



Cape Cod Cranberry Growers' Association

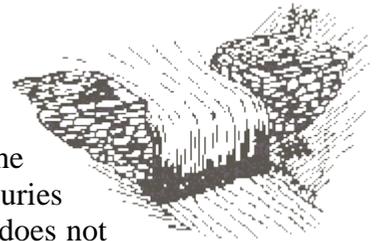
GROWER ADVISORY

Dam Monitoring & Maintenance

Introduction

Water control structures are essential to a successful cranberry operation. These structures include dams, spillways, dikes and flumes; all used to permanently or temporarily detain water. The Department of Conservation and Recreation's (DCR) Office of Dam Safety maintains records and insures compliance of dams in the commonwealth. Most cranberry dams do not follow under the jurisdiction of DCR, according to 302 CMR 10, however for those that do and for the performance of all water control structures in the cranberry system, regular monitoring and maintenance is important. Since water management is an intricate component of a cranberry operation, growers manage their water daily. This advisory is intended to remind growers of routine monitoring, better recognize signs of potential trouble and imminent failure, know what to do and who to contact when such signs are evident, and insure the longevity of water control structures on cranberry farms.

Cranberry growers need to insure that their water control structures are functioning properly to manage water efficiently for the economic benefit of their crop and farm. Routine monitoring and maintenance will only help extend the life of dams and related structures. In addition, 302 CMR 10.13 states that the dam owner is responsible for damage to the property of others and any injuries resulting from the operation or failure of a dam. It also emphasizes that DCR does not accept liability for dam failure even if the dam was permitted and approved by DCR, ultimately making it the owner's responsibility.



Monitoring Dams

Maintenance inspections should be performed on a regular basis (at least monthly) and particularly after a major flood event. Most cranberry growers monitor their dams and water levels much more frequently as part of their daily water management practice. While dam inspections typically focus on structural deficiencies, growers should supplement their regular dam inspection with observing wildlife behavior and burrow location preferences so that routine inspections can include the full range of potential performance problems. By regularly monitoring the condition of the dam, warning of potential problems will allow timely maintenance. Many problems may threaten the immediate safety of a dam and could require immediate repair under the direction of a professional engineer familiar with the construction and maintenance of dams.

Earthen Dams

Upstream Slope

The most common type of cranberry dams is earthen. Look for cracks, slides, sink holes or erosion. Cracks deeper than 1 foot are usually not caused by drying and indicate a problem. Drying cracks are usually parallel to the main axis of the dam, are found near the upstream or downstream crest and run intermittently along the length of the dam, are a few inches wide and do not have vertical offshoots. If drying cracks are suspected, mark the sides of the crack and monitor for changes in width, depth or vertical paths.

Slides indicate part of the dam is sliding or settling. Knowing the slope of the original dam is important as not all dams are built level. Taking yearly photographs of the dam and comparing them to past years is also a benefit to detecting slope changes. Sinkholes are an indication of internal dam erosion.

Often erosion is caused by improper drainage, settlement, foot traffic, 2-wheel or 4-wheel vehicles, dirt bikes or animal burrows. Burrows can weaken embankments and create seepage pathways. Additionally, waves caused by high winds or boats can erode the exposed face of an embankment or degrade the rip rap.



When the water level is drawn down upstream, it's the best time to examine the exposed slope or riprap for settlement, excessive wear, erosion, sink holes and animal burrows.

Downstream Slope

This often is when problems can be first seen. Keep the area clear of brush, trees and weeds to make inspections easier. Look for cracks, slides or seepage. Cracks can indicate normal shrinking but should be monitored to compare changes in width, length or depth. Slides can be found by bulges in the embankment, especially near the toe of the dam. All earthen dams exhibit some seepage but it needs to be controlled in amount and velocity. Seepage occurs through the dam itself and if uncontrolled can erode material from the downstream slope backward toward the upstream slope, leading to total dam failure. It can be recognized by an increase in seepage flow rate, discharge of muddy water below the dam, increasingly cloudy seepage, sinkholes on or near the dam, and a whirlpool in the reservoir. Seepage can also be detected by looking for wet spots on the embankment or areas of lush or noticeably greener vegetation.

Crest

When inspecting the crest of a dam, look for cracking or misalignment. Cracking, usually more than 1 foot deep, is a sign of instability, settlement or movement of layers from within the embankment. Typically there is one crack or a series of close parallel cracks. Misalignment indicates movement between layers of a dam, usually perpendicular. This problem can be seen close-up but it may be easier to view the dam from a distance, looking at the length of the dam's crest.

Concrete Dams

Concrete dams should be inspected for cracks, foundation weakness, and deterioration. Chipped concrete is usually caused from freezing and thawing and is not a danger if routinely monitored and maintained. However, if the dam is thin or reinforcing rods are exposed, structural damage can occur. A chemical reaction from within the concrete can cause expansion and a loss of strength. This problem can be identified by a large area of random cracking, excessive expansion, presence of gelatinous or whitish deposits on the surface of the concrete and a chalky appearance.

Spillways

Spillways are typically found close to a dam and can be an invaluable structure. Spillways remove excess water, allowing pressure to be removed from the main dam outlet. This prolongs the life of a dam and helps to prevent overtopping or failure. Erosion is common at the point where an embankment and the walls of a spillway meet and the spillway itself can also erode. Animal burrows can weaken a spillway. Debris can easily plug a spillway and raise the water level and pressure at the dam.

Immediate Action Conditions

The following conditions warrant immediate dam maintenance.



Overtopping by Floodwaters

- Open outlet to its maximum safe capacity
- Place sandbags along the crest to increase freeboard and force more water through the spillway and outlet
- Provide erosion-resistant protection to the downstream slope by placing plastic sheets or other materials over eroding areas
- Divert floodwaters around the reservoir basin if possible
- Create additional spillway capacity by making a controlled breach in a low embankment or dike section where the foundation materials are erosion resistant

Loss of Freeboard due to Storm Erosion

- Place additional riprap or sandbags in damaged areas to prevent further embankment erosion
- Lower the water level to an elevation below the damaged area
- Restore freeboard with sandbags or earth/rock fill

Slides on the Upstream or Downstream Slope of the Embankment

- Lower the water level at a rate and to an elevation considered safe given the slide condition. If the outlet is damaged or blocked, pumping, siphoning or a controlled breach may be required
- Restore lost freeboard by placing sandbags or filling in the top of the slide
- Stabilize slides on the downstream slope by weighting the toe area with additional soil, rock or gravel

Erosion Through the Embankment

- Plug the flow with whatever material is available (hay bales or plastic sheeting if the entrance to the leak is in the reservoir basin)
- Lower the water level until the flow decreases to a non-erosive velocity or until it stops
- Place a protective sand and gravel filter over the exit area to hold materials in place
- Continue lowering the water level until a safe elevation is reached
- Continue operating at a reduced level until repairs can be made

Mass Movement of the Dam on its Foundation

- Immediately lower the water level until excessive movement stops
- Continue lowering the water until a safe level is reached
- Continue operating at a reduced level until repairs can be made

Excessive Seepage or Saturation of the Embankment

- Lower the water to a safe level
- Continue frequent monitoring for signs of slides, cracking or concentrated seepage
- Continue operation at a reduced level until repairs can be made

Excessive Settlement of the Embankment

- Lower the water level by releasing it through the outlet or by pumping, siphoning or a controlled breach
- Restore the freeboard and/or add sandbags
- Lower water to a safe level
- Continue operating at a reduced level until repairs can be made

Spillway Eroding

- Reduce the flow over the spillway by fully opening the main outlet
- Provide temporary protection at the point of erosion by placing sandbags, riprap or plastic sheets weighted with sandbags
- When inflow subsides, lower the water to a safe level
- Continue operating at a low water level in order to minimize spillway flow

Spillway Blocked (full or partial)

- Reduce the flow over the spillway by fully opening the main outlet
- Remove the obstruction

Emergency Plan

In preparation of a major storm event, monitor what is going on upstream and downstream from your dam. Upstream knowledge is the most important and contributing factors such as tributaries, other grower activities and new development (impervious areas that contribute runoff) should be known to better anticipate a problem. To help alleviate potential problems, dam owners should coordinate high water flows with the adjacent upstream and downstream dam operators. A dam operator should take action to release water when a 2 inch increase in the water level has been observed or in advance of a predicted higher than normal water event. Removing splashboards before the water event occurs is important as it may become physically impossible to remove the boards once the water level rises and exerts additional pressure.

If a dam failure appears imminent and is potentially going to effect roads or structures, emergency assistance should be considered from local police/fire departments and the State Office of Dam Safety. If your dam has been rated as a high hazard, an emergency action plan should be created, available at all times and posted in several locations, especially at the dam site. The emergency plan would include what emergency conditions threaten this dam, actions to help prevent dam failure, a checklist of who to contact and when for an imminent failure, and the relevant contact information for those people and/or agencies.

Maintenance Program

A good maintenance program will protect a dam against deterioration and prolong its life. Nearly all the components of a dam and the materials used for dam construction are susceptible to damaging deterioration if not properly maintained. Growers should develop a basic dam maintenance program and create a dam inspection journal. A sample inspection journal can be found on page 7 of this advisory.

Common maintenance items are filling surface cracks, repairing erosion, filling animal burrows, removing tree and brush growth from the embankment and spillway, removing debris, and embankment mowing.

Earthen Dam Maintenance and Repair

The materials chosen for routine repair of embankments should be free of vegetation, organic materials, trash, or large rocks. The majority of the earth should be fine-grained soils or easily compacted earth clods. The final material should be easily compacted and form a firm, solid mass. As a general rule, it is usually satisfactory to replace or repair damaged areas with soils similar to those originally in place. The most important soil property affecting compaction is moisture content. Soils that are too dry or too wet do not compact well. To test the soil, make a tight ball in your hand and squeeze it – if it maintains its shape without cracking or falling apart (too dry) and without depositing excess water into your hand (too wet), the moisture content is adequate.

Remove any brush, roots, tree stumps and large rocks. Loose topsoil should also be removed, leaving the work surface with exposed firm, clean embankment material. Surfaces should be roughened to improve the bond between the new and old surfaces. Soils should be placed in loose layers up to 8 inches thick and compacted manually or mechanically to form a dense mass. Soil moisture must be maintained throughout the process. During backfilling, runoff should be directed away from the work area to promote the shedding of water.

Surface drying cracks usually close with climatic changes. If they don't, the cracks should be filled with earth and tamped in place to prevent surface water saturation of the dam. To help prevent erosion, embankments should be clear of weeds and brush. Eroded areas must be repaired to prevent more serious damage to the embankment. Repair should consist of suitable soil, topped with 4 inches of topsoil, compacted and seeded. Stacking hay bales across gullies can temporarily slow erosion. Riprap should extend 3 feet below the lowest expected normal water level but will eventually deteriorate and need replacement.

Vegetation Maintenance

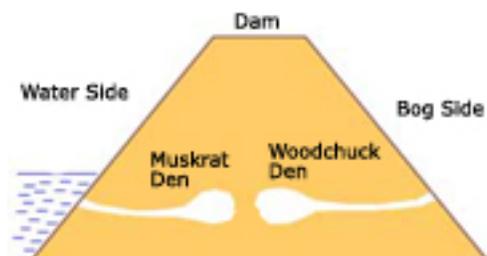
The entire dam should be kept clear of brush and trees. Only grass or low growing plants should be planted and allowed to remain. Excessive growth may cause:

- The embankment to be obscured, preventing routine maintenance
- Large trees to be uprooted in a storm, leaving large holes, that can lead to breaching of the dam
- Root systems to rot, providing passageways for water, resulting in erosion
- Root systems to lift concrete slabs or other structures
- Habitat for animals

If trees or brush are removed, try to remove the root systems and fill the resulting holes. If that is not possible, treat the cut ends with herbicide to retard further growth. Add topsoil to poorly covered or damaged areas and seed.

Animal Control

Animal control is essential to the preservation of a dam and often involves coyotes, foxes, mice, moles, muskrats, rabbits, woodchucks and voles. Burrows can be discouraged when the grass cover is kept mowed. Muskrat activity can be limited by installing riprap, heavy wire fencing laid on the embankment and reducing aquatic vegetation near the embankment.



Rodent burrows should be filled with soil. If a tunnel goes all the way through a dam, do not plug the downstream end as this could cause excess saturation in the interior of the dam. Locate the upstream entrance of the tunnel and excavate around the opening and backfill with impervious material. Then the rest of the tunnel should be filled but this can be a dangerous and costly procedure, possibly requiring an engineer.

There are regulations involving trapping or eliminating nuisance animals. According to the state trapping regulations, no license is required by any legal resident of Massachusetts or member of his immediate family for trapping on land owned or leased by him, which is used principally for agriculture, if he is actually domiciled on that land. There is a trapping season for most of the animals that could pose a problem with your operation but you first must receive training and a trapping license. There are Problem Animal Control (PAC) agents that are licensed to remove nuisance animals. It is illegal to use poisons or to trap fur-bearing mammals with any trap other than a cage or box type trap or a common rat. For further information on trapping or removing animals, contact the Division of Fisheries and Wildlife.

Concrete Maintenance

Decayed concrete can accelerate and result in serious and costly repairs. If deterioration is detected, contact an experienced engineer.

Metal Maintenance

If there are metal gates or components to your dam, make sure moving parts are greased and moved regularly. Any exposed, bare ferrous metal should be painted with appropriate paint and follow the manufacturer's directions to help prevent rust.

Spillways

If your dam has a spillway, keep it functioning properly by removing any obstructions, watching for erosion, deterioration, cracks and not allowing the spillway outlet to become undermined.

Splashboards and Flume Boards

Rotate the boards frequently to keep even wear; those that are below water tend to last longer. Install flume hooks on all boards and keep a pull hook accessible for emergencies (but not to vandals!).



Cranberry Dam Owner's Inspection Journal

National Dam ID Number: _____ Dam Name: _____

Owner's Name: _____ Date of Inspection: _____

Water Level: NORMAL HIGH LOW Notes: _____

Condition	Confirmation	If YES, Action Plan Will Be...
Earthen Dam		
Drying Cracks	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Deep Cracks*	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Embankment Erosion	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Surface Erosion, Ruts	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Sinkholes*	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Animal Burrows	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Rip Rap Degradation	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Misalignment, Slides, Bulges*	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Embankment Seepage	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Muddy or Cloudy Discharge*	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Whirlpool in Reservoir*	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Wet Spots, Isolated Lush or Green Growth	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Brush and Trees	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Debris	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Concrete Dam		
Chipped Concrete	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Exposed Rebar*	<input type="checkbox"/> YES <input type="checkbox"/> NO	
White Deposits, Chalky*	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Spillway		
Erosion	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Debris	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Rip Rap Degradation	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Brush and Trees	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Animal Burrows	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Splashboards/Flume Boards		
Cracked, Warped, Rotten	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Pull Hooks Missing/Worn	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Rotated	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Metal		
Exposed Metal	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Moving Parts Greased	<input type="checkbox"/> YES <input type="checkbox"/> NO	

* May require immediate action and the services of a certified engineer. However, many other indicators could also cause a major problem or failure, when in doubt, consult an expert.

The Cape Cod Cranberry Growers' Association, as a service to our members, provides the information in this advisory. The information represents our interpretation of good management practices and by no means is intended to act as a substitute for reading or following specific engineering requirements, accepted practices, nor will this advisory necessarily prevent a particular dam from failing.

More information on the Department of Conservation and Recreation's Dam Safety Rules and Regulations can be found at <http://www.mass.gov/eea/agencies/dcr/conservation/dam-safety>

Much of the content of this advisory was obtained from the Federal Emergency Management Agency, in a document titled *FEMA 145, Dam Safety, An Owners Guidance Manual*, published in 1986.

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