

# NEW TECHNOLOGY USED TO CREATE INUNDATION MAPS FOR DAM OWNERS

The owner of a High-Hazard Potential (HHP) dam in Missouri has the legal responsibility to provide an Emergency Action Plan (EAP). Advanced geospatial technology is now being used by Missouri's Department of Natural Resources (DNR) dam safety staff to prepare inundation maps for owners of regulated HHP dams to use with their EAPs.

DNR is starting with counties that have many HHP dams and greater populations at risk. Rapidly growing Warren County just west of St. Louis has 133 dams, 77 of which are HHP, with 33 of those under DNR regulation and now mapped. Other counties high on the DNR priority list for inundation mapping include Franklin, Greene, Jackson, Jefferson, St. Charles, St. Francois, and Washington. Each has numerous HHP dams. Missouri has 114 counties, some of which have no HHP dams.

After these maps are completed for a particular county, public meetings or workshops will bring together dam owners and other stakeholders for discussion and education on how to use the maps to finalize the EAPs. The DNR inundation maps will be transferred to the dam owner and/or county emergency managers for additional development of the EAP.

DNR dam safety staff point out that "It is critical for emergency managers to focus their limited resources where they are needed most in the event of a dam failure. The objective of accurate inundation mapping is to facilitate this focus. For this work to be effective, cooperation of the department, dam owners, emergency responders, and input from the public is necessary."



**DamSafetyAction.org**

## EMERGENCY RESPONDERS NEED THESE MAPS

State and local emergency management agencies and responders rely heavily on breach inundation maps. The maps and Emergency Action Plans (EAPs) must contain sufficient and accurate information to assure adequate warnings and evacuation of all people at risk.

Local emergency managers must understand the maps – including the terms used, the area that would need to be evacuated, and how much time they would have to evacuate the residents in case of a dam failure. Depending on the severity of a breach, the evacuation zone may be greater than or less than the area depicted by inundation maps. Maps should use terms accepted by and useful to the emergency responders and local residents.

Inundation maps and EAP information should be periodically updated to include new downstream development such as streets, bridges, and subdivisions.

More examples of inundation maps may be found online at [www.damsafetyaction.org](http://www.damsafetyaction.org). The website also includes downloadable versions of this and other brochures and information about EAPs. Supported by the Federal Emergency Management Agency, DamSafetyAction.org is part of an outreach program produced as an information and education source for dam owners and the public.

**Be an involved citizen.  
Lives depend on Emergency Action Plans.**

### QUESTIONS OR COMMENTS

Phone toll-free 877-410-3551  
eMail: [info@damsafetyaction.org](mailto:info@damsafetyaction.org)

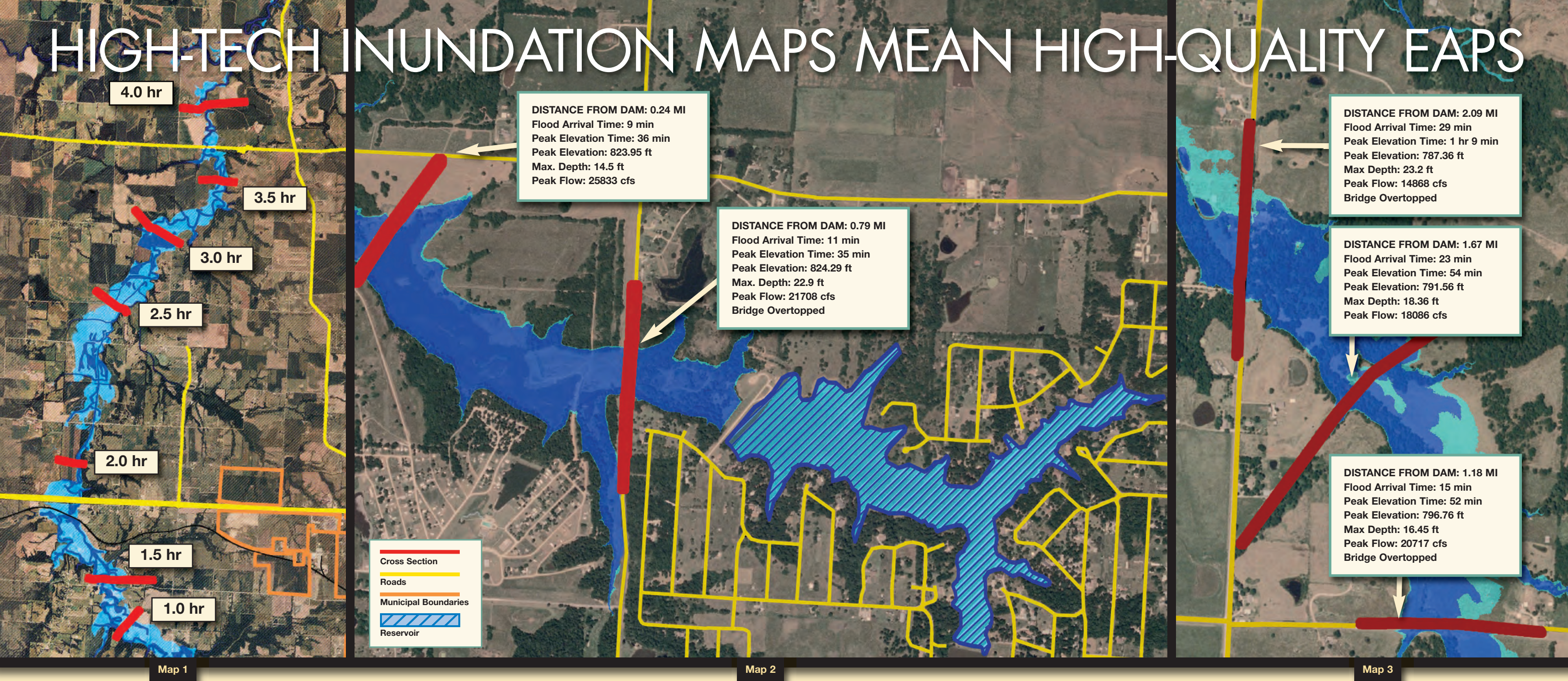
# INUNDATION MAPS MAKE EMERGENCY ACTION PLANS FOR MISSOURI DAMS MORE EFFECTIVE



**DamSafetyAction.org**



# HIGH-TECH INUNDATION MAPS MEAN HIGH-QUALITY EAPS



These inundation maps were developed by the staff of the Water Resources Center of the Missouri Department of Natural Resources (DNR). The dam, located outside the lower right area of Map 1, is more than 40 feet high and holds back about 1,000 acre-feet of water when the reservoir is full. The first map shows the length of time before flood waters would reach various downstream points. A separate, more detailed inundation map was drawn for each section of the stream. Maps 2 and 3 show the initial sections of the inundation zone and vital information. This includes roads that would be overtopped, arrival time of flood waters at key points, peak water elevation time after the breach, flow of water expected and its depth. LiDAR data was used to create the model for these inundation maps.

**Missouri DNR's Water Resources Center has developed a procedure for creating inundation maps by augmenting field surveys with highly sophisticated imaging and geospatial software and equipment. These systems include:**

- High-resolution LiDAR (Light Detection and Ranging) elevation data captured by laser equipment aboard aircraft. LiDAR data is not available for every county in Missouri at the present time, but will be helpful in developing inundation maps for some of the most populous counties. Processing of LiDAR imaging can remove foliage and structures to reveal precise ground contours and elevations.

- The U.S. Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC- RAS). HEC-RAS software allows extensive modeling of different water flow patterns and other factors that affect an inundation model.
- HEC-GeoRAS, which is a set of procedures, tools, and utilities for processing geospatial data and entering it into HEC-RAS for analysis. GeoRAS also performs the mapping procedures when the analysis is completed.
- Digital Elevation Model (DEM) data derived from U.S. Geological Survey topographic maps can be used to complete inundation analysis where LiDAR data is not available. This data provides inundation maps similar to those created from LiDAR data, though with less accuracy in the cross-section elevations.

In various combinations customizable and suitable for each dam, these technologies can provide detailed and reasonably accurate breach inundation maps. These maps facilitate the development of preparedness and warning requirements, computations of flood damage, and information to help ecosystem restoration after the water recedes.

DNR inundation maps will show areas downstream that would be inundated by at least two feet of water during the time of maximum water surface level. The details of the resulting inundation maps will be similar to this example. Other map examples will be found on the Inundation Mapping pages of the website [www.damsafetyaction.org](http://www.damsafetyaction.org). The website also includes extensive map guidelines from the Federal Energy Regulatory Commission, which regulates hydropower in Missouri.



# INUNDATION MAPS ASSURE EFFICIENT EMERGENCY RESPONSE

**Dam safety engineers with the Missouri Department of Natural Resources (DNR) have begun an initiative to create breach inundation maps for more than 400 High-Hazard Potential (HHP) dams in the state. This is a time-intensive program that will require more than a year to complete. The maps are crucial to building comprehensive Emergency Action Plans (EAPs) for those whose lives, property, and businesses are at risk.**

For maximum public safety, every EAP for a HHP dam should include inundation maps showing areas that are expected to be flooded in a dam breach. Inundation maps then can be used to develop an evacuation plan. In addition to the maps, an EAP should include procedures and information for warning downstream emergency management authorities and other crucial information. The EAP will include a notification flowchart with names, phone numbers, and priority of who is to be alerted. This will be closely correlated with the inundation maps. A notification list includes dam owner, emergency and law enforcement officials, residents downstream of the dam, and others.

Inundation maps make it possible to more accurately complete many of the other necessary EAP components. Many inundation maps display flood areas, estimated travel times for the wave front as it moves through an impact area, and the flood peaks at specific locations.

With an inundation map, emergency management officials can add to their emergency operations plans the locations of businesses, schools, hospitals, nursing homes, residences, and highways at risk in a dam failure, along with the locations of shelters and emergency resources. Evacuation routes can be developed.

Without an inundation map, it is very difficult for emergency managers to be certain that everyone at risk from a dam breach has been identified and can be notified or evacuated.

## INUNDATION MAP VS. EVACUATION AREA

Inundation maps are developed from the best available information using reasonable assumptions and standardized methods. They are approximations of the maximum water surface extents resulting from a complete dam breach and draining of the full reservoir. Inundation maps are empirical hydrologic and hydraulic simulations which can only be field verified in the event of an actual breach.

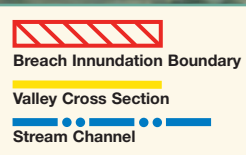
Evacuation areas and emergency call lists based on these maps should take into consideration the anticipated local impacts of flooding; knowledge of local infrastructure, both occupancy and ownership; and potentially interrupted services or cut-off access caused by dam failure. Depending upon actual circumstances, appropriate alert and evacuation areas could be more or less extensive than the simulated inundation zones shown on the maps.

This inundation map example is one of four contiguous maps prepared by the U.S. Department of Agriculture's Natural Resources Conservation Service for the EAP of a HHP dam in Missouri. The dam was built as part of a USDA conservation program and is not regulated by DNR. USDA requires EAPs and inundation maps on all HHP dams built with USDA funds.

In this map, the dam and reservoir are at the upper left. The impact area that could be flooded includes some areas of a city, with risk to offices, a health

clinic, a meeting facility, an auto dealership, city parks, and several residences, including public housing units and more than a dozen homes.

The blue dotted line is the stream channel below the dam. The red hatch marks indicate the potential inundation area if the dam were to fail. The yellow lines correlate with floodwater elevations expected at specific locations below the dam. The maps include street names and other details omitted from this reproduction.



Map courtesy of USDA/NRCS.