OWRB Dam Safety:

# Hazard Potential Analysis Guidelines

## Background

The OWRB defines the hazard potential classification of a dam by the downstream risk in the event of a failure without regard to the physical condition of the dam.[1] The hazard potential classification is descriptive of the development of the area downstream of the dam and represents the possible consequences to human life and property should a particular dam fail. **The hazard potential classification is subject to change based on changes in downstream development.**

For dams that were inventoried in the National Safety of Dams program which have a "Phase I" report, the hazard classifications set forth in such "Phase I" reports shall be presumed accurate. If the owner of the dam disagrees with the currently assigned hazard potential classification, the owner shall hire a professional engineer to contest the hazard potential classification.[2]

The OWRB can provide technical assistance in determining the hazard potential classification, but it is ultimately the responsibility of the owner to provide the OWRB with a comprehensive hydraulic and hydrologic report with evidence to determine the appropriate hazard potential classification.

## Hazard Potential Classification Levels

The three hazard potential classification levels are defined as:

**Low:** Dam failure would result in no probable loss of human life and low economic losses.

**Significant:** Dam failure would result in no probable loss of human life but can cause economic loss or disruption of lifeline facilities.

**High:** Dam failure will probably cause loss of human life.

“Loss of human life” is defined as the human fatalities that would result from a failure of the dam, excluding the occasional passer-by or recreationist and without considering evacuation or other emergency actions.[3]

## Dam Size Classifications

The size classification of dams is defined as: [4]

| Size Category | Maximum Storage (acre-feet) | Maximum Height (feet) |
|---|---|---|
| Small | < 10,000 | < 50 |
| Intermediate | 10,000-50,000 | 50 -100 |
| Large | > 50,000 | > 100 |

## Probable Maximum Flood (PMF)

The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic conditions, defined as the Probable Maximum Precipitation (PMP), and critical hydrologic conditions that are reasonably possible in the region.[5]

The *Regional Probable Maximum Precipitation Study for Oklahoma, Arkansas, Louisiana, and Mississippi* (Applied Weather Associates, 2019) shall be used in determining precipitation depth, area, and duration relationships for the PMP.[6] PMP data should be obtained using the OWRB's PMP Data Download tool. The most conservative PMP storm type and duration from the PMP data download tool should be used to adequately reflect the size and hydrologic characteristics of the watershed in which the dam is located.[7] The methods described in Hydrometeorological Report No. 52[8] should be used to calculate the PMF from the PMP. For more information on PMP and PMF calculations see OWRB's Hydrologic and Hydraulic Guidelines for Dams in Oklahoma.

The required design flood is listed in the minimum spillway performance standards and is a percentage of the calculated PMF based on the size and hazard potential classification of the dam. **No adjustments to the precipitation data should be made.** Flood design calculations must fall within 5% of the Board's current model results.

## Minimum Spillway Performance Standards

The minimum performance standards expressed as magnitude of spillway design flood and minimum freeboard are assigned based on size and hazard potential classification.[9] Spillway capacity for dams constructed prior to June 13, 1973, can be found in OAC 785:25-3-6(e).

| Minimum Spillway Performance Standards | | | |
|---|---|---|---|
| Size Category | Hazard Potential Classification | Design Flood | Minimum Freeboard |
| Small | Low | 25% PMF | 0 Feet |
| Small | Significant | 40% PMF | 0 Feet |
| Small | High | 50% PMF | 1 Foot |
| Intermediate | Low | 25% PMF | 1 Foot |
| Intermediate | Significant | 50% PMF | 1 Foot |
| Intermediate | High | 75% PMF | 3 Feet |
| Large | Low | 50% PMF | 1 Foot |
| Large | Significant | 75% PMF | 1 Foot |
| Large | High | 100% PMF | 3 Feet |
| Non-Jurisdictional Size | High | 25% PMF | 0 Feet |

## Identification of Potential Downstream Hazards

Downstream hazards are identified persons, property, or other designated areas downstream which would be directly impacted in the event of dam failure. Since all possible downstream hazards may not be well defined, any high usage areas should be evaluated and considered.

To determine if a location downstream could be potentially hazardous, the impacts based on peak depths and velocities at permanent and temporary structures, roadways, railways, and dams in the breach inundation area should be evaluated. When determining the potential persons at risk, no allowances for evacuation or other emergency actions by the population should be considered. The OWRB refers to the Assistant Commissioner – Engineering and Research (ACER) Technical Memorandum No. 11 by the U.S. Bureau of Reclamation[10] regarding depth and velocity determinations for hazard potential classification.

Any roadway that crosses a dam or is located below a dam that would be overtopped at any depth by a dam failure may be impacted. For high hazard potential dam classification the OWRB only considers impacts to roadway in the inundation area with an Annual Average Daily Traffic (AADT) of 1,500 or greater.

When another dam is located downstream of a proposed or existing dam, the potential impact of the failure of the upstream dam on the downstream dam must be determined with a dam breach analysis. The dam breach analysis will be done using the percent PMF design flood conditions for both dams. If failure of an upstream dam could contribute to failure of a downstream dam(s), the minimum hazard classification of the upstream dam should be the same as the highest classification of the downstream dam(s). If a dam is located upstream of the one being analyzed, it should be assumed that the upstream dam remains intact.

## Required Evaluation Scenarios:

The results of a dam breach inundation study would be the most accurate if we knew the exact failure scenario. Since the exact dam failure scenario is unknown, the following conservative procedure for selecting a dam hazard potential classification is recommended. Final hazard potential classification should be the result of a comprehensive process, which may include scenarios where the dam breach occurs at maximum storage under probable maximum flood conditions (worst case scenario).

### Step 1. Sunny Day Failure

First run a "sunny day" scenario, where the dam breach is initiated at the elevation of the principal spillway (normal pool) with no precipitation inflow into the reservoir (best case scenario).

Identify and evaluate all potential downstream hazardous locations within the breach area, as described above.

If a high hazard potential classification is valid, then this dam failure scenario is sufficient. If the hazard potential classification is less than high, then it is necessary to increase the loading conditions and proceed to Step 2.

### Step 2. Design Flood Breach Scenario

If the hazard potential classification obtained from Step 1 is less than high, then determine if a dam-break discharge combined with a large inflow flood would result in an increase in the hazard potential classification. Starting with the water level at normal pool, route the high hazard potential design flood based on dam size (% PMF), and initiate breach at the maximum pool elevation.

Identify and evaluate all potential downstream hazardous locations within the breach area.

If the hazard potential classification does not increase with this scenario, then the classification obtained from Step 1 should be assigned. If the hazard potential classification does increase, then the incremental effects on the downstream flooding need to be evaluated in Step 3.

### Step 3. Design Flood Breach vs. Non-Breach Incremental Comparison

The reason for comparing the breach and non-breach scenarios is to compare the flooding from a dam failure to flooding from a natural flood.

Starting with the water level at normal pool, route the same design flood inflow from Step 2 (high hazard potential design PMF based on size) with no dam breach.

Compare the results of this scenario to the results from Step 2. If the incremental difference in depth is greater than 1 foot, then assign the hazard potential classification according to the consequences shown. If the incremental difference in depth at the identified downstream hazardous locations is less than 1 foot, then the incremental effects from the barely overtopping breach and non-breach scenarios need to be compared in Step 4. If the design flood does not overtop the dam, then Step 4 is not needed.

### Step 4. Barely Overtopping Breach vs. Non-Breach Incremental Comparison

Starting with the water level at normal pool, route the storm that barely overtops that dam (fraction of PMF). In this scenario the capacity of the dam is just exceeded by the storm.

Two scenarios will be investigated in this step, one where the dam is breached and one where that dam is not breached.

Identify all potential downstream hazardous locations within the breach area.

Compare the results of these two scenarios. If the incremental difference in depth is greater than 1 foot, assign the hazard potential classification according to the consequences shown. If the incremental difference in depth at the identified downstream hazardous locations is less than 1 foot, the hazard classification from Step 1 can be used.

## Final Hazard Potential Classification Determination

All breach analyses and hydraulic reports regarding dam hazard potential classification will be reviewed by OWRB staff engineers. OWRB may request additional evaluation scenarios and further details as required for hazard potential classification determination. The final hazard potential classification will be made by the OWRB.

# References


[1] Oklahoma Administrative Code Title 785:25-3-3(a)(2)

[2] Oklahoma Administrative Code Title 785:25-3-3(b)(1)

[3] Oklahoma Administrative Code Title 785:25-1-2

[4] Oklahoma Administrative Code Title 785:25-3-3(a)(1)

[5] Oklahoma Administrative Code Title 785:25-3-6(c)(1)

[6] Oklahoma Administrative Code Title 785:25-3-6(c)(4)

[7] Oklahoma Administrative Code Title 785:25-3-6(c)(3)

[8] National Oceanic and Atmospheric Administration. *Hydrometeorological Report No. 52: Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian*. Washington, D.C.: U.S. Government Printing Office, 1982

[9] Oklahoma Administrative Code 785:25 Appendix B

[10] U.S. Bureau of Reclamation. Assistant Commissioner – Engineering and Research (ACER) Technical Memorandum No. 11. Denver, CO: U.S. Bureau of Reclamation, 1988