Dam Considerations in Flood Mapping Studies

Whether for flood control, water supply, or recreation, dams play an important role in serving the community and managing a vital natural resource, but there are hazards and risks to consider when large volumes of water are stored. Sharing information about dams during a flood mapping study can help stakeholders obtain a more complete picture of the risks within a floodplain.

**KEY DEFINITIONS AND CONTENT**

Federal, State, and local dam safety partners may use different descriptions for some key terms. Here are a few important terms used in this fact sheet:

**Dam** – “An artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water.” (FEMA 148)

**Dam Failure** – “A catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water, or the likelihood of such an uncontrolled release. It is recognized that there are lesser degrees of failure and that any malfunction or abnormality outside the design assumptions and parameters that adversely affect a dam’s primary function of impounding water is properly considered a failure. These lesser degrees of failure can progressively lead to or heighten the risk of a catastrophic failure. They are, however, normally amenable to corrective action.” (FEMA 148)

**Hazard** – FEMA defines a “hazard” as “a situation that creates the potential for adverse consequences, such as loss of life, property damage, or other adverse impacts.” (FEMA 148) A hazard potential classification system categorizes a dam according to the degree of adverse incremental consequences of a dam failure or improper operation of the dam. The hazard potential classification does not reflect the current condition of the dam, and other organizations may define classifications differently.

**Risk** – FEMA defines “risk” as “a measure of the likelihood and severity of adverse consequences.” (FEMA 148) Risk can be estimated as the probability of a specific undesirable event occurring, multiplied by the magnitude of the consequences the event will cause. Examples of consequences include property and infrastructure damage, or loss of life. Undesirable events can include dam failure, flooding upstream due to high water elevations behind the dam, or even regular or emergency operation of the dam, including large releases of water to prevent catastrophic dam failure.
IDENTIFYING DAMS: As a starting point for assessing the risk posed by dams, State and local officials should be engaged at the beginning of a flood study to share locations and information pertaining to the community’s known dams and dams of concern in a watershed. The study team should also consult accessible relevant databases or inventories for information, such as State regulatory dam databases or the U.S. Army Corps of Engineers’ National Inventory of Dams (NID). Some dams may not be regulated, and their locations and other information may be unavailable in these resources. Local officials may have information that is not available in the NID or State dam databases. The presence of previously unidentified dams can be ascertained through analysis of terrain, choke points, and other Areas of Mitigation Interest within the watershed. Some dams may have multiple names, so it is important to include an existing ID for each dam, such as the NID ID or a State-specific ID. Other important dam-specific information to capture could include the year built, length, height, storage volume, construction type, drainage area, Hazard Potential Class, etc. A list of dams within the watershed should be included in the Flood Insurance Study (FIS) report in Table 8: Non-Levee Flood Protection Measures. Refer to the FEMA fact sheet Considering Residual Risk for Dams in Flood Risk Products for details.

HYDROLOGY AND HYDRAULIC CONSIDERATIONS: Dams are important to the flood study and flood mapping process (Risk Mapping, Assessment, and Planning [Risk MAP project] because the presence of a dam within a watershed can have significant effects on peak flows and flood elevations. It is important to consider hydrology and hydraulics (H&H) modeling assumptions on a case-by-case basis, because dams vary significantly in size, age, construction type, and function. Spillway releases, a design function of many dams, can cause sudden increases in downstream flow. The gates that regulate the flow on outlet structures may be operated according to established rules that determine the relationship between inflow, outflow, storage, and water demand. During a hydrology analysis, the definition of a sub-basin at a dam location allows a refined evaluation that can take these effects into consideration and should be part of the watershed study. Flood study contractors can reach out to known dam owners or dam regulators (State or Federal) to determine whether applicable engineering information exists for that dam, including any dam H&H studies. Early identification of dams in the watershed and their owners is a critical first step in trying to incorporate the dams’ effects in a flood study.

While most dams are not designed for flood control, they are important to consider during the flood hazard identification process. The primary purpose of approximately 16,000 dams out of the 90,000+ dams in the NID is flood control. Dam outlet control structures can affect both the flow rates downstream of the dam and the flood levels upstream of the dam, whether or not their primary purpose is flood control. Non-breach risk (a spillway flow without the breach of a dam, or overtopping without a breach) can result in sudden flooding upstream or downstream of the dam, and other unexpected conditions. For more information on the risks associated with a spillway release, refer to the fact sheet Considering Residual Risk for Dams in Flood Risk Products for details.
IMPORTANCE OF CONSIDERING DAMS IN FLOOD MODELING:
Sharing information about dams during Flood Insurance Studies (Risk MAP projects), floodplain modeling, and mapping allows a more complete view of the risk within a floodplain. As an example, State dam safety regulations may require inundation maps to be provided for only a specific dam failure scenario, not for a large reservoir release or different dam failure scenarios; however, it is a best practice for owners of dams with the potential for large reservoir releases to coordinate with the appropriate State/local government agencies to provide them with inundation maps for more than one dam failure scenario and potential large water release outflows. Further, it is a best practice for State and local government agencies to incorporate this information into emergency operations planning, evacuation planning, mitigation planning, and other community planning efforts. Obtaining this information at the beginning of a study will help build a more complete understanding of the risk and hydraulic effects of the dams. Dam safety is a shared responsibility. Communicating through Risk MAP about the risk associated with local dams helps enable a community to be better prepared for, mitigate against, respond to, and recover from dam failures and incidents.

REFERENCES:
FEMA Select EM-Related Terms and Definitions (2007)
DHS Estimating Loss of Life for Dam Failure Scenarios (2011)
DHS Estimating Economic Consequences for Dam Failure Scenarios (2011)
National Inventory of Dams Website
FEMA National Dam Safety Program Page
Association of State Dam Safety Officials (damsafety.org)
FEMA Dam Safety Fact Sheets 2, 3, and 4 of 4 by Region IV
FEMA Technical Advisory 2: Risk Exposure and Residual Risk Related to Dams - North and South Carolina;
Hurricane Matthew DR-4285 and DR-4286
FEMA Dam Safety Fact Sheet Series (8 fact sheets total)

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