Kansas Department of Agriculture

# Breach Inundation Maps

Decision-making uses

## How do you predict flooding from dam failure?

In Kansas, dams are divided into three hazard classifications: high, significant, and low. Statute and regulations term these hazard class C, B, and A dams respectively.

Hazard classifications categorize dams based on the consequences if the dams should fail. Hazard classification does not indicate the condition of a dam — only the potential for death, major economic loss, or interruption of public utilities or services should the dam fail.

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One of the tools used to determine hazard classification, a breach inundation map describes where water stored behind a dam is likely to go and how much land it will flood if the dam fails. These maps can be valuable to local units of government, landowners, and others concerned about land use management below dams and how downstream development can alter the hazard classification of a dam.

They also are used in emergency action plans and can be used by emergency personnel to plan evacuation routes and identify those who need to be evacuated in case of flooding.

A breach inundation study determines the maximum rate of discharge that will result if the dam fails under specified circumstances. It is dependent upon several factors including the water depth behind the dam at the time failure occurs.

After estimating the dam breach outflow, it is possible to route a flood wave downstream to predict the flooding limits, including the maximum height water will reach and how long after the breach occurred that this height is reached at points of interest downstream of the dam. Under Kansas regulations, routing typically proceeds until the flood wave has reached the point that it is contained within the 100-year floodplain of the stream. Knowing the elevation of the maximum water surface reached during the flooding caused by the hypothetical breach at set sections, the area that may be flooded can be depicted on a topographic or aerial map.

Engineers use various methods of analysis to estimate dam breach outflows. Physically-based methods use an erosion model based on principals of hydraulics, sediment transport, and soil mechanics. Parametric models are based on case studies, simulation, a time-dependent linear process, and hydraulic principles. In the comparative analysis method, engineers compare the dam under consideration to others similar in size and construction with a well-documented dam failure — if they can find one.

Because of the many variables involved, flood routing and breach inundation mapping are an inexact science. Of particular importance is good topographic data. Fortunately, field surveys have been enhanced with technological advancements, for example, GIS and thigh-resolution LiDAR — Light Detection and Ranging. These tools provide much improved topographic data and the U.S. Army Corps of Engineers' HEC-RAS computer modeling program (the most commonly used modeling tool) has been enhanced to easily use these data. Dam breach inundation mapping is more complex than modeling 100-year flood events because a dam breach flood wave develops over time and flow is dynamic through the downstream environment, conditions most often ignored when creating flood

rate insurance maps.

For example, the Natural Resources Conservation Service has been updating its hazard classifications and breach inundation areas for hundreds of dams in Kansas using HEC-GeoRAS with ArcGIS and the HECRAS model. In Douglas County, NRCS uses a two meter digital elevation model developed from the LiDAR data. Not only is this mapping providing a complete set of the breach inundation areas for Douglas County, it also can be used by the county's planning and zoning authority.

Sources for this publication include Division of Water Resources staff and *Breach Route Analysis and Inundation Mapping for Kansas Dams* (Kansas Geological Survey).