State of Colorado

Department of Natural Resources
Division of Water Resources
Office of the State Engineer
Dam Safety Branch

GUIDELINES FOR EARLY WARNING SYSTEM PROGRAMS

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TABLE OF CONTENTS

Section 1. **Purpose**

The *Guidelines for Hydrologic Hazard Analysis* states, "Any proposed early warning system that would serve to reduce expected life loss consequences from overtopping (or other hydrologic failure mode) dam failure must be prepared in a written plan, reviewed and approved by the Colorado Dam Safety Branch."

This document establishes minimum requirements and provides guidance for an Early Warning System Program (EWSP). The primary purpose is to develop an effective framework to notify, warn, and move the population at risk (PAR) out of harm's way in the event of an overtopping failure.

Section 2. **Background**

An Early Warning System Program (EWSP) is a risk reduction measure for High- and Significant-Hazard dams to provide advanced warning of an impending hydrologic event that could lead to a dam failure. EWSP's will be used to reduce the potential consequences of dangerous reservoir releases from large spillway flows and/or dam breach flows to the downstream PAR.

EWSPs are not required on dams in Colorado but may be used at candidate dams as a means to reduce the hydrologic hazard category and thereby reduce spillway design and construction requirements.

An effective EWSP is a well-coordinated effort between the dam owner, dam owner's engineer, local and state emergency management, National Weather Service (NWS), and a representative of the Colorado Dam Safety Branch. Other EWSP stakeholders may be included as appropriate based on the dam location and downstream impacts. The EWSP must include consideration of effective means and methods to detect, verify, alert, and take action on extreme hydrologic events.

Section 3. **Minimum Requirements**

Dam owners contemplating development of an EWSP to reduce the risk at their dam are required to perform an EWSP feasibility study. The EWSP feasibility study should be prepared to assess roles and responsibilities of all identified stakeholders, site constraints and costs. The EWSP feasibility study should include estimated equipment capital costs, annual maintenance and training costs, and costs for any third-party contractors.

The EWSP must establish and document equipment needs and communication protocols for the necessary emergency event detection, verification, alerting and response actions during an EWSP detected event. The following are key components of an effective EWSP feasibility study:

- Minimum physical equipment for event detection should include a reservoir level instrument (e.g., air bubbler system) with telemetry and remote data acquisition capabilities (e.g., uplink data in a timely manner to warning entities such as NWS and emergency managers). Redundancy for equipment should be considered.

- The plan must define requirements for regular maintenance, monitoring and testing of all installed equipment.

- The EWSP feasibility study should include adequate discussion of reliable means of verifying detected events.

- To provide for event verification and redundancy, additional equipment such as stream gauges (e.g., flumes and weirs), instrumented seepage weirs, rainfall gauges, and/or piezometers may be incorporated into the EWSP based on owner discretion and stakeholder needs.

- Communication (alerting) and response (actions) protocols must be established and described in the dams Emergency Action Plan (EAP). The EAP shall be prepared in general accordance with Rule 13.7.1.

- The EAP should include three inundation maps: (1) A modeled sunny day dam breach map, (2) a modeled event with the spillway operating at maximum capacity (no overtopping) and (3) a reservoir release from an overtopping dam failure.

- The methods of alerting (i.e., TV, radio, social media) and responsibilities for developing messaging and delivering alerts should be discussed with stakeholders and clearly described in the EAP.

- To ensure continued EWSP reliability, the EAP must be tested through annual EAP exercises. The EWSP should be reviewed annually by all key stakeholders as part of EAP exercises.

Review and approval of the EWSP by all stakeholders is required prior to acceptance of any such project by the State Engineer. The State Engineer will issue an acceptance letter upon approval of the EWSP by stakeholders and a final SEO inspection once the system is operational. Proper maintenance, operation, and exercising will be reviewed during annual physical inspection of the dam to confirm the EWSP continues to meet these minimum requirements.