DAM BREACH / HAZARD CLASS ANALYSIS

Warren Johnson, P.E.
Civil Engineer
Frederick, Maryland
Dam Classification

- **Structure Hazard Classification** - Documentation of the classification of dams is required.

- Documentation is to include but is not limited to location and description of dam, configuration of the valley, description of existing development (houses, utilities, highways, railroads, farm or commercial buildings, and other pertinent improvements), potential for future development, and recommended classification.
Dam Classification Documentation

• $Q_{\text{max}}$ discharge.
• Description of Dam.
• Description of all roads, structures and utilities downstream of pond.
• Map showing pond, downstream structures, cross section locations and proposed breach wave.
• All appropriate, routing, computations and supporting cross sections.
• Conclusion.
Dam Classification

• The class (“a”, “b”, and “c”) as contained in this document is related to the potential hazard to life and property that might result from a sudden major breach of the earth embankment.

The classification of a dam is the responsibility of the designer, and subject to review and concurrence of the approving authority.
Dam Classification

- The classification of a dam is determined only by the potential hazard from failure, not by the criteria. Classification factors in the NRCS - National Engineering Manual, as supplemented, are given below:

- Class “a” - Structures located in rural, agricultural or urban areas dedicated to remain in flood tolerant usage where failure may damage non-inhabited buildings, agricultural land, floodplains or county roads.
Dam Classification

• Class “b” - Structures located in rural, agricultural, or urban areas where failure may damage isolated homes, main highways or minor railroads or cause interruption of use or service of relatively important public utilities.

• Class “c” - Structures located where failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads.
Dam Breach

• NRCS uses a Sunny-day breach approach.
  – Increased likelihood of people down stream.
  – Conservative discharge on small structures.
Dam Failure Methods for Small Dams

• Use Breach Equation to determine Breach Flows

• Determine Downstream Flood Depths
  – Simple approach, Manning’s formula with downstream cross sections
  – HECRAS Model

• Stop Danger Reach when hazard no longer exists
Dam Breach

• The minimum peak discharge of the breach hydrograph, regardless of the techniques used to analyze the downstream inundation area, is as follows:

  • \( Q_{\text{max}} = 3.2 H_w^{2.5} \) where, \( Q_{\text{max}} \) = the peak breach discharge, cfs.
  
  • \( H_w \) = depth of water at the dam at the time of failure, feet. This is measured to the crest of the emergency spillway or to design high water, if no emergency spillway exists. Use “nonstorm” conditions downstream of the dam.
Dam Breach

Emergency Spillway or DHW Elevation

Excavate for Barrel

Existing Ground

Hw
Dam Breach

Emergency Spillway or DHW Elevation

Hw

Existing Ground
Dam Breach

Emergency Spillway or DHW Elevation

Hw

Existing Ground
**Dam Breach**

Where breach analysis has indicated that only overtopping of downstream roads will occur, the following guidelines will be used:

<table>
<thead>
<tr>
<th>Class</th>
<th>Depth of Flow (d) ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>“a”</td>
<td>$d \leq 1.5$</td>
</tr>
<tr>
<td>“b” &amp; “c”</td>
<td>$d &gt; 1.5$</td>
</tr>
</tbody>
</table>

Importance of the roadway shall be considered when making a classification.
Flood Danger for Cars

- **Low Danger Zone**
- **Judgement Zone**
- **High Danger Zone**

![Graph showing flood danger zones based on velocity and flood depth. The graph contains color-coded areas indicating low, judgement, and high danger zones.](image-url)
Dam Breach

- Breach flow against a house. Class “b” - Structures located in rural, agricultural, or urban areas where failure may damage isolated homes, .......

- Use Flood Danger for Houses graphics for determination of hazard.

- If home has basement and breach water may enter basement via window well or door, this may be considered damage.
Flood Danger for Houses

Source: USBR Hazard Charts, 1988
Flood Danger for Adults

Source: USBR Hazard Charts, 1988
Dam Breach – How far downstream should the analysis be taken

- To a point where there are no structures present downstream of the pond.
- The breach wave enters a flood prone area where no structures are present.
- The total volume of proposed breach is stored within the downstream valley, another storage structure or by a roadway fill.
This method is based on information contained in the Soil Conservation Service TSC - Technical Note - Engineering-UD-16, which was issued on July 3, 1969.

This method is based on the following:

1. The dam is assumed to fail when the water depth is at the top of the dam.

2. The peak rate of the breached hydrograph is based on data supplied by the Bureau of Reclamation for actual dam failures.

3. The method is based upon a valley flood routing method taken from the Journal of the Proceedings of the ASCE, Hydraulics Division, May 1964, "Hydrology of Spillway Design", by Franklin F. Snyder.

The graph as plotted has the width of the valley below the dam in feet versus the length of reach per acre foot of storage behind the dam for a depth (Above bankfull stage) at the lower end equal to one foot. Actual storage is to be calculated from the top of dam and the width of the valley would normally be the 100-year frequency storm floodplain.
Determining Danger Reach Length

- Height of dam = 10 feet
- Volume of storage = 8 acre feet
- Average valley width (usually at the 100 year flood plain) = 400 feet
Width of Valley in Feet (100 year flood plain)

H = Height of Dam

8 ac. ft. x 160 length of reach per ac. ft. = 1280 ft.
Example Dam Breach Analysis
DAM BREACH ANALYSIS

**Embankment Facing Office Building**

The embankment facing the office building is almost completely in cut. Louis Diequez at Anne Arundel Soil Conservation District stated that as a rule of thumb an embankment can be classified as excavated if the width of the embankment is ten times the height plus 20 feet. The height is measured from the pond bottom to the 100 year storm elevation. Using this criteria, the embankment facing the office building can be considered excavated and not a danger to breach. See cross-section BB. Soil borings in the area show that the soils are a classification of 'CL'. This soil type is specified in Md. 378 as acceptable material to construct the impervious core and core trench. Since the soils are of good quality for an embankment and because the pond can be considered as excavated in this area, a dam breach is highly improbable and not considered a danger.

**Breach Towards Residential Area**

The embankment facing the residential community is in the vicinity of the access drive to the bottom of the facility. Therefore, the width of the embankment is very large at the bottom and easily falls within the criteria for an excavated pond. However, a breach may occur towards the top of the embankment so an analysis was performed considering the bottom of the embankment to be at a point were the slope becomes less than 3:1 (see section AA). The following is an analysis assuming a breach under the above mentioned conditions:
Breach discharge = 3.2(Hw)^2.5

Hw = Design high water (100 yr. clogged elevation) - slope decrease = 195.3 - 192.0 = 3.3'

Q = 3.2(3.3)^2.5 = 63.3 cfs

A dam breach towards the residential area would be minimal in affect. The breach discharge would spread out and flow between the various existing houses. The worst case scenario would be if all of the flow were to flow between two houses set closely together. A field inspection revealed that swales are graded between the existing houses. See photographs and Figure 2. An analysis using Flowmaster was performed to model the effects of 63 cfs flowing between two houses. The result would be a depth of flow about 3 to 4 tenths of a foot deep.
Conclusion

The pond embankment can be considered excavated for much of its length and therefore not a danger to breach. A limited breach could occur towards the residential area. In this case, the depth of flow would only be around 3 to 4 tenths of a foot deep. This depth of flow would cause little property damage and would pose no threat to loss of life. This facility can be safely classified as a type ‘A’ hazard.
BETWEEN HOUSES 2 AND 3, FROM ROAD
LEFT OF HOUSE 3, FROM ROAD
Dam Classification

- Other things to look out for.
Dam Classification

• Ponds exempt from the requirements of the Soil Conservation District Small Pond Approval Letter (i.e., excavated ponds) must be classified prior to exemption. The exemption must be reviewed and have concurrence of the approving authority.
Dam Breach

Excavated Pond
Class “a” Structure?

3’
### TABLE 1 - HYDROLOGIC CRITERIA FOR PONDS

<table>
<thead>
<tr>
<th>Structure Class</th>
<th>Storage Height Product</th>
<th>Watershed Area (Acres)</th>
<th>Height To Emergency Spwy Crest (Feet)</th>
<th>Normal Surface Area (Acres)</th>
<th>Spillway Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>“c” &amp; “b”</td>
<td>Any</td>
<td>Any</td>
<td>Any</td>
<td>Any</td>
<td>TR 60</td>
</tr>
<tr>
<td>“a”</td>
<td>3,000 or more</td>
<td>Any</td>
<td>Any</td>
<td>TR 60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>320</td>
<td>&gt;20 - 35</td>
<td>10 YR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Less and</td>
<td>≤20</td>
<td>25 YR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Larger</td>
<td>&lt;15</td>
<td>10 YR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>&gt;20 - 35</td>
<td>25 YR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“a” than to</td>
<td>≤20</td>
<td>10 YR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>320</td>
<td>&lt;15</td>
<td>5 YR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Less</td>
<td>&gt;20 - 35</td>
<td>5 YR</td>
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<tr>
<td></td>
<td></td>
<td>3,000</td>
<td>Then</td>
<td>10% of 25 YR Peak</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>&lt;15</td>
<td>5 YR</td>
<td></td>
</tr>
</tbody>
</table>

- **Principal**: TR 60
- **Emergency**: TR 60
- **Freeboard**: TR 60

Therefore Class “a”
Where to Breach

Breach Here

Breach Here

Breach Here
Dam Breach – Weir length at road

Weir Length At Road
Dam Breach – Weir length at road

Average Breach Width

2H

Width At Road
Dam Breach – Breach width downstream

Average Breach Width

2H

Width At House

1

2
Dams In Series
Dams in Series - Considerations

• Effects of the proposed breach, from the upstream pond, on the downstream pond.
• Potential breach of downstream pond.
• Effects of breach of from both ponds.
Potential for Downstream Development

- Zoning
- Land use Plans
- Pathway for breach