



Dams After the Flood:

REGULATIONS, RESPONSIBILITIES AND RECOVERY



Dams 101

What do owners need to know about dams?

Jill Stewart, P.E., DHEC Dam Safety program

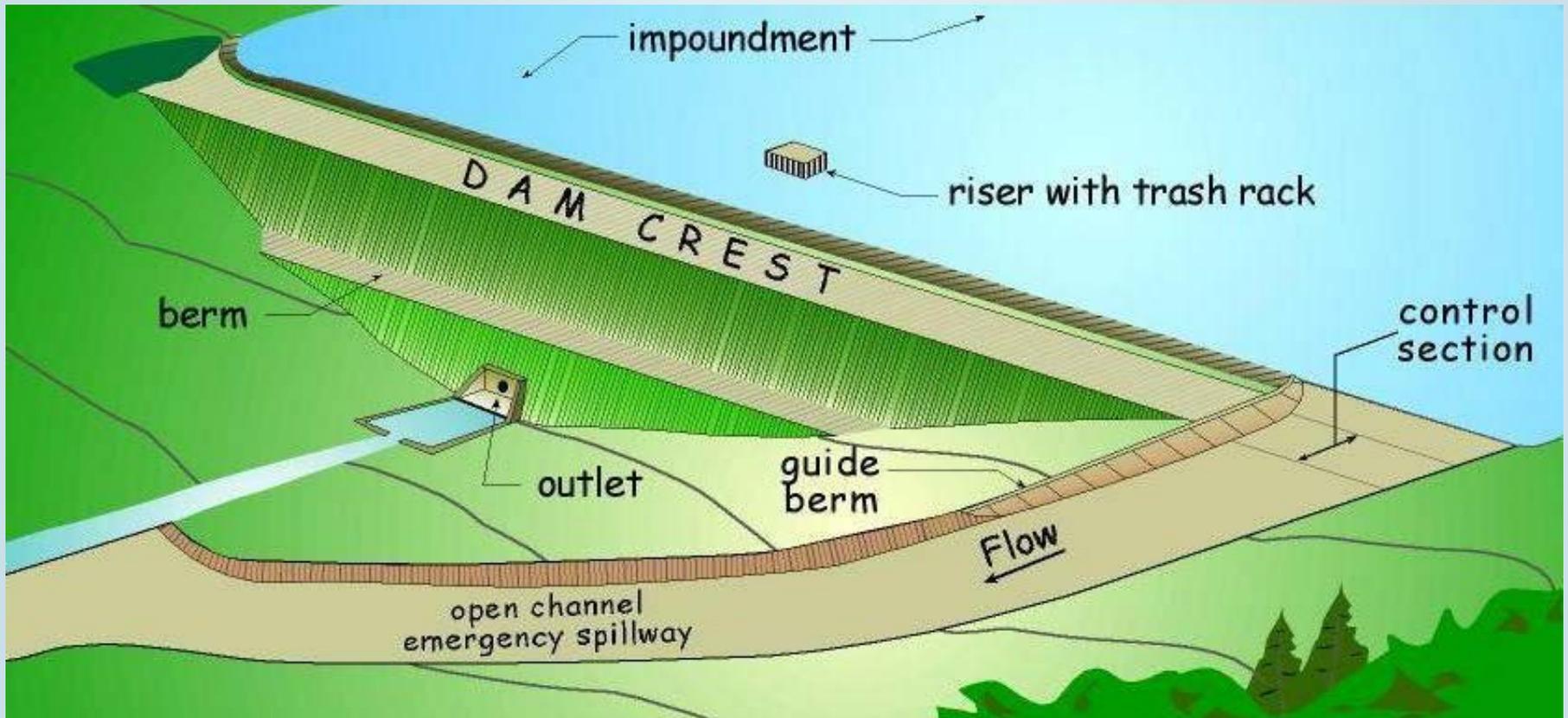
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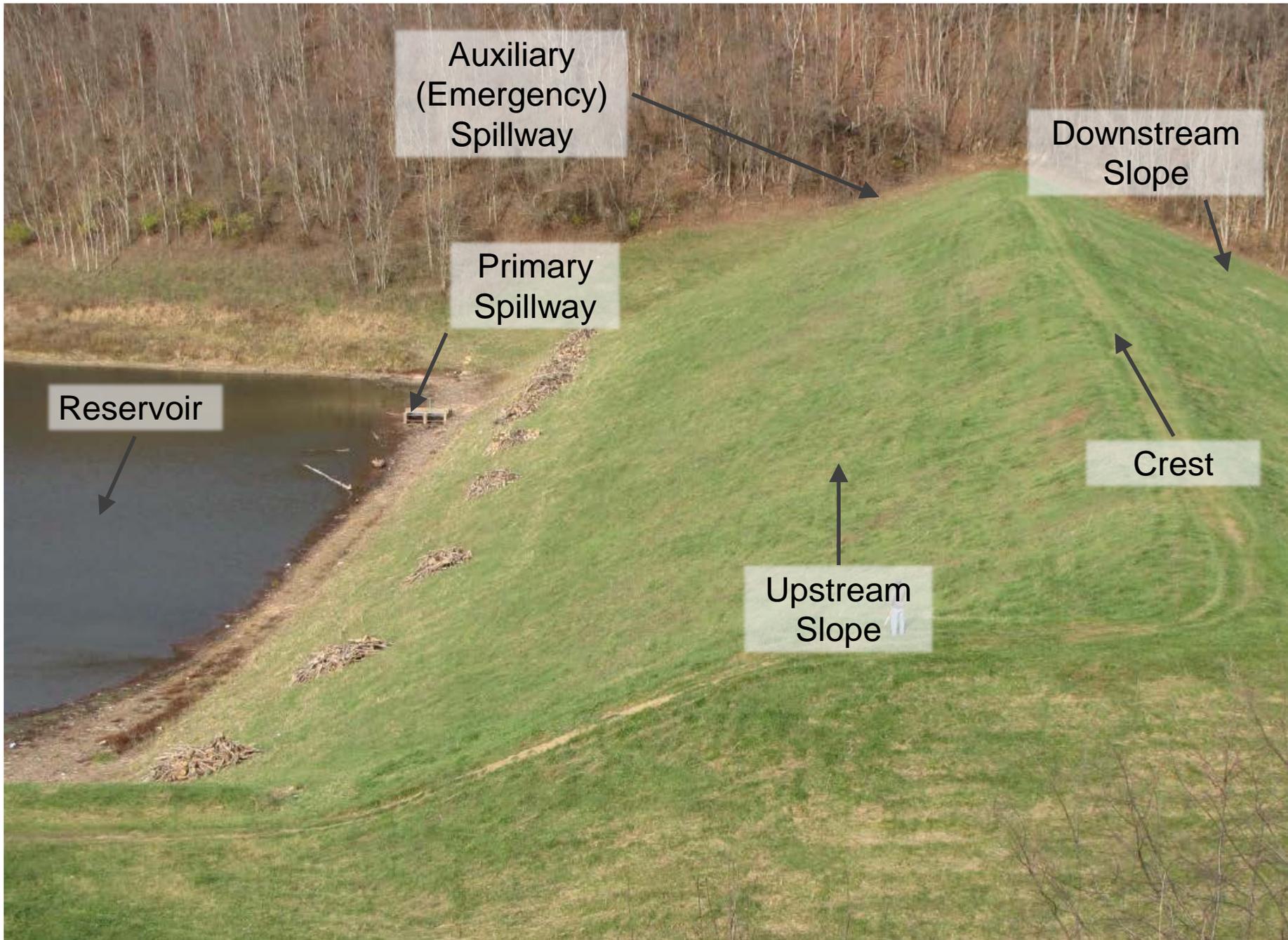
What is a Dam?



Parts of A Dam



Note: Not all dams have all of these parts



Auxiliary
(Emergency)
Spillway

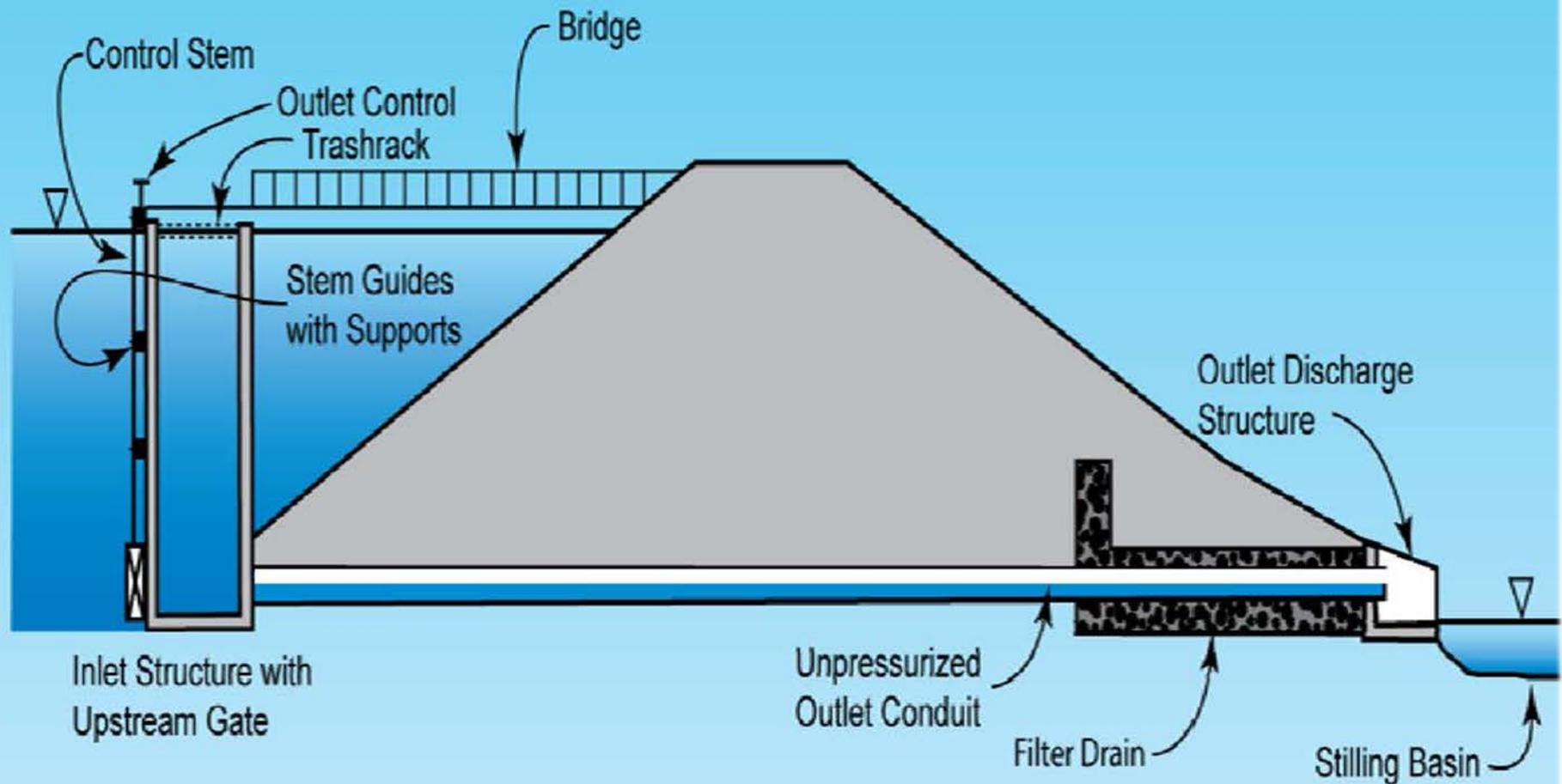
Downstream
Slope

Primary
Spillway

Reservoir

Crest

Upstream
Slope



Combination Outlet Works and Spillway

Source: Chris Veesaert, USBR, Hawaii Dam Safety Training Seminars 2006



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Dam Safety Regulation

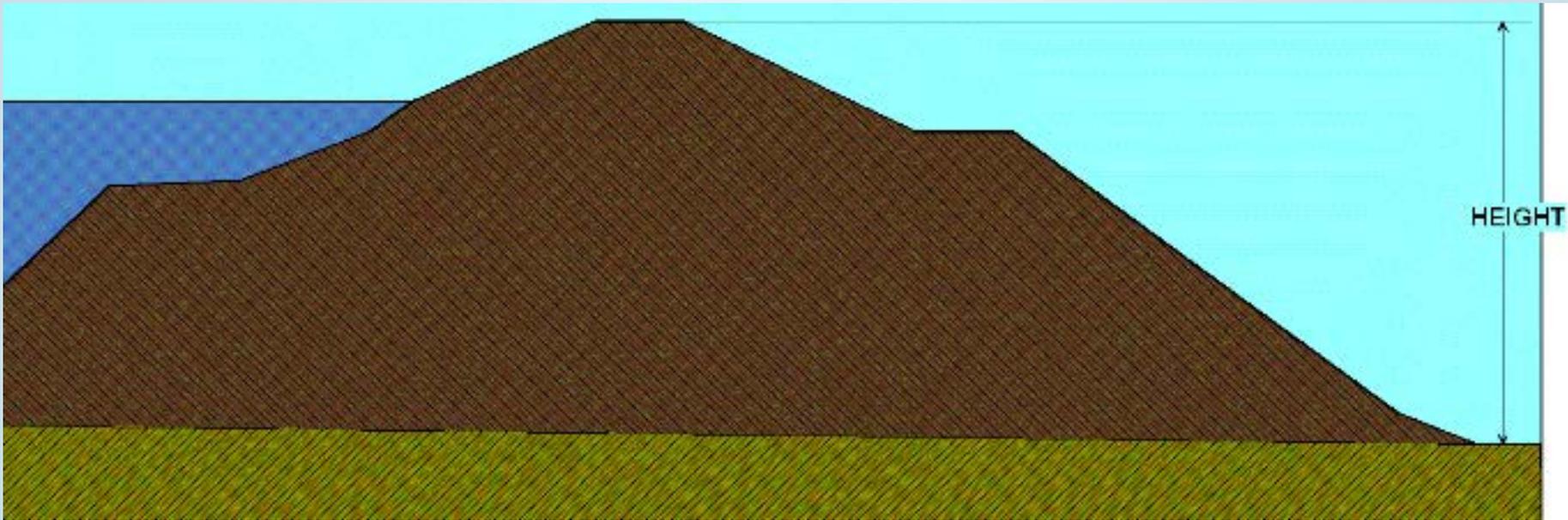


Criteria for Regulation

- Dams that meet any of the following three criteria:
 - 25' in height
 - Impounds 50 ac-ft or more
 - Potential failure may cause loss of human life



Measuring Height





Hazard Classification

- Dams are classified based on the “hazard” they could bring in the event of failure.
- Hazards can be homes, roads, critical utilities (water, gas, sewer) that might be flooded if a dam breaks or “breaches.”



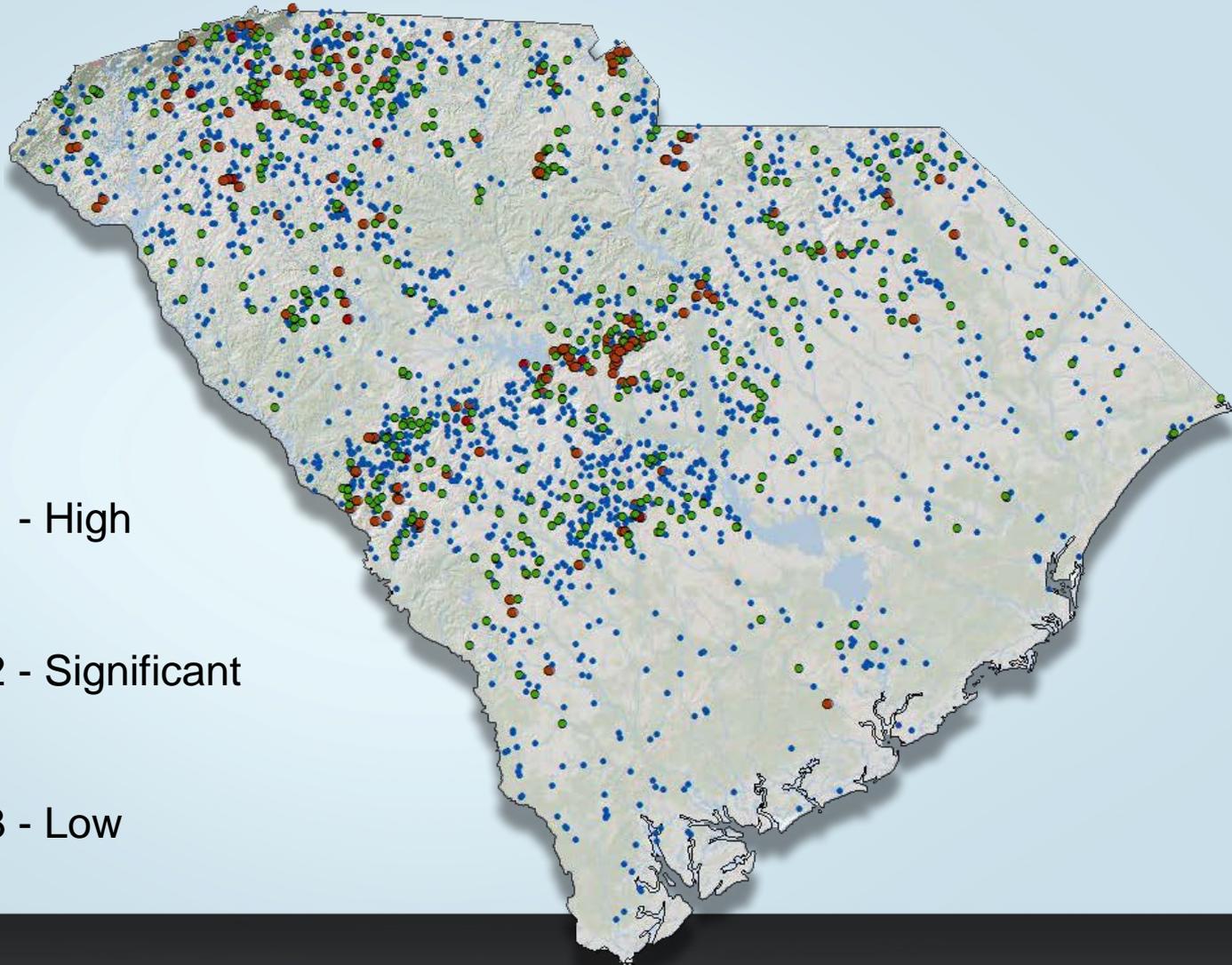


Classification of Regulated Dams

Class 1	Class 2	Class 3
High Hazard	Significant Hazard	Low Hazard
Dam failure would likely result in loss of life.	Dam failure wouldn't likely result in loss of life, but property, roads and other key infrastructure would be damaged.	Dam failure might cause minimal property damage to others. Loss of life is not expected.

South Carolina's Regulated Dams

- Class 1 - High
- Class 2 - Significant
- Class 3 - Low



Permitting for Repair of Dams





Maintenance vs. Repair

- ***Maintenance*** includes those activities performed on a routine basis by the owner to keep the dam in proper working order. No permit is needed for maintenance.
- ***Repair*** refers to those activities undertaken that might affect the safety of the dam. Permits are required before repairs are made to a dam.



Maintenance Examples

- Removing trash and debris from a spillway
- Mowing
- Trapping rodents and filling in rodent burrows
- Operating spillways
- Installation of stone or rip-rap for erosion protection (as long as no excavation occurs)



Repair Examples

- Replacement of or work to spillway structures
- Grading and excavation of slopes, spillways or dam crest
- Removal of tree roots and stumps
- Installation of drainage controls (toe drains)

Repair

- Owners of regulated dams **must** obtain a permit from DHEC before they begin repairs to their dams.



Permit Process





Applications

- Applications for repair should include:
 - Application form
 - Engineering report outlining planned repairs
 - Engineering plans
 - Calculations to support engineering design



Plan Preparation

- Regulations require that all plans to repair a regulated dam be prepared by an engineer licensed to practice in South Carolina.





Dam Inspections: Identifying Present or Developing Dam Deficiencies

Shawn Frazer

South Carolina Department of Health and Environmental Control

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Lookin' For Trouble:

Find Big Problems Before They're Too Big.



- It's typically easier to fix a small problem early on than letting it become a bigger problem.



First things first: Why bother?

- “Doesn’t DHEC inspect my dam for me?”
- “My dam was just repaired/rebuilt, it’ll hold.”
- “It’s fine. My dam survived ____.”
 - The 2015 Historic Rain Event
 - A hundred years of use...
 - Hugo



“Doesn’t DHEC do that?” (We do... but you should too!)

- The owners and the people who use the dam regularly may be more familiar with day-to-day conditions.
- DHEC dam inspections are intermittent. (Every two, three or five years)



“I just fixed it...”

- Recent repairs should be treated just as carefully as a known problem area.
- Think of it as a medical procedure. If your dam just underwent surgery, it should probably have regular checkups for a while.



“My dam survived...” (The ‘Survivalist’ Attitude)

- External conditions might have been different at that time.
- There is ALWAYS a worse storm that could hit.
- Stress and wear are cumulative.



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Keeping An Eye On Things: Inspecting Like An Inspector



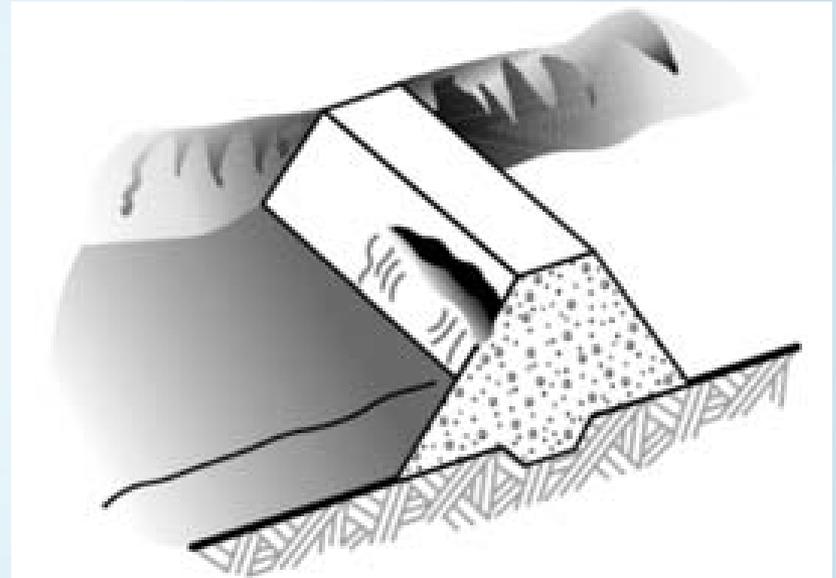
Sliding, Slumping, Slipping

Likely Cause:

Over-steep slopes or an unstable foundation can cause embankment material to shift out of place down the embankment slope.

Watch for:

Cracking lengthwise across the dam, bulging or sagging areas on the slopes.



Sliding, Slumping, Slipping



Riprap

Typical Deficiencies:

- Poor quality riprap or poorly-graded riprap (oversized or undersized) can break down or offer insufficient protection.
- Wave action can move embankment materials and shift placed riprap, increasing exposed embankment area and allowing further erosion.



Riprap



Erosion

Likely Cause:

Water flowing over the surface of the dam or over earthen spillways transports sediment away from the embankment.

Bare dirt or non-grassed slopes are common occurrence areas.

Watch for:

After heavy rains, look for areas of exposed dirt, and for gullies and rills in the dirt.



Erosion



Erosion



Trees and Vegetation

Deficiencies: (See FEMA-534)

- Woody brush and tree growth on dams are undesirable.
- Vegetation obscures inspection, can harbor rodents, or can topple in high winds.
- Excessive vegetation or debris in spillways.

Recommendations:

- Trees and brush that are 4" in diameter or smaller should not require a permit to cut.





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Trees and Vegetation



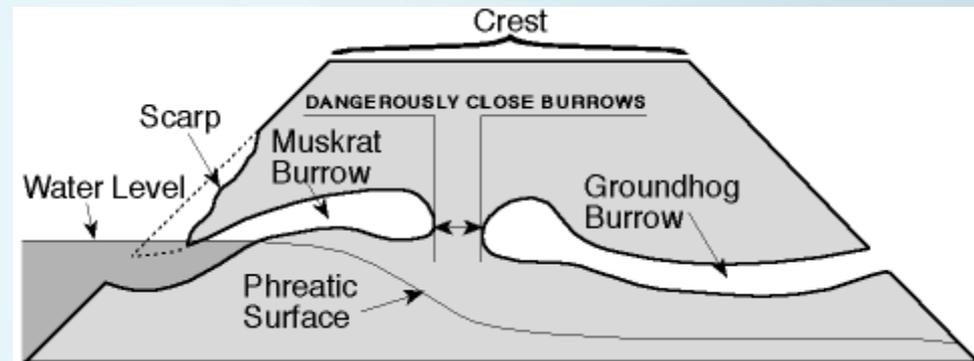
Animal Impacts

Deficiencies: (See FEMA-473)

- Thick vegetation and wooded areas near the reservoir can provide a habitat for beavers, muskrats and other burrowing rodents.
- Livestock or other animal paths over a dam can significantly damage slopes.

Watch for:

- Rodent activity, bare paths over the dam.



Animal Impacts



Animal Impacts





Cracking

Transverse Cracking (Across the Dam)

Likely Cause:

Uneven movement of the dam or adjacent segments might occur and cause transverse cracking.

Potential Problems:

Transverse cracking can create an area susceptible to deformation or failure and a path for seepage through the dam.

Longitudinal Cracking (Along the Dam)

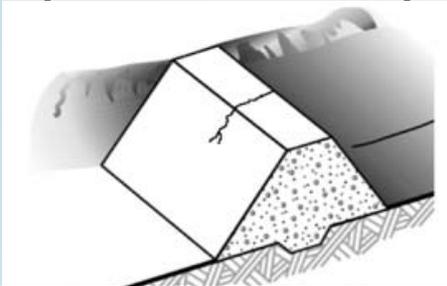
Likely Cause:

Foundation movement and settlement occurring unevenly along the dam length can cause longitudinal cracking.

Potential Problems:

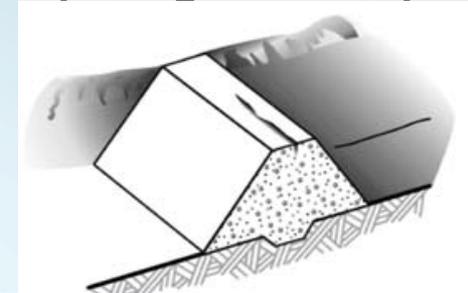
Longitudinal cracking can create an area susceptible to failure and decreases embankment support, which can result in sliding or slumping.

Transverse Cracking (Across the Dam)



Cracking

Longitudinal Cracking (Along the Dam)



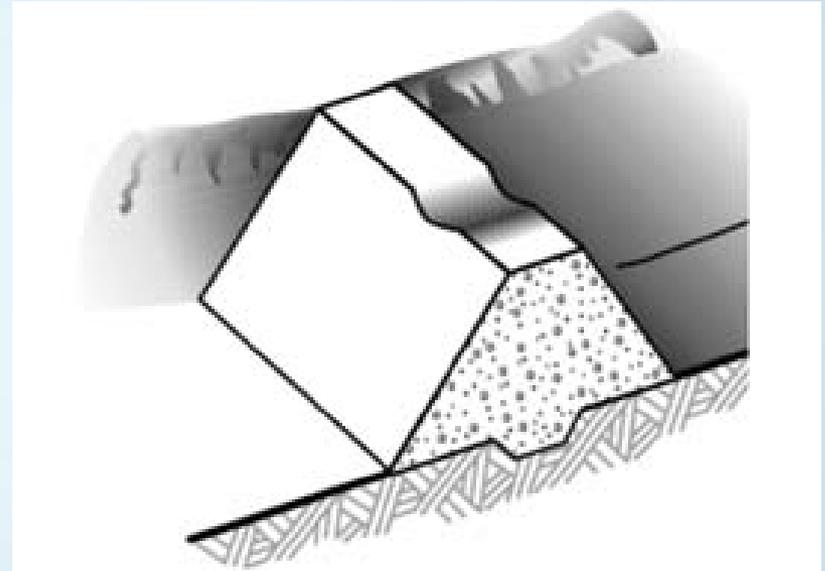
Low Areas On Crest

Likely Cause:

Non-uniform or excessive settlement of the dam embankment or foundation can lower a portion of the top of the dam.

Potential Problems:

Decreased freeboard will cause spillways to be less able to handle large flows before overtopping occurs.



Low Areas on Crest



Seepage Water Flows

Piping: (Through the Embankment)

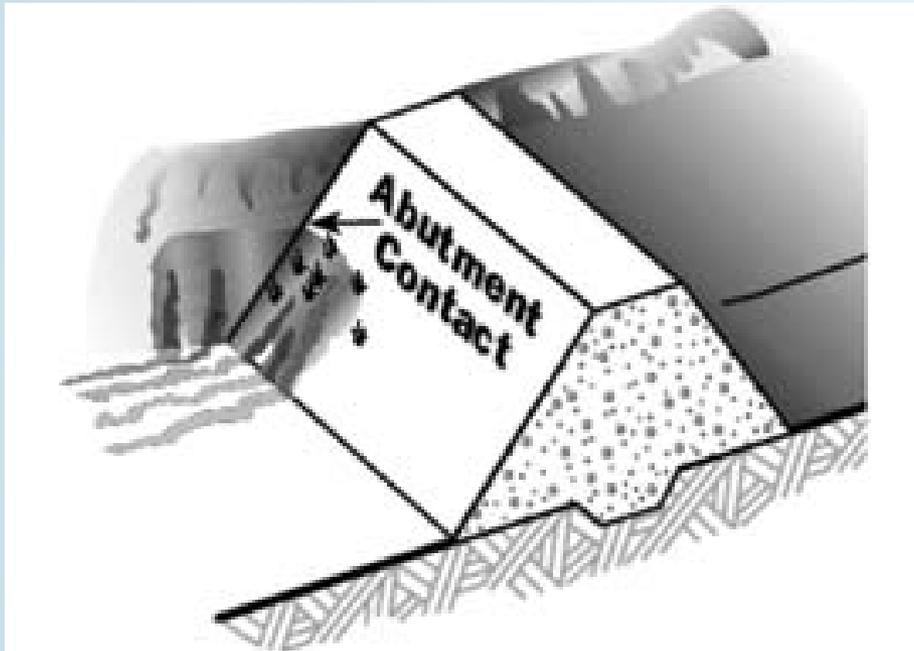
- A channel or pathway has opened through the dam that allows water to freely flow through.
- Continued flow can saturate the surrounding embankment, leading to further erosion or slumping/sliding.

Look for:

- Color/cloudiness/muddiness of flowing water.
- Changes in the flow rate



Seepage Water Flows



Flow at Abutment or Along Groin

- Seepage is occurring at the joint between the abutment and the embankment.
- Continued flow can saturate the surrounding embankment, leading to further erosion or slumping/sliding.

Look for:

- Color/cloudiness/muddiness of flowing water.
- Changes in the flow rate

Seepage Water Flows

Boils

- A path has opened through the foundation of the dam that allows water to freely flow through.
- Continued flow can further erode the dam foundation. (Condition for Sinkhole)

Look for:

- Typically at or beyond the toe of dam
- Shallow “anthill” mounds of material both above and below water
- Cloudiness/color of water



Seepage Water Flows



Seepage Water Flows



Flow Outside of Outlet Pipe

- Seepage is occurring along the path of the outlet pipe running through the dam.
- Continued flow can destabilize the outlet structure, which may cause the flow from the outlet to erode back through the dam along the pipe.

Look for:

- Water flowing underneath or around the outlet pipe
- Color and flow rate of the water.

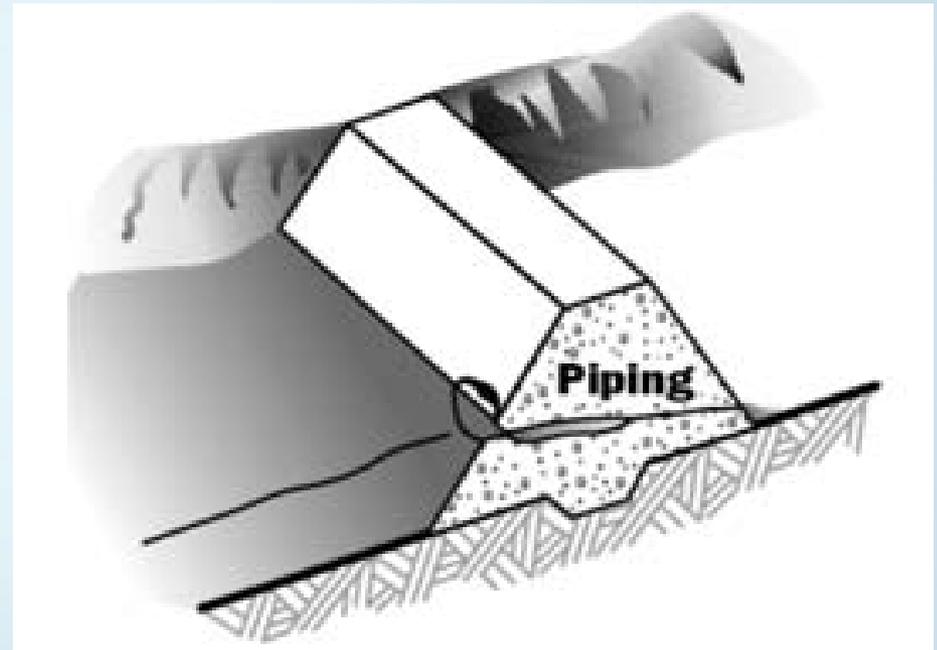
Sinkholes

Likely Cause:

- Internal erosion within the dam has carried away embankment materials.
- Holes or defects in outlet pipes through the embankment are common causes.

Watch for:

- Cloudy or muddy water at the outlet can indicate internal erosion in the embankment.



Sinkholes





Event Partners

Information Booths

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American Rivers

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Association of State Dam Safety Officials

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Gills Creek Watershed

Erich Miarka
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South Carolina Department of Health and Environmental Control
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S.C. Department of Health and Environmental Control

Myra Reece, Director of Environmental Affairs

John Litton, Dams Safety Program

Jill Stewart, Dams Safety

Heather Preston, Water Quality



South Carolina Department of Health and Environmental Control
Promoting and Protecting the Health of the Public and the Environment

S.C. Department of Natural Resources

Carolyn Hefner
Lexington Soil and Water
Conservation District



South Carolina Department of Health and Environmental Control
Promoting and Protecting the Health of the Public and the Environment

S.C. Department of Transportation

Ashleigh Sandel

Natalie Moore



South Carolina Department of Health and Environmental Control
Promoting and Protecting the Health of the Public and the Environment

S.C. Emergency Management Division

Elizabeth Ryan



South Carolina Department of Health and Environmental Control
Promoting and Protecting the Health of the Public and the Environment

U.S. Army Corps of Engineers

Kristin Andrade

Les Parker



Dams After the Flood: Regulations, Responsibilities and Recovery

For More Information:

Shelly Wilson

wilsonmd@dhec.sc.gov

(803) 898-3138

