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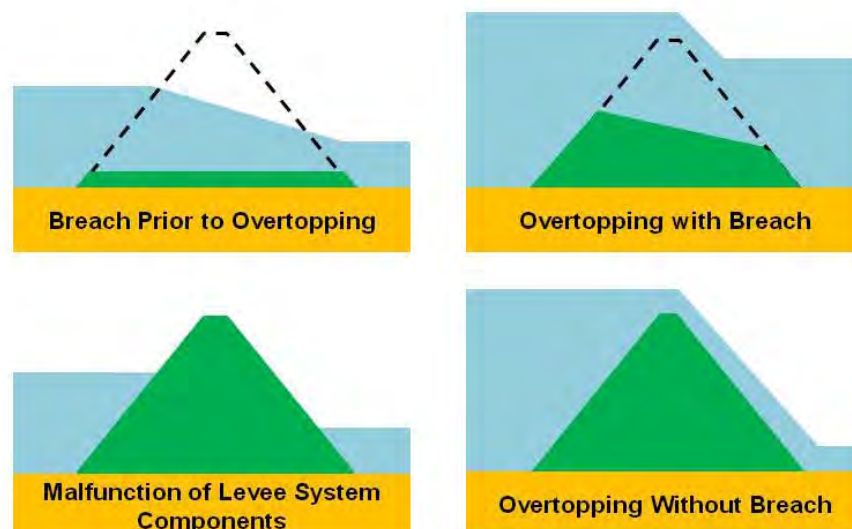
Subject: Interim Risk Reduction Measures (IRRM) for Levee Safety

Applicability: Directive and Guidance. The US Army Corps of Engineers (USACE) will use this directive and guidance for all levee systems in the USACE Levee Safety Program, which includes those 1) USACE operated and/or maintained; 2) federally authorized, typically USACE constructed, and locally operated and maintained; and 3) locally constructed and locally operated and maintained, but have been accepted into the USACE Rehabilitation and Inspection Program (RIP). Content of this Engineering and Construction Bulletin (ECB) will be incorporated into the future Levee Safety Program Engineer Circular (EC).

1. Introduction

Interim Risk Reduction Measures (IRRM) are actions to reduce inundation risks posed by a levee system that has identified levee safety issues while more long-term and comprehensive inundation risk reduction and management solutions are being pursued. “Inundation risk” is defined as the likelihood and consequences that may arise from inundation of a leveed area. For the USACE Levee Safety Program, four inundation scenarios have been adopted as defined below in Figure 1. Many IRRMs are good practice for levee operators and maintainers regardless of the levee condition. It is important to understand that IRRMs represent an important step in an ongoing adaptive risk management process that recognizes the dynamic nature of sources of inundation risk. In establishing IRRMs, the prevention of loss of life is paramount, followed by prevention of high economic or environmental losses. The IRRM Plan (IRRMP) is intended to reduce the probability and consequences of inundation risk of the leveed area from the four inundation scenarios. These four scenarios are to be addressed in the IRRMP.

Figure 1. Inundation Scenarios



2. When to Develop and Implement an Interim Risk Reduction Measures Plan (IRRMP)

The development and implementation of the IRRMP is “triggered” for levee systems that have the potential for loss of life and/or high economic or environmental consequences. This can be caused by different natural events or specific levee safety activities that indicate a need for additional risk reduction measures beyond ordinary operations and maintenance. Those triggers include, but are not limited to, the following:

- a. Routine, Periodic or Special Inspections that indicate operation, maintenance and/or performance concerns.
- b. Flood events, emergencies or incidents revealing performance issues with levees (e.g. seepage, instability, erosion, etc. that could threaten levee integrity).
- c. Risk assessments, such as Levee Screenings or other types, which indicate safety issues (i.e. Levee Safety Action Classification (LSAC) I, II or III).
- d. Deviations to an approved water control plan to reduce potential consequences.
- e. System-wide Improvement Framework (SWIF) request by a levee sponsor. Reference Memorandum CECW-HS, “Policy for Development and Implementation of System-Wide Improvement Frameworks (SWIFs)” dated 29 Nov 2011.
- f. I-wall evaluations that did not pass the Phase II criteria. Reference “Phase II Interim Guidance for Evaluating Existing I-Walls” dated 25 Oct 2006.

3. Interim Risk Reduction Measures Plan (IRRMP) Content

The general content of the IRRMP should include the following:

- a. Overall levee system description and purpose. Include the National Levee Database (NLD) identification number.
- b. Overview of identified potential failure modes associated with the four inundation scenarios in Figure 1.
- c. General consequences associated with each identified potential failure mode as associated with the four inundation scenarios.
- d. Structural and nonstructural IRRM alternatives, examples are in Paragraphs 5 and 6, considered to reduce the probability of inundation or consequences in the leveed areas associated with the four inundation scenarios.
- e. General discussion of potential consequences and impacts on project purpose, environmental considerations, and economics associated with the IRRMs, both positive and negative.
- f. Recommended IRRMs and risk informed justification for each recommended IRRM.
- g. Schedules and costs associated with implementation of IRRM recommendations.
- h. Schedule and costs associated with a more detailed risk assessment, if needed, to better evaluate IRRMs.

- i. Communication plan (internal and external). The plan shall specifically address communication with all responsible, affected, and interested stakeholders, including the public.

4. Formulation and Prioritization Factors for Interim Risk Reduction Measures (IRRM)

Life safety must always be given a higher priority over all other project purposes and benefits.

In formulating and prioritizing IRRM, it must be kept in mind that each levee system has its own unique attributes that have to be addressed on a case by case basis using expert judgment. The following questions should be considered when determining appropriate IRRM:

- a. How will the probability of inundation of the leveed area and the associated consequences be reduced using structural and nonstructural measures?
- b. Is it ensured that implementation of the IRRM will not increase the life safety risks at any time?
- c. Have the IRRM been assessed for potential adverse impacts to the levee system, including the areas upstream and downstream of the levee system?
- d. Does the IRRM increase the level of confidence that any changes associated with the levee safety issue (failure mode) will be promptly detected?
- e. Does the IRRM increase the confidence that emergency management agencies will be notified promptly when a levee safety issue is detected?
- f. Does the IRRM increase the warning time and effectiveness of evacuation of the population at risk?
- g. Does the IRRM reduce the probability of the initiating load (for example, if adjusting an upstream reservoir water control plan - discuss the consequences of changing the reservoir water control plan)?
- h. Does the IRRM preserve the public trust and address stakeholder issues?
- i. Is the degree of confidence or uncertainty in understanding the scope of the problem and effectiveness of the interim solution improved?
- j. Can the IRRM be incorporated into permanent solutions?
- k. Are there impacts to the authorized project purposes or other project benefits?
- l. Do the recommended IRRM maximize cost effectiveness?
- m. Has the recommended IRRM considered any social disruption and environmental impacts?

5. Examples of Nonstructural Interim Risk Reduction Measures (IRRM)

- a. Develop or update a levee system-specific Flood Warning and Emergency Evacuation Plan (FWEEP) that reflects system-specific risks and includes emergency exercises that are appropriate for the risk involved. A coordinated FWEEP addresses who, what, when and how the flood warning and emergency response will be executed. The FWEEP should include an explanation of flood warning procedures, emergency notification, evacuation routes, trigger elevations, monitoring, detection and flood fighting. The FWEEP should also include inundation mapping that illustrate consequences of potential failure mode(s). The FWEEP should describe the actions

by the entity responsible for levee system operations and maintenance in the event of a flood or hurricane, earthquake or natural disaster type emergency. The FWEEP document should be complementary to the Federal Emergency Management Agency (FEMA) All Hazards Mitigation Plan requirement and the Comprehensive Preparedness Guide 101. See also the US Army Corps of Engineers; “General Guidelines for Comprehensive Flood Warning/Preparedness Studies” dated October 1988.

- b. Develop specific response plans with specific “trigger” conditions to activate plans. For example, use stream gages, instrumentation and monitor visual indicators as “trigger points” or threshold limits to initiate more urgent or emergency response. This includes contingency plans or “what’s next type planning” if initial actions prove ineffective.
- c. Conduct appropriate emergency exercises that plan for a range of failure scenarios (including the combined effects of multiple failure modes and different timing of detection). Train existing and/or additional personnel for prompt and effective emergency response. Exercises should include setting closures on a routine basis.
- d. Pre-position emergency supply contracts or stockpile emergency materials, such as, rock, sand, sand bags, emergency bulkheads, or other operating equipment or supplies.
- e. Consider temporary deviations to upstream reservoirs water control plan within existing authorities and policies to reduce the potential impact of known levee deficiencies.
- f. Improve and/or increase inspection and monitoring pre-flood event, during and after the flood event to detect evidence of worsening conditions. Map and document levee system performance. For example, identify seepage areas and the related water level when the seepage started. Use this information to guide repairs and pre-flood preparation for future events.
- g. Conduct appropriate engineering investigations and analysis to confirm potential failure modes.
- h. Adapt local National Levee Database processes to accommodate use during emergency response.
- i. Collaborate with federal, state and local agencies, including the National Weather Service, FEMA, and state and local Emergency Management Agencies (EMAs). More specifically, ensure collaboration with state Hazard Mitigation Officers and state National Flood Insurance Program (NFIP) coordinators. Work with existing interagency teams when available.
- j. Work with the local communities to promote flood mitigation and emergency response. Inform them of opportunities and resources available to complete activities that reduce risk and provide reduction in NFIP premiums through FEMA’s Community Rating System and other programs (www.fema.gov).
- k. Create and implement a communication plan to actively advise people about the levee condition and potential inundation risk, flood insurance availability and FWEEP measures. Ensure information about flood insurance, flood risk, floodplain management, and evacuation is readily available, for example, through direct mailings, community events, community websites and social media, local television and print media, and at the local library.

- l. Enact and enforce regulations that exceed FEMA's NFIP minimum standards.
- m. Prepare, adopt, implement, evaluate, and update a comprehensive floodplain management plan, which may include zoning. Acquire, relocate, or retrofit existing buildings and maintain drainage ways and retention basins.
- n. Reinforce landward critical facilities (e.g., medical and emergency services).
- o. Additional information on nonstructural alternatives can be found on the USACE National Nonstructural Floodproofing Committee (NFPC) website. Link is as follows: <http://www.nwo.usace.army.mil/nfpc/>.

6. Examples of Structural Interim Risk Reduction Measures (IRRM)

- a. Isolate problem area (for example construct sub-levee around failed gravity drain(s) or other levee feature to reduce head differential).
- b. Construct or improve seepage control measures to retard seepage and reduce uplift, such as toe drains, relief wells, riverside or landside seepage control blankets, or shallow cutoff trenches.
- c. Implement a target grout program specifically for suspected problem area(s) to slow seepage.
- d. Increase resilience to overtopping.
- e. Increase erosion protection at waterside toe where necessary.
- f. Lower levees along the downstream perimeter until the levee can safely withstand design water levels (this may result in more frequent interior flooding).
- g. Construct landside stability-berm to strengthen weak areas.
- h. Evaluate internal drainage features, such as ponding areas, and consider alternatives such as additional pumps, to address potential issues.

Note: Structural measures may require Section 408 approval processes to be followed for federally authorized-locally operated and maintained levee systems.

~~**7. USACE Operated and/or Maintained Levee Systems**~~

~~USACE Districts that operate and/or maintain levee systems that require IRRMs shall develop the levee system specific IRRMP. The District is to implement the IRRMs for all high consequences levee systems as aggressively as possible and preferably prior to the next flood season. District IRRMPs shall be approved by the District Levee Safety Officer (LSO) and copied furnished the Major Subordinate Command (MSC) LSO. Changes to the IRRMP shall be formally approved by the District LSO and furnished to the MSC LSO. Within 90 days of approval of the IRRMP, the District shall develop and implement a communication plan that is coordinated through the appropriate public affairs offices at the MSC and HOUACE as needed. Funding for IRRMPs preparation and implementation of IRRMs for USACE operated and/or maintained levees will be from the general Operations and Maintenance account or project specific appropriations, if applicable.~~

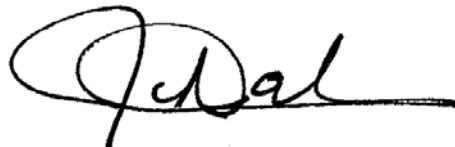
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8. Federally Authorized-Locally Operated and Maintained Levee Systems and Non-Federal Levee Systems

For the federally authorized-locally operated and maintained levee systems and non-federal levee systems in the USACE Levee Safety Program, development and implementation of IRRMPs will be the levee sponsors' decision. Based on information from the Levee Safety Program activities as described in Paragraph 2, USACE will advise the levee sponsors of identified levee safety issues and recommend the need for IRRMs. It is ultimately the responsibility of the levee sponsor to develop and implement the IRRMs. USACE Districts may use levee safety funding (Inspection of Completed Works or Flood Control and Coastal Emergencies (FCCE) accounts) to advise levee sponsors in the development of their IRRMP. In addition, potential programs for joint collaboration of IRRMPs include the Silver Jackets Program; Planning Assistance to the States (PAS); and Floodplain Management Services (FPMS).

9. The implementation point-of-contact for this action is the District Levee Safety Program Manager (LSPM). The HQ technical proponent is Ms. Tammy Conforti, HQUSACE LSPM, 202-761-4649.



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