

## Introduction

This report was prepared for the Waterways Experiment Station, headquarters of the U.S. Army Engineer Research and Development Center. The goal is to provide documentation on methods and instrumentation that can be used to monitor seepage in dams.

Failure by erosion and piping caused by seepage is a potential failure mode for dams. Approximately 1 in 200 earth embankment dams fail due to piping and 1 in 60 dams have a piping incident (Fell et al. 2003). Therefore monitoring seepage effectively, at a frequency to detect problems before any potential failure initiates, is an essential part of a dam safety program. This document details the methods used to monitor seepage in dams, the frequency of monitoring, and what seepage conditions warrant further investigation.

Seepage can be monitored by quantity, location, or pressure. This document categorizes seepage as these three types. For each type, methods and instruments used to monitor the seepage are discussed. Frequency of monitoring for each type of seepage is a function of consequences and potential for failure due to erosion and piping.

**Table 1 Percentage of dam failures by mode (Foster et al. 2000a)**

<b>Mode of failure</b>	<b>% of total failures</b>
Piping through embankment	31
Piping through foundation	15
Piping from embankment to foundation	2
Slope instability	4
Overtopping	46
Earthquake	2

## Seepage Types

In order to monitor seepage effectively, the source and location of the seepage must be understood. Seepage in earth dams can occur in three different areas: through, under, and around embankment dams. Seepage can also occur as a combination of these areas.