dam Safety Officer, travel to and visit the Louisville District Office and interview managers and staff selected by the LRL Dam Safety Officer, and travel to and visit the Rough River Dam project in Falls of Rough, KY and interview project personnel. The panel will also interview leadership for National Centers (RMC and DSMMCX) located at LRD and LRL. It is anticipated that this task will be completed in the same trip.

Task 7. MVD Site Visit: The panel will visit the Mississippi Valley Division office and interview managers and staff selected by the MVD Dam Safety Officer, travel to and visit the St. Louis District Office and interview managers and staff selected by the MVS Dam Safety Officer, and travel to and visit the Lock and Dam 25 project in Winfield, MO and interview project personnel. The panel will also interview leadership for National Centers (MMC and MVD Production Center) located at MVD. It is anticipated that this task will be completed in the same trip.

Task 8. SPD Site Visit: The panel will visit the South Pacific Division office and interview managers and staff selected by the SPD Dam Safety Officer, travel to and visit the Sacramento District Office and interview managers and staff selected by the SPK Dam Safety Officer, and travel to and visit the Isabella Dam project in Bakersfield, CA and interview project personnel.

The panel will also interview leadership for National Centers (SPD Production Center) located at SPK. It is anticipated that this task will be completed in the same trip.

Task 9. Prepare Draft Report: The IEPR Contractor shall prepare a Draft Review Report that answers the General Charge Guidance (Appendix B) questions and recommends courses of action to HQUSACE. The expert panel, in addition to their overall observations, shall include a set of numbered recommendations that they believe would improve the program. These recommendations should be grouped into four types:

- Category A – Critical
- Category B – Urgent
- Category C – Important
- Category D – Other

The recommendations should be formatted as Year-Category-Number (ex. 2016-A-07).

All comments shall be entered in DrChecks by the IEPR Project Manager or Representative. The IEPR Project Manager shall review the expert reviewer comments prior to placing them in DrChecks, remove any duplicate comments and resolve all contradicting comments. All review panel comments shall be entered as team comments that represent the group and be non-attributable to individuals. The Project Manager is to seek consensus, but where there is a lack of consensus, note the non-concurrence and why. The draft DrChecks comments shall be included as an appendix in the draft report for review by USACE. After USACE review of the IEPR comments, a half-day conference call will be held to clarify comments.

Task 10. Brief HQUSACE Senior Leaders: Prior to finalizing the report, the IEPR Contractor Project Manager and the 3 panel members will brief HQUSACE on the contents of the report. This brief should be in person at HQUSACE.

Task 11. Prepare Final Report: The IEPR Contractor shall finalize the Review Report following the HQUSACE briefing. The Final Review Report shall focus on answering the General Charge Guidance (Appendix B) questions and the review panel shall clearly address these questions in the report. The Final Review Report shall be submitted for USACE approval within 30 calendar days after the brief to HQUSACE Senior Leaders.

All comments shall be finalized in DrChecks by the IEPR Project Manager following the briefing to HQUSACE Senior Leaders and the half-day conference call to clarify comments. The USACE shall evaluate the IEPR Contractor's comments and provide responses in DrChecks. The IEPR Contractor shall close all comments once the USACE responses have been entered. Concurrence of comments is not necessary. All comments in the report will be finalized by the panel prior to the Final Report being submitted for USACE approval. The Final Report is intended to provide final documentation of the IEPR process for the project.

5. REPORTING REQUIREMENTS.

The IEPR Contractor shall provide all reproduction. The IEPR Contractor shall provide ten (10) hard copies of the Final Report (Task 11), a distribution list for the hard copies shall be coordinated with the USACE Technical Representative, Travis Tutka. An electronic copy of all

deliverables and reports shall be provided to the Risk Management Center through the USACE Alternate Technical Representative, Chris Hogan. Electronic submittals of the Draft and Final Report shall contain all electronic files in both Microsoft Word and Adobe PDF formats on DVD or CD. Reports generated by the IEPR Contractor, expert reviewers or their subcontractors shall not be released for publication or dissemination without the USACE contracting officer's written approval following coordination with the COR. The USACE shall solely own all reports and information, and publish accordingly as governed by USACE criteria.

See Appendix A for table of Deliverables and Milestones by task.

6. QUALIFICATION REQUIREMENTS.

The IEPR Contractor shall have the following qualifications:

- a. Experience establishing and administering design, engineering, and construction independent external peer reviews,
- b. Free from conflicts of interest with the HQUSACE Dam Safety Program and,
- c. Proven ability to deliver under significant time constraints.

7. PERIOD OF PERFORMANCE, WORK DAYS AND TRAVEL.

a. Place of Performance. A majority of the work will be conducted at the IEPR Contractor's facilities with the exception of the following tasks.

- Task 3: Orientation Briefing is expected to consist of a full day project briefing at HQUSACE in Washington, D.C. Meeting space will be provided by USACE. Contractor is responsible for their travel arrangements.
- Task 6: Great Lakes and Ohio River Division (LRD) site visit is expected to consist of a full day visit in Cincinnati, OH. Also full day visits to Louisville District (LRL) in Louisville, KY, and Rough River Dam in Falls of Rough, KY. Meeting space will be provided by USACE. Contractor is responsible for their travel arrangements.
- Task 7: Mississippi Valley Division (MVD) site visit is expected to consist of a full day visit in Vicksburg, MS. Also full day visits to Saint Louis District (MVS) in Saint Louis, MO, and Lock and Dam 25 in Winfield, MO. Meeting space will be provided by USACE. Contractor is responsible for their travel arrangements.
- Task 8: South Pacific Division (SPD) site visit is expected to consist of a full day visit in San Francisco, CA. Also full day visits to Sacramento District (SPK) and Isabella Dam near Bakersfield, CA. Meeting space will be provided by USACE. Contractor is responsible for their travel arrangements.
- Task 10: HQUSACE Senior Leader Briefing is expected to consist of a full day project briefing at HQUSACE in Washington, D.C. Meeting space will be provided by USACE. Contractor is responsible for their travel arrangements.

b. Estimate Travel. Travel will be from the IEPR Contractor's facilities to HQUSACE, MVD, LRD and SPD as described below. The number of people indicated below refers to the expert reviewers. The IEPR Contractor Project Manager will also participate.

- Task 3: 1 trip/3 days including travel/3 expert reviewers plus one IEPR Contractor Project Manager to Washington, D.C.
- Task 6: 1 trip/6 days including travel/3 expert reviewers plus one IEPR Contractor Project Manager to Cincinnati, OH; Louisville, KY; and Falls of Rough, KY.
- Task 7: 1 trip/6 days including travel/3 expert reviewers plus one IEPR Contractor Project Manager to Vicksburg, MS; Saint Louis, MO; and Winfield, MO.
- Task 8: 1 trip/6 days including travel/3 expert reviewers plus one IEPR Contractor Project Manager to San Francisco, CA; Sacramento, CA; and Bakersfield, CA.
- Task 10: 1 trip/3 days including travel/3 expert reviewers plus the IEPR Contractor Project Manager to Washington, D.C.

c. Period of Performance: The period of performance shall be 12 months after contract award. See Appendix A.

8. RESTRICTIONS. There are no known conflicts of interest with the USACE' Dam Safety Program, the USACE, or the IEPR that are assembled.

9. SECURITY. Security clearance is not required.

10. TASK ORDER MANAGER.

11. USACE TECHNICAL REPRESENTATIVE.

12. USACE ALTERNATIVE TECHNICAL REPRESENTATIVE.

Name: Christopher Hogan

Address: 600 Dr. Martin Luther King Jr. Pl., Suite 377J, Louisville, KY, 40202

Phone Number: 502-315-7449

Email: christopher.j.hogan@usace.army.mil

13. USACE PROJECT MANAGER

Name: Travis Tutka

Address: 136 Chattanooga Dr, Edwardsville, IL, 62025

Phone Number: 314-288-7035

15. RELEVANCE.

Independent External Peer Review of this project is required by public law WRDA 2007 (Public Law 110-114), Section 2035.

16. CAPABILITY STATEMENT.

By public law WRDA 2007 the peer review must be done by reviewers external to the Government, thus the requesting agency does not have the necessary in-house capability to perform the tasks specified in this statement of work.

17. AT/OPSEC REQUIRMENTS

All contractor and all associated sub-contractors employees shall comply with applicable installation, facility and area commander installation/facility access and local security policies and procedures (provided by government representative). The contractor shall also provide all information required for background checks to meet installation/facility access requirements to be accomplished by installation Provost Marshal Office, Director of Emergency Services or Security Office. Contractor workforce must comply with all personal identity verification requirements (FAR clause 52.204-9, Personal Identity Verification of Contractor Personnel) as directed by DOD, HQDA and/or local policy. In addition to the changes otherwise authorized by the changes clause of this contract, should the Force Protection Condition (FPCON) at any installation or facility change, the Government may require changes in contractor security matters or processes.

The contractor and all associated sub-contractors shall receive a brief/training (provided by the RA) on the local suspicious activity reporting program. This locally developed training will be used to inform employees of the types of behavior to watch for and instruct employees to report suspicious activity to the project manager, security representative or law enforcement entity. This training shall be completed within 30 calendar days of contract award and within 30 calendar days of new employees commencing performance with the results reported to the COR NLT 5 calendar days after the completion of the training.

The Contractor must pre-screen Candidates using the E-verify Program (<http://www.uscis.gov/e-verify>) website to meet the established employment eligibility requirements. The Vendor must ensure that the Candidate has two valid forms of Government issued identification prior to enrollment to ensure the correct information is entered into the E-verify system. An initial list of verified/eligible Candidates must be provided to the COR no later than 3 business days after the initial contract award. ■

18. Pay Estimates:

The AE Contractor shall submit Pay Estimates using ENG Form 93, Payment Estimate - Contract Performance. ENG Form 93 may be found on the Internet at:

http://www.publications.usace.army.mil/Portals/76/Publications/EngineerForms/Eng_Form_93_2014Mar.pdf

Requests for payments and requests for retainage refunds shall be submitted on the same ENG Form 93. All ENG Form 93 shall be submitted to the project engineer and LRL-AE.Payments@usace.army.mil . The preferred method of submission is electronic in pdf format.

Progress Reports: The AE shall include a progress report with the ENG Form 93, Payment Estimate as justification for the amount of payment requested. The progress report shall include in narrative form a summary of activities, estimated percentage complete, project schedule evaluation, and problems and recommended solutions.

A Release of Claims shall accompany the final ENG Form 93. The Release of Claims shall be signed, include the final Task Order amount, and include a statement similar to the following: "The undersigned architect-engineer firm under Contract No. W912QR-16-D-0004, Task Order No. ####, between the United States of America and said contractor for services at ####, City, State, hereby releases the United States, its officers, agents, and employees from any and all claims arising under or by virtue of said contract or any modification or change thereof except with respect to those claims, if any, listed below:"



APPENDIX A. IEPR Reporting and Milestone Schedule

The IEPR Contractor will propose a schedule based on the milestones and deliverables listed below:

IEPR Schedule of Deliverables for HQUSACE Dam Safety Program Review

Task #	Deliverable (D) or Milestone (M)	Action/Activity	Calendar Days After NTP	Due Date	Comments
	M	Type II IEPR Safety Assurance Review NTP			
1	D	Submit Final Peer Review QCP (PRQCP)	14		
2	D	Submit list of final IEPR expert reviewers	14		
3	M	USACE provides materials for Orientation Briefing	30		
3	M	Orientation Briefing at HQUSACE in Washington, D.C.	45		
3	M	Final General Charge Guidance (Appendix B) to Expert Reviewers	56		
6	M	Expert reviewers visit LRD	70		
7	M	Expert reviewers visit MVD	90		
8	M	Expert reviewers visit SPD	110		
9	D	Submit draft report to USACE	200		
10	D	Brief to USACE Senior Leaders in Washington, D.C.	230		
11	D	Submit Final IEPR SAR Report	260		
	M	Project Closeout	300		

APPENDIX B. General Charge Guidance

The expert reviewers shall address the numbered questions listed below. The panel shall address the following questions regarding the overall USACE' Dam Safety Program:

- Is the direction of the program appropriate?
- Has USACE overlooked any critical items?
- What is the panel's evaluation of how USACE has integrated design and construction?
- Does the panel have recommendations regarding improvement in methodologies or approaches to implementation?
- Does the panel have any other observations to add?

SECTION C - DESCRIPTIONS AND SPECIFICATIONS

The following have been added by full text:

MODIFICATION SCOPE OF WORK

**Modification to W912QR-16-D-0004, Task Order 0002
Assessment, Analysis, and Evaluation of the USACE Dam Safety
Program Review**

SOW

6 January 2017

Previous: 30 November 2016

Add the following Task:

Task 12:

Attend and Participate in USACE DSO Workshop: The PM and **three** panel members shall attend and present at the USACE DSO Workshop on Tuesday, 7 Feb 2016 and Wednesday, 8 Feb 2016 in Galveston, TX. The Contractor shall prepare a fifteen minute presentation summarizing the key “draft” findings from the panel review. The Contractor shall also participate in one hour Strengths, Weakness, Opportunities, Threats (SWOT) breakout session. The panel will cycle through five groups of approximately thirty persons to discuss the review findings as part of the SWOT session which will be facilitated by others. Additional time on these two days can be used to interview additional USACE personnel as needed. An agenda for the DSO Workshop will be provided by USACE at a later date.

Revise Appendix A:

The revised schedule of deliverables are below in red. There is no change in the POP which is to be completed NLT 28 June 2017.

IEPR Schedule of Deliverables for HQUSACE Dam Safety Program Review

Task #	Deliverable (D) or Milestone (M)	Action/Activity	Calendar Days After NTP	Due Date	Comments
	M	Type II IEPR Safety Assurance Review NTP			
1	D	Submit Final Peer Review QCP (PRQCP)	14		
2	D	Submit list of final IEPR expert reviewers	14		
3	M	USACE provides materials for Orientation Briefing	30		
3	M	Orientation Briefing at HQUSACE in Washington, D.C.	45		
3	M	Final General Charge Guidance (Appendix B) to Expert Reviewers	56		
6	M	Expert reviewers visit LRD	70		
7	M	Expert reviewers visit MVD	90		
8	M	Expert reviewers visit SPD	110		
	M	Attend the USACE DSO Workshop in Galveston, TX		7-8 Feb 2016	
9	D	Submit draft report to USACE	244	28 Feb 2016	
10	D	Brief to USACE Senior Leaders in Washington, D.C.	266	Approximately 22 Mar 2016	Subject to USACE and panel availability
11	D	Submit Final IEPR SAR Report	290	24 days after Task 10 is complete	
	M	Project Closeout and Release of Claims Submitted	365		

SECTION E - INSPECTION AND ACCEPTANCE

The following Acceptance/Inspection Schedule was added for CLIN 0002:

INSPECT AT
N/A

INSPECT BY
N/A

ACCEPT AT
N/A

ACCEPT BY
Government

SECTION C - DESCRIPTIONS AND SPECIFICATIONS

The following have been added by full text:

SCOPE OF WORK - MOD 02

**Modification 0002 to W912QR-16-D-0004, Task Order 0002
Assessment, Analysis, and Evaluation of the USACE Dam
Safety Program Review**

SOW

**Revision: 11 May
2017**

Previous Version: 12 April 2017

Add the following Tasks:

- 1.) Add maturity matrix to the IEPR report to visually summarize the IEPR panel evaluation of the current state of the USACE dam safety program.
- 2.) Evaluate and make a recommendation whether Critical Infrastructure Program should be incorporated into the HQUSACE dam safety organization.
- 3.) Modify the draft report to reflect the products of tasks 1 and 2.
- 4.) Task 10a represents a call that was originally part of Task 9 that did not occur.
The level of effort for Task 10a is expected to be the same as the level of effort for the call that did not occur in Task 9.
- 5.) Adjust the remaining project schedule per the table below. The red text denotes changes or additions.
- 6.) In Modification 0001 for this task order, it was negotiated that the PM and three panel members would attend and present at the USACE DSO Workshop. However, one of the three panel members was unable to attend the meeting in Galveston, Texas. The panel member did spend eight (8) hours participating with the other team members in preparation for the presentation but did not make the trip or participate in the meeting. This modification should show a credit for the travel and effort for that panel member that did not attend and participate in the USACE DSO Workshop.

Revise Appendix A:

The revised schedule of deliverables are below in red. There is a change in the POP which is to be completed NLT 25 August 2017.

Task #	Deliverable (D) or Milestone (M)	Action/Activity	Due Date	Comments
8	M	Attend the USACE DSO Workshop in Galveston, TX	7-8 Feb 2017	
9	D	Submit draft report to USACE	28 Feb 2017	

9a	D	Re-Submit Draft Report to USACE	14 June 2017	
10	D	Brief to USACE Senior Leaders in Washington, D.C.	Approximately 22 Mar 2016	Subject to USACE and panel availability
10a	M	Call to Discuss Draft Report/Revisions	14 June 2017	
11	D	Submit Final IEPR SAR Report	24 days after Task 10a is complete Approximately 14 July 2017	
12	M	Project Closeout and Release of Claims Submitted	25 August 2017	

IEPR Schedule of Deliverables for HQUSACE Dam Safety Program Review

Task #	Deliverable (D) or Milestone (M)	Action/Activity	Calendar Days After NTP	Due Date	Revised Date*	Actual	Comment(s)
	M	Type II IEPR Safety Assurance Review NTP		6/29/16		6/29/16	
1	D	Submit Final Peer Review QCP (PRQCP)	14	7/13/16		8/2/16	
2	D	Submit list of final IEPR expert reviewers	14	7/13/16		8/2/16	Candidates submitted on 7/8. USACE selected panel on 7/12
3	M	USACE provides materials for Orientation Briefing	30	7/29/16		8/19/16	Materials provided during Orientation Briefing
3	M	Orientation Briefing at HQUSACE in Washington, D.C.	45	8/13/16	8/18/16	8/18/16	
3	M	Final General Charge Guidance (Appendix B) to Expert Reviewers	56	8/24/16		8/18/16	Charge guidance provided during Orientation Briefing
6	M	Expert reviewers visit LRD**	70	9/7/16	9/19/16	9/19/16	Visit held 9/19-21
7	M	Expert reviewers visit MVD**	90	9/27/16	11/7/16	11/7/16	Visit held 11/7-10
8	M	Expert reviewers visit SPD**	110	10/17/16	11/14/16	11/14/16	Visit held 11/14-17
12	M	Expert reviewers attend DSO Meeting			2/6/17	2/6/17	3 of 4 IEPR Team members attended from 2/6-8.
9	D	Submit draft report to USACE	200	1/15/17	3/10/17	3/14/17	Date revised based on discussions with USACE. Revised draft (minor edits) submitted on 3/21/17
10	D	Brief to USACE Senior Leaders in Washington, D.C.	230	2/14/17	3/31/17	3/31/17	
9a	D	Resubmit Draft Report to USACE (incl. CIPR & Maturity Matrix)		6/14/17	6/30/17	7/1/17	Due Date revised based on discussions with USACE.
10a	D	Call to discuss revised draft report		6/14/17			Several calls with USACE related to revised draft and CIPR
11	D	Submit Final IEPR Report		7/14/17	7/31/17		Revised due date based on discussions with USACE
	M	Project Closeout		8/25/17			

* If no date shown, this is the "Due Date".

** For LRD, MVD, and SPD trips, the date shown is the Monday of a multi-day trip.

APPENDIX B

LIST OF DOCUMENTS PROVIDED BY USACE

Category	Document	Filename	Provided by	Provided on
IEPR-General	Summary of 2013 IEPR comments and actions	2013 Dam Safety Program IEPR summary as of 2016 08 12.xlsx		8/19/2016
IEPR-General	2014-2015 PROGRESS REPORT TO FEMA ON THE IMPLEMENTATION OF THE FEDERAL GUIDELINES FOR DAM SAFETY	2014-15 USACE Dam Safety Biennial Report.pdf		8/19/2016
Instrumentation/Data Management	2015 USACE INSTRUMENTATION AND MONITORING PROGRAM INTERNAL PEER REVIEW	2015 District Instrumentation and Monitoring Program Review Final.pdf		8/19/2016
2016 Visits	2016 Sign in Sheet	2016 HQ 08 18 sign in sheet.pdf		8/19/2016
Technical Centers	First Progress Report on USACE Technical Centers, Supporting the Dam and Levee Safety Programs	Assessing Progress with National Technical Centers - Final Draft 30 July 2014.pdf		8/19/2016
EAPs	GUIDANCE FOR EMERGENCY ACTION PLANS FOR DAMS AND LEVEES	DRAFT EC1110-2-212 Guidance for EAPs for Dams Levees Rev07182016.docx		8/19/2016
Dam Safety Modification Studies	Lessons Learned Workshop, Summary of Major Findings and Recommended Best Management Practices	DSMS - Lessons Learned Summary 20150723.pdf		8/19/2016
ER1156	Summary of Major Findings and Recommended Best Management Practices	ER 1110-2-1156 2014 Mar 31.pdf		8/19/2016
EAPs	A Guide to Public Alerts and Warnings for Dam and Levee	Guide to Public Alerts.pdf		8/19/2016
Project Management	Improved Dam Safety Project Management	Improved Dam Safety Project Management-Signed.pdf		8/19/2016
DSPMT	CELRD Summary 8/18/2016	LRD ScorecardSummary.xlsx		8/19/2016
Issue Evaluation Studies	PHASE II ISSUE EVALUATION STUDY REPORT, GREEN RIVER LAKE DAM & DIKE, SUMMARY OF FINDINGS, VOLUME 1 of 3	LRL Green River IES Phase II (1) Summary of Findings.pdf		8/19/2016
Issue Evaluation Studies	PHASE II ISSUE EVALUATION STUDY REPORT, GREEN RIVER LAKE DAM & DIKE, SUMMARY OF FINDINGS, VOLUME 2 of 3	LRL Green River IES Phase II (2) Report.pdf		8/19/2016
Issue Evaluation Studies	PHASE II ISSUE EVALUATION STUDY REPORT, GREEN RIVER LAKE DAM & DIKE, SUMMARY OF FINDINGS, APPENDIX, VOLUME 3 of 3	LRL Green River IES Phase II (3) Appendix .pdf		8/19/2016
Issue Evaluation Studies	GREEN RIVER DAM AND DIKE ISSUE EVALUATION REPORT, MAIN REPORT	LRL Green River IES Vol I of II.pdf		8/19/2016
Issue Evaluation Studies	GREEN RIVER DAM AND DIKE ISSUE EVALUATION REPORT APPENDIX, VOLUME II OF II	LRL Green River IES Vol. II of II.pdf		8/19/2016
DSAC and DSOG	Dam Senior Oversight Group Review of the Dam Safety Action Classification for Mississinewa Lake Dam (IN03004)	LRL Mississinewa PA.pdf		8/19/2016
Dam Safety Modification Studies	DAM SAFETY MODIFICATION REPORT, ROUGH RIVER DAM	LRL Rough River DSMR (1) Final Submittal 2012.pdf		8/19/2016
Dam Safety Modification Studies	Environmental Assessment and Finding of No Significant Impact, Rough River Lake, Kentucky, Dam Safety Improvements	LRL Rough River DSMR (2) EA signed 30 July 2012.pdf		8/19/2016
Dam Safety Modification Studies	REPORT APPENDIX - Part 1, ROUGH RIVER DAM	LRL Rough River DSMR (3) Appendix Part 1 Final Submittal		8/19/2016
Dam Safety Modification Studies	REPORT APPENDIX - Part 2, ROUGH RIVER DAM	LRL Rough River DSMR (4) Appendix Part 2 Final Submittal 2012.pdf		8/19/2016
Dam Safety Modification Studies	REPORT APPENDIX - Part 2 (CONTINUED), ROUGH RIVER DAM	LRL Rough River DSMR (5) Appendix Part 2 Final Submittal 2012 2nd Half.pdf		8/19/2016
Dam Safety Modification Studies	DAM SAFETY ACTION DECISION SUMMARY, ROUGH RIVER DAM	LRL Rough River DSMR (6) DSAD Final Submittal 2012.pdf		8/19/2016
Periodic Inspections & Assessments	West Fork Dam (OH00029), West Fork Mill Creek, Ohio, Main Dam Embankment, Dike Embankment and Spillway, Periodic Inspection No. 10	LRL West Fork Periodic Inspection 10.pdf		8/19/2016
DSPMT	CEMVD Summary - 8/18/2016	MVD ScorecardSummary.xlsx		8/19/2016
Periodic Inspections & Assessments	Lock and Dam 25 (MO10301), Mississippi River, Missouri, Lock and Dam, Storage Yard, Overflow Dike & Sandy Slough Dike, Periodic Inspection No. 14	MVS LD25 PI 14 Final.pdf		8/19/2016
Periodic Inspections & Assessments	MELVIN PRICE LOCKS AND DAM IL50077, MISSISSIPPI RIVER, ALTON, IL, Locks and Dam, Overflow Dike, and Spur Dike, Periodic Assessment No. 1	MVS Melvin Price PA.pdf		8/19/2016
Periodic Inspections & Assessments	Lake Shelbyville Dam (IL00118), Kaskaskia River, Illinois Embankment and Spillway, Semi-Quantitative Risk Assessment	MVS Shelbyville SQRA.zip		8/19/2016
Cost Estimating	USACE Dam Safety, Project Cost Change, Root Cause Analysis & Solutions	RCAS Booklet, 2015-10-14.pdf		8/19/2016
Technical Centers	RMC-TR-2016-01, Quality Management Audit of the USACE DSMMCX, Audit of USACE Dam Safety Modification, Mandatory Center of Expertise, LRD Dam Safety Production Center and LRH support of the DSMMCX and LRD DSPC	RMC-TR-2016-01 - DSMMCX Quality Management Audit.pdf		8/19/2016

DSPMT	CESPD Summary 8/18/2016	SPD ScorecardSummary.xlsx		8/19/2016
Periodic Inspections & Assessments	BREA DAM (CA10016), Brea Creek, California, Embankment, Saddle Dike, Outlet Works and Spillway, Periodic Inspection No. 10, Periodic Assessment No. 01	SPL_Brea Dam - Periodic Inspection No 10 - Periodic Assessment 01.pdf		8/19/2016
Periodic Inspections & Assessments	Fullerton Dam, East Fullerton Creek, Santa Ana River Basin, Orange County, CA, Periodic Inspection and Continuing Evaluation Report No. 10, dated March 2015	SPL_Fullerton PI No.10.pdf		8/19/2016
Periodic Inspections & Assessments	San Antonio Dam Appendices A through H	SPL_San Antonio SQRA Appendix CR revisions 20140702.pdf		8/19/2016
Periodic Inspections & Assessments	SAN ANTONIO DAM (CA10023), San Antonio Creek, San Antonio Heights, California, SEMI-QUANTITATIVE RISK ASSESSMENT	SPL_San Antonio SQRA Report CR Revisions 20140702.pdf		8/19/2016
Periodic Inspections & Assessments	Santa Fe Dam (CA10024), San Gabriel River, California, Embankment and Spillway, Semi-Quantitative Risk Assessment	SPL_Santa Fe SQRA Post CR.pdf		8/19/2016
IEPR-General	USACE Dam Safety Program, History of the Dam Safety Program	USACE DS-History-Update-Not-Briefed-to-IEPR-JPB-17Aug2016.pptx		8/19/2016
IEPR-General	Glossary of USACE Acronyms & Definitions	USACE DS-LS acronyms_23Feb15.docx		8/19/2016
IEPR-General	List of the documents provided to the IEPR panel 8/19/2016	USACE IEPR documents provided to the panel.msg		8/19/2016
EAPs	Federal Guidelines for Dam Safety, Emergency Action Planning for Dam Owners	fema-64_EAP.pdf		8/19/2016
IEPR-General	Federal Guidelines for Dam Safety	fema-93.pdf		8/19/2016
IEPR-General	Federal Guidelines for Dam Safety Risk Management	FEMAP-1025_Risk management.pdf		8/19/2016
IEPR-General	Dam Safety Program External Review, Status from 2013 IEPR Recommendations	2013 IEPR status Tutka_ver1.pptx		8/19/2016
2016 Visits	2016 Orientation Meeting for Independent External Peer Review Dam Safety Program Review	2016 DS IEPR-HQ-Mtg-Agenda-19 Aug 2016 .xlsx		8/19/2016
IEPR-General	Got Change? Emerging Issues and the Panel Charge	DS IEPR DSO Remarks.pptx		8/19/2016
IEPR-General	Charge questions	DS IEPR Panel Brief- Charge Questions 2016 08 17.pptx		8/19/2016
IEPR-General	Dam Safety Program IEPR Orientation Meeting	DS IEPR Panel Brief- Intro 2016 08 17.pptx		8/19/2016
IEPR-General	Dam Safety Program Brief for IEPR Panel	DS IEPR Panel Brief - FINAL-EH-TT-JPB-17Aug2016.pptx		8/19/2016
IEPR-General	Dam Safety Construction Project Status, August 2016 - Update	DSP-IEPR(20160818) - Construction Status - Carlson.pptx		8/19/2016
IEPR-General	Dam Safety Modification Studies Project Status, August 2016 - Update	DSP-IEPR(20160818) - DSMS Status - Carlson.pptx		8/19/2016
DSPMT	USACE Scorecard – DSPMT, LRD, MVD, SPD	ScorecardSummary_16Aug2016 v4.pptx		8/19/2016
IEPR-General	Portfolio Perspectives	Snorteland IEPR.pdf		8/19/2016
IEPR-General	USACE Dam Safety Program , Updating the DS Program: 2013-2016	USACE-DS-Update-Bianco-to-IEPR-17Aug2016.pptx		8/19/2016
Dam Safety Modification Studies	U.S. Army Corps of Engineers, Sacramento District (SPK) Final Submittal for Approval of the Final Dam Safety Modification Report (DSMR), Final Environmental Impact Statement (EIS) and Final Real Estate Design Memorandum (REDM), Isabella Lake, Kern County, California	01_Final Draft Isabella Transmittal SPK to SPD_REV02.pdf		8/19/2016
Dam Safety Modification Studies	Isaella Lake Dam Modification Study Executive Summary	02_Isabella DSMRExeSummary_FINAL_25OCT2012.pdf		8/19/2016

Dam Safety Modification Studies	CERTIFICATION OF LEGAL REVIEW OF THE DAM SAFETY MODIFICATION STUDY, ISABELLA LAKE, KERN COUNTY, CALIFORNIA	03 Revised Final Isabella Legal Cert dtd 12 Oct 12.pdf		8/19/2016
Dam Safety Modification Studies	Dam Safety Modification Report, Isabella Lake, Kern County, California - Final USACE Response to Independent External Peer Review	04 IEPR Isabella USACE Response.pdf		8/19/2016
Dam Safety Modification Studies	Post Authorization Decision Document Checklist	05 Post Auth Decision Checklist_FINAL.pdf		8/19/2016
Dam Safety Modification Studies	Dam Safety Modification Report Issue Checklist	06 DSMR Issue Checklist_r01.pdf		8/19/2016
Dam Safety Modification Studies	DAM SAFETY ACTION DECISION SUMMARY, ISABELLA LAKE, KERN COUNTY, CALIFORNIA	07 DSADS FINAL_25OCT2012.pdf		8/19/2016
Dam Safety Modification Studies	DAM SAFETY MODIFICATION STUDY, ISABELLA LAKE, KERN COUNTY, CALIFORNIA	08 Isabella DSMR_Final25October2012.pdf		8/19/2016
Dam Safety Modification Studies	Appendix A.1, Baseline Risk Assessment Report	Appendix A - Risk Reduction-FINAL.pdf		8/19/2016
Dam Safety Modification Studies	Appendix B, Economic and Life Lose Consequences	Appendix B - Economic and Life Loss Consequences.pdf		8/19/2016
Dam Safety Modification Studies	Appendix C.1, Flood Control Act of 1944	Appendix C - Authorizing Legislation Memos_r01.pdf		8/19/2016
Dam Safety Modification Studies	Appendix D - Section 1: Cost Appendix Summary	Appendix D Isabella Cost Appendix_SEP2012_part_1.pdf		8/19/2016
Dam Safety Modification Studies	Appendix D - Section 1: Cost Appendix Summary, Part 2	Appendix D Isabella Cost Appendix_SEP2012_part_2.pdf		8/19/2016
Dam Safety Modification Studies	Appendix D - Section 1: Cost Appendix Summary, Part 3	Appendix D Isabella Cost Appendix_SEP2012_part_3.pdf		8/19/2016
Dam Safety Modification Studies	Appendix D - Section 1: Cost Appendix Summary, Part 4	Appendix D Isabella Cost Appendix_SEP2012_part_4.pdf		8/19/2016
Dam Safety Modification Studies	Appendix D - Section 1: Cost Appendix Summary, Part 5	Appendix D Isabella Cost Appendix_SEP2012_part_5.pdf		8/19/2016
Dam Safety Program Management	USACE Dam Safety Program, Dam Safety Officer Update, July 2013	2013 07 DSO Update.docx		8/19/2016
Dam Safety Program Management	USACE Dam Safety Program, Dam Safety Officer Update, December 2013	2013 12 DSO Update.docx		8/19/2016
Dam Safety Program Management	USACE Dam Safety Program, Dam Safety Officer Update, May 2014	2014 05 DSO Update.docx		8/19/2016
Dam Safety Program Management	USACE Dam Safety Program, Dam Safety Officer Update, September 2014	2014 09 DSO Update.DOCX		8/19/2016
Dam Safety Program Management	USACE Dam Safety Program, Dam Safety Officer Update, December 2014	2014 12 DSO Update.DOCX		8/19/2016
Dam Safety Program Management	USACE Dam Safety Program, Dam Safety Officer Update, April 2015	2015 03 DSO Update.DOCX		8/19/2016
Dam Safety Program Management	USACE Dam Safety Program, Dam Safety Officer Update, July 2015	2015 07 DSO Update.docx		8/19/2016
Dam Safety Program Management	USACE Dam Safety Program, Dam Safety Officer Update, February 2016	2016 02 DSO Update.docx		8/19/2016
Dam Safety Program Management	USACE Dam Safety Program, Dam Safety Officer Update, May 2016	2016 05 DSO Update.docx		8/19/2016
Dam Safety Program Management	USACE Dam Safety Program, Dam Safety Officer Update, August 2016	2016 08 DSO Update.docx		8/19/2016
Technical Centers	USACE Dam Safety Modification Mandatory Center of Expertise & Great Lakes and Ohio River Division Dam Safety Production Center	DSMMCX-DSPC-Org Chart.pdf		8/19/2016
2016 Visits	SPD Regional DSPC	DSPC SPD Org Chart (Aug 2016).pdf		8/19/2016
2017 Visits	CELRD Organization Chart, dtd 21 January 2016, as modified by RBR/PDM to highlight current staffing issues and vulnerabilities. (ver. 21 Jan 16)	LRD Org Chart AS MODIFIED BY 21 Jan 2016.doc		8/19/2016
2018 Visits	DAM SAFETY COMMITTEE - MEMBERS/ALTERNATES, LOUISVILLE DISTRICT CONTACT NUMBERS	LRL Dam Safety Committee Members 4Q 2016.xls		8/19/2016

2019 Visits	LRL Dam Safety Program Structure	LRL Dam Safety Org Chart.pdf		8/19/2016
Technical Centers	MMC Leadership and Organizational Structure	MMCCX Organization.jpg		8/19/2016
2016 Visits	MVD Dam and Levee Safety Production Center Organizational Chart, June 2016	MVD DLSPC Organizational Chart 201606.pdf		8/19/2016
2017 Visits	Regional Busines Directorate	MVD Org Chart.pptx		8/19/2016
2018 Visits	St. Louis District Levee Safety Program Organization	MVS Dam & Levee Safety Org Chart.pptx		8/19/2016
Technical Centers	MG Donald E. (Ed) Jackson, Deputy Commanding Gen., Civil & Emergency Ops, Steve Stockton, Director of Civil Works	RMC Org chart.pdf		8/19/2016
	SPD Unofficial Contact List	SPD Contact List.xlsx		8/19/2016
2016 Visits	Los Angeles District Dam Safety Committee Members (SPL OM 1110-2-8)	SPL 20160802_Dam Safety Committee Membership.xlsx		8/19/2016
Technical Reviews	REVIEW POLICY FOR CIVIL WORKS	217 8-17-2016 ATR HQ Review-Clean.docx		8/19/2016
Technical Reviews	REVIEW POLICY FOR CIVIL WORKS	217 8-17-2016 ATR HQ Review-Clean.pdf		8/19/2016
Technical Reviews	EC 1165-2-217, REVIEW POLICY FOR CIVIL WORKS, Replaces EC 1165-2-214 CIVIL WORKS REVIEW	EC 217 Rollout Presentation for Reviewers.pptx		8/19/2016
DSPMT	DSPMT Score Card Questions and Values	Scorecard Questions & Values Jun 2015.pptx		8/22/2016
EAPs	GUIDANCE FOR EMERGENCY ACTION PLANS FOR DAMS AND LEVEES	EC1110-2-212 Guidance for EAPs for Dams Levees_Rev08222016.docx		8/22/2016
Consequence Estimates	Barren River Dam, NID: KY03009, Consequence Assessment Report, April 2015	Barren River Dam KY03009 Consequence Assessment Report.pdf		9/20/2016
Consequence Estimates	Estimated Population at Risk	Barren River Dam KY03009 CTSWorksheet.xlsxm		9/20/2016
IEPR-General	Response to 2013 Independent External Peer Review of the U.S. Army Corps of Engineers Dam Safety Program	2013 USACE Dam Safety Program external review report and response.pdf		9/20/2016
2016 Visits	DRAFT AGENDA (Revised 07 September 2016) , Independent Peer Review Visits (IEPR) -- 18 thru 22 September 2016	Agenda-IEPR Visit-to-LRD-final-07sept (002).docx		9/20/2016
2016 Visits	IEPR Dam Safety Program Review, LRL Program Overview, September 20, 2016	Day1_1 LRL IEPR DS Program Overview.pptx		9/20/2016
2016 Visits	Mississinewa Lake Dam (IN03004) Project Review Briefing	Day1_2 Mississinewa IEPR Wheeler.pptx		9/20/2016
2016 Visits	Instrumentation 20 September 2016	Day1_3 LRL Instrumentation.pptx		9/20/2016
2016 Visits	LRL RISK CADRE	Day1_4 LRL Cadres_Hoehler.pptx		9/20/2016
2016 Visits	Rough River Dam, Independent External Peer Review (IEPR), Part 1	Day2_1 Rough IEPR Presentation - Print.pptx		9/20/2016
2016 Visits	Rough River Dam, Independent External Peer Review (IEPR), Part 2	Day2_2 Rough IEPR WM_Connelly.pptx		9/20/2016
Instrumentation	2015 Annual Instrumentation Review, Patoka Lake Dam, Middle Wabash River Basin, Indiana	FY16 Patoka IR.pdf		9/20/2016
2016 Visits	LRD Visit – Preparation and Advance Questions	Memo - LRD Visit - Advance Questions and Requests-FINAL.PDF		9/20/2016
2016 Visits	USACE Dam Safety Facts for John W. Flannagan Dam	Draft John W Flannagan Dam Safety Fact Sheet-June 2015.docx		9/20/2016
2016 Visits	John W. Flannagan Dam, NID: VA05101, Consequence Assessment Report, October 2014	John W Flannagan VA05101 Consequence Assessment Report.pdf		9/20/2016
2016 Visits	Consequence Assessment / CTS Worksheet	John W Flannagan VA05101 CTSWorksheet.xlsxm		9/20/2016
2016 Visits	John W. Flannagan Dam, Big Sandy River Basin, VA05101, Dickenson County, Virginia, Model Report for Hydraulics, Flood Inundation Modeling & Consequence	John W Flannagan VA05101 Model Report for Hydraulics.pdf		9/20/2016
2016 Visits	MMC Products for Flannagan Dam PA	MMC Products for Flannagan Dam PA.msg		9/20/2016
2016 Visits	Attendance List 9-20-2016	IEPR LRL District sign in 9 20 16.pdf		9/23/2016

2016 Visits	Attendance List 9-21-2016	IEPR LRL Rough Rlver sign in 9_21_16.pdf		9/23/2016
2016 Visits	Sign in Sheets - RE: IEPR of USACE Dam Safety Program - LRD (UNCLASSIFIED)	Sign in Sheets - REIEPR of USACE Dam Safety Program - LRD (UNCLASSIFIED).msg		9/23/2016
Risk Analysis	DAMRAE v4.0.0.0 Technical Document	DAMRAE Technical Document Outline.docx		9/26/2016
Risk Analysis	USER HELP MANUAL, VERSION 3.0.1.2, 02/29/2015	DAMRAE User Manual v3.0.1.2.pdf		9/26/2016
Risk Analysis	USER HELP MANUAL, VERSION 4.0.0.0, 3/29/2016	DAMRAE User Manual v4.0.0.0.pdf		9/26/2016
Risk Analysis	DAMRAE Documentation	FWDAMRAE Documentation.msg		9/26/2016
Hydrologic Hazards	CHAPTER 4, HYDROLOGIC LOADING	06 Chapter 4 Hydrologic Loading NFD PA1 PI10 20140911.pdf		9/28/2016
Hydrologic Hazards	Hydrologic Hazard Curve Development – Supplement	Bluestone Dam Hydrologic Hazard Curve Supplement_24Mar2016.pdf		9/28/2016
Hydrologic Hazards	Cherry Creek Hydrologic Loading	Cherry Creek Loading Curve Extension Memo_08 Jul 2016.pdf		9/28/2016
Hydrologic Hazards	Cherry Creek Dam (CO01280), Cherry Creek, Colorado, RMC-TR-2016-##, Stochastic Wind-Wave Hazard Modeling	Cherry Creek Stochastic Wind-Wave Hazard Modeling.pdf		9/28/2016
Hydrologic Hazards	Hydrologic Hazards Team (HHT) Information	Hydrologic Hazards Team (HHT)Information .msg		9/28/2016
DSAC and DSOG	QCC Out-brief for Abiquiu Dam IES	Final Briefing Paper Abiquiu Dam 16-04-18.docx		11/1/2016
Project Management	Improved Dam Safety Project Management	Improved Dam Safety Project Management-Signed.pdf		11/1/2016
	USACE Dam Safety Program Peer Review	REUSACE Dam Safety Program Peer Review.msg		11/1/2016
DSAC and DSOG	Dam Safety Modification Report—Executive Summary, Whittier Narrows Dam	Whittier Narrows DSOG Read Ahead 041516.pdf		11/1/2016
Cost Estimating	2016 IEPR info request: cost estimating root cause analysis report	2016 IEPR info requestcost estimating root cause analysis report .msg		11/2/2016
Cost Estimating	USACE Dam Safety, Project Cost Change, Root Cause Analysis & Solutions (DRAFT)	USACE Dam Safety Cost Root Cause Analysis and Solutions Report - DRAFT v2015-09-25.pdf		11/2/2016
Consequence Estimates	Consequences SOP Revisions, MMC White Paper 2016	EarlyDraft-MMC Consequences SOP Uncertainty White Paper.docx		11/8/2016
Dam Safety Program Management	Terms of Reference for South Atlantic Division Command Group	Signed Terms of Reference.pdf		11/9/2016
Asset Management	OCA Documentation	OCA documentation.7z		11/10/2016
IEPR-General	Dam Safety external review - info request	RE Dam Safety external review - info request .msg		11/10/2016
2016 Visits		Rough River.7z		11/10/2016
Asset Management		OCA documentation		11/10/2016
Asset Management	file corrupt - can't open	AM INav v2 Training_FRM.ppt		11/10/2016
Asset Management	OCA Documentation version 2	OCA_Documentation_v2.docx		11/10/2016
DSAC and DSOG	USACE Dam Senior Oversight Group 17-19 July 2012, Minutes Version 3 (as of 7 Sep 2012)	2012 July SOG Minutes_Final.pdf		11/10/2016
DSAC and DSOG	Notification Letter, Dam Safety Modification Project, Rough River Dam, Kentucky	2016 Rough River Notification Letter and Attachments signed 2, MAY 2016.pdf		11/10/2016
DSAC and DSOG	Notification Letter, Dam Safety Modification Project, Rough River Dam, Kentucky	LRL_Rough River Dam_Construction Phase 2 to ASA(CW)_signed.docx.pdf		11/10/2016
DSAC and DSOG	Dam Safety Modification Report, Rough River Dam, Green River Basin, Falls of Rough, Kentucky	Rough River Approval Notice to ASA(CW) - Sept 2012 -Signed Copy.pdf		11/10/2016
DSAC and DSOG	Rough River Lake Dam, Kentucky Safety Modification Report	Rough River_ASA Approval DSMR_March 2013.pdf		11/10/2016
Consequence Estimates	Influence Weights and Measures for the Factors Shaping First Alert/Warning Delay, Diffusion and Protective Action Initiation Curves for Dam Breaches, Controlled Dam Releases, and Levee Breaches or Overtopping	ASSIGN CURVES Rev 17_USACE mods.docx		11/14/2016

Consequence Estimates	First Alert or Warning Diffusion Time Estimation for Dam Breaches, Controlled Dam Releases and Levee Breaches or Overtopping	DIFFUSION Rev 26 .docx		11/14/2016
Consequence Estimates	INTERVIEW SCHEDULE, Community Warning Issuance, Diffusion, and Protective Action Initiation Estimation	INTERVIEW SCHEDULE USACE Consequences.docx		11/14/2016
Consequence Estimates	First Alert and/or Warning Issuance Time Estimation for Dam Breaches, Controlled Dam Releases, and Levee Breaches or Overtopping	ISSUANCE Rev 35.docx		11/14/2016
Consequence Estimates	Protective Action Initiation Time Estimation for Dam Breaches, Controlled Dam Releases, and Levee Breaches or Overtopping	MOBILIZATION Rev 35 .docx		11/14/2016
IEPR-General	Coordinating an Interview with the Dam Safety IEPR Panel	FW Coordinating an Interview with the Dam Safety IEPR Panel.msg		11/16/2016
Instrumentation/Data Management	USACE Dam Safety and Levee Safety Programs, Data Management Status Report, 10 November 2016	Dam and Levee Safety Program Data Management Interviews.pdf		11/22/2016
Instrumentation/Data Management	Data Management, STRATEGIC PLAN, FY2016-2020	DM StratPlan_ver9_finaldraft.pdf		11/22/2016
Consequence Estimates	Consequences SOP Revisions, MMC White Paper 2016, September 2016	EarlyDraft-MMC Consequences SOP Uncertainty White Paper.docx		11/22/2016
Technical Centers	Info for IEPR panel	FWInfo for IEPR panel.msg		11/22/2016
Technical Centers	Modeling, Mapping, and Consequences Production Center, Quarterly Program Management Report, Fourth Quarter FY2016	Metrics-MMC-4Q16.docx		11/22/2016
Technical Centers	APPENDIX, MMC Program Metrics – Definitions	Metrics-MMC-Definitions2016Q4.docx		11/22/2016
Technical Centers	MMC White Paper 2016, Cascading Failure for Dams, September 2016	MMC Cascading Failure White Paper 2016 for Dams (003).docx		11/22/2016
Periodic Inspections & Assessments	XYZ Dam L&D (XX#####), XYZ River, State, Embankment and Spillway, Periodic Inspection No. ## Periodic Assessment No. ##, Semi-Quantitative Risk Assessment	00 Cover Page 20150812.docx		11/28/2016
Periodic Inspections & Assessments	EXECUTIVE SUMMARY	01 Executive Summary 20160922.docx		11/28/2016
Periodic Inspections & Assessments	TABLE OF CONTENTS	02 Table of Contents 20161117.docx		11/28/2016
Periodic Inspections & Assessments	CHAPTER 1, FINDINGS AND RECOMMENDATIONS	03 Chapter 1 Findings and Recommendations 20161107.docx		11/28/2016
Periodic Inspections & Assessments	CHAPTER 2, BACKGROUND	04 Chapter 2 Background (High Haz FRM) 20160919.docx		11/28/2016
Periodic Inspections & Assessments	CHAPTER 2, BACKGROUND	04 Chapter 2 Background (Low-Sig Haz NAV) 20160919.docx		11/28/2016
Periodic Inspections & Assessments	Chapter 2, Description of Dam and Construction History	04a Chapter 2 Background (Mississinewa Dam PA Example).pdf		11/28/2016
Periodic Inspections & Assessments	CHAPTER 3, PERIODIC INSPECTION	05 Chapter 3 Periodic Inspection 20160919.docx		11/28/2016
Periodic Inspections & Assessments	CHAPTER 4, HYDROLOGIC LOADING	06 Chapter 4 Hydrologic Loading (Low-Sig Haz NAV) 20150804.docx		11/28/2016

Periodic Inspections & Assessments	CHAPTER 5, SEISMIC LOADING	07 Chapter 5 Seismic Loading 20160919.docx		11/28/2016
Periodic Inspections & Assessments	CHAPTER 6, CONSEQUENCES	08 Chapter 6 Consequences (High Haz FRM) 20161006.docx		11/28/2016
Periodic Inspections & Assessments	CHAPTER 6, CONSEQUENCES	08 Chapter 6 Consequences (Sig Haz NAV) 20160919.docx		11/28/2016
Periodic Inspections & Assessments	CHAPTER 7, RISK ASSESSMENT	09 Chapter 7 Risk Assessment 20160919.docx		11/28/2016
Periodic Inspections & Assessments	CHAPTER 7, RISK ASSESSMENT	09a Chapter 7 Risk Assessment (FRM Examples) 20150807.docx		11/28/2016
Periodic Inspections & Assessments	CHAPTER 7, RISK ASSESSMENT	09b Chapter 7 Risk Assessment (NAV Examples) 20150807.docx		11/28/2016
Periodic Inspections & Assessments	APPENDIX A1, EXCLUDED POTENTIAL FAILURE MODES IN NEAR TERM, THAT WARRANT FURTHER EVALUATION AS PART OF MAJOR REHABILITATION STUDY	10 Appendix A1 Excluded Potential Failure Modes (NAV Major Rehab Study) 20150807.docx		11/28/2016
Periodic Inspections & Assessments	APPENDIX A2 EXCLUDED POTENTIAL FAILURE MODES IN NEAR TERM AND OVER LONG TERM	10 Appendix A2 Excluded Potential Failure Modes (NAV) 20150807.docx		11/28/2016
Periodic Inspections & Assessments	USACE Dam Safety Facts for XYZ Locks and Dams - notes	11 Appendix I Dam Safety Fact Sheet (High Haz NAV).txt		11/28/2016
Periodic Inspections & Assessments	USACE Dam Safety Facts for XYZ Locks and Dams	11 Appendix I Dam Safety Fact Sheet (Sig Haz NAV) 20160219.docx		11/28/2016
Periodic Inspections & Assessments	APPENDIX J REFERENCES	12 Appendix J References 20151207.docx		11/28/2016
Periodic Inspections & Assessments	Risk Assessment Report Concurrence and Approval - Levees	13 Appendix K Report Concurrence and Approval Sheet 20161117 (Levees).docx		11/28/2016
Periodic Inspections & Assessments	Risk Assessment Report Concurrence and Approval - Dams	13 Appendix K Report Concurrence and Approval Sheet 20161117.docx		11/28/2016
Periodic Inspections & Assessments	Risk Assessment Report Concurrence and Approval - text notes	13 Appendix K Review Documentation.txt		11/28/2016
Periodic Inspections & Assessments	APPENDIX L APPLICABLE ESSENTIAL USACE GUIDELINES AND COMPLIANCE REVIEW	14 Appendix L Essential USACE Guidelines 20160527.docx		11/28/2016
Periodic Inspections & Assessments	Periodic Assessment Semi-Quantitative Risk Assessment in-Briefing for PA SQRA Team	District In-Briefing 20160922.pptx		11/28/2016
Periodic Inspections & Assessments	Dam Name (NID) Periodic Assessment Findings IES SQRA Findings	District Out-Briefing 20160929.pptx		11/28/2016
Periodic Inspections & Assessments	DSAC AND DSPMT, CODE GUIDANCE	DSAC and DSPMT Code Guidance 20160919.pptx		11/28/2016
Periodic Inspections & Assessments	Corps Dam Safety Officer Review of the Dam Safety Action Classification for XYZ Dam (NID)	DSAC Review Memorandum 20160219.docx		11/28/2016

Periodic Inspections & Assessments	DSOG BRIEFING (RECOMMEND, CHANGING DSAC)	DSOG Briefing (Recommend Changing DSAC) 20161107.pptx		11/28/2016
Periodic Inspections & Assessments	DSOG BRIEFING (RECOMMEND, MAINTAINING DSAC)	DSOG Briefing (Recommend Maintaining DSAC) 20161107.pptx		11/28/2016
Periodic Inspections & Assessments	GUIDELINE FOR ESTIMATING REPAIR COSTS FOR NAVIGATION DAMS AS PART OF PA/SQRA	Guidelines for Estimating Repair Costs for NAV Dams 20151029.docx		11/28/2016
Periodic Inspections & Assessments	LSAC AND NFIP, GUIDANCE 20160929	LSAC and NFIP Guidance 20160929.pptx		11/28/2016
Periodic Inspections & Assessments	MMC Hydraulic Model Feedback Form	MMC Hydraulic Model Feedback Form.docx		11/28/2016
Periodic Inspections & Assessments	XYZ Dam L&D PA SQRA (XX#####)	MMC Products General Feedback Form.docx		11/28/2016
Periodic Inspections & Assessments	XYZ Dam L&D PA SQRA (XX#####)	PA-SQRA Notes 20160919.docx		11/28/2016
Periodic Inspections & Assessments	SEMI-QUANTITATIVE RISK ASSESSMENT QUICK REFERENCE FOR "LOSS OF DAMMING SURFACE" POTENTIAL FAILURE MODES	Quick Reference Sheet - Loss of Damming Surface 20160922.docx		11/28/2016
Periodic Inspections & Assessments	SEMI-QUANTITATIVE RISK ASSESSMENT QUICK REFERENCE FOR "LOSS OF SERVICE" POTENTIAL FAILURE MODES	Quick Reference Sheet - Loss of Service 20160922.docx		11/28/2016
Periodic Inspections & Assessments	Seismic Hazard Curve for PGA - notes	Seismic Hazard Curve for PGA.txt		11/28/2016
Periodic Inspections & Assessments	SEISMIC SITE CLASSIFICATION - notes	Seismic Site Classification.txt		11/28/2016
Periodic Inspections & Assessments	SHIPPER CARRIER COST TABLES	Shipper Carrier Cost Tables - 11-04-16.xlsx		11/28/2016
Asset Management	Standardized Activities and Costs Common Levels of Performance	20161104 RAMs OM Budget Transformation + AM efforts.pdf		1/3/2017
Asset Management	Implementing Asset Management for USACE Civil Works	20161123-24 IAM Implementing AM for USACE Leitch-Ellsworth		1/3/2017
Asset Management	PROGRAM MANAGEMENT PLAN (PgMP) For Civil Works Asset Management	AM PGMP Final signed Dec 2014 rev0.pdf		1/3/2017
Asset Management	Documents from Interview	Documents from Interview.msg		1/3/2017
Asset Management	USACE O&M 20/20 Communication Plan Ver2016.12.08	USACE OM 20-20 Communication Plan 2016 12.08.pdf		1/3/2017
Risk Analysis	Center Hill Post Implementation Evaluation (PIE) Report	Center Hill Dam PIE Report rev 20161208 (ATR-QCC Draft).pdf		1/23/2017
Risk Analysis	Center Hill PIE ATR/QCC Brief	Center Hill Dam PIE ATR In-Brief.pptx		1/23/2017
Consequence Estimates	Consequences - Recent Updates and Validation presentation	Consequences Dam Safety IEPR 2016.pptx		2/3/2017
2016 Visits	USACE Dam Safety CoP Meeting - presentations	All presentations - no link.		2/8/2017
Design and Construction	USACE LED MEGA DESIGN AND CONSTRUCTION EVALUATION REPORT, Isabella Lake Dam Safety Modification Project - Lake	FY15 Isabella Mega DCE Report - Signed Final.pdf		2/22/2017

Design and Construction	HQUSACE LED MEGA DESIGN AND CONSTRUCTION EVALUATION REPORT, Hinton, WV – Bluestone Dam Safety Modifications	FY16 Bluestone Mega DCE Report_Final.pdf		2/22/2017
Design and Construction	HQUSACE LED MEGA DESIGN AND CONSTRUCTION EVALUATION REPORT, South Florida – Herbert Hoover Dike Rehabilitation Project	FY16 Herbert Hoover Dike Mega DCE Report_Final.pdf		2/22/2017
Design and Construction	Dam Safety Officer Roles, Responsibilities, Qualifications, and Professional Registration Requirements. Team Report, U. S. Army Corps of Engineers, Great Lakes and Ohio River Division, February 2004	DSO RolesResponsibilitiesReport2004.pdf		3/6/2017
CIPR Program	Critical Infrastructure Protection and Resilience Program	CIPR Fact Sheet (2016).pdf		4/3/2017
CIPR Program	Common Risk Model for Dams	CRM-D Fact Sheet.pdf		4/3/2017
CIPR Program	2010 Dams Sector Exercise Series - Green River Valley (DSES-10)	DSES-10 Fact Sheet.pdf		4/3/2017
CIPR Program	CRITICAL INFRASTRUCTURE PROTECTION AND RESILIENCE PROGRAM, DIRECTORATE OF CIVIL WORKS, OFFICE OF HOMELAND SECURITY	GENERAL TALKING POINTS CIPR - 2017.pdf		4/3/2017
CIPR Program	INFORMATION PAPER, U.S. Army Corps of Engineers (USACE) Common Risk Model for Dams (CRM-D) Methodology Compliance with the ANSI/ASME-ITI/AWWA J100-10 Standard	INFORMATION PAPER (CRM-D vs J100-10).pdf		4/3/2017
CIPR Program	Critical Infrastructure Protection and Resilience Program, Risk Assessment and Management Framework	Summary CIPR Risk Process.pdf		4/3/2017
CIPR Program	Risk-Informed Framework for Critical Infrastructure Security and Resilience (presentation)	USACE CIPR PROGRAM (APPA 2016).pdf		4/3/2017
IEPR-General	Technical Brief: Using Maturity Matrices to Evaluate Dam Safety Programs	0234_Brief.pdf		5/4/2017
IEPR-General	Spreadsheet: Using Maturity Matrices to Evaluate Dam Safety Programs	0234_Matrices.xlsx		5/4/2017
IEPR-General	Presentation: Using Maturity Matrices to Evaluate Dam Safety Programs	0234_Presentation.pdf		5/4/2017
IEPR-General	CEATI Report No. T132700-0234, Using Maturity Matrices to Evaluate Dam Safety Programs - User Manual	0234_Report.pdf		5/4/2017

APPENDIX C

INFORMATION FROM IEPR VISITS

HQ Briefing
LRD Visit
MVD Visit
SPD Visit
Dam Safety CoP Meeting
Additional Interviews

HQ Briefing

U.S. Army Corps Of Engineers

as of 8/3/2016

Title:	2016 Orientation Meeting for Independent External Peer Review Dam Safety Program Review
Location:	HQUSACE
Date:	Aug 18-19, 2016

Thursday - 18 August 2016

Start	End	Time	Item	Lead
8:30:00 AM	9:00:00 AM	0:30	Introduction	
9:00:00 AM	9:30:00 AM	0:30	Dam Safety Officer Introduction	
9:30:00 AM	10:00:00 AM	0:30	Update of the USACE's Dam Safety Program	
10:00:00 AM	10:30:00 AM	0:30	Break	
10:30:00 AM	11:30:00 AM	1:00	Program Overview	
11:30:00 AM	12:30:00 PM	1:00	Lunch	
12:30:00 PM	2:00:00 PM	1:30	Dam Safety Project Status	
2:00:00 PM	2:30:00 PM	0:30	Open Discussion	
2:30:00 PM	5:00:00 PM	2:30	Panel work independently. Individual interviews	

Friday - 19 August 2016

8:00:00 AM	8:30:00 AM	0:30	Overview of 2013 IEPR Report & Status of IEPR Recommendations	
8:30:00 AM	10:00:00 AM	1:30	Trends in Program Execution: TRG, IES, DSMS, PA	
10:00:00 AM	10:30:00 AM	0:30	Break	
10:30:00 AM	11:00:00 AM	0:30	Routine Activities	
11:00:00 AM	11:30:00 AM	0:30	Survey to Districts discussion	
11:30:00 AM	12:00:00 PM	0:30	Open Discussion	
12:00:00 PM	1:00:00 PM	1:00	Lunch	
1:00:00 PM	5:00:00 PM	4:00	Panel work independently. Individual interviews	

LRD Visit

DRAFT AGENDA
(Revised 07 September 2016)

Independent Peer Review Visits (IEPR) -- 18 thru 22 September 2016

**Great Lakes & Ohio River Division (LRD), Louisville District (LRL)
and Rough River Project Office**

Time/Activity

Trans/Remarks

Sunday, 18 September 2016

Uniform/Business Casual

- Travel Day for IEPR Team: Fly into Cincinnati, OH, Pick-up Rental Car & Arrive at Hotel

Monday, 19 September 2016 (at LRD HQ Office)

Uniform/Business Casual

0730 Independent Peer Reviewers Arrive at LRD - HQ Office

Meeting Location – Main Conference Room

Address:

Great Lakes and Ohio River Division
550 Main Street
Cincinnati, Ohio 45202
P

Activity: Check In / Show ID/Acquire Day Security Badges/

0800 Meeting with the LRD Dam Safety Committee

- Introduction to LRD Dam Safety Committee
- Opening Remarks by LRD - MSC SES & Dam Safety Officer (DSO)
- (LRD Commander could participate if available & time slot permits)

LRD Participants

0820 Dam Safety Program Overview by LRD-Dam Safety Program Manager (DSPM)

0900 Progress of National Centers Supporting Dam Safety; and
Root Cause Analysis and Solutions Study/Report.

1000 Break

1015 - 1130 Key Dam Safety Issues at the Districts

- DSO's & DSPM's from: Buffalo; Chicago; Detroit; Huntington; Louisville, Nashville
& Pittsburg District Offices

1130 Lunch

on Your Own

IEPR DS Program: LRD Division & Districts 18-22 September 2016

TIME/ACTIVITY

TRANS/REMARKS

1230 -1730 Individual Interviews

1230 Individual Interviews with LRD Key Staff

- Dam Safety Officer
- Dam Safety Program Manager
- Chief, Civil Integration Division (CID)
- Chief, Operations and Maintenance

1500 Break

1530 Interview with Director DSMMCX

1630 Interview with Chief, Ohio River Water Management Division

1730 Adjourn for the Day

1730 IEPR Team Leaves Cincinnati & Travels to Louisville, KY (Drive ~ 100 miles)

1930 IEPR Team Arrives at Hotel in Louisville, KY

Peer Review Team

IEPR DS Program: LRD Division & Districts 18-22 September 2016

Time/Activity

Trans/Remarks

Tuesday, 20 September 2016 - at Louisville District (LRL)

Uniform/Business Casual

0730 Independent Peer Reviewers Arrive at LRL - HQ Office

Room 862A

Address:

Louisville District
Romano Mazzoli Federal Building
600 Dr. Martin Luther King, Jr. Place
Louisville, KY 40202

Parking – Garage located between 7th and 8th streets with access from Magazine Street (South side)

Activity: Check In – Room 862A (Small Conference Room for Interviews and Panel)

0800 Introductions & Briefings with LRL Key Dam Safety Staff

Room Location – Room 10 (basement)

Web Meeting Address: <https://www.webmeeting.att.com>

- Introductions between LRL Staff & Panel Members
- Opening Remarks by LRD - Dam Safety Officer (DSO)
- Program Overview & Dam Safety Management (DSPM)
 - O&M Activities
 - Funding Procedure & Processes
 - DSPMT Scorecard Remarks
 - Risk Management (District Projects)

LRL & IEPR Participants

1000 Break

1015 Key/Selected Dam Safety Projects and/or Issues by LRL Staff

Room 10 (basement)

- Mississinewa Lake Dam (IES Phase II)
- District Instrumentation Program (USACE Review FY15)
- LRL Risk Cadres

1200 Lunch

On Your Own

1330 IEPR Interviews with Key LRL Dam Safety Staff & RMC- East Chief

Room 856A (8th Floor)

- Risk Management Center (RMC) - East Chief
- Dam Safety Officer (DSO)
- Dam Safety Program Manager (DSPM)
- Chief, Geotech and Dam Safety Section (Dam Safety)
- Chief, Geotech and Dam Safety Section (Risk Cadres)

1500 Break

1515 Continue with Interviews of Key LRL Staff

- Water Management Team Lead
- Chief, Navigation Design Section
- FRM Business Line Manager

1730 Adjourn for Day – Return to Hotel in Louisville

IEPR DS Program: LRD Division & Districts 18-22 September 2016

Time/Activity

Trans/Remarks

Wednesday, 21 September 2016 - at Louisville District (LRL) **Uniform/Business Casual**

(with PPE & Steel Toed Boots)

Local Time at Project is CST

0700 (0600 CST) IEPR Members Depart Louisville, KY - Drive to Rough River Dam

Meeting Location – Project Trailer Meeting Room (upstream side of crest road, left abutment)

Address:

Rough River Lake
14957 Falls of Rough Road
Falls of Rough, KY 40119

0845 (0745 CST) Arrive at Project Site

0900 (0800 CST) Project Site Introductions & Briefings

Location - Project Trailer

Web Meeting Address: <https://www.webmeeting.att.com>

- Rough River Dam Project
 - Overview
 - DSMR Timeline – History of decision documents
 - Dam Safety Issues
- Water Management Issues
- Emergency Action Plan Activities
 - Inundation Maps
 - Exercises & Local Emergency Preparedness Partnerships

1100 (1000 CST) Discussion with Key Project Staff

- Engineering Division
- Construction Division
- Operations Division

1200 (1100 CST) Lunch at State Park Lodge (located near project office, open buffet line, no special arrangements)

1300 (1200 CST) Tour of Project Features - Dam Crest & Spillway, Intake Tower, Other Ancillary Features.

1530 (1430 CST) Complete Tour of Rough River Dam & Initiate Return to Louisville, KY

1700 (1600 CST) IEPR Team Returns to/Arrives at Hotel in Louisville, KY

Time/Activity

Trans/Remarks

Thursday, 22 September 2016

Uniform/Business Casual

IEPR Team Members

Travel Day Home

MEMORANDUM

TO:	DATE:	September 8, 2016
COMPANY: US Army Corps of Engineers, Lakes and Rivers Division	SUBJECT:	LRD Visit – Preparation and Advance Questions
ADDRESS:	PROJECT NAME/NO.:	Independent External Peer Review of the USACE Dam Safety Program / 16C35002.09
FROM:	CC:	

This memorandum provides an overview of the objective of the independent external peer review (IEPR), along with topics and questions that the IEPR team will be discussing with various USACE staff, including the Dam Safety Officer (DSO), Dam Safety Program Manager (DSPM), Commander, and other key members of the Dam Safety Program.

The Statement of Work (SOW) includes the following objective for the IEPR:

“examine how well the USACE is implementing the federal guidelines for dam safety and executing its stated mission ... The [IEPR] shall provide an external view of the policies, procedures, and performance of the USACE dam safety program. This should provide the USACE with an external examination of its internal workings, with external ideas to improve performance, and assess USACE in comparison to industry dam safety practices. The review should also provide a level of transparency for the USACE and the public that will determine if the USACE is effectively and efficiently managing risks for its dams. ... The review will encompass dam safety activities being done by HQUSACE, the Risk Management Center (RMC), Dam Safety Production Centers (DSPC), the Modeling, Mapping, and Consequence Center (MMCC), Divisions (MSC’s), and Districts.”

In addition, the following “General Charge Guidance” was provided by USACE in the SOW: The IEPR shall address the following questions with regard to the dam safety program.

- Is the direction of the program appropriate?
- Has USACE overlooked any critical items?
- What is the panel’s evaluation of how USACE has integrated design and construction?
- Does the panel have recommendations regarding improvement in methodologies or approaches to implementation?
- Does the panel have any other observations to add?

The key resources necessary to effectively implement a dam safety program – namely human resources, dam safety expertise, and available timely funding – are distributed nationwide throughout the USACE across many organizational units and geographical locations. Further, within the Dam Safety Program, the responsibility for many components is distributed among HQUSACE, Divisions, Districts, and the centers noted above. This is the reality of a large Federal dam owner with hundreds of dams and thousands of staff across the country; however, it is essential that a dam safety program has a highly developed and effective cooperation, collaboration, and communication protocol in place. To this end, the IEPR team is looking for input related to:

- The technical efficacy of the dam safety regulations and processes (ER-1110-2-1156).

SENT VIA: First Class Mail Overnight Service Email Other

- USACE staff (District and Division) understanding of the Dam Safety Program.
- The consistency and quality of implementation of the USACE Dam Safety Program across all levels and geographies of the program.
- Evidence of cooperation, collaboration, and communication internal to USACE, as well as between USACE and local Emergency Managers (for implementation of effective EAPs).

INFORMATION TO BE PROVIDED BY USACE AT THE MEETINGS

1. A listing of the anticipated participants, including their affiliation and title. A sign-in sheet should be provided during the meetings.
2. Organization chart (5 copies) for the District and Division, highlighting staff involved in the Dam Safety Program.
3. Electronic and hard copies (5) of all PowerPoint presentations used during the meetings.
4. One copy of the most recent version of ER 1110-2-1156 should be available during the meeting.

QUESTIONS FOR DSO, DSPM, AND DISTRICT/DIVISION DAM SAFETY STAFF

To assist in the process, the IEPR team has developed the following initial list of questions for key staff involved in dam safety. While many of these questions may not be directly asked by the panel, USACE should focus presentations, etc., toward answering these questions. The IEPR team suggests one possible approach is presentation of one or more example dam projects that have been through various phases of program implementation (Periodic Assessments, Issue Evaluation Studies, Dam Safety Modification Studies, Design and/or Construction). The example project(s) need not be focused on technical details of the project, as much as the effectiveness of the implementation of the Dam Safety Program. Focus should be on Division/District experience with the various components of the Dam Safety Program, including experiences working with HQUSACE, DSOG, RMC, DSMMCX, DSPCs, MMCC, and various review (ATR, IEPR, QCC, etc.) and other processes.

1. Discuss the Division/District role in the overall Dam Safety Program. How do you interact and relate to HQUSACE, the "Centers," and other Districts/Divisions?
2. Regarding the evolution of the USACE Dam Safety Program over the past 10 to 12 years:
 - a. What are the challenges?
 - b. What is not working?
 - c. What has been gained?
 - d. Where can further gains be most easily achieved (low hanging fruit)?
 - e. Discuss the effectiveness and relevancy of the scorecard system.
 - f. Discuss the efficacy of the methods and implementation of risk analysis with regard to making decisions. For instance, are public safety risk estimates too high? Too low?
3. Review a typical instrumentation program for a dam and discuss data monitoring and follow-up procedures.
4. Describe your areas of compliance and non-compliance with ER 1110-2-1156, including where you feel you exceed the requirements of this ER.
5. Discuss the Division/District portfolio of dams specifically in the context of the ongoing risk prioritization. Do you have projects where the DSAC rating has changed? What was your involvement in the changes in prioritization of these projects?

6. Describe the authorities that have been defined from the Division Commander down to operators at a District project(s) with regard to decision making (possible triage circumstances) during a time-sensitive incident.
7. Describe the current communication, cooperation, and collaboration between the vertical levels within USACE and the local Emergency Management Agencies with regard to notifications and evacuations during a dam safety incident or emergency. Do you have confidence in the downstream emergency responders?
8. Describe/discuss the integration between project design and construction.
9. Discuss issues related to the project review processes (District/Division QC Reviews, ATR, DSOG, and Type I and Type II IEPR, etc.):
 - a. Timeliness
 - b. Relevance
 - c. Value
 - d. Coordination
 - e. Cost
 - f. Overlap
10. Rate the District/Division dam safety capabilities and execution (1–5, with 1 being poor and 5 being excellent) for the following areas:
 - a. Periodic inspections
 - b. Instrumentation monitoring, interpretation, and response
 - c. Periodic assessments
 - d. Risk assessments
 - e. Application of interim and permanent risk-reduction measures
 - f. Design (contract plans and specifications)
 - g. Construction field engineering and QA
 - h. Construction engineering office support
 - i. Project operations and maintenance
 - j. Emergency action planning and preparedness
 - k. Incident response and follow up
 - l. Dam safety modification studies
 - m. Project completion reports
11. What is your coordination with the asset management program?
 - a. What systems do the asset management program monitor, fix, etc., that also have a role in the safe operation of dams?
 - b. How do you find out about issues associated with the reliability of mechanical, electrical, or electronic equipment?
12. Discuss the process for putting together a team for a major modification study and/or project design. Who makes the assignments for design and discipline leads, project manager, etc.?
13. The IEPR will include interviews of the individual(s) at each level or office in the Dam Safety Program who is involved in developing and implementing effective EAPs, including managers, reviewers, QC, and the USACE contact with local Emergency Managers.

14. Is the Dam Safety Program encouraging, developing, and embracing innovation and new knowledge (e.g., new hydrologic, seismic, consequence estimating methodologies, etc.) effectively?
15. How is innovation (not only in technologies, analysis methods, etc., but also in policies) spread and documented across the Dam Safety Program. How involved are the Districts/Divisions in advancement and innovation of policies, technologies, and methodologies (e.g., updating tolerability frameworks, risk software, climate change consideration)?

QUESTIONS FOR THE DSO

The Federal Guidelines for Dam Safety (FEMA 93) state: "The head of each Federal agency having responsibility for design, construction, operation, or regulation should establish a dam safety office (officer) which reports directly to the head of the agency or his designated representative."

FEMA 93 notes the duties of the dam safety office (officer) to include:

- Surveillance and evaluation of administrative and technical/regulatory practices related to dam safety
- Recommending improvements in the practices when deficiencies in the program are identified
- Maintaining an inventory of agency dams

It is our understanding that the DSO has control of the decision-making process in coordination with the Commanders and Division or District Business Line Manager.

Given the roles and responsibilities of the DSO, the peer review team has the following questions for discussion with the DSO. In addition, it may be beneficial to have the DSPM participate in this discussion.

1. What is a good dam safety program?
2. What are your Dam Safety Program priorities?
3. What are USACE's dam safety strong points?
4. What are the weaknesses?
5. What are your top concerns about the program?
6. What changes and improvements are planned?
7. What input or control does the DSO have on funding at the District/Division levels? Are you satisfied with your level of input on budgeting processes to facilitate and promote dam safety activities, both for O&M and for project remedial activities?
8. Do you have opinions regarding the organizational changes within the USACE Dam Safety Program, including the creating of the "Centers?"
9. What has been your experience with DSOG reviews?
10. Do you consider the current methods for determining the scorecard rankings to be adequate?
11. Does HQUSACE solicit input in developing procedures, guidelines, etc., from the District/Division, i.e., bottom-up feedback?
12. Does your Public Affairs officer work with staff and the local communities in getting the right message out? Is open communication with the community encouraged?
13. Do you feel the right metrics are being measured in the scorecard system?

MVD Visit

DRAFT AGENDA
(Dated 20 July 2016)

Independent Peer Review Visits (IEPR) – 6 thru 10 November 2016

**Mississippi Valley Division (MVD), Saint Louis District
& Lock 25 Project Office**

Time/Activity

Trans/Remarks

Sunday, 6 November 2016

Uniform/Business Casual

- Travel Day to MVD HQ Office (fly into Jackson, MS & drive over to Vicksburg, MS)
- Arrive at Hotel in Vicksburg, MS

Monday, 7 November 2016 (at MVD HQ Office) Uniform/Business Casual

0730 Independent Peer Reviewers Arrive at MVD - HQ Office

Meeting Location – TBD

Address: Mississippi Valley Division
1400 Walnut St
Vicksburg, MS 39183-3435

Activity: Check In / Acquire Day Security Badges

0800 Meeting with the MVD Dam Safety Committee

RCO Conference Room

Web Meeting Address: <https://www.webmeeting.att.com>

- Introduction to MVD Dam Safety Committee
- Opening Remarks by MVD - MSC Dam Safety Officer (DSO)
- MSC SES Leadership & Oversight of the DS Program

MVD Participants

0820 Dam Safety Program Overview by MVD-Dam Safety Program Manager (DSPM)

0900 - 1015 Key Dam Safety Issues at the Districts

Round Robin Discussion with MVD Districts
Web Meeting Address: <https://www.webmeeting.att.com>

- DSO's & DSPM's from: Rock Island, Saint Louis, Saint Paul & Vicksburg District Offices

1015 Break

1030 MMC/Data Management Methods, Processes & Procedures

1130 Lunch

on Your Own

IEPR DS Program: MVD Division & Districts 6-10 November 2016

TIME/ACTIVITY

TRANS/REMARKS

1300 -1630 Group & Individual Interviews

1300 Group Interview with MVD Key Staff (DSO, DSPM, Programs, Civil Works, etc) RB Chief (Acting)

1500 Break

1515 Continue Group Interviews

1600 Interview with Director, MMCCX

1630 Adjourn for the Day

Return to Hotel in Vicksburg, MS

Peer Review Team

Time/Activity

Trans/Remarks

Tuesday, 8 November 2016

Uniform/Business Casual

IEPR Team Members travel from Vicksburg, MS to Saint Louis, Missouri

Arrive at Hotel in Saint Louis

This is Election Day – Recommend Voting in Advance of Traveling

IEPR DS Program: MVD Division & Districts 6-10 November 2016

Time/Activity

Trans/Remarks

Wednesday, 9 November 2016 - at Saint Louis District (MVS) Uniform/Business Casual

0730 Independent Peer Reviewers Arrive at MVS - HQ Office

Meeting Location –

Address:

St. Louis District
1222 Spruce Street
St. Louis, MO 63103-2822

Activity: Check In / Acquire Day Security Badges

0800 Introductions & Briefings with Key MVS Dam Safety Staff **Room Location – Meramec Conf Room (E&C)**

Web Meeting Address: <https://www.webmeeting.att.com>

- Introductions between MVS Staff & Panel Members MVS & IEPR Participants
- Opening Remarks by MVS - Dam Safety Officer (DSO) & Commander D
- Program Overview & Dam Safety Management (DSPgM)
- Risk Management
- O&M Activities
- Funding Procedure & Processes
- DSPMT Scorecard Remarks

1000 Break

1015 Presentations of Key/Selected Dam Safety Projects and/or Issues by MVS Staff

- Lock 25 – Emergency Scour Repair & Barge Accident
- Scour Upstream of Lock Piers
- Wire Ropes

1200 Lunch

1330 IEPR Interviews with Key MVS Dam Safety Staffing and/or Issues

- DSO
- DSPgM,
- Lead Engineer for Lock 25 Dam
- DS Section Chief
- Chief, Geotechnical Branch

1500 Break

1515 Continue with Interviews of Key MVS Staff

- Chief, Water Control
- Chief, Design Branch
- Business Line Managers (FRM & NAV)
- Deputy Director, MVD Dam Safety Production Center
- National Instrumentation Peer Review Panelist

1700 Adjourn for Day – IEPR Teams Return to Hotel in Saint Louis

IEPR DS Program: MVD Division & Districts 6-10 November 2016

Time/Activity

Trans/Remarks

Thursday, 10 November 2016 - at Saint Louis (MVS)

Uniform/Business Casual
(with PPE & Steel Toed Boots)

0700 IEPR Members Meet for trip to Lock 25 Dam

Meeting Location - Meramec Conf Room (E&C)

0700 Project Site Briefing

Web Meeting Address: <https://www.webmeeting.att.com>

- Lock 25 Dam Project Overview
- Dam Safety Modification Study
- Dam Safety Training and Emergency Action Plan Exercise

0800 Depart for Project Site

Address:

Lock and Dam 25
10 Sandy Slough Rd
Winfield, MO 63389

0930 Arrive at Project Site – meet project staff

1000 Begin Tour of Lock 25 Project Features - Dam & Spillway, Locks, Other Ancillary Features

1200 Depart Project Site

1230 Stop for Lunch on Return Trip

1330 Continue Drive Back to St. Louis

1430 Return Location Can be District Office or Airport

Depart from Saint Louis Airport – IEPR Team Returns to Home

Note – Friday – 11th of November 2016 is a US FEDERAL Holiday (Veteran's Day)

SPD Visit

DRAFT AGENDA
(Dated 28 Oct 2016)

Independent External Peer Review Visits (IEPR) – 13 thru 17 November 2016

**South Pacific Division (SPD) & Los Angeles District (SPL)
& Whittier Narrows Dam Project Office**

Time/Activity

Trans/Remarks

Sunday, 13 November 2016

Uniform/Business Casual

- Travel Day to SPD HQ Office (fly into San Francisco, CA & drive to Hotel)
- Hotel in San Francisco, CA =

Monday, 14 November 2016 (at SPD HQ Office)

Uniform/Business Casual

0730 Independent Peer Reviewers Arrive at South Pacific Division - HQ Office

SPD HQ 20th floor (CMT)

Address:

USACE South Pacific Division
1455 Market Street
San Francisco, CA 94103
20th Floor, CMT

Activity: Check In / Acquire Day Security Badges

CMT Conf Room (20th Fl)

Web Meeting Address: <https://www.webmeeting.att.com>

0800 Welcome

Meeting with the SPD Dam Safety Committee

- Introduction to SPD Dam Safety Committee

- Opening Remarks by SPD - MSC Dam Safety Officer (DSO)

- MSC SES Leadership & Oversight of the DS Program

0820 Dam Safety Program Overview by SPD-Dam Safety Program Manager (DSPgM)

0900 Key Dam Safety Issues/Concerns at the Districts

Round Robin Discussion with SPD Districts
Web Meeting Address: <https://www.webmeeting.att.com>

IEPR DS Program: SPD Division & Districts 13-17 November 2016

Access Code: 9655204

Security Code: 1111

- DSO's & DSPgM's from: Albuquerque, Los Angeles, Sacramento & San Francisco District Offices:
-

1015 Break

1030 - 1130 Developments in Consequence Estimation & Improving Emergency Response

1130 Lunch

on Your Own

TIME/ACTIVITY

TRANS/REMARKS

1300 -1700 Group & Key Individual Interviews

1300 Individual Interview with SPD Key DS Staff (DSO, DSPgM, Programs, Civil Works, Others)

- Dam Safety Officer
- Dam Safety Program Manager
- Chief, Civil Integration Division (CID)
- Chief, Operations and Maintenance

1530 Break

1545 Interview with Director, SPD Dam Safety Production Center (DSPC)

1700 Adjourn for the Day

IEPR Team Returns to Hotel in San Francisco, CA

Peer Review Team

Tuesday, 15 November 2016 – (Travel to & SPL HQ Office) Uniform/Business Casual

0600-1200 IEPR Team Travels from San Francisco, CA to USACE - Los Angeles District HQ Office

0600 IEPR Team Departs Hotel; Arrives at San Francisco Airport for Early Flight to Los Angeles (LAX)

0730-1000 Window to Fly (1 Hour Flight) from San Francisco to Los Angeles, CA (LAX Airport)

1000-1115 IEPR Team Picks up Rental Car, Leaves LAX & Travels to Los Angeles District HQ Office

1115 -1200 Lunch in Vicinity of Los Angeles District Office

1200 Independent Peer Reviewers Arrive at Los Angeles District HQ Office (SPL) Security Office (11th Floor)

Address:

USACE Los Angeles District
915 Wilshire Boulevard
Los Angeles, California 90017

IEPR DS Program: SPD Division & Districts 13-17 November 2016

Activity: Check In / Acquire Day Security Badges

1215 Introductions & Briefings

Engineering Division Conference Room (13th Floor)
Web Meeting Address: <https://www.webmeeting.att.com>

- Introductions between SPL Staff & Panel Members SPL & IEPR Participants
- Welcome
- Opening Remarks by SPL - Dam Safety Officer (DSO)
- Program Overview & Dam Safety Management (DSPgM)
 - o O&M Activities / Funding Procedure & Processes
 - o Instrumentation Review and District Strategy
 - o Incident Management/Reporting

Time/Activity

Trans/Remarks

1445 Break

1500 – 1700 Key/Selected Dam Safety Projects and/or Issues by SPL Staff

- Fullerton Periodic Inspection (Routine)
- Brea Periodic Assessment (Routine)
- Carbon Canyon Issue Evaluation Study (non-Routine)

1700 Adjourn for the Day

IEPR Team Travels to Hotel in Los Angeles, CA

Wednesday, 16 November 2016 - at Los Angeles, CA

Uniform/Business Casual

0745 IEPR Team Departs Hotel & Returns to Los Angeles District HQ Office
Division Conference Room (13th Floor)

Meeting Location - Engineering

Address:

USACE Los Angeles District
915 Wilshire Boulevard
Los Angeles, California 90017

0800 IEPR Interviews with Key SPL Dam Safety Staff

- Chief, Operations Branch 30 minutes
- Chief, Hydrology & Hydraulics Branch 90 minutes
- Chief, Soils and Materials Section
- Chief, Geology Section
- Chief, Structural Section
- Chief, Cost Section
- Chief, Emergency Management 30 minutes
- Dam Safety Program Manager 60 minutes

IEPR DS Program: SPD Division & Districts 13-17 November 2016

Time/Activity

Trans/Remarks

Thursday, 17 November 2016 - at Los Angeles, CA

Uniform/Business Casual
(with PPE & Steel Toed Boots)

0630 – 0715 IEPR Team Departs LA Hotel and Travels to Whittier Narrows Dam Project Site

Address:

SPL District Baseyard
645 N. Durfee Avenue
South El Monte 91733

0715 Arrive at District Baseyard

0730 Project Site Introductions & Briefings

Web Meeting Address: <https://www.webmeeting.att.com>

- Whittier Narrows Dam - Project Overview
- Water Management
- Dam Safety
- Inundation Maps
- Exercises & Local Emergency Preparedness Partnerships

0900 Begin Tour of Whittier Narrows Dam Project Site - Dam & Spillway, Other Ancillary Features

1100 Complete Tour - Lunch Boxes Provided at Project Site

1130 Depart Whittier Narrows Dam & Drive to Los Angeles Airport (LAX)

1230 Arrive at LAX Airport

IEPR Team Departs LAX for Home or the Following Morning based on Return Flight Availability

Dam Safety CoP Meeting

USACE DAM SAFETY COMMUNITY OF PRACTICE (COP) WORKSHOP

“The Next Decade of Dam Safety”

Galveston, TX
6-10 February 2017



Workshop Objectives

- Share updates and successes of Dam Safety Program activities since the last CoP workshop in August, 2014.
- Share existing experiences, lessons learned and adjust approaches to risk conversations with sponsors and communities.
- Build relationships and network across the community of practice.
- Collect feedback from the field on what is or is not working.
- Develop leaders for the next decade of dam safety at USACE.

Travel Day: Monday, February 6, 2017

<u>TIME</u>	<u>ACTIVITY</u>	<u>LOCATION</u>
12:00 PM– 5:00 PM	Early Sign-In	
6:30 PM – 9:30 PM	Dam Safety Program Ice Breaker (hors d’oeuvres, iced tea, soda, water & cash bar)	

Day One: Tuesday, February 7, 2017

<u>TIME</u>	<u>ACTIVITY</u>	<u>SPEAKER</u>	<u>MODERATOR</u>	<u>LOCATION</u>
7:30 – 8:00 AM	Sign-In			
8:00 – 8:10 AM	Welcome			Auditorium
8:10 – 8:30 AM	Introductions, Objectives, Agenda, and Logistics			Auditorium
8:30 – 9:00 AM	Dam Safety: How We Got Here Mr. Baummy will discuss what he learned from his experiences during and after Hurricane Katrina.			Auditorium
9:00 – 9:30 AM	Dam Safety: A Focus on Governance Mr. Escuder-Bueno will discuss the factors that are important in determining the success of a program.			Auditorium
9:30 – 9:45 AM	The Next Decade of Dam Safety: Where We’re Going Mr. Halpin will project forward a decade; discussing focal areas, changes to come and vision for the next decade of dam safety at the USACE.			Auditorium
9:45 – 10:00 AM	BREAK			

**USACE DAM SAFETY
COMMUNITY OF PRACTICE WORKSHOP 2017**



10:00 – 10:15 AM	Tech Talk: Status of 2013 Independent External Peer			Auditorium
10:15 – 10:45 AM	Preliminary 2016 IEPR Findings Mr. Paxson will brief the preliminary findings of the most recent programmatic IEPR. This will be followed by a facilitated discussion and Q&A.			Auditorium
10:45 – 11:00 AM	Tech Talk: O&M Budget Process Changes			Auditorium
11:00 – 11:30 AM	Tech Talk: Mosul Dam Risk Assessment			Auditorium
11:30 PM – 12:45 PM	LUNCH (On Your Own)			
12:45 – 1:00 PM	Purpose and Instructions for SWOT Analysis			Auditorium
1:00 – 1:15 PM	Move to Breakout Rooms			
1:15 – 3:00 PM	Programmatic SWOT Analysis (Small Groups) Small groups will discuss and assess strengths, weaknesses, opportunities and threats of/to the USACE Dam Safety Program. Inputs from this session will be analyzed and discussed on Day 2.			Auditorium Breakout Rooms
3:00 – 3:15 PM	BREAK			
3:15 – 4:00 PM	The Future of Dam Safety Guidance Mr. Bank will review recent changes, plans for future updates, and opportunities for feedback into key issues related to dam safety guidance.			Auditorium
4:00 – 4:15 PM	Tech Talk: How Baghdad Made Me Better			Auditorium
4:15 – 4:45 PM	Awards			Auditorium

**USACE DAM SAFETY
COMMUNITY OF PRACTICE WORKSHOP 2017**



4:45 – 5:15 PM	<p>Question and Answer Session Question/Comment cards will be available throughout the day where you may pose questions to leadership or other subject matter experts in attendance. These questions will be read to the group and answered by the appropriate individual. Please have your question cards turned in by 3:00 PM each day. There will also be an opportunity to ask question aloud during this session.</p>		Auditorium
5:15 PM	ADJOURN		

**USACE DAM SAFETY
COMMUNITY OF PRACTICE WORKSHOP 2017**



Day 2: Wednesday, February 8, 2017

<u>TIME</u>	<u>TOPIC</u>	<u>SPEAKER</u>	<u>MODERATOR</u>	<u>LOCATION</u>
8:15 – 8:30 AM	Housekeeping and Agenda Review			Auditorium
8:30 – 9:15 AM	What We Learned from Megaprojects about How the COPs Talk Mr. Moore and Mr. Simmons will discuss lessons learned from recent DCE visits and JFP Cofferdam including common themes/trends from several districts and risk-informed decision making.			Auditorium
9:15 – 9:30 AM	Tech Talk: Drilling/Embankments			Auditorium
9:30 – 10:00 AM	BREAK			
10:00 – 10:45 AM	Panel: Lessons Learned from District Staff with Recent High Water Events Panel will discuss best practices and lessons learned associated with planning for, responding to, and reacting after high water events.			Auditorium
10:45 – 11:15 AM	Panel: Emergency Action Plan Exercises The panel will discuss USACE policy and share lessons learned for EAP exercises and dissemination of EAP maps. Consider planning and during the event.			Auditorium
11:15 – 11:45 AM	Tech Talk: A Fracking Hard Problem			Auditorium
11:45 – 1:00 PM	LUNCH (On Your Own)			
1:00 – 1:45 PM	Debrief and Discuss SWOT Analysis Results and Discussion from Day One			Auditorium
1:45 – 2:00 PM	Tech Talk: News Coverage About Dams and Levees			Auditorium
2:00 – 3:30 PM	Open Format / Table Top Discussions/Break This informal, self-paced session includes round tables with exhibits/information staffed by subject matter experts on a particular topic. Participants can choose to ask a question or provide feedback to the SMEs.			Assembly Room
3:30 – 4:15 PM	Daily Awards and Question and Answer Session Question/Comment cards will be available throughout the day where you may pose questions to leadership or other subject matter experts in attendance. Cards to be turned in by afternoon break.			Auditorium

USACE DAM SAFETY
COMMUNITY OF PRACTICE WORKSHOP 2017



4:15 – 5:15 PM	2017 Formal Workshop Closing			Auditorium
5:15 PM	ADJOURN			

**USACE DAM SAFETY
COMMUNITY OF PRACTICE WORKSHOP 2017**



Day 3: Thursday, February 9, 2017

<u>TIME</u>	<u>TOPIC</u>	<u>SPEAKER</u>	<u>MODERATOR</u>	<u>LOCATION</u>
7:00 AM	<p>Tour Group <u>One</u> Leaves for Addicks/Barker Dam Participants who signed up for a tour will leave at their assigned time, travel to the dam (near Houston) and be taken by van for an approximately 2 -hour tour of the dam. Tour Group One: Leave Galveston at 7:00 a.m. Tour Group Two: Leave Galveston at 9:00 a.m. Tour Group Three: Leave Galveston at 11:00 a.m.</p>			Houston, TX
8:00 – 8:45 AM	<p>Panel Discussion -- Hearing from the Centers (All Participants Not on the First Tour) Panel and plenary discussion regarding how to remain relevant and adapt to changes in the future.</p>			Auditorium
9:00 AM	<p>Tour Group <u>Two</u> Leaves for Addicks/Barker Dam</p>			Houston, TX
9:00 – 11:00 AM	<p>Risk Communication Skills for Dam Safety Practitioners (All Participants Not on the Tours) Participants who choose this option will be taken through a series of exercises intended to improve their ability to develop meaningful and engaging risk communication materials associated with dams and engage with key stakeholders. Registration is necessary</p>			Auditorium
11:00 AM	<p>Tour Group <u>Three</u> Leaves for Addicks/Barker Dam</p>			Houston, TX
11:00 AM	Adjourn			
11:00 AM	ADJOURN – Have a Safe Journey Home!			

Additional Interviews

APPENDIX D

2013 INDEPENDENT EXTERNAL PEER REVIEW – SELECTED DOCUMENTS

IEPR Report: Cover Letter, Table of Contents, Executive Summary
USACE Response to Findings and Recommendations
IEPR Report: Maturity Matrix

IEPR Report: Cover Letter, Table of Contents, Executive Summary



**FINAL REPORT
2013 INDEPENDENT EXTERNAL PEER
REVIEW**

**U.S. Army Corps of Engineers Dam Safety Program
Contract No. W912QR-10-D-0031
Task Order C0002**

Schnabel Reference 11615026.08
November 22, 2013





November 22, 2013

Risk Management Center (RMC)
U.S. Army Corps of Engineers
12596 West Bayaud Avenue, Suite
400 Lakewood, CO 80228

Subject: FINAL REPORT, 2013 Independent External Peer Review of the USACE Dam Safety Program, W912QR-10-D-0031 Task Order C0002, Louisville District (LRL) (Schnabel Reference 11615026.08)

SCHNABEL ENGINEERING CONSULTANTS, INC. (Schnabel) is pleased to submit this **Final Report** for our 2013 Independent External Peer Review of the USACE Dam Safety Program. This peer review was performed in accordance with our contract dated April 22, 2013, modified on May 20 and June 27, 2013.

Our draft report was submitted on October 14 and a meeting was held on October 22, 2013, to brief USACE senior leaders and various staff involved with the Dam Safety Program. During that meeting, the findings and recommendations were discussed, and this final report includes revisions developed based on those discussions.

We appreciate the opportunity to be of service for this project. Please contact me if you have any questions regarding this report.

Sincerely,

SCHNABEL ENGINEERING CONSULTANTS, INC.

Gregory S. Paxson, PE
Principal

GSP:DBC:DJM:RPB:MJM:MCC:SAR:hcf

**U.S. Army Corps of Engineers
2013 Independent External Peer Review of the USACE Dam Safety Program**

Distribution:

**FINAL REPORT: 2013 INDEPENDENT EXTERNAL PEER REVIEW
USACE DAM SAFETY PROGRAM**

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LIST OF ACRONYMS USED IN THIS REPORT

- ASDSO – Association of State Dam Safety Officials
- ATR – Agency Technical Review
- CEATI – Centre for Energy Advancement through Technological Innovation
- CIPR – Critical Infrastructure Protection and Resilience
- COI – Conflicts of Interest
- DDR – Design Document Reports
- DSAC – Dam Safety Action Classifications
- DSM – Dam Safety Modification
- DSMMCX – Dam Safety Modification Mandatory Center of Expertise
- DSMR – Dam Safety Modification Report
- DSO – Dam Safety Officer

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DSOG – Dam Safety Oversight Group
DSPC – Dam Safety Production Center
DSPCSC – Dam Safety Production Center Steering Committee
DSPM – Dam Safety Program Manager
DSPMT – Dam Safety Project Management Tool
DSSC – Dam Safety Steering Committee
EAP – Emergency Action Plan
EC – Engineering Circular
EMA – Emergency Management Agencies
ER – Engineering Regulation
FCCSET – Federal Coordinating Council for Science, Engineering and Technology
FEMA – Federal Emergency Management Agency
FERC – Federal Energy Regulatory Commission
GAO – Government Accountability Office
H&H – Hydrology and Hydraulics
HQ – Headquarters
HQUSACE – Headquarters United States Army Corps of Engineers
IEPR – Independent External Peer Review
IES – Issue Evaluation Study
IRRM – Interim Risk Reduction Measures
IWR – Institute for Water Resources
LRL – Louisville District
M&I – Municipal and Industrial
MMC – Mapping, Modeling and Consequences Production Center
MSC – Major Subordinate Command
NAS – National Academy of Sciences
NEPA – National Environmental Policy Act
NWD- Northwest Division
NWP – Portland District
O&M – Operation and Maintenance
OMB – Office of Management and Budget
OMRR&R – Operation, Maintenance, Repair, Replacement and Rehabilitation
PA – Project Assessment
PI – Project Inspection
PMF – Probable Maximum Flood
POA – Alaska District
POD – Pacific Ocean Division
PRQCP – Peer Review Quality Control Plan
PSHA - Probabilistic Seismic Hazard Analysis
RMC – Risk Management Center
SOW – Statement of Work
SWD – Southwest Division
SWT – Tulsa District
USACE – United States Army Corps of Engineers
USGS – United States Geological Survey
WRDA – Water Resources Development Act

1.0 ACKNOWLEDGEMENTS

This report provides the results of the 2013 Peer Review of the United States Army Corps of Engineers' (USACE) Dam Safety Program by an Independent External Peer Review (IEPR) Team. The review was performed during the time period of May to October 2013, with the report finalized in November 2013, following a briefing meeting at HQUSACE on October 22, 2013.

The IEPR Team acknowledges the significant amount of time, effort and support provided by USACE personnel that went into making this review meaningful. The candid participation of representatives from HQUSACE, the DSSC, the DSOG, and staff from RMC, NWD, NWP, POD, POA, RMC, SWD and SWT is gratefully acknowledged, along with the efforts of individuals from across USACE that supported this effort with thoughtful and incisive survey responses. The IEPR Team appreciates the effort expended by staff at all levels in following up on requests, preparation of materials for review, candor in answering questions, courtesies extended, and the general cooperation and assistance throughout the IEPR process. In particular, the IEPR Team acknowledges the support of Tom Bishop (RMC) in managing the IEPR for USACE. In addition to responding promptly to requests for additional information, he provided valuable information regarding the organization and workings of USACE.

Respectfully submitted

2.0 EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE) contracted with Schnabel Engineering Consultants, Inc. (Schnabel) to perform an Independent External Peer Review (IEPR) of the USACE Dam Safety Program. This report summarizes the results of the IEPR, performed between May and October, 2013.

As described in the Statement of Work (SOW), an objective of the IEPR is to “examine how well the USACE is implementing the federal guidelines for dam safety and executing it’s stated mission.” The SOW included the following general “charge” questions to be answered as part of the IEPR:

- Is the direction of the program appropriate?
- Has USACE overlooked any critical items?
- Does the panel have any other observations to add?

An IEPR Team was selected by Schnabel and approved by USACE, consisting of a project manager and a four member panel of reviewers with expertise in dam safety, dam engineering, and management of a dam safety program.

USACE provided numerous documents to the IEPR Team as part of the review, and several additional documents were provided upon request from the IEPR Team. In addition, the IEPR Team performed visits to Headquarters (HQ), the Risk Management Center (RMC), and several USACE Districts/Divisions.

The USACE Dam Safety Program is the largest in the United States, and USACE owns and regulates hundreds of high and significant hazard dams, with the majority constructed between 1930 and 1980. This period of construction was followed by the current period of dam safety modifications to address deficiencies at existing dams.

In 2001, the Association of Dam Safety Officials (ASDSO) conducted a peer review of the USACE Dam Safety Program, with the following major finding:

[USACE] “is currently considered to have a minimally acceptable Dam Safety Program and any further reductions in their Program will endanger their dams and the lives and property they protect.”

This finding, coupled with other events such as the levee failures resulting from Hurricane Katrina, motivated a series of significant changes in the USACE Dam Safety Program, most notably the adoption of a risk-informed approach for dam safety portfolio management and decision making. The changes in the program since 2001 have been dramatic and are continuing. As preface to summarizing the IEPR findings, it is worth noting the progress and positive steps of the program in the past decade:

- The USACE has made a commitment to risk-informed management in the dam safety program that less than a decade ago would have been considered inconceivable. This includes the establishment of the RMC.
- Staff has been established (through new hires and education) and a new programmatic structure created to implement the risk-informed management program.
- The RMC has recognized the value and importance of education and training of the USACE staff, resulting in the ongoing development of a strong training program in risk analysis methods,

facilitator training and certification, etc. The IEPR Team observed that this training has provided benefits across USACE.

- The dam safety program has established and is implementing an effective programmatic structure for managing its portfolio of dams.

The change in direction of the dam safety program to the use of risk-informed management has been extremely positive. While the IEPR findings note that this evolution is not complete, the changes in the program have been highly successful and should continue with the full support of USACE leadership.

The IEPR Team has developed findings and recommendations with regard to the USACE Dam Safety Program. With regard to the objectives identified in the SOW, the IEPR Team offers the following:

- The USACE Dam Safety Program is being implemented in general accordance with the federal guidelines for dam safety. In many areas, USACE exceeds the requirements of the federal guidelines. Updating of EAPs appears to fall short of the federal guidelines.

With regard to the “charge” questions listed in the SOW:

- *Is the direction of the program appropriate?* The answer to this question is clearly “yes.” The implementation of a risk-informed approach for dam safety portfolio management and decision making is a great improvement in the program and the program continues to mature. USACE should be commended for the positive changes made in the past decade.
- *Has USACE overlooked any critical items?* The IEPR Team has identified three findings as “critical”; however, it may not be correct to state that USACE has “overlooked” a given item. One of the findings could be considered to have been overlooked by USACE (2013-A-18: Decision-Making for Time Critical Emergencies). In addition, there are elements of the program that warrant improvement and change.
- *Does the panel have any other observations to add?* Many of the findings and recommendations presented in this report are considered to fall into this category.

The IEPR Team identified 26 findings, with a recommendation for each. The findings and recommendations are summarized as follows (grouped into six subject areas):

Organization and Management: The overall organizational structure of USACE is complex and creates obstacles in organizing its dam safety program. In addition, given the amount of activity and attention required to safely operate and maintain hundreds of large high and significant hazard dams, the USACE Dam Safety Program demands full-time leadership dedicated to its dam infrastructure (excluding levees). The IEPR Team holds the people leading the dam safety program in very high regard. However, we believe the demands of such a large, complex and risk-sensitive infrastructure require the full attention of the Dam Safety Officer. Additionally, the stresses deriving from the major transformation of the dam safety program in the past decade demand leadership attention to critical USACE staff resources. There exists a reservoir of good will towards the changes that have been driven to advance the program. Issues related to communication and trust are stressed, but they are not broken, so the door is open for coalescing the team’s sense of community and commitment. The pace of change has been intense, so a continuing focus on training and development to build expertise in using the new tools and processes that form the foundation of the dam safety program is essential.

Dam Safety Policies and Procedures: The policies and procedures of the USACE Dam Safety Program are detailed in "Safety of Dams" (ER 1110-2-1156), which has gone through significant transformation as the dam safety program has changed. The significant changes warrant an external peer review of this regulation, with a focus on the risk-informed procedures, methodology, etc. Most engineering manuals and regulations are still framed in deterministic terms and do not relate to risk-informed processes. It is recommended the USACE review the status of their ERs and EMs that are important to dam safety, and develop a plan to systematically revise them in a manner that is consistent with risk-informed and performance-based methods.

Risk-Informed Management: The introduction and implementation of risk-informed approaches to dam safety management is the area where the greatest change is taking place. The changes that have taken place are significant and positive. At the same time they are ongoing. A number of findings and associated recommendations have been made relative to risk-informed aspects of the dam safety program. A number of the findings are based on the observation that current practices do not seem to implement the dam safety regulations, ER 1110-2-1156. For example, this seems to be the case with regard to meeting OMB guidelines with regard to risk management and uncertainty analysis. In other cases there appear to be areas that are not being addressed. Examples include systems-based risk analysis, analysis of operational risks, and the utilization of risk concepts to support areas of the dam safety program such as emergency action plan development, operator training, etc.

Risk concepts and performing risk analysis studies are new to much of the USACE Dam Safety Program staff. While the dam safety program has placed a considerable emphasis on training, there are consistency and quality issues that need to be addressed. There are elements of risk analysis that are counter-intuitive for engineers who are accustomed to standards-based practices. The issues of consistency and quality are in part the evolutionary transition that is taking place. It is also a function of the number of qualified staff who have the educational and experience background that are needed to carry out a job on the scale of the USACE Dam Safety Program.

Emergency Preparedness: Effective Emergency Action Plans (EAP) are a major program feature for preventing life loss downstream of USACE dams. The USACE EAP program, however, continues to be a significant risk to the dam safety program. While substantial improvements have been realized in improving inundation mapping and providing it to the local Emergency Management Agencies (EMA), the problems and deficiencies identified in the 2001 Peer Review remain.

There appears to be limited USACE management or oversight above the District office level with regard to implementation of EAPs. For a dam safety program as geographically diverse and multi-leveled as USACE, consistency and effectiveness cannot be maintained without nationwide oversight. The panel found insufficient evidence that the guidance and requirements regarding the importance of a strong relationship and close coordination with local EMAs in ER 1110-2-1156 and the Federal Guidelines are broadly understood or uniformly implemented across the USACE nationwide program.

Another issue identified by the panel related to emergency preparedness involved clear lines of the authority across the Division, District and projects with regard to the management of dam incidents, as they evolve in real time. This appears to be a subject that has been overlooked.

Dam Safety Program Implementation: Findings indicate that the substantial changes to the overall USACE Dam Safety Program have required significant redefinition of both activities and staff. While

these extensive changes have been executed to bring major benefits to the dam safety program for the long term, the retooling and retraining efforts are, understandably, a work in progress. Centers are being stood up and, in some cases, are getting down to business. Given their newness, they are still developing, maturing and defining their missions. Quality processes are inadequate and not effectively audited. Therefore, the range in quality of work products is broad. Consistency of performance and diligence in dam safety monitoring and documentation are goals that have not been broadly or consistently achieved, with the quality and consistency of instrumentation monitoring a critical concern. There are loose ends to be tied and processes to be updated and upgraded to allow effective and efficient implementation of the full menu of dam safety activities.

Technical Capabilities for Dam Engineering: The quantity and quality of technical resources are fundamental to the success of the USACE Dam Safety Program. USACE has some of the world's leading experts on dam safety, particularly at the HQ and Centers (RMC, MMC, DSMMCX). However, USACE also has a massive backlog of dam evaluations, studies, and designs, and the overall complement of trained and experienced staff to complete this work is limited. Therefore, the upper echelon of expertise is mature and leading the way, while much of the dam engineering staff attending to the day to day needs related to the full array of activities from construction through operation and maintenance are still maturing into critical roles and responsibilities. Additionally, much of the USACE expertise is aging, so serious consideration needs to be directed towards replacement of retiring senior engineers.

As a means of summarizing the state of the USACE Dam Safety Program, the IEPR Team applied the Maturity Matrix approach to provide an aggregate assessment of the state of each subject area noted above. The Maturity Matrix is presented in Section 5.9 of the report.

In addition to the findings and recommendations, the IEPR Team developed several "lessons learned" through the IEPR process that will likely benefit future peer reviews.

To maximize the benefit of this peer review, the IEPR Team recommends that USACE develop and provide to USACE Leadership a response to the findings and recommendations included in this report, which include:

- Proposed approach to implementing the recommendation.
- Proposed schedule for implementing the recommendation.
- A summary of and response to the Survey Questionnaire of the Districts, Divisions, RMC, etc. which was performed as part of the Peer Review.

Based on discussions at the October 22, 2013, meeting, we understand that USACE is initiating their response to this report.

USACE Response to Findings and Recommendations



DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

SEP 12 2014

CECW-CE

MEMORANDUM FOR FILE

SUBJECT: Response to 2013 Independent External Peer Review of the U.S. Army Corps of Engineers Dam Safety Program

1. An Independent External Peer Review (IEPR) was conducted for the U.S. Army Corps of Engineers (USACE) Dam Safety program in accordance with Civil Works Review policy EC 1165-2-214, and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review. This program review was at USACE discretion and is not related to any statutory mandate.
2. USACE contracted with Schnabel Engineering Consultants (Schnabel) to perform an IEPR of the USACE Dam Safety Program. The IEPR Team selected by Schnabel consisted of a project manager and a four member panel of reviewers with expertise in dam safety, dam engineering, and management of a dam safety program.
3. I approve the final written responses to the IEPR in the enclosed document. The IEPR Report and USACE responses will be posted on the internet to share lessons learned with other dam owners.
4. The point of contact for this review is Barbara Schuelke, HQ Dam Safety Program Manager, at (202) 761-4643.

STEVEN L. STOCKTON, P.E.
Director of Civil Works

Encl



DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

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SEP 9 2014

MEMORANDUM FOR DIRECTOR OF CIVIL WORKS

SUBJECT: Response to 2013 Independent External Peer Review of the U.S. Army Corps of Engineers Dam Safety Program

1. References:

- a. EC 1165-2-214, Civil Works Review, 15 Dec 2012
- b. Office of Management and Budget, Final Information Quality Bulletin for Peer Review, 2004
- c. Federal Emergency Management Agency, 1979 (Jul), "Federal Guidelines for Dam Safety," FEMA 93, Washington, DC

2. An Independent External Peer Review (IEPR) was conducted for the U.S. Army Corps of Engineers (USACE) Dam Safety program in accordance with Civil Works Review policy EC 1165-2-214, and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review. This program review was at USACE discretion and is not related to any statutory mandate. USACE contracted with Schnabel Engineering Consultants (Schnabel) to perform an IEPR of the USACE Dam Safety Program. The objective of the IEPR was to examine how well the USACE is implementing the Federal Guidelines for Dam Safety and executing its stated mission. The review provided an external view of the policies, procedures, and performance of the USACE Dam Safety Program.

3. The USACE Dam Safety Program uses a risk-informed approach to manage its portfolio of 707 dams, with public safety as the highest priority. This risk-informed approach was adopted to improve our understanding of the safety of our dams, better communicate the risks and benefits of the dams, and to enhance dam safety decisions. The Dam Safety Program seeks to ensure that USACE owned and operated dams do not present unacceptable risks to people, property, or the environment.

4. An IEPR team was selected by Schnabel and approved by USACE, consisting of a project manager and a four member panel of reviewers with expertise in dam safety, dam engineering, and management of a dam safety program. Selection of expert reviewers for IEPR efforts was in accordance with the National Academy of Science (NAS) Policy on Committee Composition and Balance and Conflicts of Interest.

5. The Panel conducted its review of the Dam Safety Program between May and October 2013. The review encompassed routine and non-routine dam safety activities being performed by Headquarters (HQ), the Dam Senior Oversight Group (DSOG), Risk

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SUBJECT: Response to 2013 Independent External Peer Review of the U.S. Army Corps of Engineers Dam Safety Program

Management Center (RMC), Dam Safety Production Centers (DSPC), Modeling, Mapping, and Consequence Center (MMCC), Divisions (MSCs), and Districts.

6. Schnabel issued the final IEPR report on November 22, 2013 with twenty-six (26) Comments. The IEPR team rated the comments as either Category A – Critical, Category B – Urgent, Category C – Important, or Category D – Other.

a. Critical: The issue has the potential to significantly degrade or undermine the Dam Safety Program, or otherwise can lead to dramatic negative consequences. Includes “must do” recommendations.

b. Urgent: The finding is of significant importance to the program and can provide substantial dam safety benefits.

c. Important: The recommendation is worthy of implementation and would likely provide a definitive return on investment. Timeline for implementation could be long.

d. Other: Observations, considerations and perspectives worthy of USACE review regarding its Dam Safety Program.

7. The USACE responses to individual IEPR comments are enclosed. Recommend adopting seventeen (17) of the panel recommendations, partially adopting seven (7), not adopting one (1), and one (1) had no action required. Additional explanations of the partially adopted are included in the responses. Actions have been prioritized in consideration of the above categories and are being implemented within current priorities as funding permits. Many actions will be phased such as updating guidance first, then revising associated procedures, followed by training to aid the field with implementation.

8. The agency responses were coordinated with the panel. Request your approval of the IEPR report and our agency responses to the panel findings and recommendations.

9. The point of contact for this review is Barbara Schuelke, HQ Dam Safety Program Manager, at (202) 761-4643.

Encl



JAMES C. DALTON, P.E., SES
Corps Dam Safety Officer
Directorate of Civil Works

USACE Responses to the 26 Independent External Peer Review
Comments on the Dam Safety Program.

Note: The USACE action lead organization or entity includes the following:
Headquarters (HQ), Dam Safety Steering Committee (DSSC), Dam Senior Oversight
Group (DSOG), Institute of Water Resources (IWR), Risk Management Center (RMC).

1. IEPR Comment – Category B - Urgent: The leadership and management of a Dam Safety Program of the size and nationwide breadth of the USACE requires a full time Dam Safety Officer (DSO) with dam safety knowledge, expertise and experience. The Chief, Engineering and Construction has too many other responsibilities to be able to serve as the DSO.

The panel experts recommended the following actions to resolve this comment:

The Dam Safety Officer of the USACE Dam Safety Program should be a full time senior level position staffed by a professional engineer with knowledge, expertise and experience in dam safety, and a clear commitment to the program's mission.

USACE Lead Organization or Entity: Headquarters (HQ)

USACE Response: **Partially Adopted.** USACE assignment of the Dam Safety Officers, including at the agency headquarters, exceeds the letter and the spirit of the Federal Guidelines for Dam Safety and the subject IEPR comment. No further action is required. The Federal Guidelines are quoted below with summary of USACE dam safety governance:

- (1) "The head of each Federal agency having responsibility for design, construction, operation, or regulation of dams should establish a dam safety office (officer) which reports directly to the head of the agency or his designated representative". USACE is compliant with this requirement via the assignment of the agency Dam Safety Officer (DSO) to a Senior Executive Service Member that reports to the agency head. The DSO is supplemented with three full-time senior staff positions (GS-15) at the headquarters to aid administration of dam and also levee safety programs:
 - a. Special Assistant for Dam and Levee Safety that reports directly to the HQ DSO,
 - b. Dam Safety Program Manager (DSPM) that supports the Special Assistant
 - c. Levee Safety Program Manager that supports the Special Assistant.

These offices are further informed and supported by DSOs and DSPMs at the District and Division level, that have similar roles but at the local and regional levels. All positions are selected based on qualifications, requiring relevant experience, education, and professional registration.

Enclosure – IEPR Responses

- (2) “The functions of the office should be advisory to the agency head, and through the agency head to the agency administrative and technical units. The staffing and detailed duties of the office should be commensurate with the agency mission.” The USACE program and DSOs function in the manners specified, with supporting staff that are commensurate with the mission including three robust national technical centers and six regional production centers. USACE views dams and levees as a portfolio of infrastructure with similar challenges and needs that demand an integrated management and leadership approach. Also, the USACE approach to leading, managing, and staffing the program leverages a broad host of competencies provided from other, complimentary mission areas.

2. IEPR Comment – Category B - Urgent: In conjunction with the finding that the USACE have a full time Dam Safety Officer (DSO), it is equally important for there to be active, informed oversight of the Dam Safety Program. This oversight can best be provided by the Chief, Engineering and Construction, whose responsibility should include the review of the overall Dam Safety Program, and the review and contribution to the program’s mission, strategic plan, and overall fiscal planning.

The panel experts recommended the following actions to resolve this comment:

The DSO shall report to the Chief, Engineering and Construction, who should have dam safety knowledge and provide program implementation and strategic planning oversight.

USACE Lead Organization or Entity: Headquarters (HQ)

USACE Response: **Not Adopted.** USACE concurs with the need for having full-time, active and informed oversight of the program and believes our current governance structure meets and exceeds the Federal Guideline DSO requirements as described in comment 1 response.

3. IEPR Comment – Category C – Important: Staff has undergone major change over the past five years, which can lead to frustrations and misunderstandings, and, in turn, to mistrust. Communications are strained by new demands and organizational changes. There exists a common thread of subdued, but hopeful, optimism. The door is open for coalescing team community and commitment. HQ leadership is generally viewed positively, which is a powerful message. However, Divisions and Districts sense that HQ is not giving adequate credibility to their concerns and does not communicate with sufficient candor or frequency.

The panel experts recommended the following actions to resolve this comment:

There is a need to recognize staff at HQ, Divisions, Districts and Centers as mutually critical. Full time leadership is needed to develop a strategy that will build unity and common purpose, and better instill common passions and values to all levels. Key HQ dam safety personnel need to make more visits to Divisions

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and Districts. This will provide a significant morale lift, providing closer connectedness with the mission. Candid, regular communications are needed to build trust and unity. The IEPR Team applauds the HQ leadership for the exceptional job it is doing and for the passion, dedication and focus it provides. Because HQ is asking staff to do more – HQ efforts and actions need to be more visible and more accessible, so that HQ is seen as doing more than is currently visible to staff.

USACE Lead Organization or Entity: Headquarters (HQ)

USACE Response: **Adopted**

Action to be Taken:

HQ recognizes the need expressed in the comment. In order to foster a clear understanding of the mutually critical roles and responsibilities of team members at all levels of the organization and to build team unity the USACE will continue to conduct a biennial dam safety workshop that includes HQ, Risk Management Center (RMC), Modeling Mapping Consequence Center (MMCC), Dam Safety Production Centers (DSPC), Division, and District management and staff.

Division Dam Safety Committee meetings are conducted at least annually and are attended by district dam safety and DSPC representatives from the respective region. Division Dam Safety Program Manager will assure appropriate representatives from HQ, RMC, and MMC are included either in person or virtually, as appropriate, in the meeting agenda to share current information and also to foster internal communication and relationships.

Some of the more complex and expensive dam safety projects in design and construction will be managed with mega-projects requirements, ECB 2013-11. HQ Senior Leaders and Engineering and Construction staff as well as Division, RMC and DSPC senior engineers will serve in an oversight and advisory role to the project teams, providing a framework for structured and regularly scheduled vertical team interaction with the field.

USACE will continue to provide technical dam safety focused webinars to build capability and unity in the program. This virtual training, necessitated by travel and budget constraints, has the advantage of recordings which can be referred to by a larger number of employees on an as needed basis. USACE will continue to provide quarterly DSO Updates (Dam Community of Practice internal newsletter).

4. IEPR Comment – Category C - Important: The USACE Dam Safety Program has gone through considerable change; however, there remains more to be done. The evolution that has taken place to date has been extremely positive. There is considerable need to assimilate the new tools and processes. This is a long-term proposition, so a long view is needed. Building a focus on training and building confidence in working with new tools requires collaboration, communication and trust

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(Finding 2013-C-03). This positions USACE to accomplish more with available resources.

The panel experts recommended the following actions to resolve this comment:

USACE HQ and RMC should focus on advancing staff experience and expertise related to the recent changes in processes and procedures. This could be accomplished through both training and providing opportunities for staff to work on projects led by the experts that developed the new processes. USACE should prioritize ongoing changes to streamline and advance their objectives, and regulate changes to avoid overwhelming USACE staff.

USACE Lead Organization or Entity: Dam Safety Steering Committee (DSSC)

USACE Response: **Adopted**

Action to be Taken:

USACE will update the Dam Safety Career Paths and Developmental Plan, including continuing the appropriate training, webinars and other communication avenues to broadly share information about changes in dam safety related policies and procedures across the organization and beyond the traditional target audiences of Engineering Division / Dam Safety offices. The documents will be reviewed annually by the DSSC, updated as necessary, and made available to all personnel who may have a current or future interest in the program.

The existing Development Plan maps recommended career development for the USACE District DSO, DSPM, DS Modification Lead Engineer and DS Project Manager and will be evaluated for inclusion of others. Developmental assignments and training have been structured and scheduled to provide opportunities for field staff to learn from and work directly with experts that were involved in developing the process and tools, to the extent practicable. Additionally, USACE will continue to provide quarterly DSO Updates (Dam Community of Practice internal newsletter) and quarterly webinars on hot topics or new policies.

USACE will continue to align on-going training with policy changes as needed.

5. IEPR Comment – Category B - Urgent: Whereas ER 1110-2-1156 is key to the USACE Dam Safety Program, a peer review of the current document has not been performed and is warranted.

The panel experts recommended the following actions to resolve this comment:

The USACE should conduct a comprehensive external peer review of ER 1110-2-1156 and in particular its risk-informed elements (methodology, training, etc.) and how risk analysis concepts and risk-informed management are being

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implemented. The review should be carried out in a manner that takes full advantage of the longer and more extensive experience in other areas of civil engineering and the sciences where risk analysis and risk-informed decision making have been implemented.

USACE Lead Organization or Entity: Headquarters (HQ)

USACE Response: **Adopted**

Action to be Taken:

USACE plans to conduct the next Independent External Peer Reviews (IEPR) of its Dam Safety Program in 2016. In response to this recommendation, a focus of the next Dam Safety Program IEPR will be on ER 1110-2-1156, and how its risk informed elements, risk analysis concepts, and risk-informed management are being implemented.

6. IEPR Comment – Category B - Urgent: There are a number of USACE ERs and EMs that are out-of-date and/or whose basis and approach are likely inconsistent with a risk-informed/performance-based approach to engineering analysis and design.

The panel experts recommended the following actions to resolve this comment:

It is recommended the USACE review the status of their ERs and EMs that are important to dam safety and develop a plan to systematically revise them in a manner that is consistent with risk-informed and performance-based methods. Once developed, independent external peer review of these documents should be carried out to review their technical adequacy and consistency with state-of-practice methods.

USACE Lead Organization or Entity: Headquarters (HQ)

USACE Response: **Adopted**

Action to be Taken:

A prioritized engineering guidance update plan has been developed and is implemented within budget constraints. As these products are developed, they will be evaluated on a case by case basis for external peer review.

7. IEPR Comment – Category D - Other: In the last seven years, the USACE has made risk-informed management the foundation of the dam safety program. This is a positive step for the agency, for staff, for use of the nation's resources, and the management of a major part of the nation's infrastructure. Re-direction from a standards-based approach to a risk-informed program is a clear measure of the scale and effectiveness of change that has taken place.

The panel experts recommended the following actions to resolve this comment:

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There is not a specific recommendation to be implemented by USACE regarding this finding. USACE is to be commended for the major positive changes in the program in incorporating risk-informed management.

USACE Lead Organization or Entity: Headquarters (HQ)

USACE Response: **Comment much appreciated, no response necessary**

8. IEPR Comment – Category C - Important: A focus on public safety is clearly appropriate for dams that may have significant consequences in the event of uncontrolled release of the reservoir. However, it is not clear the current focus is consistent with the broad agency responsibility of managing a critical part of the nation's infrastructure. In fact, it appears it is inconsistent with Office of Management and Budget (OMB) principles. Discussions with all levels of USACE/dam safety program staff suggest the program may be too narrowly focused and that OMB principles are not being met.

The panel experts recommended the following actions to resolve this comment:

The USACE should examine the focus and implementation of the dam safety program as it relates to the degree to which its practices are consistent with OMB principles which it says it is following. The USACE should conduct a comprehensive peer review of ER 1110-2-1156 and in particular its risk-informed element (methodology, training, etc.) and how risk analysis concepts and risk-informed decision-making is being implemented.

USACE Lead Organization or Entity: Dam Senior Oversight Group (DSOG)

USACE Response: **Partially Adopted**

Action to be Taken:

USACE will include a review of ER 1110-2-1156 in the next Independent External Peer Review (IEPR).

For the comment regarding narrowness of focus on life safety associated with uncontrolled reservoir release, USACE will re-evaluate policy and procedures for other risk considerations.

In reference to compliance with OMB principles, USACE does not concur with the IEPR comment: "In fact, it appears it is inconsistent with Office of Management and Budget (OMB) principles". Evidence for this position follows:

- Appropriate use of and references to The OMB principles of risk management, (U.S. Office of Management and Budget (OMB) 1995; Memorandum for Regulatory Working Group, Principles for Risk Analysis (1995) and U.S. Office of Management and Budget (OMB)

Enclosure – IEPR Responses

2007 Updated Principles for Risk Analysis, September 19, 2007), exist throughout our Dam Safety policy and our practices. We believe this will be confirmed in the future Independent External Peer Review (IEPR) of ER 1110-2-1156.

- Every risk analysis and risk assessment performed by USACE on dams in its portfolio has calculated, evaluated and considered the economic risks inherent in the system, and where available, the environmental and cultural risks associated with a decision. This practice is consistently reflected in our characterization of risks via DSAC, as evidenced by the number of DSAC 1 and 2 navigation projects for which there are no loss of life risks.
- USACE approach to assessing and managing risks, including the priority of investments, is coordinated with the Assistant Secretary of the Army for Civil Works (ASA CW) and OMB on an annual basis – they have been supportive and complimentary of the current approach.
- Investments in the modification of non-life safety projects, such as navigation, have been substantial in recent years.

9. IEPR Comment – Category B - Urgent: The current practice to estimating extreme inflows appears to be the extrapolation of flood frequency distribution. This approach does not take into account modern methods of statistical analysis, hydrologic and stochastic modeling methods and uncertainty analysis. The current USACE regulation for the development of the inflow design flood for spillways and reservoirs is established in ER 1110-8-2. As described in ER 1110-8-2, the PMF is used for most USACE projects. In the context of a risk-informed dam safety management program, there is no logical basis for the consideration or use of the PMF or related concepts in establishing the design basis for spillways and reservoirs, or as a basis to measure the safety of a dam or the risk to the public.

The panel experts recommended the following actions to resolve this comment:

USACE should develop and implement modern approaches to the assessment of flood frequencies at dams that include the assessment of epistemic uncertainties, which is the standard practice in the analysis of extreme events. The approach should include alternative levels of analysis that reflect the varying project needs of the USACE and the level of risk for dams across its portfolio. In addition, ER 1110-8-2 should be revised to reflect a full-scope probabilistic approach to developing inflow flood frequencies and design floods for spillways and reservoirs.

USACE Lead Organization or Entity: Headquarters (HQ)

USACE Response: **Partially Adopted**

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Action Taken:

USACE will not adopt the recommendation for a *fully* probabilistic based approach for selecting inflow design floods. However, methods and tools for estimating inflow design floods will be updated and improved to support credible risk informed decisions. Because the USACE dam safety program is risk informed (not risk based), engineering design standards will continue to be used as appropriate in conjunction with risk estimates and other factors to inform dam safety decisions. Note that USACE currently provides technical guidelines and recommendations for several modern approaches in the Best Practices Manual for Dam and Levee Safety Risk Analysis and in a draft Hydraulics and Hydrology (H&H) methodology guideline document.

USACE adopts the panel recommendations to make improvements to methods and tools for stochastic modeling and uncertainty analysis through several ongoing research and development efforts. Additional improvements include the following:

- a. Develop and enhance in-house core competencies in hydrology, meteorology, and risk analysis through additional education, training, and experience opportunities.
- b. Establish a senior level meteorologist position within USACE,
- c. Establish a cadre or center of expertise for hydrologic hazard analysis,
- d. Develop a comprehensive database of historical extreme storm events.
- e. Update the hydrometeorological reports for application at all dams and supplement with site specific studies for dams with hydrologic risk drivers.
- f. Modify existing hydrologic software tools to include capability for developing and evaluating design storms.
- g. Develop GIS based tools for storm analysis,
- h. Update guidance to explicitly include consideration and communication of uncertainties in Probable Maximum Precipitation PMP and Probable Maximum Flood PMF estimates.
- i. Update guidance to utilize expert elicitation to characterize epistemic uncertainties and to explore plausible scenarios that have not been observed in the historic record (the unknown unknowns).
- j. Update guidance to clarify the intent and purpose of PMP and PMF estimates.

Enclosure – IEPR Responses

k. Research emerging methods for use in informing PMP estimates.

10. IEPR Comment – Category C - Important: Observations and discussions during the IEPR suggest unwarranted variations in the consistency and quality of the risk cadres. Part of the consistency and knowledge issues may be due to foundational educational and experience requirements RMC has established for staffing the risk cadres. Coupled with this may be the need to establish risk cadres that are formed around dam safety risk generalists.

The panel experts recommended the following actions to resolve this comment:

USACE should review and evaluate the performance of the risk cadres, how they are constituted (membership), what their roles and responsibilities are when risk studies are performed, etc. USACE should also establish a dam safety risk generalist position and include individuals in this position in each cadre. This position should have the 'specialty' educational and experience requirements similar to what is required for other dam engineering topical areas (i.e., hydrologists, geotechnical engineers, etc.).

USACE Lead Organization or Entity: Risk Management Center (RMC)

USACE Response: **Adopted**

Action to be Taken:

USACE will develop more formal guidelines to review and evaluate the performance of risk cadres on an annual basis. USACE is also in the process of identifying the educational, training, and experience requirements for the development of dam/levee safety risk analysts.

11. IEPR Comment – Category C - Important: The quality and consistency of PAs is important to the quality of the USACE risk management program. Issues with consistency and quality in applications and documentation have been identified. This included a series of problematic PAs presented at the DSOG meeting attended during the IEPR.

The panel experts recommended the following actions to resolve this comment:

The RMC should assess the root causes of risk analyses that have failed to meet its quality and consistency standards and, as appropriate, provide more and better training, make changes to procedures, modify the role of risk cadres, clarify the role and responsibilities of facilitators, and provide uniform guidance to district staff.

USACE Lead Organization or Entity: Risk Management Center (RMC)

USACE Response: **Adopted**

Enclosure – IEPR Responses

Action to be Taken:

USACE reviewed the root causes of Periodic Assessment (PA) risk analyses that failed to meet quality and consistency standards. USACE developed and implemented appropriate revisions to policies and procedures to ensure quality and consistent PA work products and processes. Training will continue to be conducted following Dam Senior Oversight Group meetings as necessary to share future lessons learned with facilitators and district staff.

12. IEPR Comment – Category B - Urgent: Operations at dams can involve various staff levels, processes, and structure, system and component reliability. Understanding and mitigating operational risks are difficult without the benefit of systems-based risk analyses that look specifically at these aspects of dam operations and performance. The potential for the USACE to fail one of its own dams as a result of misoperation might be a consequence of not understanding how the dam system performs during the full range of operating scenarios.

The panel experts recommended the following actions to resolve this comment:

The USACE Dam Safety Program should include operation risk analysis, which is necessarily a systems-based assessment of dam operations. As appropriate, the results (lessons and insights) of these studies should be integrated into project operating procedures, emergency action plans, training, etc. This recommendation is a natural subset of the recommendations associated with incorporating systems-based methods into the Dam Safety Program (Finding 2013-B-15).

USACE Lead Organization or Entity: Risk Management Center (RMC)

USACE Response: **Adopted**

Action to be Taken:

USACE recognizes that operational risk analysis is an important element to decision making on dams and believe that the current approaches to this risks can be further examined to enhance evaluation. The major component of this risk that current USACE efforts have focused on has to do with the non-breach risks involved in simply following our water control manuals – in some cases, this is substantial. Risks analyses also consider potential failure modes that are operational in nature. To date, such PFMAs have not been major drivers of risk. Lastly, the Asset Management Program in USACE has a mature process to examine operational condition assessments and risks in order to prioritize investments in major maintenance packages – this program was not part of the IEPR scope of work.

The USACE annual budget guidance for the Flood Risk Management business line includes the following “FRM Priority Investment Objectives” along with their

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respective “Metrics”, which will be reviewed and modified, if required, with Human and Mechanical Reliability in mind.

- a. Efficiently fund operation of USACE FRM projects to maximize investment (OM) and
- b. Maximize investments in maintenance to ensure that these projects will perform as designed (OM).

The Human Reliability (people, process and procedures) should also inform, and refine the required operational Levels of Service (LoS) at each of our project sites. Additionally, to address Mechanical Reliability, the Asset Management program is in the process of developing and implementing a Maintenance Management Improvement Plan (MMIP) and Strategy that aligns specific maintenance activities (preventive, recurring, corrective etc) with Levels of Performance (LoP) desired at each project site.

13. IEPR Comment – Category C - Important: The USACE Dam Safety Program is currently focused on the assessment of public safety risks and their management. This focus is appropriate (in general) and clearly an advantage of a risk-informed approach. There are other opportunities for using risk concepts and the results of risk analyses to support many of the elements of the Dam Safety Program. It appears the development and implementation of risk-informed concepts to all aspects of dam safety and more broadly the management of the USACE dam infrastructure have not occurred. There does not appear to be a clear plan/approach to the implementation of risk analysis insights and lessons to all aspects of the program. As such, the notion of having a risk-informed dam safety program is limited.

The panel experts recommended the following actions to resolve this comment:

The USACE should plan for and evolve to the utilization of risk-informed approaches to support all elements of the Dam Safety Program and Asset Management.

USACE Lead Organization or Entity: Risk Management Center (RMC)

USACE Response: **Adopted**

Action to be Taken:

Although USACE is implementing risk analysis in an increasingly more comprehensive manner (non-breach risks, operational PFMs, targeted instrumentation and monitoring, Interim Risk Reduction Measure plans, asset management, etc...), we concur that there is room for improvement in how it is applied. To be clear, we do not believe risk analysis is the decision tool for all aspects of the program – many routine activities are deterministic in nature and should remain that way. However, ER1110-2-1156, annual budget guidance, and

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Maintenance Management Improvement Plan will be reviewed, and modified as appropriate to incorporate risk informed approaches more broadly for the maintenance, inspections, and other routine Dam Safety Program activities in coordination with the Asset Management Program.

14. IEPR Comment – Category B - Urgent: The guidance in ER 1110-2-1156 with regard to the evaluation of uncertainties is limited. This leads to inconsistency with respect to how uncertainties are identified, evaluated, and ultimately integrated into a risk analysis and the management of risks. In principle, there is no clear evidence the guidance in ER 1110-2-1156 is followed. While sensitivity calculations are a useful step in understanding the effects of uncertainties, they are not a replacement for a more thorough evaluation and incorporation in a risk analysis.

The panel experts recommended the following actions to resolve this comment with regard to the evaluation of uncertainties:

- a. ER 1110-2-1156 should be expanded to include an in-depth discussion of uncertainties that includes a framework for their assessment, methods for uncertainty evaluation and recommendations for the level of analysis that is required for different applications.
- b. Development of training to describe the evaluation of uncertainties (material in ER 1110-2-1156), with examples, elicitation training, etc.
- c. Development of tools to perform the calculations required in risk quantifications where uncertainty analysis is required.

USACE Lead Organization or Entity: Risk Management Center (RMC)

USACE Response: **Adopted**

Action to be Taken:

- a. USACE will revise policy documents (ER 1110-2-1156) and methodology documents (e.g. Best Practices in Dam and Levee Safety Risk Analysis) to document the use and application of uncertainty in dam and levee safety risk analyses. Policy will define and identify when uncertainty will be included in the risk analysis process and to what level of detail it will be provided. The methodology documents will identify how to elicit uncertainty, how to analyze and evaluate uncertainty, and how to report the results of uncertainty in dam and levee safety risk analyses.
- b. USACE has been actively pursuing revisions to both Dam Safety Risk Analysis Engine (DAMRAE) and @risk software to incorporate uncertainty functions and analysis/output capabilities to evaluate uncertainty in dam and levee risk analyses. These efforts are currently underway.

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c. Following completion of recommendations a. and b., training of RMC, cadre, and district personnel will be performed to aid implementation of the revised policy and methodology, and provide examples of the use and interpretation of uncertainty in risk analyses.

15. IEPR Comment – Category B – Urgent: While not exclusively the case, it appears that USACE risk analyses do not generally take a systems-based approach. In addition, the notion of systems-based risk analysis did not seem to be part of the experience or mindset of most USACE staff who were interviewed.

The panel experts recommended the following actions to resolve this comment:

USACE should incorporate systems-based approaches to the evaluation of dams. As part of this effort, thought should be given to:

- a. Levels of systems-based analyses that are required for different applications.
- b. The elements of the Dam Safety Program that may be supported by systems-based applications.
- c. Development (or acquisition) of tools to support systems-based analysis.

USACE Lead Organization or Entity: Institute of Water Resources (IWR)

USACE Response: **Partially Adopted**

Action to be Taken:

USACE is somewhat restricted in adopting true, large scale systems approach as Congress generally authorizes and funds by specific project, with an identified specific sponsor and cost sharing entity. Approaches which seek to reallocate risk reduction measures more cost effectively within a larger system require a cost shared sponsor and Congressional authorization. USACE has system wide authorities in limited areas, and that may be the reason why the approach was not as familiar with those interviewed.

USACE methodology documents (e.g. Best Practices in Dam and Levee Safety Risk Analysis) document the use and application of systems-based risk analyses. USACE will continue training efforts to further educate personnel on risk methodology including system-based analyses.

USACE recognizes the benefits of systems based approach in evaluating not only dams, but entire watersheds. As a first step, USACE has initiated the implementation of the Corps Water Management System (CWMS) on a watershed basis across the nation. CWMS allows for analyses of systems including not only dams, but levees and other water control structures. It is an automated information system supporting the USACE Water Management

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mission. CWMS integrates real-time data acquisition, database storage, flow forecasting of watershed runoff, reservoir operations decision support, river profile modeling, inundation area determination, consequence/damage analysis, and information dissemination into a comprehensive suite of software supporting water management decision processes.

USACE will adopt the recommendation to incorporate system based approaches in analyzing dams by utilizing the implementation of CWMS in its 213 USACE operational basins. The use of CWMS models will help inform USACE dam safety portfolio decisions by better understanding system variables and relationships. CWMS is currently being operated in 30 basins.

16. IEPR Comment – Category B – Urgent: USACE uses the USGS national hazard map to estimate the ground motion hazard at dam sites as part of the risk analysis performed for a PA. The analysis that is the basis for the USGS seismic maps is not adequate to support risk analyses for critical infrastructure facilities. Based on experience in comparing the USGS PSHA results to the results of full-scope PSHAs in the U.S. suggests use of USGS seismic maps may be either conservative or non-conservative. As a consequence, they cannot be considered a reliable basis to estimate the seismic risk of USACE dams.

The panel experts recommended the following actions to resolve this comment:

The USACE should examine and implement an improved approach for estimating earthquake ground motion hazards at project sites. The approach that is developed should be applicable to the various levels of analysis that are required and levels of risk. There are opportunities for doing this in a reasonable, efficient, and technically sound manner that will provide greater consistency across its portfolio. This examination should recognize and be consistent with the current standard-of-practice in PSHA.

USACE Lead Organization or Entity: Risk Management Center (RMC)

USACE Response: **Adopted**

Action to be Taken:

USACE will develop and implement an improved approach for estimating seismic ground motion hazards at project sites where risks warrant more in-depth studies. USACE will investigate and evaluate methods to estimate seismic ground motion hazards for use in dam and levee safety risk analyses including approaches used by the NRC and US Bureau of Reclamation.

17. IEPR Comment – Category A – Critical: The management, implementation and coordination of EAPs continue to exhibit the problems and deficiencies documented in the 2001 ASDSO Peer Review. There appears to be no USACE management or oversight above the District office level to drive consistent, quality implementation of

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EAPs, including the importance of a strong and collaborative relationship between USACE and the local EMAs, and close emergency management coordination considered the state of practice for dam safety programs.

The panel experts recommended the following actions to resolve this comment with regard to implementation of EAPs:

- a. The management and oversight of the EAP program should be raised to the HQ level, including development of a database tracking system to certify that all USACE dams have an effective, up to-date EAP.
- b. A USACE-wide initiative should be implemented to ensure the effectiveness of the EAP by raising the leadership and staff's awareness of the importance of a strong relationship and close coordination between the dam owner and the downstream local emergency management agencies.
- c. USACE should meet annually, at a minimum, with the local EMAs to ensure understanding of what to expect during a dam-related emergency, and be provided the information they need to plan the appropriate evacuation procedures. During the annual communication with the local EMA, USACE should specifically review the amount of time the detection and confirmation of the emergency will require, and the time it will take to notify the local EMA of the emergency. This should be compared to the amount of time before the nearest affected downstream development is impacted by the flood flows associated with the emergency and the amount of time the local EMA needs to accomplish timely notifications and/or evacuations, if necessary.

USACE Lead Organization or Entity: Dam Safety Steering Committee (DSSC)

USACE Response: **Partially Adopted**

Action to be Taken:

USACE will conduct a comprehensive review of all applicable guidance and regulations and revise and/or provide clarification as necessary to ensure that updates, exercises, and reviews of EAPs are in accordance with the Federal guidelines.

- a. USACE will maintain certification of EAPs at District and Regional level. Effectiveness will be addressed through exercises on systems and/or on individual projects. USACE has a central database that tracks the existence and currency of EAPs. Note USACE is compliant with Federal Guidelines regarding EAPs. District Dam Safety Officers are responsible per ER 1110-2-1156 for development of EAPs as well as keeping the EAPs current, accurate and complete. Division Offices manage implementation and HQ provides oversight. HQ will review EAP metrics and make improvements to better assess EAP effectiveness.

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b. USACE will implement an agency-wide communication initiative to raise awareness and emphasize the vital importance of USACE, as the dam owner, in developing and maintaining close relationships with downstream local emergency management agencies. HQ s will address the topic directly with Division and District Commanders and senior leadership through a memorandum specifically addressing this issue. Public affairs and emergency management offices at all organizational levels will be tasked to develop effective communication tools to ensure that all staff is fully aware of the USACE’s roles and responsibilities as a dam owner.

c. Exercise guidance will address the information that local EMAs need to plan evacuation procedures. Policy improvements will utilize a scaled approach for annual meetings with local EMAs in consideration of risks: such as meetings not required for low hazard potential dams.

18. IEPR Comment – Category A – Critical: In the course of Division, District and on-site meetings, USACE staff were asked whether the lines of authority and responsibility throughout the Division with regard to the management of dam incidents, as they evolve in real time, were defined, clearly communicated, and understood by all personnel including on-site staff. The findings from these discussions varied from one Division to the next, but there were common observations:

a. Clear lines of authority are not defined within a Division (from the commander down to the project operators).

b. Authorities and responsibilities that are conveyed from commanders to staff are ad hoc and at the discretion of the Division and District commanders.

c. Evaluations (system analyses) have not been carried out to the degree the range of potential incidents that may be experienced and associated incident management challenges have been identified. Coupled with this is the fact project staff have not been trained to manage these events or know what their authorities and responsibilities are.

These findings reflect a gap in the USACE Dam Safety Program with regard to defining clear responsibilities for managing dam incidents.

The panel experts recommended the following actions to resolve this comment:

The USACE should undertake an effort to develop comprehensive incident management authorities and responsibilities. This effort should include the development of incident management training to include project operators.

USACE Lead Organization or Entity: Dam Safety Steering Committee (DSSC)

USACE Response: **Adopted**

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Action to be Taken:

USACE will undertake an agency wide review of dam safety incident management and make revisions to dam safety training and exercises to ensure emphasis is placed on lines of authority and responsibility for incident management. The lines of communication upward and incident management authorities and responsibilities of personnel on the ground will be evaluated and guidance developed and/or revised as necessary. Reviews of incident management procedures with project staff, and preferably involving local EMAs, will be incorporated into project specific dam safety training that is required on a five year frequency.

19. IEPR Comment – Category A – Critical: Based on survey responses, the Dam Safety Scorecard examples provided, and interviews, current project surveillance programs appear acceptable. On-site and District personnel are trained and understand the critical nature of their work. The data acquisition phase of a project instrumentation program appears adequate, but there are concerns that the data are not always reviewed and evaluated in a timely manner by experienced engineers. Lack of timely data reviews can lead to unacceptable levels of risk. Interviews uncovered a lack of reliable exception reporting, where reading changes beyond predefined limits are not flagged for priority reporting and response. Failure to adequately collect, interpret, and report findings in a timely manner is an urgent shortcoming.

The panel experts recommended the following actions to resolve this comment:

HQ should take a more active role in conjunction with the Divisions to ensure project engineers and project operators fully understand their roles with regard to their project instrumentation program. The panel strongly recommends that a review or audit program be developed and implemented quickly with each District DSO and DSPM for evaluating each project's instrumentation records. Developing a webinar might be useful to set standard file management practices and for training of project engineers and operators on processing and interpreting data. An integral part of a PA is the review of the historical instrumentation data. Prior to the start of a PA, the PA lead engineer should meet with the project engineer to review the instrumentation files and the quality of how the data is reduced and presented prior to the start of the PA panel work.

USACE Lead Organization or Entity: Dam Safety Steering Committee (DSSC)

USACE Response: **Adopted**

Action to be Taken:

USACE will develop a new course on dam instrumentation. Key instrumentation talking points and template slides will be extracted from the new course material to be used by district personnel when providing the required project specific dam safety training that is on a 5-year frequency per project.

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Each Division Dam Safety Program Manager will annually verify that all dams in the region have been adequately evaluated and documented. USACE will revise the existing routine dam safety program metrics regarding the instrumentation annual report to assure the report includes data evaluation and interpretation. USACE will develop and provide an annual instrumentation webinar. This webinar will cover standard file management practices and proper techniques and procedures for processing and interpreting instrumentation data.

It is USACE's intent that all projects are adequately instrumented and the resulting data collected is properly processed and thoroughly evaluated and interpreted. USACE will update the quality management system process for Periodic Assessments to clarify and strengthen the coordination between the PA team and the District project engineer responsible for the project's instrumentation data.

20. IEPR Comment – Category B – Urgent: Significant concerns were expressed to the IEPR Team related to poor data management of project files. Disorganized and incomplete files are resulting in lost time, budget overruns, and improper or unneeded project recommendations. While the panel cannot identify whether this is a widespread issue, it is of sufficient concern that actions should be taken to address the problem.

The panel experts recommended the following actions to resolve this comment:

HQ should develop quality audit team(s) to perform project file reviews for adherence with basic data management policies and procedures. Each project has an assigned project engineer who should be held accountable for his project file and data management. District DSO and the DSPM need to be engaged with the project engineers to ensure file and data management is receiving proper attention. Division DSO and DSPM should work with Division counterparts to standardize procedures and conduct periodic and routine reviews of project files.

USACE Lead Organization or Entity: Risk Management Center (RMC)

USACE Response: **Adopted**

Action to be Taken:

USACE will oversee development of standards, guidelines and other recommendations for dam project data storage, document and photo storage and the collection of legacy documents with assistance from the Divisions, RMC, and national centers. Additionally, HQ will provide oversight and support, directly and through the national centers, to the Major Subordinate Commands (Division DSO/DSPM) for Quality Assurance activities, including site visits to districts for periodic and routine reviews of project files. Metrics will be developed to provide HQ visibility and ensure accountability.

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21. IEPR Comment – Category C - Important: The USACE Dam Safety Program has implemented a fiscally responsible program to handle ‘non-routine’ (aka major) dam modifications. Funding for the ‘routine’ O&M of dams is somewhat problematic and competes with the operation and maintenance for all the other assets and programs within a District. District Commanders may not have a thorough knowledge of the project risks. For example, many USACE dams have large gate systems that are aged with known deficiencies. There is a significant degree of uncertainty that gates will operate as designed. Additionally, the use of the terms ‘routine’ and ‘non-routine’ in separating dam safety program activities may lead to diminishing the perceived value of O&M, along with activities such as PIs, PAs, and surveillance and instrumentation.

The panel experts recommended the following actions to resolve this comment:

A separate funding mechanism should be developed for operation and maintenance costs associated with project features that have a significant role in the operation of the project such as gate systems. Possibly a separate priority list can be developed for operating systems based on risk and consequences resulting from gate and other operating system failure, regardless of whether such failure is structural or operational. HQ’s DSO should work closely with District and Division Commanders to facilitate appropriate O&M funding levels for critical dam operation components. Division personnel should quickly review with new District Commanders the need for and the current status of major dam O&M requirements. To better differentiate critical dam safety project activities from the District-funded O&M work, consider replacing the ‘routine’ and ‘non-routine’ terms to better reflect the importance of all critical dam safety program activities.

USACE Lead Organization or Entity: Headquarters (HQ)

USACE Response: **Partially Adopted**

Action to be Taken:

USACE will not adopt a separate funding mechanism for operation and maintenance costs associated with project features such as gate systems. An additional funding mechanism or separate priority list is not consistent with transitioning to a risk-informed budget process. Additionally, such a “fenced” approach to budgeting unnecessarily complicates the dynamic prioritization of investments between projects, regions, and business lines. The highest life safety risk issues have generally not been gates.

USACE will adopt improvements to better prioritize O&M funding. The USACE Infrastructure Strategy (UIS) Asset Management (AM) team is developing and phasing the implementation of a risk informed prioritization process for all USACE asset investments. This initiative along with the Operational Risk Assessments (ORA) and Maintenance Management Improvement Plan (MMIP) will alleviate the possibility of de-emphasizing “routine” (e.g. preventive

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maintenance) activities by using a risk-informed approach and improved definitions of maintenance activities as referenced in the Budget EC.

22. IEPR Comment – Category C - Important: Of the new dam and levee safety oriented centers, RMC is most mature and historically most central to the Dam Safety Program. RMC actions and activities have been a focal point of the peer review process. RMC functions as the HQUSACE Dam Safety Program implementation, oversight and support entity. It appears to the panel that RMC is currently providing considerable production oversight and guidance for studies and designs; processes ultimately to be contained within the Dam Safety Modification Mandatory Center of Expertise (DSMMCX) and DSPCs. The RMC has very successfully staffed itself with considerable high-end dam engineering expertise that could significantly benefit a wider range of USACE dam safety needs than are defined in ER 10-1-55. The panel has heard from multiple sources that the stand up of the DSMMCX has been slowed by an inability to attract needed expertise to Huntington, WV.

The Districts hold command and control responsibility for dam projects (“The Commanders at each level of USACE have the ultimate responsibility for dam safety within their commands.”). While Districts rightfully would not choose to surrender that responsibility, in many locations, they appear to be eager to have allies willing to walk the path with them in collaboration and to offer them guidance and counsel along the way.

The panel experts recommended the following actions to resolve this comment:

Promoting service to customers is imperative in developing positive relationships between Centers and Districts, and in rebuilding expertise at Districts and Divisions. Centers will best advance the USACE dam safety mission by providing collaborative support for dam safety demands within the District’s mission. USACE should consider relocating the DSMMCX to Denver or co-locating a portion of the DSMMCX to Denver, where dam engineering expertise can be more readily attracted and where many of the DSMMCX and RMC staff can be readily borrowed and loaned to support both Centers as needed.

USACE Lead Organization or Entity: Dam Safety Steering Committee (DSSC)

USACE Response: **Partially Adopted**

Action to be Taken:

USACE Centers have adopted collaborative support for dam safety demands within the locales and regions for sharing technical resources. The DSMMCX is actively collaborating with the RMC to share resources and transfer knowledge to benefit both organizations. The DSMMCX frequently staffs developmental assignments at the RMC and will continue to seek these opportunities. DSMMCX staff will continue to actively participate in RMC sponsored training and training development to promote knowledge transfer across the Agency.

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The DSMMCX will continue regular communications, and to facilitate a focused discussion each month, with the RMC and DSPC Directors with the purpose of collaboration, promoting and enhancing knowledge transfer, and coordinating work sharing.

The RMC and the DSMMCX will continue to explore flexible recruitment options combined with the use of virtual resources to attract and retain the highest qualified individuals to the Centers. For example, the Centers are recruiting for positions that will allow interested individuals to select from multiple locations, including Denver, across USACE.

USACE will not adopt relocation of the DSMMCX. The activities described above demonstrate that complete co-location is not required to achieve coordinated efforts. The DSMMCX was located in Huntington, WV largely due to the dam safety talent that already existed there – a testimony to the ability to recruit talented professionals to Huntington, WV. This has enabled the DSMMCX to efficiently and expeditiously standup and staff to approximately 50% level. Therefore, relocation of the DSMMCX to Denver is undesirable due to the projected loss of many of the existing professionals.

23. IEPR Comment – Category B – Urgent: Current review processes entail redundant reviews of questionable value and focus. Review milestones are major stall points for project progress. It is reported that some units do not perform baseline calculation checks. Accountability for quality processes at the Division and District levels, and perhaps at Centers, is lacking. Concerns with quality processes are broad-based and have a common foundation across all reporting entities.

The panel experts recommended the following actions to resolve this comment:

Quality processes need significant attention. Quality reviews need to be improved to reduce schedule and budget impacts, and to focus on issues of importance to production and review personnel. Dam safety quality audit teams should be created to visit Districts and perform project file reviews for adherence with calculation checking, as well as with policies and standards of practice for quality reviews and comment resolution. HQ may want to consider quality compliance ratings that define a range of types and frequencies for future reviews based on audited compliance and process effectiveness.

Quality oriented behaviors should be incentivized, with rewards, including less frequent future audits and transition to “on-board review” opportunities for units with increasing levels of compliance. For units stubbornly out of compliance, formal critiques, and more frequent and intense audits are needed. Accommodation of on-board reviews that don't stall project development are recommended for those commands embracing quality review processes. The panel recommends that the ATR, IEPR Type II and Board of Consultants' concepts be integrated into an updated ATR concept (to the extent allowed by law), with outside experts added to ATR teams to eliminate the need for separate

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and sometimes overlapping appraisals. This recommendation better integrates independent (outside) perspectives into design guidance and review processes and helps to address the acknowledged shortage of senior dam engineering expertise.

USACE Lead Organization or Entity: Risk Management Center (RMC)

USACE Response: **Adopted**

Action to be Taken:

USACE will review and evaluate the performance of quality control and quality assurance efforts, guidance, procedures and processes with a focus on achieving efficiencies and improving quality, budget, and schedule performance. Opportunities for improving Division quality assurance audits of districts will be investigated. Existing Quality Management System policies will be reevaluated with a focus toward streamlining where possible. Opportunities for integration of ATR, Quality Control and Consistency, IEPR Type II and Board of Consultants' concepts, as well as early engagement of outside experts when necessary and frequent onboard reviews into an updated ATR concept will be thoroughly investigated. USACE has sufficient authority within current statutory requirements and implementation guidance to more effectively and efficiently integrate these processes.

24. IEPR Comment – Category C - Important: There is considerable concern regarding funding and, therefore, staffing levels to meet recognized demands. Based on economic conditions and political stalemates, it should be assumed budgets will continue to shrink. The panel was exposed to dam projects with engineering costs (planning through construction) well above 50% of construction cost. Private sector dam engineering costs for planning through construction are commonly in the range of 20% to 30% of construction cost. The panel was also exposed to project designs that were overly conservative and/or included misdirected design elements and/or approaches. Additional guidance and expert reviews beginning early in the dam safety modification process will provide significant benefits. DSOG deliberations exposed both technical and cost issues that are concerning.

The panel experts recommended the following actions to resolve this comment:

A “doing more with less” attitude needs to be broadly adopted. To the extent possible, USACE should benchmark the costs of dam design activities against other federal agencies and the private sector. The re-maturation of USACE dam safety expertise needs to include a significant focus on economy of design and construction along with the redevelopment of dam safety engineering expertise discussed in Finding 2013-B-26.

Enhancing design effectiveness, cost-effectiveness of construction engineering services and construction contract management will reap great benefits. Many elements fold into one another to compound benefits. More relevant and cost

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efficient construction measures reduce engineering costs. Better reviews improve direction, trim schedules and reduce costs. Dam safety leadership needs to undertake a thorough review of costs for engineering, effectiveness and judiciousness of designs, and construction cost management.

The Dam Safety Program needs to undertake a thorough review of:

- a. The utility of cost streams for engineering services
- b. The feasibility, effectiveness and judiciousness of design measures
- c. The costs to translate designs into completed remediation projects

Areas of improvement need to be prioritized, action plans developed to enhance performance standards and expectations, and accountability measures put into place to drive actions. The panel believes that the Dam Safety Program has the potential, over time, to improve the effectiveness of its work product delivery.

USACE Lead Organization or Entity: Dam Senior Oversight Group (DSOG)

USACE Response: **Adopted**

Action to be Taken:

USACE will undertake a comprehensive review of the Dam Safety Program processes and procedures and develop meaningful performance metrics designed to improve overall effectiveness of designs, reduce design and construction costs, improve product quality, and deliver risk reduction measures more quickly and efficiently. Some of the more complex and expensive dam safety projects in design and construction will be managed with mega-projects requirements, ECB 2013-11. Mega-project governance includes development of enhanced Project Management Plans (PMP) and cost and schedule control measures utilizing earned value management techniques.

HQ Senior Leaders and Engineering and Construction staff as well as Divisions, RMC and DSPC senior engineers will serve in an oversight and advisory role to the mega-project teams and provide a framework for structured, regularly scheduled vertical team interaction, including cost control and administration of project contingencies and approval of construction reserves.

The Divisions, RMC and Dam Safety Production Centers (DSPC) will work closely with Districts to formulate the enhanced PMPs for each project to implement the appropriate risk reduction measures and utilize appropriate level of resources to execute in the shortest time frame possible. Reviews that are required by law are being coordinated and implemented to reduce redundancies and time required to complete. Each project is required to develop a detailed

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Review Plan as part of the PMP that meets requirements of USACE quality processes and those required by law.

USACE will continue to interact with other Federal agencies on implementation and execution of dam and levee safety programs from a national perspective. USACE will engage other Federal agencies to review and compare costs. Recognized industry experts will be utilized early in the design and construction processes as part of Agency Technical Review (ATR) teams, as warranted, based on project size and/or complexity.

25. IEPR Comment – Category C - Important: Many IRRMs entail significant reductions in benefits, which can be tied to direct (hydropower) or indirect (flood protection, recreation, etc.) income streams and/or functions that benefit the public. IRRMs are many times used to defer structural measures. Benefits losses present collateral impacts that for some projects are reported to sum to many hundreds of millions of dollars. Risk-informed processes, discussed as separate findings, can equally be applied to characterize economic risks (and rewards). Where IRRM costs significantly reduce upgrading costs (singly and/or as systems), expediting expenditures can provide a net benefit.

The panel experts recommended the following actions to resolve this comment:

For IRRMs that are costly in terms of lost benefits, creative avenues should be considered to turn benefit losses into funding to accelerate structural upgrades. Creative cost sharing measures should be explored to accelerate restoration of full project operations. Accelerated benefits recovery should be central to project funding and scheduling discussions.

USACE Lead Organization or Entity: Institute of Water Resources (IWR)

USACE Response: **Adopted**

Action to be Taken:

USACE has established an Alternative Financing Product Delivery Team (PDT) as part of the overall USACE Infrastructure Strategy initiative. Pilot projects and case studies are being developed, including potential options using both existing authorities and potential new authorities for public-private partnerships that may be enabled by the Water Resources Development Act /Water Resources Reform and Development Act language currently being considered in the Congress. As part of the Alternative Financing PDT, USACE will work to develop a case study or pilot that prescribes opportunities to invest in Interim Risk Reduction Measures as an enabler for broader project development in Fiscal Year 15.

26. IEPR Comment – Category B – Urgent: Dam engineering has a great need for generalists who have an array of skills and experiences related to dams, their foundations and their ancillary structures. These multidisciplinary dam engineering

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skills are also an important foundation for Risk Cadres (discussed separately). USACE has depth of engineering expertise, but much of that expertise is focused within sub-disciplines (silos). USACE has a major decades-long backlog of dam remediation projects, and shares a broadly held recognition that its Dam Safety Program lacks sufficient dam engineering experience and expertise.

The panel experts recommended the following actions to resolve this comment:

Expanded development of dedicated dam engineering specialists is recommended to lead the execution of the USACE's major, long-term dam safety upgrading program. It is recommended that Divisions, Districts and applicable Centers be directed to earmark interested and capable engineers for an expanded developmental program for careers focused on dam engineering. The dam engineering consulting community should be better leveraged to provide additional expertise to bridge the shortfall in internal talent.

USACE Lead Organization or Entity: Dam Safety Steering Committee (DSSC)

USACE Response: **Adopted**

Action to be Taken:

USACE will work to expand development of dam engineering specialists throughout the agency. These specialists will focus primarily on dam safety engineering and will be supplemented as needed with private industry dam safety consultants. The DSMMCX will improve coordination among DSPCs and facilitate work sharing using national contract and developmental assignments.

USACE will strategically utilize dam engineering consultants when internal resources and expertise are constrained, or the programs/projects demand specialized expertise that is limited or unavailable in USACE.

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The dam engineering consulting community needs to be better leveraged to provide the additional expertise needed to bridge this shortfall. Increased engagement of outside expertise could provide the dual function of infusing USACE dam engineering teams with experiences representing independent value perspectives as well as providing enhanced opportunities for training and development of USACE dam design staff. An infusion of additional expertise is of significant benefit to the cost-effective development of designs critical to the USACE Dam Safety Program and to training a new generation of highly capable dam design engineers.

Finding: Dam engineering has a great need for generalists who have an array of skills and experiences related to dams, their foundations and their ancillary structures. These multidisciplinary dam engineering skills are also an important foundation for Risk Cadres (discussed separately). USACE has depth of engineering expertise, but much of that expertise is focused within sub-disciplines (silos). USACE has a major decades-long backlog of dam remediation projects, and shares a broadly held recognition that its dam safety program lacks sufficient dam engineering experience and expertise.

Recommendation: Expanded development of dedicated dam engineering specialists is recommended to lead the execution of the USACE's major, long-term dam safety upgrading program. It is recommended that Divisions, Districts and applicable Centers be directed to earmark interested and capable engineers for an expanded developmental program for careers focused on dam engineering. The dam engineering consulting community should be better leveraged to provide additional expertise to bridge the shortfall in internal talent.

5.9 Summarizing the State of the USACE Dam Safety Program

The previous sections of this report have identified findings and recommendations related to various aspects of the dam safety program. As a means of summarizing the state/maturity of the program, the panel used the Maturity Matrix approach to provide an aggregate assessment of the state of each program category. This is a high level use of the Maturity Matrix concept that gives the panel a means to communicate the overall assessment.

A Maturity Matrix is a visual decision-making tool that can be used to review program activities against regulatory requirements, industry standards, guidelines, and best practices (Bennett, T. and C. Sykes [2010] "Improving Communications Within a Dam Safety Program Using a Maturity Matrix Approach, Canadian Dam Association Conference"). It is presented as a matrix that is used to display the maturity of a program; in this case the USACE Dam Safety Program. Rows of the matrix correspond to specific program activities, categories or goals. Columns, moving from left to right, reflect increasing levels of maturity. When developed in detail, individual cells of the matrix refer to specific criterion or levels of accomplishment/achievement.

Based on a review of a particular program as measured against the established performance criteria, each program element is assessed with regard to its level of maturity. Cells or rows are shaded to highlight the level of maturity. In addition to characterizing the current state of a program, the Maturity Matrix can provide a systematic approach for identifying opportunities and priorities for improvement. A number of dam safety programs have begun to use the Maturity Matrix approach, including Ontario Power and the Ireland Electricity Supply Board. It is also being shared with CEATI's Dam Safety Interest Group.

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A first step in using the Maturity Matrix tool is to define the criteria or standard that will be used to evaluate each element of the program. The IEPR Team defined a set of criteria for each subject area in which findings have been made. A 'maturity scale' is defined in terms of broad categories/maturity levels:

- Developing
- Maturing
- Mature

These maturity levels have been selected specific to this review and were used as a general guide for the panel to provide an assessment of the maturity level of the dam safety program elements (i.e., they are not used as 'bins' [mutually exclusive categories]). In fact, the assessment of maturity is more of a continuous, sliding scale that depends on a number of factors, such as:

- How has the IEPR Team rated the findings?
- Are some or all of the criteria being implemented well?
- Are they being implemented at all districts and levels within the dam safety program?

The maturity levels provide a measure of the overall maturity of the dam safety program. Two of the three levels of maturity reflect the notion of a transitioning program or a work in progress, thus the characterizations of "Developing" and "Maturing." The last level indicates an achieved level of maturity. In the broader use of the Maturity Matrix approach, the center or middle level of the maturity scale could be interpreted as "Mature" and the far right of the scale would indicate transition to excellence, and/or exceptional.

Table 5.1 summarizes the criteria used to evaluate the maturity of each category. In a given category, if all criteria are being carried out well by all elements of the USACE, the program would be judged to be mature.

Table 5.1: Maturity Matrix Criteria for the USACE Dam Safety Program

Category	Criteria for Evaluating Maturity Level
Organization and Management	<p>A mature dam safety organization is one in which senior management of the dam safety program is:</p> <ul style="list-style-type: none"> • Properly staffed • The dam safety officer is dedicated full-time to the management and implementation of the dam safety program • Senior management provides oversight of the strategic direction of the dam safety program • The dam safety officer is the authority to obtain funds for and to address dam safety problems in a timely manner
Dam Safety Policies and Procedures	<p>A mature dam safety program has policies and procedures which are:</p> <ul style="list-style-type: none"> • Current and up to date • Well documented and consistent across disciplines • Well written and readily understood by those implementing or following them • Represent, at a minimum, the current state of practice in the industry • Consistent with a risk-informed management program • Reviewed by experts outside of the organization that developed them.
Risk-Informed Management	<p>A mature risk-informed management program is one in which:</p> <ul style="list-style-type: none"> • Risk-based evaluations are used to inform all major aspects of a dam safety program • Alternative levels of analysis are applied to meet programmatic and decision making needs • Uncertainties are appropriately evaluated • Decision making frameworks satisfy OMB guidelines • Staff has the educational background, training and experience to implement risk analysis methods and decision processes
Emergency Preparedness	<p>A dam safety program is mature with respect to emergency preparedness if:</p> <ul style="list-style-type: none"> • Emergency action plans have been developed for all dams • Emergency action plans are maintained • USACE personnel meet with local emergency managers annually • The public is provided information (inundation maps) about flood risks associated with controlled and uncontrolled releases from USACE projects • Lines of authority and responsibility regarding incident management have been developed, are clearly defined, and staff receive regular training

Table 5.1: Maturity Matrix Criteria for the USACE Dam Safety Program (continued)

Category	Criteria for Evaluating Maturing Level
Dam Safety Program Implementation	The implementation of a dam safety program is mature if the following criteria are met: <ul style="list-style-type: none"> • Standard reporting activities (dam inspection reports) are carried out in a timely and effective manner • Activities are carried out consistently • Resources are available to address time sensitive dam safety issues • Program activities such as design and construction are carried out efficiently and effectively • Dam safety regulations as defined in ER 1110-2-1156 are fully implemented and the quality of the implementation is carried out well and consistently throughout the USACE
Technical Capabilities for Dam Engineering	A dam safety program is founded on the fundamentals of dam engineering; geotechnical engineering, structural engineering, dam safety inspections, dam instrumentation and monitoring, etc. A program is mature if: <ul style="list-style-type: none"> • All engineering elements of a dam safety program are well staffed and well integrated • Regular dam safety activities (dam inspections, dam monitoring, etc.) are carried out on a reliable, timely basis and are well documented • Project staff are well trained to identify and respond to dam safety deficiencies that may be observed in the field

Based on the IEPR findings and the characterization (i.e., Urgent, Critical, etc.) of each finding, a consensus assessment of the maturity of each category was made. The findings are color coded:

- Developing – Red
- Maturing – Yellow
- Mature – Green

Figure 5.1 presents the IEPR summary of the maturity of the USACE Dam Safety Program in each of the six subject areas. The maturity of each includes a range that reflects:

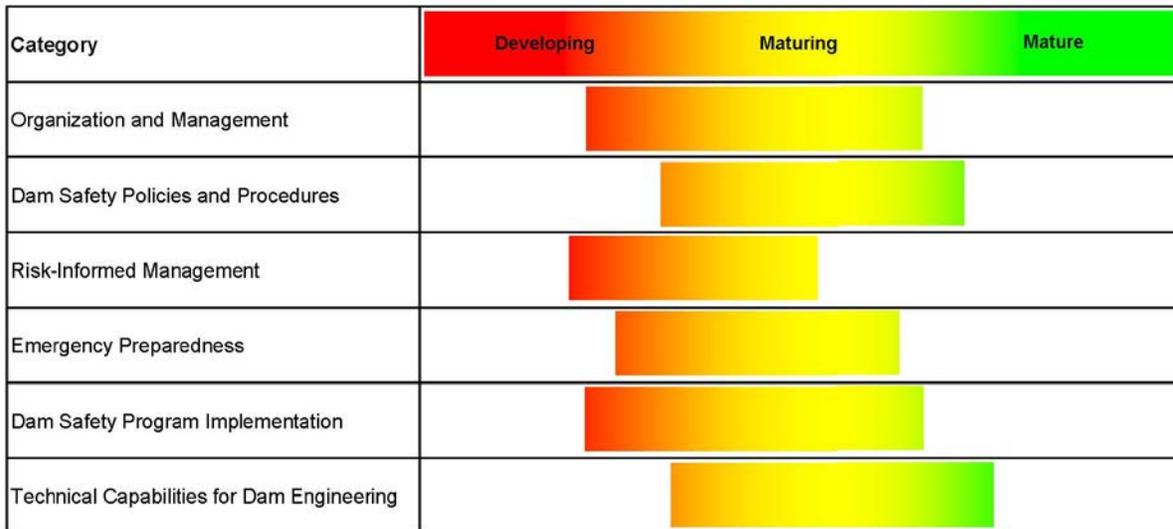
- The IEPR Findings and Recommendations in each category.
- IEPR Team consensus that is based on the range of individual member assessments, team discussion of the reasoning and basis for the assessments, and a final interpretation to reflect the assessed state of the program.
- Factors and inter-relationships between subject areas that are not necessarily reflected in the individual Findings (i.e., the impact of Organization and Management issues on downstream activities related to implementation).

For a given category, the width of the bar reflects the consistency or quality control (a variation in the quality of work that is being carried out), and/or incompleteness (e.g., something is missing or is not being carried out yet by all districts). Narrow bars suggest the IEPR Team finds that activities are being carried out consistently and completely; wider bars reflect negative diversity/undesirable variability.

Where a bar is placed along the maturity scale, it reflects the IEPR assessment of the general or central tendency of where the program is at this time. Overall the panel's assessment indicates the USACE Dam Safety Program is maturing (in a central tendency sense) in all categories. At the same time, there are

aspects in each category where there are areas of quality and/or incompleteness, while at the same time there are areas where a level of maturity has been achieved.

Figure 5.1: Maturity Matrix for the USACE Dam Safety Program



In summary, the Maturity Matrix reflects the IEPR assessment that the USACE Dam Safety Program has evolved significantly in a positive direction in the past decade – the course of the ship has been dramatically reversed. As a consequence, the Maturity Matrix provides a measure of the dam safety program that is generally mature (in a central tendency sense). At the same time, however, the process of maturing is ongoing. The width of the bars reflects the observations of inconsistency, incompleteness and/or the need for further development in all phases of the program. Undoubtedly, some (if not much) of this is a by-product of the considerable and ongoing evolution of an organization as large as the USACE, which is moving from a “procedure and standards-based” organization to one that is implementing risk-informed management. The IEPR Team is encouraged by the fact that a foundation is well-established, and is confident that USACE will continue to make improvements.

To provide further explanation of the Maturity Matrix concept, the “Risk-Informed Management” category can be expanded upon as an example. At the time of the 2001 ASDSO peer review and beyond (to 2005 or later), the assessment of the dam safety program approach to risk-informed management would likely have been depicted with a narrow, red bar (very consistent), anchored to the left of the chart. In less than a decade, there are elements of the program (with respect to risk-informed management) that are generally mature (the center of mass has changed); but there remains work to be done.

Risk-informed management is the core of the USACE Dam Safety Program. By any measure this represents a major paradigm shift for an agency that had been a traditional industry stalwart of ‘procedure and standards-based methods.’ This change was so significant that the Army was compelled to notify the OMB (USACE, 2008) of this change.

For the staff required to implement these changes, the shift has been even more dramatic as measured by:

- The need for new skills.
- The need for additional staff.
- A change for the staff and management in mindset and perspective when addressing dam safety issues that may be counter-intuitive to the standards-based methods in which they were trained.
- Broader dimensionality of risk-based evaluations.
- A realization that traditional approaches to dam safety evaluations which were ingrained in the USACE program were incomplete and/or mis-guided.

These and related factors define the backdrop and context for the significant changes and successes of the dam safety program. As senior management has found, it is a difficult task to move the agency into full-scale implementation of a risk-informed approach for dam safety management. What has been accomplished in a relatively short period of time is an impressive feat in itself.

The job of transitioning the agency is ongoing and incomplete. Within the broad spectrum of changes that have occurred, the IEPR assessment of the maturity of the dam safety program with regard to risk-informed management reflects our findings and discussions with USACE staff on a broad range of issues and a sharing of perspectives that provides insight into the mindset of those charged with successful implementation.

In addition to the IEPR specific findings, the assessment of the dam safety program's maturity with regard to risk-informed management reflects:

- Selected staff that has not embraced the concept of risk and risk management, either due to a lack of understanding or a differing philosophical perspective.
- A wide range of foundational educational and experience background throughout USACE with regard to probability, risk analysis and risk-management.
- A sense that not all staff is fully implementing all aspects of the risk guidelines (i.e., uncertainty analysis).
- Technical elements of the program which require updating or improvement.
- Apparent variation in the approaches that are used to perform risk analyses (i.e., expert elicitations).
- Variations in the quality of the analyses.

There appears to be a trend within the hydropower industry toward adopting the Maturity Matrix as a tool to evaluate their dam safety program. Among the advantages of using an approach like the Maturity Matrix is the level of detail it brings to the assessment of the program and the ability to measure progress over time. While this IEPR used the Maturity Matrix to provide a high-level programmatic assessment, the USACE could consider this approach to provide ongoing detailed programmatic evaluation.

5.10 Independent External Peer Review – Lessons Learned

Based on our experience with this peer review, the IEPR Team has developed the following “lessons learned” and recommendations for future peer reviews.

Planning and Development of IEPR Scope: USACE should provide future panels with clear expectations (a better defined scope at the time of the Work Order request). To the extent possible, allow in-coming IEPR Team representatives to participate in defining expectations and scope. Within the overall budget framework, allow the IEPR to engage HQ to collaborate in defining timing, travel

APPENDIX E

2013 USACE SURVEY QUESTIONNAIRE

2016 USACE Dam Safety Program (Program) Peer Review Survey Questionnaire

Organization (e.g. HQ, Center, Division, District): _____

Role of Individual Completing the Survey (Note that the intent is for responses to represent the consensus of your organization):

DSO DSPM Director Other: _____

This survey has been organized into several categories, with a general question regarding each category. For each of these general questions, please provide an overall rating (1 to 5) and respond in terms of key strengths, weaknesses, and suggestions for improvement. In responding to these questions, please consider whether the aspect of the program is:

- well established and consistently implemented across the USACE
- on the right path but not there yet
- on the right path but not implemented consistently from project to project
- not on the right path in important areas, inconsistently applied, etc.

The general question is followed by more specific questions with a request for another 1 to 5 rating and clarifying comments.

1. Organization and Management:

A. Provide your thoughts on the organization and management of the Program as it relates to effectively managing the USACE portfolio (consider all levels involved in the Program: HQ, Divisions, Districts, and Centers).

	Overall Rating from 1 (poor) to 5 (excellent):	
Strengths:		
Weaknesses:		
Suggested Improvements:		

B. Rate the following from 1 (poor) to 5 (excellent) and provide clarifying comments:

Interaction, collaboration, and communication between the various levels of the Program (Districts, Divisions, Centers, HQ):	
Interaction, Communication, and Delegation of responsibilities across levels at your [District, Division, Center], including roles of the Commander, DSO, DSPM, and staff involved in implementation of the Program:	

2. Program Policies and Procedures:

- A. Assess the direction of the Program with regard to the management of the USACE portfolio. Focus your response on the Program policies as described in ER 1110-2-1156. Is the regulation clear with respect to defining the USACE policies and procedures and does it provide appropriate and effective guidance for implementation.**

Overall Rating from 1 (poor) to 5 (excellent):		
Strengths:		
Weaknesses:		
Suggested Improvements:		

B. Rate the following from 1 (poor) to 5 (excellent) and provide clarifying comments:

Adequacy of Program policies and procedures:	
Timeliness of policy and procedure development and implementation. Are they changing too fast? Are they being implemented too slow?	

Completeness of coverage of Program policies and procedures:	
Clarity of the guidance for implementation of the Program policies and procedures:	

3. Program Implementation:

A. Appraise the direction and implementation of the Program, including:

- roles of the Divisions, Districts, Centers, and HQ,
- review processes, and
- coordination between design and construction.

This also includes funding mechanisms for both routine activities and dam safety issue evaluations and modifications.

Overall Rating from 1 (poor) to 5 (excellent):		
Strengths:		
Weaknesses:		
Suggested Improvements:		

B. Rate the following from 1 (poor) to 5 (excellent) and provide clarifying comments:

Current mechanisms for funding of the Program (routine and nonroutine):	
Effectiveness and value of review processes:	

Management of Instrumentation and other project data:	
Review of instrumentation data and response to outlier data:	

4. Analysis of Dam Safety Risks:

- A. Characterize the technical adequacy and effectiveness of the Program’s methods and practices with regard to the analysis of dam safety risks. For example, are risks being adequately and appropriately estimated; are the analyses technically sound and defensible?**

Overall Rating from 1 (poor) to 5 (excellent):		
Strengths:		
Weaknesses:		
Suggested Improvements:		

- B. Rate the following from 1 (poor) to 5 (excellent) and provide clarifying comments:**

Overall technical adequacy and effectiveness of the USACE risk analysis methods:	
Expertise and experience across all levels of the program (Districts through RMC and HQ) with regard to risk analysis:	
Consideration of operational risks (e.g. operations of outlet works, gates, etc. during a flood or emergency, which requires decision making from staff at multiple levels, reliability of mechanical equipment, off site factors such as upstream dams, etc.) :	

Consistency of application of semi-quantitative and quantitative risk analyses:	
Adequacy of risk analysis tools (e.g., training guidance, software):	

- C. Share your experience with and your assessment of the ongoing evolution of risk analysis processes and guidelines. Where do you see the program in five years, particularly as more quantitative risk analysis are completed and implemented? Where will these QRAs fit into the “Routine” aspects of the Program?

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5. Risk-Informed Management and Decision Making:

- A. Characterize the effectiveness of the risk-informed management of the Program and portfolio. For example, what is the value of risk analysis results (semi-quantitative, fully quantitative)? Are risks being reduced effectively? Are they being reduced in a timely manner?

Overall Rating from 1 (poor) to 5 (excellent):		
Strengths:		
Weaknesses:		
Suggested Improvements:		

- B. Rate the following from 1 (poor) to 5 (excellent) and provide clarifying comments:

Overall direction of the Program of risk informed management:	
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Overall implementation of the Program’s risk-informed decision making policies:	
Implementation of Interim Risk Reduction Measures:	
Value and consistency of application of semi-quantitative and quantitative risk analyses to sound risk-informed management of the USACE portfolio:	

6. Emergency Preparedness:

- A. Evaluate performance and responsiveness related to coordination, implementation and oversight of the Program’s emergency preparedness procedures, including incident response and emergency action plans.**

Overall Rating from 1 (poor) to 5 (excellent):		
Strengths:		
Weaknesses:		
Suggested Improvements:		

- B. Rate the following from 1 (poor) to 5 (excellent) and provide clarifying comments:**

Clarity with regard to authorities that are defined for all personnel from the Commander, to the DSO to onsite facility operators for decision-making during time critical emergencies:	
Effectiveness and frequency of coordination with local EMA personnel:	

Effectiveness of the Emergency Action Plan, including the contents of the EAP and regular testing of the plan:	
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7. Technical Capabilities for Dam Engineering:

A. Assess the Program with regard to developing and maintaining dam engineering technical capabilities.

Overall Rating from 1 (poor) to 5 (excellent):		
Strengths:		
Weaknesses:		
Suggested Improvements:		

B. Rate the following from 1 (poor) to 5 (excellent) and provide clarifying comments:

Identification and development of dam engineering specialists at all levels:	
Use of consultants to supplement in-house Program expertise:	
Internal and external training of dam safety staff:	

Use the area below to provide any additional comments that you think would benefit this peer review of the USACE Dam Safety Program

APPENDIX F

IEPR TEAM BIOS

2016 INDEPENDENT EXTERNAL PEER REVIEW (IEPR) OF THE USACE DAM SAFETY PROGRAM – IEPR TEAM BIOGRAPHIES

IEPR Three-Member Panel

Randall (Randy) Bass, PE
Principal
Schnabel Engineering

Randy Bass has been extensively involved with the dam safety community since 1978 when he started work with the newly formed Georgia Safe Dams Program (Program). Randy worked for the Program for six years, where for the last four of those years he was the manager. This Program was started from scratch with a staff of five and had to immediately ramp up to identify which of the over 5,000 dams in the state were high hazard and then develop a process of identifying the deficiencies. Processes had to be developed to prepare Phase I inspections with reports, notification of deficiencies to dam owners, and review of subsequent consultants' designs. Randy's experience in developing and managing a regulator dam safety program along with all the processes required to implement such a program, including training staff, educating dam owners, interfacing with the legal department, and developing fair and legally defensible criteria for determining hazard classification, and developing design review guidelines would be a benefit in carrying out the tasks as outlined in the USACE RFP for reviewing District Dam Safety Programs. Since leaving the Program, Randy has been a private consultant working in the dam inspection and design field and as a contractor building dams. He was the national water resources engineer for the Portland Cement Association where he interfaced extensively with various USACE district offices on the technical issues of RCC and soil cement. Randy served on the 2013 IEPR Panel for review of the USACE Dam Safety Program and two others IEPRs for the Sacramento and Nashville Districts.

Ignacio Escuder-Bueno, PhD, PE
Founding Partner
iPresas RISK ANALYSIS

Ignacio Escuder-Bueno has been a Professional Civil Engineer since 1996, and a University Professor at Universitat Politècnica de València (UPV, Spain) as well as promoter and associate founder of iPresas (a technology based SPIN-OFF company of UPV). He has been a Visiting Professor at University of Maryland (USA, 2014) and Utah State University (USA, 2006), and Teaching Assistant at University of Wisconsin-Milwaukee (USA, 1995-1996). He has been Chairman of the Technical Committee on Dams Computational Aspects of the International Commission on Large Dams (ICOLD) and Secretary-General of ICOLD European Club in the period 2010-2017. In 2016 he was appointed by the Spanish Minister of Environment as a member of the Spanish Commission for Legal Codes for Design and Safety of Dams.

Ignacio has been Principal Investigator in a number of Spanish and European competitive research projects on dams and flooding risk. He has authored or co-authored more than 100 publications including the Spanish National Committee on Large Dams (SPANCOLD) Guidelines on "Risk Analysis Applied to Dam Safety Management" (2012), and he is co-developer of the software iPresas, a risk analysis code suitable for dams and other infrastructures. For more than 20 years, he has worked as a consultant in areas related to safety studies, risk analysis and design projects concerning more than 70 dams and

hydropower facilities in Europe, America, and Asia. He regularly works as a consultant for the World Bank and the Inter-American Bank of Development on developing governance strategies for natural hazards, critical infrastructures, and dam safety.

Martin (Marty) W. McCann, Jr., PhD

President

Jack R. Benjamin and Associates, Inc.

Martin McCann, PhD, has been involved with dam engineering and risk analysis for dams for more than 30 years. Following publication of the Federal Guideline for Dam Safety, Marty and colleagues at Stanford University developed early methods for performing portfolio risk analyses and detailed risk analysis for dams. Following this project, the Stanford group held risk analysis training classes around the country for state, federal, and private sector professionals (mid-1980s). Marty has worked on numerous dam risk analyses and potential failure modes analysis projects. As part of his work at Stanford, Marty developed the first probabilistic method for using historical data and expert assessments to estimate the frequency of dam failure associated with 'sunny-day' failures such as seepage and piping, etc.

He has been an invited lecturer on applications of dam and levee safety risk analysis methods for over 30 years. Marty continues to participate in and offer risk analysis training courses for dams and levee systems, and teaches a course on risk management for critical infrastructure at Stanford University. He is also the Director and founder of the National Performance of Dams Program at Stanford University. Currently, Marty is working on several dam risk analysis projects including development and implementation of risk-informed approaches for hydropower projects. He is also working with a dam owner to evaluate the seismic risk of multiple dam failures that may simultaneously be impacted by a single large magnitude earthquake. As part of these studies, Marty is working with the owner's engineering staff and consultants to implement the risk analysis solutions. Marty served on the 2013 IEPR Panel for review of the USACE Dam Safety Program.

IEPR Project Manager

Gregory (Greg) Paxson, PE, D. WRE

Principal

Schnabel Engineering

Greg Paxson is Schnabel's National Practice Leader for Dams and has over 23 years of experience in analysis and design for dam engineering projects, for both evaluation and upgrading of existing dams and design of new dams. Specific experience includes hydrologic and hydraulic (H&H) analyses, gravity dam stability, design of hydraulic structures, including labyrinth spillways, roller compacted concrete (RCC), embankment seepage rehabilitation designs, and risk assessment. He has served as project manager, lead designer, or senior reviewer for more than 40 dam projects. He has also served as project manager for Type II Independent External Peer Reviews for USACE projects. He is a licensed professional engineer in seven states.

Greg has authored or co-authored more than 40 technical papers in the United States and internationally, primarily related to dam rehabilitation and H&H. Greg currently serves as Vice Chair of the ASDSO Advisory Committee and the Chair of the USSD Committee on Hydrology and Hydraulics. Greg was the Project Manager for the 2013 IEPR of the USACE Dam Safety Program.