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MEMORANDUM

TO: Chau Vo, P.E.

FROM: John R. King, P.E.

SUBJECT: Lake Medina Dam
Recommendations for Follow Up to the July 2002 Flooding

DATE: July , 2002

Our inspection report, issued July 11, 2002, documents our findings, assessments and recommendations made to the TNRCC on July 5 and 6, 2002. Following are our recommendations with respect to post-flood follow up assessments:

1 Early Warning Criteria. Early warning criteria should be developed as soon as possible. Our July 6 recommendation was to not allow the reservoir to overtop or to flank the dam. Criteria needs to be developed to allow BMA's on-site operations staff to predict the time it will take for the reservoir to reach critical stages and thus allow a timely early warning notice to be issued.

2. Revisions to Existing Stability Analyses. We understand that several engineering firms, the U. S. Army Corps of Engineers (USACOE), and the U.S. Bureau of Reclamation (USBR) have assessed the stability (structural and hydraulic) of the dam since the 1970's. We recommend that the hydraulic and seepage conditions we observed during the flood event be used to calibrate the past stability analyses. The analyses should also assess compliance with the required factors of safety against sliding and overturning failures for floods up to the Probable Maximum Flood (PMF).

3. Assessment of Horizontal Lift Joints. On July 6, 2002, we observed evidence of seepage having exited 300 feet along the highest horizontal lift joints in the left abutment and river concrete gravity sections. The stability of the lift joints should be assessed, under the assumption that the lift joints are pressurized, in accordance with USACOE and USBR criteria.

4. Assessment of Foundation Stability Along Right Abutment. We observed substantial seepage and concentrated leakage exiting the rock foundation outcropping immediately downstream of the right abutment's concrete gravity section. This foundation zone should be investigated and the sliding and overturning stability of the concrete gravity section along this zone should be assessed.

5. Assessment of Scour Potential Around Right Abutment. During the inspections we witnessed active erosion around the right end of the right abutment's concrete gravity section. The hydraulic conditions at the abutment should be assessed with respect to the potential for breaching the right abutment.

6. Assessment of Emergency Spillway Erosion Cutback. We did not see evidence of the "lip" of the emergency spillway actively working its way back towards the right end of the dam or towards the reservoir; however, the flow conditions were very turbulent. The erodibility of the "lip" of the emergency spillway should be assessed, including any necessary stabilization (e.g. rock stitch anchors). The post-flood condition of the emergency spillway should be surveyed for future reference and for predictions of the rates of erosion.

7. Assessment of Foundation Scour along Toe of Dam. After observing the minimal tailwater within the river channel, the bedded and fractured limestone foundation zones that were visible, and the turbulent emergency spillway discharges, we strongly felt that if the concrete gravity sections had been overtopped, the foundation materials along the toe of the dam very likely would have eroded, and very likely would have precipitated a sliding or an overturning failure. The erodibility of the foundation materials needs to be assessed, especially assuming hydraulic impact pressures approaching full reservoir head. If the concrete gravity sections are to be allowed to be overtopped across the entire length of the crest, then alternative means for scour protection and foundation pressure relief should also be assessed. This assessment should include the abutments and river sections.

8. Assessment of Alternative Means to Prevent Overtopping. The revised stability analyses and the assessments of foundation scour should be used to determine if the costs and risks are reasonable to allow the concrete gravity structures to be overtopped (with appropriate protective measures). However, if it is not feasible to allow overtopping, then alternative means to prevent overtopping should be assessed (e.g. increased emergency spillway discharge capacity, raising the crests of the concrete gravity sections, providing operable flood gates, etc.).

9. Monitoring System. A more formal and comprehensive monitoring system is needed at the dam, including:

   a. automated piezometers (to measure foundation pressures),
   b. automated inclinometers (to measure structural and foundation movements),
   c. weirs (to measure seepage flow rates),
   d. automated lake level gage (to measure headwater and tailwater levels).

10. Outlet Works. The three outlet works should be immediately rehabilitated. If ever the dam were to undergo distress, the outlet works are the only means to lower the lake once the lake level falls below the emergency spillway crest. Since the valves are at the downstream face of the dam, the conduit running through the dam is subjected to full reservoir pressure whenever the valves are closed. It is not advisable to have a pressurized conduit through the dam under normal non-discharge conditions. If the valve(s) fail, then it will be very difficult,

if not impossible to block off the intake. Also, if the concrete gravity sections are allowed to be overtopped, then the outlet works valves, housing, and chute will be subjected to the full impact pressures of the overtopping flows.

Vegetation. All vegetation should be removed at least 50 feet away from the downstream toes of all concrete gravity sections and from around the foundation outcropping seepage areas. There needs to be unobstructed view and access (foot and vehicle) to these areas.

12. Tailwater. A tailwater staff gage is needed to measure tailwater levels.

13. Discharge Rating Curve. The discharge rating curve for the emergency spillway needs to be revised to reflect the irregularly-shaped apex of the "lip" of its control section (i.e. the crest length should be the "lip" length) and which takes into account any cutback erosion that has eroded the "lip" alignment and thus increased its length.

14. Reservoir Stage Staff Gage. The location of the staff gage should be moved further within the reservoir, outside of the drawndown effects of the emergency spillway flows and outside the standing waves.

15. Documentation. At least one copy of all construction drawings, inspection reports, stability analyses, maps, O & M manuals, Emergency Action Plan, inundation mapping, etc. should be kept on site at all times.

Breach Analyses and Inundation Mapping. Breach analyses should be performed to assess the breach impacts of floods up to the PMF and for "sunny day" conditions for potential failure modes under existing conditions, and for potential failure modes under any proposed, rehabilitated conditions. Breach analyses should extend downstream along the Medina River to the point where breach conditions are within one (1) foot of non-breach conditions. The breach analyses should provide breach wave hydrographs, travel velocities, and stages at critical locations along the river. The breach analyses should also result in the development of inundation mapping with breach wave travel times (i.e. warning time) to be used by local emergency management officials to evacuate the downstream populace.

17. Emergency Action Plan. A formal, comprehensive emergency action plan (EAP) should be developed to provide guidelines for reactions and communications to a wide variety of dam-related emergencies. The EAP should incorporate the results of the breach analyses and inundation mapping. The EAP should also dovetail with local emergency response capabilities and resources. Clear lines of communications, duties, responsibilities, and authority should be identified and agreed upon by the dam owner and all public officials. Public hearings should be conducted within the local communities to educate the public on the EAP.

18. Annual Dam Safety Inspections. There should be a formal, comprehensive dam safety inspection performed on an annual basis. All instrumentation data should also be assessed annually and after flood events.

19. Periodic Dam Safety Re-Assessment. Every three to five years, there should be a re-assessment of instrumentation data, of the stability of the dam, of the scour potential of the dam, of the EAP, and of the dam's dam safety program in general. This re-assessment should also occur after every major flood event, especially if the emergency spillway engages.

20. Peer Review Board. An independent Peer Review Board should be convened to assess the current condition of the dam and to make recommendations.