

EMERGENCY ACTION PLAN

FAWN LAKE DAM
SPOTSYLVANIA COUNTY, VIRGINIA

Inventory Number: 177009

Fawn Lake
HISTORIC FREDERICKSBURG, VIRGINIA

March 3, 2020

Fawn Lake Dam
Emergency Action Plan
March 3, 2020

DISTRIBUTION

Fawn Lake Community Association (3)
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Virginia State Emergency Operations Center (3)
Spotsylvania County Emergency Operations Center (3)
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REVISIONS

Revision Number	Description	Revision Pages	Added by
1	Responses to DCR review comments.	Pages 1-38 and Inundation Maps. Retain all other appendix figures.	P. O'Hara
2	Updates generated from EAP Drill held on 4/15/11	Cover, Pages 1,3,16,19, 20, 22	P. O'Hara
3	Change of ownership	Cover, Pages 1,3,11, 13, 28, 29	P. O'Hara
4	Updates from EAP Table Top Exercise held on 12/18/12	Remove pages 1-38 and replace with new pages 1-34. Retain all maps and appendix figures.	P. O'Hara
5	Updates from EAP Table Top Exercise held on 10/20/14, EAP Drill held on 12/9/15 and replacement of low-level outlet gate.	Cover, Remove pages 1 – 34 and replace with new pages 1 – 32. Retain all maps and appendix figures.	P. O'Hara
6	Updates from EAP Table Top Exercise held on October 15, 2016	Cover, Remove pages 1 – 32 and replace with new pages 1 – 32. Retain all maps and appendix figures.	P.O'Hara
7	Revise contact information for Region 2 Dam Safety Engineer	Cover, Remove pages 1 – 32 and replace with new pages 1 – 32. Retain all maps and appendix figures.	P. O'Hara
August 31, 2017	<ol style="list-style-type: none"> 1. Updated 911 overlay on inundation map 2. Updated Contact Numbers 2. Added weather and non-weather related emergency terminology 3. Added Emergency Levels 4. Increased font size to make document more readable 	Cover, remove Pages 1-32, and inundation maps. Replace with updated pages.	P. O'Hara
November 14, 2017	<ol style="list-style-type: none"> 1. Added 39 Waucoma Drive to properties in the inundation zone. 	Cover, remove pages 1-13 and Map #7. Replace with updated pages	P. O'Hara

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November 6, 2018	1. Updated participant contact data in Appendix C		P. O'Hara
December 20, 2018	<ol style="list-style-type: none"> 1. Updated VDOT and VDEM Contacts 2. Included use of SpotsyAlert. 3. Added structures 101, 102 and 103 to inundation zone. 	Remove all pages with the exception of as-built plans and site map. Replace with updated pages.	P. O'Hara
March 3, 2020	1. Updated participant contact data.	Remove and replace pages iii, 4, 5, 7, 17, 30 – 32 and 37.	P. O'Hara

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EXECUTIVE SUMMARY

The Emergency Action Plan is formatted to be used as a planning tool as well as a working document. In case of emergency, the sections with the red colored tabs at the top of the pages will be of the most immediate use to someone who has never read this plan.

Inundation maps are contained within Section VIII of this Emergency Action Plan. The maps show the area downstream of the Fawn Lake Dam that will be flooded in the event of a dam breach. The inundation zone extends from the Fawn Lake Dam over 24 miles running from a to a point approximately 1.6 miles downstream of Interstate 95 and approximately 1.6 miles upstream of the confluence of the Po and Ni River. The initial and peak flood wave arrival times (FWAT) in the event of a dam break is shown on the maps for various points along Greenfield Creek and the Po River. In the event of a dam breach during a full probable maximum flood (PMF) event, the peak FWAT to reach Interstate 95 is approximately 6 hours.

There are eleven occupied structures within the sunny day breach inundation zone. There are 84 occupied structures within the PMF breach inundation zone. **The initial and peak PMF FWATs to the first structure located at 9811 Catharpin Road are 15 minutes and 54 minutes, respectively.** The maximum flood depth is estimated to be 21.3 feet in this area. However, the inundation zone mapping shows this structure being just inside the zone.

A list of structures that will be inundated due to a Sunny Day or PMF dam breach is contained in appendices A and B.

Upon detection of an existing or potential emergency, it is preferable that the dam operator and Fawn Lake Community Association be notified immediately. Regardless of the initial assessment of severity, notification should be made to the Spotsylvania County Emergency Dispatch Center so as to alert them of a potential emergency. It is best to err on the side of caution and notify emergency services early. Phone numbers for all participants are located in

Appendix C. A notification flow chart is located on page 5 of this document.

Because of method, procedures, and assumptions used to develop the flooded areas, the limits of flooding shown and flood waver travel times are approximate and should be used only as a guideline for establishing evacuation zones. Actual areas inundated will depend on actual failure or flooding conditions and may differ from areas shown on maps.

I. CERTIFICATIONS

Certification by Dam Owner/Operator

I certify that procedures for implementation of this Emergency Action Plan have been coordinated with and a copy given to each local Emergency Services Coordinator serving the areas potentially impacted by the dam. Also, that a copy of this Emergency Action Plan has been filed with the Virginia Department of Emergency Management in Richmond and a copy of the Dam Break Inundation Map has been provided to the local government office with plat and plan approval authority or zoning responsibilities as designated by the locality for each locality in which the dam break inundation zone resides; that this plan shall be adhered to during the life of the project; and that the information contained herein is current and correct to the best of my knowledge.

(Signature of Dam Owner/Operator)

This _____ day of _____, 20____

Printed Name: Stephen Grees, Jr for the Fawn Lake Community Association

Certification by Preparer

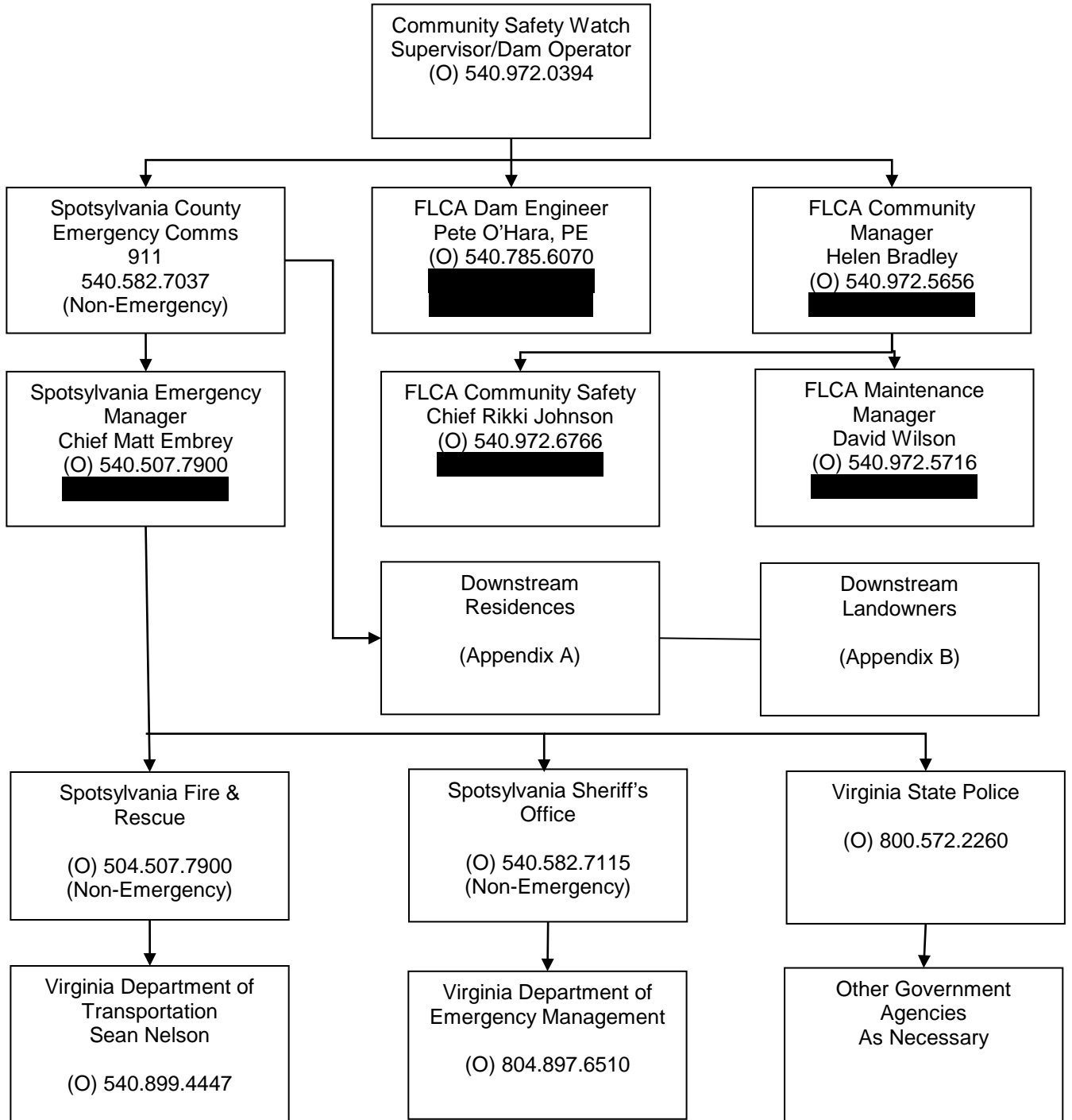
I certify that the information provided in this report has been examined by me and found to be true and correct in my professional judgment.

(Signature of Preparer)

This _____ day of _____, 20____

Printed Name: Peter W. O'Hara, PE Title: Principal Engineer

II. NOTIFICATION FLOW CHART



III. STATEMENT OF PURPOSE

The purpose of this Emergency Action Plan (EAP) is to safeguard lives and reduce property damage downstream of the dam. This EAP provides the following:

1. Information about Fawn Lake Dam.
2. A basis for pre-planning the necessary response by the dam owner/operator and the responsible local, state, and federal emergency organizations.
3. Contact information for persons residing within the inundation zone of the dam in order to provide timely warning of a dam emergency, and
4. A listing of conditions which could lead to the failure of the dam and typical responses.

It is not the intent of this plan to be used for “cookbook” solutions for all situations. Rather it should be used in conjunction with sound judgment of engineering and emergency services professionals.

IV. PROJECT DESCRIPTION

Description of Dam

Fawn Lake Dam is located on Greenfield Creek in Spotsylvania County, Virginia. The dam is owned by Fawn Lake Community Association. The dam creates a 45.5 acre lake used for recreational purposes. The lake's drainage area is 4.14 square miles. The reservoir flood storage capacity is 6,875 acre-feet at the emergency spillway crest. Downstream of the dam, Greenfield Creek runs through Beal's farm, passes under Catharpin Road between Solon Drive and Robert E. Lee Drive and then enters the Po River. Original Design Plans (with some sheets missing) are contained in Appendix D. All elevations are referenced to MSL.

The main components of the dam are:

1. A homogenous earth embankment, approximately 2,230 feet long with a crest elevation of 343 feet and an approximate structure height of 61 feet.
2. A 2.5H:1V to 3.0H:1V upstream embankment slope with a 10 feet wide berm at elevation 336.46 feet, a 17 feet wide crest, and a 2.5H:1V downstream slope.
3. A concrete rectangular drop inlet principal spillway, with interior dimensions of 3 feet by 9 feet. It has two inlets at elevation 335.5 feet.
4. A low-level drain with a 30-inch diameter knife gate valve located at elevation 284 approximately 112 feet upstream of the drop inlet. It is operated hydraulically from the control panel on the upstream berm near the riser. The hydraulic pump can be operated with the 12V marine battery in the panel which is charged by a solar panel, jumper cables attached to another vehicle or by hand pump. The control panel is located on the upstream berm adjacent to the drop inlet. This valve is used as an emergency drain. It can initially lower the lake at the normal pool elevation ~14 inches on the first day, with that rate decreasing as the pool elevation decreases.
5. A high-level drain with a 10-inch diameter knife gate valve with an invert at elevation 325.5. This valve is controlled with the same control panel at the 30-inch diameter knife

gate valve. This valve is primarily used to supply a downstream cattle farm with water when water is not flowing through the drop inlet.

6. A pre-stressed cylinder concrete principal spillway conduit and outlet, 36 inches in diameter with an outlet invert elevation of 281.0 feet. A series of anti-seep collars provide seepage control at the downstream end of the conduit.
7. A riprap lined stilling pool.
8. A vegetated earth channel emergency spillway, 200 feet wide at the bottom with a control elevation of 338 feet located at the left abutment.

Known Conditions

Iron ocre is present in the original and right toe drains. Although this material may look like soil, it is actually a waste product of iron bacteria. Iron ocre has been known to clog drains. If water flow through the toe drains decreases significantly, iron ocre should be considered as one of the potential causes.

Inundation Zone

A breach analysis of the Fawn Lake Dam and a mapping of the downstream inundation zone were completed by Dewberry & Davis in March of 2010. A breach analysis is the modeling of how a breach of the embankment would affect the downstream floodplain. It takes into account the volume in the reservoir, the physical dimensions of the embankment, and the topography of the downstream floodplain. This model is used to determine the area which would be inundated if the embankment were to breach under a number of scenarios ranging from a “sunny day” failure where the embankment fails due to internal erosion to an overtopping of the embankment during a “probable maximum flood” (PMF). It should be noted that actual storms will vary from this design standard in duration and intensity. The area that is flooded (or inundated) due to these scenarios is mapped and presented as an inundation zone map.

The analysis extended from the Fawn Lake Dam to a point just approximately 1.6 miles downstream of Interstate 95 and approximately 1.6 miles upstream of the confluence of the Po and Ni Rivers. The inundation zone ends approximately 14 miles downstream of the dam at the confluence of the Po and Ni Rivers. Inundation maps showing the area that would be inundated by a sunny day breach and a PMF breach as well as failure flood profiles for the floodplain are included in Section VII and Appendix E.

Residences Affected by a Breach or Major Flooding

Based on our analysis, there are 8 residences that may be affected by floodwater during a sunny day breach and 80 residences (as well as several camping lots along the river at Indian Acres Camp Ground) that may be affected by a PMF breach. A listing of structures affected by a **sunny day breach** is included in **Appendix A** and a listing of structures affected by a **PMF** is included in **Appendix B**.

Public Roadways Affected

Roadways that are expected to be submerged or partially submerged during an PMF Breach

are as follows:

1. West Catharpin Road (Rte. 608) – From 11236 West Catharpin Road to 11670 West Catharpin Road. A length of approximately 3,000 ft.
2. Catharpin Road (Rte. 612) – 9768 Catharpin Road to intersection of Catharpin Road and Corbin Lane.
3. Corbin Lane - From intersection of Catharpin Road (Rte. 612) to 4,250 ft. west of intersection.
4. Mill Pond Road - from intersection with Beaver Lane to 2,000 ft. south of intersection.
5. Private Drive – Located on east side of Mill Pond Road between Fox Hunt Trail and Vanreenen Way. Beginning 530 ft. from intersection with Mill Pond Road and continuing past that point approximately 300ft.
6. Vanreenen Way – Beginning approximately 1,000 ft. east from intersection with Mill Pond Road and continuing past that point approximately 225 ft.
7. Mystic Lane – Beginning approximately 2,000 ft. north of the Intersection with Robert E. Lee Drive and Mystic Lane, and continuing past that point approximately 800 ft.
8. JR Montgomery Lane – Beginning approximately 900 ft. north of intersection with Robert E. Lee Drive and continuing north approximately 300 ft.
9. Robert E. Lee Drive (Rte. 608) – From 8974 Robert E. Lee Drive to 8528 Robert E. Lee Drive. A length of approximately 3,700 ft.
10. River Valley Lane – Beginning at the intersection with Robert E. Lee Drive (Rte. 608) and extending north on River Valley Lane approximately 1,100 ft.
11. Singing Wood Lane – Two areas along this road: (a) From approximately 8305 Singing Wood Lane to Singing Wood Lane 8100, (b) From approximately 8028 Singing Wood Lane to 8305 Singing Wood Lane.
12. Millwood Drive – Three areas along this road: (a) From approximately 8700 Millwood Dr. to 8802 Millwood Dr, (b) From approximately 8805 Millwood Dr to 8809 Millwood Dr, (c) From approximately 8909 Millwood Dr to 8911 Millwood Dr.
13. Millwood Court – West of 9009 Millwood Ct.
14. North Lake Drive – Two areas along this road: (a) Beginning at the Intersection of

Jennings Lane and Northlake Drive, (Two isolated areas), go approximately 528 ft. west on Northlake Drive to the beginning of the inundated area for the length of approximately 158 ft, (b) proceed approximately another 1,000 ft. to the beginning of the inundated area for the length of approximately 264 ft.

15. Southlake Drive – Two areas along this road: (a) Beginning at the intersection of Jennings Lane and Southlake Drive, go approximately 580 ft. south to the beginning of the inundated area for a length of approximately 425 ft. (b) proceed approximately another 850 feet to the beginning of the inundated area for the length of approximately 700 feet.
16. Millwood Drive – Two areas along this road: (a) Intersection of Millwood Drive, east to end of Millwood Drive at cul-de-sac, (b) from approximately 8810 Millwood Drive to 8812 Millwood Drive.
17. Old Mill Lane – From approximately 8312 Old Mill Lane to 8314 Old Mill Lane.
18. Block House Road (Rte. 648) From approximately 7893 Blockhouse Road to 7812 Blockhouse Road over the Poe River.
19. Courthouse Road (Rte. 208) - 8150 Courthouse Road to 8044 Courthouse Road, a length of approximately 1,400 feet.
20. Snow Hill Drive – From approximately 7142 Snow Hill Drive to 7240 Snow Hill Drive.
21. Garner Farm Road – Beginning approximately 1,250 ft east of intersection with Courthouse Road and extending 1,000 feet beyond that point.
22. Blackfish Lane – Two location on this road: (a) Between Iowa Lane and Ponca Lane, (b) Between Kusan Lane and Cornstalk.
23. Laughing Water Lane – From intersection with Fawnskin Lane, east to end of Laughing Water Lane.
24. Fawnskin Lane – From Laughing Water Lane to Canonchet Lane.
25. Naomi Lane – From Laughing Water Lane to Snow Bird Lane.
26. Blackfoot Lane – For its entire length.
27. Algonquin Drive – From Blackfoot Lane to Seneca Drive.
28. Maya Lane – From Cliff Dweller Lane to Kickapoo Lane

29. Jefferson Davis Highway (Rte. 1) - 6828 Jefferson Davis Highway South to 6636 Jefferson Davis Highway, length of approximately 1,200 ft over the Po River.
30. North Roxbury Mill Road (Rte. 632) – From 6906 North Roxbury Mill Road to 6973 North Roxbury Mill Road over the Po River
31. Interstate 95 - over the Po River at approximately mile marker 119.

Bridges and culverts that would be affected include:

1. Catharpin Road (Rte. 612) over the Po River
2. Mill Pond Road over Wright's Pond
3. Robert E. Lee Drive over the Po River between 8700 and 8517
4. Block House Road (Rte. 648) over Po River
5. Courthouse Road (Rte. 208) over the Po River
6. Jefferson Davis Highway (Rte.1) over the Po River
7. North Roxbury Mill Road (Rte. 632) over the Po River
8. Interstate 95 over the Po River

Impoundments

Wright's Pond is located on Mill Pond Road. It is the only impoundment within the inundation zone which has Fawn Lake Dam in its watershed. The dam at Wrights Pond will be overtopped during a dam breach. This dam should be inspected when the water recedes and prior to opening Mill Pond Road to traffic.

Jennings Pond and Lake Pocahontas (Indian Acres) may be inundated by the backwater during a dam breach. These dams should also be inspected after any upstream breach event.

Critical Facilities

No known critical facilities, such as hospitals, rescue and relief facilities, water supply facilities, or hazardous waste facilities are located in the hazard area.

Time Line

The estimated travel times of the flood wave from the time of a PMF breach to the bridges along the main channel are as follows:

	<u>Initial Impact</u>	<u>Flood Peak</u>
Corbin Lane/Catharpin Road	15 min	54 min
Mill Pond Road	40 min	1hr 56min
Robert E. Lee Drive	1hr 30min	3hr 13min
XSEC 58352	2hr 40min	5hr 13min
Courthouse Road	2hr 55min	5hr 46min
Indian Acres	3hr 15min	6hr 28min
N. Roxbury Mill Road	3hr 40min	6hr 45min

Because of method, procedures, and assumptions used to develop the flooded areas, the limits of flooding shown and flood waver travel times are approximate and should be used only as a guideline for establishing evacuation zones. Actual areas inundated will depend on actual failure or flooding conditions and may differ from areas shown on maps.

V. EMERGENCY DETECTION, EVALUATION, AND CLASSIFICATION

This section describes the events or conditions that indicate an emergency, defines the stages of emergency, and describes how EAP participants and the public should be notified in the event of emergency.

There are two basic classifications of emergencies – weather related and non-weather related. Weather related emergencies normally come with a warning from the National Weather Service allowing some level of preparation to mitigate an emergency. **Non-weather related emergencies can start small but evolve into a catastrophic emergency within hours of initial detection.** This section addresses detection and evaluation of each emergency individually.

Non-Weather Related Emergency (Sunny Day)

Non-weather related (NWR) emergencies are typically referred to as a ‘sunny day event’. NWRs are typically caused by internal erosion of the embankment or failure of the outlet works. Although these typically result in progressive failures over considerable time, an earthquake can also instigate a NWR, potentially causing a rapid NWR. In terms of emergency action planning and response, NWR scenarios tend have smaller inundation zones and longer time lines since flooding downstream due to other watersheds will be unlikely.

Possible NWR failure modes at Fawn Lake include: piping failure within the embankment, piping failure along the principal spillway conduit caused from infiltration or exfiltration, failure of the upstream outlet works (riser tower or drains). Any of these can cause a rapid progression from a stable condition to failure.

Although not technically an emergency a sustained controlled release of water from the reservoir using the low-level drain can create flow conditions downstream that are significantly

greater than normal. This creates the potential for clogging culverts and minor flooding of roadways.

Non-weather related emergencies may be detected by visual observation. Fawn Lake Dam has a three-tiered detection system. Their community safety patrols pass over the dam at least once a shift (three times a day), maintenance crews cut the grass every few weeks as needed and the dam engineer walks the dam once a quarter.

Seepage should be evaluated periodically based on quantity of flow as well as turbidity. Seepage that is essentially stagnant and clear in color is generally not an urgent condition. However, when the flow increases and becomes turbid, an emergency should be declared. It is important to note that seeps can change in character very quickly; hence they should be taken seriously.

Appendix M provides potential situations that might be encountered on an earth embankment dam.

Weather Related

Weather related (WR) emergencies are the result of rising lake levels that have the potential of activating the emergency spillway sending large volumes of water downstream in a controlled fashion or the breach of the dam embankment due to overtopping of the embankment.

The potential for a weather related emergencies is typically known a few days if not a week in advance. The National Hurricane Center (www.nhc.noaa.gov) provides emails with public advisories including forecasted storm track, precipitation amounts and wind speeds. Once the potential for a storm event of greater than 10 inches of rain in 24 hours is detected preparatory actions should be taken to evaluate and mitigate the situation. Based on empirical data, the lake level will rise approximately 3 inches for every inch of rain.

The potential for overtopping should be evaluated based on whether the reservoir level is rising, falling, or remaining steady as well as the current and forecast weather. Also, as the water level in the reservoir rises existing seeps may flow at a faster rate and begin to transport soil due to the increased head pressure. As stated above in the section regarding normal operating conditions, seeps should be taken seriously and monitored periodically for changes.

Flood or high water events are to be tracked using a system of “stages” which are defined as follows:

Stage I Condition	0.5 feet below emergency spillway control section
Stage II Condition	1.0 feet of flow in emergency spillway
Stage III Condition	2.0 feet of flow in emergency spillway

The emergency spillway can convey up to 4 feet of water prior to overtopping the embankment. The Surveillance section of this plan discusses the requirements for periodic monitoring of the water level.

Classification

The table in Appendix F provides an easy to understand system for communicating the severity and urgency of various situations. Each situation is assigned one of four colors listed below.

Green – Normal operation

Yellow – Non-emergent, unusual event, slowly developing

Orange – Potential dam failure situation, rapidly developing

Red – Urgent; dam failure appears imminent or is in progress.

VI. GENERAL RESPONSIBILITIES

Impounding Structure Owner Responsibilities

The owner, Fawn Lake Community Association maintains the dam. David Wilson is the dam operator. An emergency phone number list is located in Appendix C.

The dam operator works at Fawn Lake and observes the dam two or three times a month during inspections and routine maintenance. The operator is also on call during high water conditions.

The dam owner is responsible for enacting the EAP. The owner and the owner's engineer are responsible for coordinating the Emergency Action Plan with Spotsylvania County's emergency managers.

In the case of a storm event that threatens an overtopping event; all boats at the marina shall be removed from the water or moved up stream and secured to a dock or beached so that they will not obstruct the flow of water through the emergency spillway.

Responsibility for Notification

The following persons or agencies are authorized to implement this plan:

1. Fawn Lake Community Association – Stephen Grees (President) and Helen Bradley (Community Manager)
2. Owner's Engineer – Peter O'Hara, PE
3. Dam Operator – David Wilson
4. Fawn Lake Community Safety Department – Chief Rikki Johnson (Director) or Shift Supervisor
5. Fawn Lake Maintenance Department Manager – David Wilson

6. Any State or Local Emergency Management Agency
7. Virginia Department of Dam Safety and Floodplain Management

Any other persons should contact the Fawn Lake Community Safety Department if they believe an unsafe condition exists at the dam.

Detection of a condition or event that is the basis for an existing or potential emergency will most likely be by Fawn Lake's Community Safety Department during routine patrols (three times per day) or Fawn Lake's Maintenance Department during routine maintenance. Upon detection, it is preferable that the dam operator and Fawn Lake Community Association be notified immediately. If the observed condition is such that the situation is not urgent (e.g. a small seep flowing clear), it is best if the owner's engineer is requested to make a site visit to make a determination as to the severity and urgency of the condition. However, if these people cannot be contacted, then notification should be made to the Spotsylvania County Emergency Dispatch Center.

Upon notification, the party that first detected the condition shall proceed to the dam and establish constant monitoring until relieved. At the same time, the owner and owner's engineer shall proceed to the dam to make an initial assessment. In the case of a non-weather related event, the Emergency Services Coordinator may respond to the dam. However, during a weather related event there may be multiple emergency situations which may result in another officer being assigned to the site. In a worst case scenario, there may be no emergency services officer assigned.

In order to expedite this initial assessment, Fawn Lake Community Safety should be notified that first responders will be arriving at the gate and will need access and/or directions to the dam.

Once the initial site visit has been completed, a command post should be established at the

Fawn Lake Community Association Clubhouse located at the end of Longstreet Drive (from the Main Gate proceed straight to the end of the road). The location of the clubhouse is show on the area map contained in Appendix I of this report. A holding area for members of the media should also be established should the emergency condition attract media attention.

Responsibility for Evacuation

Warning and evacuation of persons downstream is the responsibility of the Spotsylvania County Emergency Management. Initial notification will be accomplished using Spotsylvania County's automated phone call system and SpotsyAlert. The Fawn Lake Community Association will encourage residents and owners of properties in the inundation zone to subscribe to SpotsyAlert.

Responsibility for Duration, Security, Termination, and Follow-up

The dam operator is responsible for on-site monitoring of the situation at the dam and keeping local authorities informed of developing conditions at the dam from the time that an emergency starts until the emergency has been terminated.

Fawn Lake Community Safety shall secure and control access control to the dam embankment for the duration of the emergency.

The Emergency Services Manager, in consultation with the Owner's Engineer, shall be responsible for the decision to declaring that the emergency is terminated. A WR event should not be terminated until the lake level starts to recede (non-breach/no seepage situation) or the lake level has dropped as not to present a continuing threat (breach situation). A NWR event should not be terminated until either the lake level has been sufficiently lowered as not to present a continued threat.

Any roads, utilities, and structures should be inspected prior to reentry into flooded areas. The Virginia Department of Transportation, the Building Official, and appropriate utility agencies

should be on hand to conduct the inspections. Photographs and written logs should be used to document any damage. The Spotsylvania County Sheriff's department will control access into these areas until such time that these areas are declared safe.

The owner's engineer shall convene an initial emergency evaluation conference within 7 days of the termination of the emergency to be attended by representatives of all participants in the emergency event. A report detailing the nature of the emergency and a chronology of events during the response shall be prepared within 30 days of the termination of the emergency.

EAP Coordinator Responsibility

The owner's engineer shall be the EAP Coordinator. Responsibilities of the EAP coordinator shall include preparing revisions to the EAP, establishing training seminars, and coordinating EAP exercises. The EAP Coordinator shall be the point of contact for any questions related to the plan. Bi-annual table top exercises conforming to 4VAC50-20-53 are required for this dam. Drills shall be conducted during alternate years.

VII. PREPAREDNESS

Actions can be taken that can help to mitigate the extent of damage resulting from any emergency events.

Surveillance

The level of surveillance during an emergency event will depend on the severity and urgency of the condition.

Emergency Level	Stage	Storm Event Pool Elevations (Relative to Emergency Spillway)	Sunny Day Incident	Surveillance Frequency
Green	0	Normal Pool	Normal Operation	Daily
Yellow	1	0.5 ft below & rising	Unusual condition slowly developing	Every 2 Hours
Orange	2	1.0 ft above & rising	Potential dam failure situation rapidly developing	Every 30 minutes
Red	3	2.0 ft above & rising	Dam failure appears inevitable	Continuous

Table 1. Definition of stages, surveillance frequency and notifications for storm events and sunny day incidents.

It may be necessary to conduct surveillance more often when the reservoir level is rising rapidly.

Response During Periods of Darkness

During periods of darkness it will be necessary to light the affected areas of the dam with flash lights and car headlights. Light plants should be brought in if the situation is expected to occur over a long period of time.

Access to the Site

Access to the dam will normally be by automobile along Fawn Lake Parkway. In the case, where access to the low level outlet valve control panel is necessary and the emergency spillway is either in operation or expected to operate, it will be necessary to access the dam from the right side using Fawn Lake Parkway. The map in Appendix J shows the primary and secondary access routes to the dam.

Response During Weekends and Holidays

Fawn Lake Community Safety is available 24 hours a day, 7 days a week. Phone numbers are available for all key participants. **Phone numbers are contained in Appendix C.**

Response During Periods of Adverse Weather

During flood watches, the dam operator will be available on property.

Alternate Systems of Communication

The primary system of communication within the Fawn Lake Property will be by cell phone and Community Association portable radios operating on Channel 2. Fawn Lake Community Safety 'Base' will monitor this channel. **Phone numbers are contained in Appendix C.** Alternate systems will be either landline from a neighboring house or the Fawn Lake Community Association office.

Emergency Supplies and Information

Stockpiling Materials and Equipment

The following equipment and materials are available on-site.

1. Backhoe Loader
2. 1 Ton Dump Truck

Sand and stone can be obtained at a local quarry during business hours or possibly from the Virginia Department of Transportation after hours. A light plant can be rented from a local rental company. Contact information is contained in Appendix G.

Potential Mitigating Actions

There are certain actions that can be taken to prevent a dam failure or mitigate damage if taken in a timely manner. However, it is important to note that these actions are not always appropriate and therefore should be carefully considered before attempting.

Open Low Level Outlet

In most cases where the low level outlet pipe and the principal spillway pipe are not affected by the emergency, the concept of reducing the amount of the water behind the dam is sound. This will have two results. First, it reduces the pool level by approximately 14 inches per day when starting at the normal pool elevation. Second, by decreasing the pressure head on any seeps, the velocity of water will be lowered which will eventually decrease below a point where it can no longer transport soil from the embankment.

However, care should be taken to ascertain if the spillway conduit is damaged prior to opening the outlet. If the principal spillway conduit became clogged with soil or debris, allowing a high volume of water under high pressure may cause further damage the conduit to a point where piping could occur.

A secondary concern with rapid lowering of the reservoir is surficial slope failures on the upstream slope. Based on experience during the uncontrolled release in 2014, the upstream slope experienced very superficial movement of the slope with depths of only a few inches.

Finally, the potential of failure while personnel are opening the low level outlet should be considered prior to conducting such an operation. If it is decided to open the outlet, it is suggested that two people be present. One person should operate the valve(s) while the other

observes the embankment for changes. Also, an escape route should be planned prior to the operation should the need to evacuate the dam crest arise. The key for the control cabinet is kept at the Front Gatehouse.

Reduction in Freeboard and/or Loss of Dam Crest Width

1. Place additional rip rap or sandbags in damaged areas to prevent further embankment erosion.
2. Lower the water level to an elevation below the damaged area.
3. Restore freeboard with sandbags or earth and rockfill.
4. Continue close inspection of the damaged area until the storm is over.

Slide on the Embankment Slope

If a slide occurs on the embankment slope, initiate lowering the reservoir level to a level below the bottom of the failure.

Piping through the Embankment, Foundation, or Abutments

Immediately open the low level outlet in order to lower the reservoir level. Then place an inverted filter at the exit area of the pipe if the flow velocity is slow enough. Also attempt to plug the flow on the upstream end with whatever material is available (hay bales, bentonite, or plastic sheeting) if the entrance is apparent in the reservoir.

In the case of small boils or seeps whose flow is relatively slow, an “inverted filter” can be constructed by placing layers of granular materials with increasing grain size over the affected area. Ideally, the first layer should be sand, followed by VDOT #78 stone, VDOT #57 Stone, and VDOT #3 Stone. The purpose of the inverted filter is to allow water to pass, but to prevent soil from being transported out of the dam. If the flow of water is too fast, it will simply transport the filter away. At that point, eventual failure is very likely.

When flows from boils are relatively slow, sand bags can be used to create circular pools over boils effectively slowing or stopping the flow.

Failure of Outlet Works

Implement temporary measures to protect the damaged structure, such as closing an outlet or providing temporary protection for a damaged spillway. Employ experienced, professional divers, if necessary, to assess the problem and possibly implement an expedient repair.

If possible, lower the water level to a safe elevation. If the outlet is inoperable, pumping, siphoning, or a controlled breach may be required.

Because of uncertainties about their effectiveness, these preventive actions should be carried out simultaneously with appropriate notification of an alert condition or warning condition.

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VIII. Inundation Maps

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IX. Appendices

Appendix A – Structures in Sunny Day Dam Breach Inundation Zone

Map ID	Address	Phone Number
	Map 1	
	None	
	Map 2	
	None	
	Map 3	
3	9428 Mill Pond Road	
4	9415 Mill Pond Road	
5	9429 Mill Pond Road	
9	9444 Mill Pond Road	
	Map 4	
	None	
	Map 5	
23	8100 Singing Wood Lane	
28	8517 Robert E Lee Drive	
30	8425 Robert E Lee Drive	
	Map 6	
63	7300 Snow Hill Drive	
64	7240 Snow Hill Drive	
79	7818 Courthouse Road	
	Map 7	
72	Indian Acres	
	Map 8	
	None	

Notes:

1. Inundation Zone did not change from the 2010 mapping. However, accuracy of building placement improved resulting in structures being removed based on location as well as better information regarding whether structures are habitable or not.
2. At the time of this update, the Spotsylvania County Reverse 911 lookup as not available. Phone numbers will be added once that information becomes available.

Appendix B – Structures in the PMF Dam Breach Inundation Zone

Map ID	Address	Phone Number	Map ID	Address	Phone Number
	Map 1		37	8804 Millwood Drive	
	None		38	8806 Millwood Drive	
	Map 2		39	8808 Millwood Drive	
1	9811 Catharpin Road		40	8810 Millwood Drive	
	Map 3		41	8812 Millwood Drive	
2	9452 Mill Pond Road		45	9003 Millwood Drive	
3	9428 Mill Pond Road		46	8323 Old Mill Lane	
4	9415 Mill Pond Road		47	8401 Old Mill Lane	
5	9429 Mill Pond Road		102*	9001 Millwood Court	
6	9742 Beaver Lane			Map 6	
7	9842 Beaver Lane		48	7720 Po River Drive	
8	9448 Mill Pond Road		49	7714 Po River Drive	
9	9444 Mill Pond Road		50	7640 Po River Drive	
10	10024 Beaver Lane		51	7630 Po River Drive	
11	10530 Beaver Lane		52	7708 Hunter Cove	
12	9401 Mill Pond Road		53	7700 Hunter Cove	
13	9621 Paradise Court		54	7707 Hunter Cove	
14	9409 Mill Pond Road		55	7741 Courthouse Road	
15	9490 VanReenan Way		56	7737 Courthouse Road	
16	8308 Singing Wood Lane		57	7801 Courthouse Road	
17	8304 Singing Wood Lane		58	7800 Courthouse Road	
18	8217 Singing Wood Lane		59	7732 Courthouse Road	
101*	8216 Singing Wood Lane		60	7736 Courthouse Road	
	Map 4		61	7320 Snow Hill Drive	
42	8520 Heron Pointe Way		62	7901 Melton Lane	
43	9510 Northlake Drive		63	7300 Snow Hill Drive	
44	9430 Northlake Drive		64	7240 Snow Hill Drive	
	Map 5		65	7315 Snow Hill Drive	
19	8136 Singing Wood Lane		66	8004 Sourwood Court	
20	8135 Singing Wood Lane		67	4 Shetland Court	
21	8619 Robert E Lee Drive		68	230 Morgan Lane	
22	8114 Singing Wood Lane		69	225 Morgan Lane	
23	8100 Singing Wood Lane		70	223 Morgan Lane	
24	8921 River Valley Lane		71	310 Clydesdale Court	
25	9001 River Valley Lane		77	7225 Gardner Farm Road	
26	9011 River Valley Lane		78	7235 Gardner Farm Road	
27	8926 River Valley Lane		79	7818 Courthouse Road	
28	8517 Robert E Lee Drive		103*	7669 Courthouse Road	
29	8911 River Valley Lane			Map 7	
30	8425 Robert E Lee Drive		72	Indian Acres	
31	8421 Robert E Lee Drive		73	6437 Morris Road	
32	8415 Robert E Lee Drive		74	47 Waucoma Trail	
33	8484 Robert E Lee Drive		75	7001 Jefferson Davis Hgwy	
35	8510 Robert E Lee Drive		76	6908 S Roxbury Mill Road	
36	8802 Millwood Drive		80	39 Waucoma Trail	

Appendix C - Participants

Participant	Point of Contact	Contact Information
<p>Owner Fawn Lake Community Association 11300 Longstreet Drive Spotsylvania, VA 22551</p>	<p>Stephen Gress (President)</p>	<p>540-412-1868 - Office [REDACTED] [REDACTED]</p>
	<p>Helen Bradley (Community Manager)</p>	<p>540-972-1000 – Office [REDACTED] [REDACTED] [REDACTED]</p>
	<p>Rikki Johnson (Director of Community Safety)</p>	<p>540-972-6766 - Office [REDACTED] [REDACTED]</p>
	<p>Teresa Snyder (Asst. Director of Community Safety)</p>	<p>[REDACTED]</p>
	<p>Josh Delancey (Maintenance Crew Leader)</p>	<p>[REDACTED]</p>
	<p>David Wilson (Maintenance Dept Manager)</p>	<p>[REDACTED] [REDACTED]</p>
	<p>Main Gate</p>	<p>540-972-0394 – Office</p>

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<p>Owner’s Engineer ECS Mid-Atlantic, LLC 915 Maple Grove Dr Ste 100 Fredericksburg, VA 22407</p>	<p>Peter O’Hara, P.E. Dustin Schleifer, P.E.</p>	<p>540-785-6070 - Office [REDACTED] [REDACTED] [REDACTED] 540-785-6100 – Office [REDACTED] [REDACTED]</p>
<p>Dam Operator Fawn Lake Community Association 11300 Longstreet Drive Spotsylvania, VA 22553</p>	<p>David Wilson</p>	<p>540-972-5716 - Office [REDACTED] [REDACTED]</p>
<p>Dam Gauge Observer Fawn Lake Community Safety</p>	<p>Fawn Lake Community Safety</p>	<p>540-972-0394 - Phone</p>
<p>County Emergency Services Spotsylvania County Emergency Communications 9119 Dean Ridings Lane PO Box 818 Spotsylvania, VA 22553</p>	<p>Chief Matt Embrey Division Chief - Emergency Management and Logistics</p>	<p>Non-Emergency 540-507-7900 – Office [REDACTED] Emergency – 911 [REDACTED]</p>
<p>Virginia Department of Transportation Virginia Department of Transportation Fredericksburg Residency 87 Deacon Road Fredericksburg, VA 22405</p>	<p>Kyle Bates – Asst. Resident Admin Duane Shifflett– Maintenance Ops Manager Michael Dobson – Chancellor AHQ Superintendent</p>	<p>540-899-4300 - Main [REDACTED] [REDACTED] [REDACTED] [REDACTED]</p>
<p>Spotsylvania County Sheriff’s Office 9119 Dean Ridings Lane Spotsylvania, Virginia 22553</p>	<p>Roger Harris - Sheriff</p>	<p>540-582-7115 – Non-Emergency</p>
<p>Division of Dam Safety Virginia Dept of Conservation & Rec. Division of Dam Safety</p>	<p>Mark Killgore, P.E. Dam Safety Engineer</p>	<p>804-786-1359 – Office [REDACTED] [REDACTED]</p>

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<p>600 East Main Street, 24th Floor Richmond, VA 23139</p>		
<p>State Emergency Operations Center Virginia Dept of Emergency Mgmt 7700 Midlothian Turnpike Richmond, VA 23235</p>	<p>Daniel Bradway IFLOWS Chief (804) 674-2405 Mark Stone VDEM Chief Regional Coordinator (Region 2) Alexa Hussar Disaster Response and Recovery Officer (DRRO)</p>	<p>804-674-2400 – 24/7 Phone [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED]</p>

Fawn Lake Dam
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Appendix D – Original Dam Design Plans (Partial Set)

Appendix E –Flood Depths

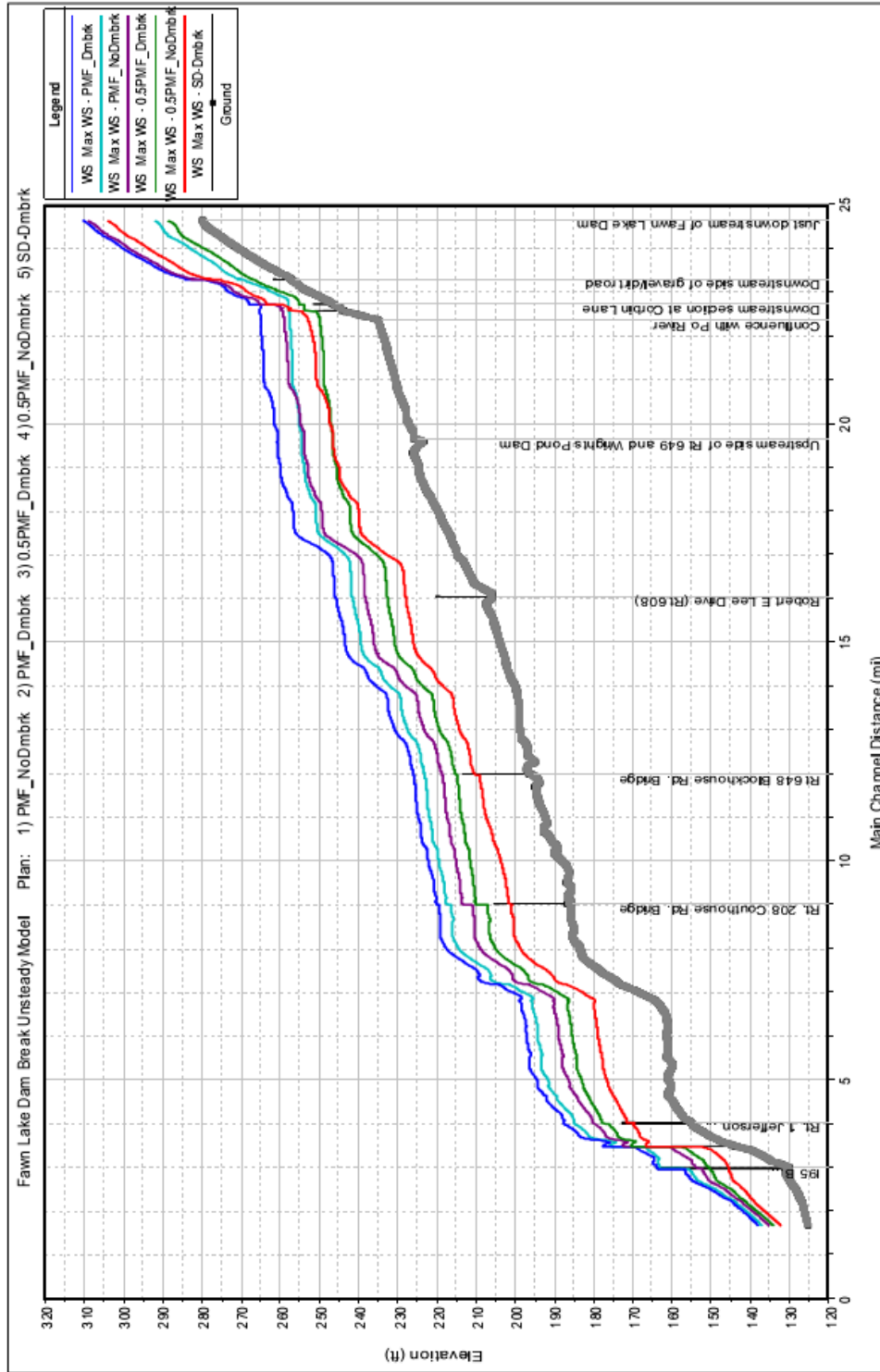


Figure 5. Maximum Water Surface Elevation Profiles.

Appendix F – Emergency Levels

Event	Situation	Emergency Level
Embankment Overtopping	Water is flowing through the emergency spillway	Yellow
	Lake level is 2 feet below the top of dam	Orange
	Water is flowing over the dam	Red
Seepage	New seepage areas in or near the dam embankment	Yellow
	New seepage areas with cloudy discharge or increasing flow rate	Orange
	Toe drains with cloudy discharge or increasing flow rate	Orange
	Toe drains with significant reduction in flow rate	Yellow
Sinkholes	Observation of a sinkhole in the embankment, abutments or downstream toe.	Orange
	Rapidly enlarging sinkhole in the embankment, abutments or downstream toe.	Orange
Embankment Cracking	Cracks (parallel or perpendicular to embankment) in the top third of the embankment without water flow	Yellow
	Cracks (parallel or perpendicular to embankment) in the lower two-thirds of the embankment with or without water flow	Orange
Embankment Movement	Visual movement/slippage of the embankment slope	Orange
	Sudden slides of embankment slope	Red
Instruments	Instrumentation readings beyond normal ranges	Yellow
Earthquake	Measurable earthquake felt within 50 miles of the dam	Yellow
	Earthquake resulting in visible damage to the dam or appurtenances	Orange
	Earthquake resulting in uncontrolled release of water from the dam	Red
Security Threat	Credible threat (e.g. bomb) that could damage dam	Orange
	Threat carried out causing damage to dam	Red
Sabotage/Vandalism	Damage to dam with no impacts to the functioning of the dam	Green
	Damage to the dam that could adversely impact the functioning of the dam (e.g. valve operating panel damaged)	Yellow
	Damage to the dam that has resulted in uncontrolled seepage flow	Orange
	Damage to the dam that resulted in uncontrolled water release	Red

Appendix G – Emergency Supplies

(Companies that can provide assistance in the event of an emergency)

CONTRACTORS

Bander-Smith (Dam Repair/Diving) 22 S Davis Ave, Richmond, VA 23220	Mr. Cameron Smith Mr. Austen Bander, P.E.	██████████
--	--	------------

W.C. Spratt Inc. 491 Central Road Fredericksburg, VA 22401	Mr. Doug Tait	██████████
--	---------------	------------

Chemung Contracting Corp. 7201 Rail Line Court Gainesville, VA 20155	Mr. Ed Dalrymple	██████████
--	------------------	------------

EQUIPMENT RENTAL (Lights and Pumps)

Sunbelt Rentals 1200 Belman Road Fredericksburg, VA 22401	540-710-1300 800-667-9328
---	------------------------------

United Rentals 10 Le Way Drive Fredericksburg, VA 22406	540-599-0053 800-877-3687
---	------------------------------

RSC Rentals 4616 Lassen Lane Fredericksburg, VA 22408	540-710-2300 800-222-7777
---	------------------------------

MATERIALS - SAND

Ennstone Inc 1170 Kings Highway, Fredericksburg, VA 22405-3814	540-361-1653
--	--------------

Fawn Lake Dam
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MATERIALS – CRUSHED STONE

9100 Luck Stone Ln	540-898-6060
Fredericksburg, VA 22407-5302	

MATERIALS – MISC

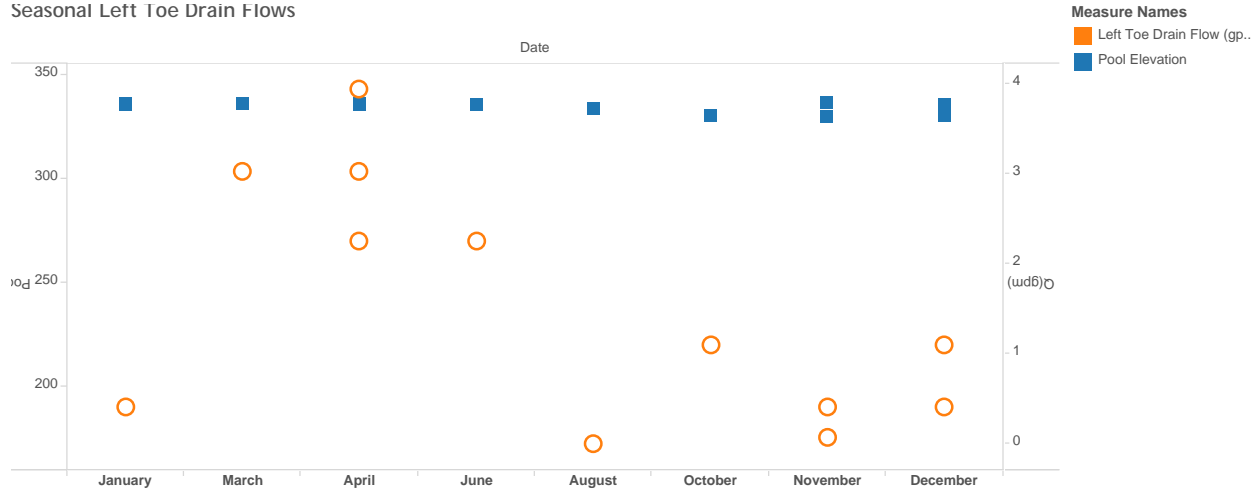
Home Depot	540-785-8871
5771 Plank Road	
Fredericksburg, Virginia 22407	

The residents of Fawn Lake are also potential sources of materials and equipment (e.g. pontoon boats), etc.

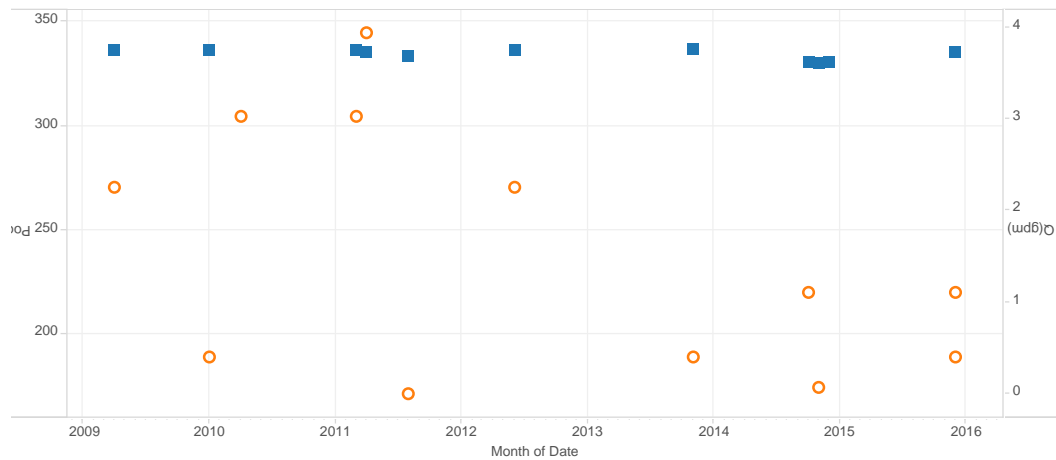
Appendix H - Site-Specific Concerns

There is a weir box located to the left the principal spillway that measures the quantity of flow from the left toe drain and lake pool elevations. Flows outside these ranges are a potential indicated of a developing problem and should be addressed in a timely manner.

Seasonal Left Toe Drain Flows



Left Toe Drain Flows over Time



Flow Rates for a 90 degree V-Notch Weir where H is the depth of water measured at the upstream side of the weir box

Flow Rates for a V Notch Weir

H (in)	Q (cfs)	Q (gpm)
0	0.0000	0.00
0.25	0.0002	0.07
0.5	0.0009	0.40
0.75	0.0024	1.10
1	0.0050	2.25
1.25	0.0088	3.93
1.5	0.0138	6.20
1.75	0.0203	9.11
2	0.0284	12.72
2.25	0.0381	17.08
2.5	0.0495	22.23
2.75	0.0629	28.21
3	0.0781	35.07
3.25	0.0954	42.83
3.5	0.1149	51.55
3.75	0.1365	61.26
4	0.1604	71.98
4.25	0.1866	83.76
4.5	0.2153	96.63
4.75	0.2464	110.61
5	0.2802	125.75
5.25	0.3165	142.06

1. H is depth of water through weir plate

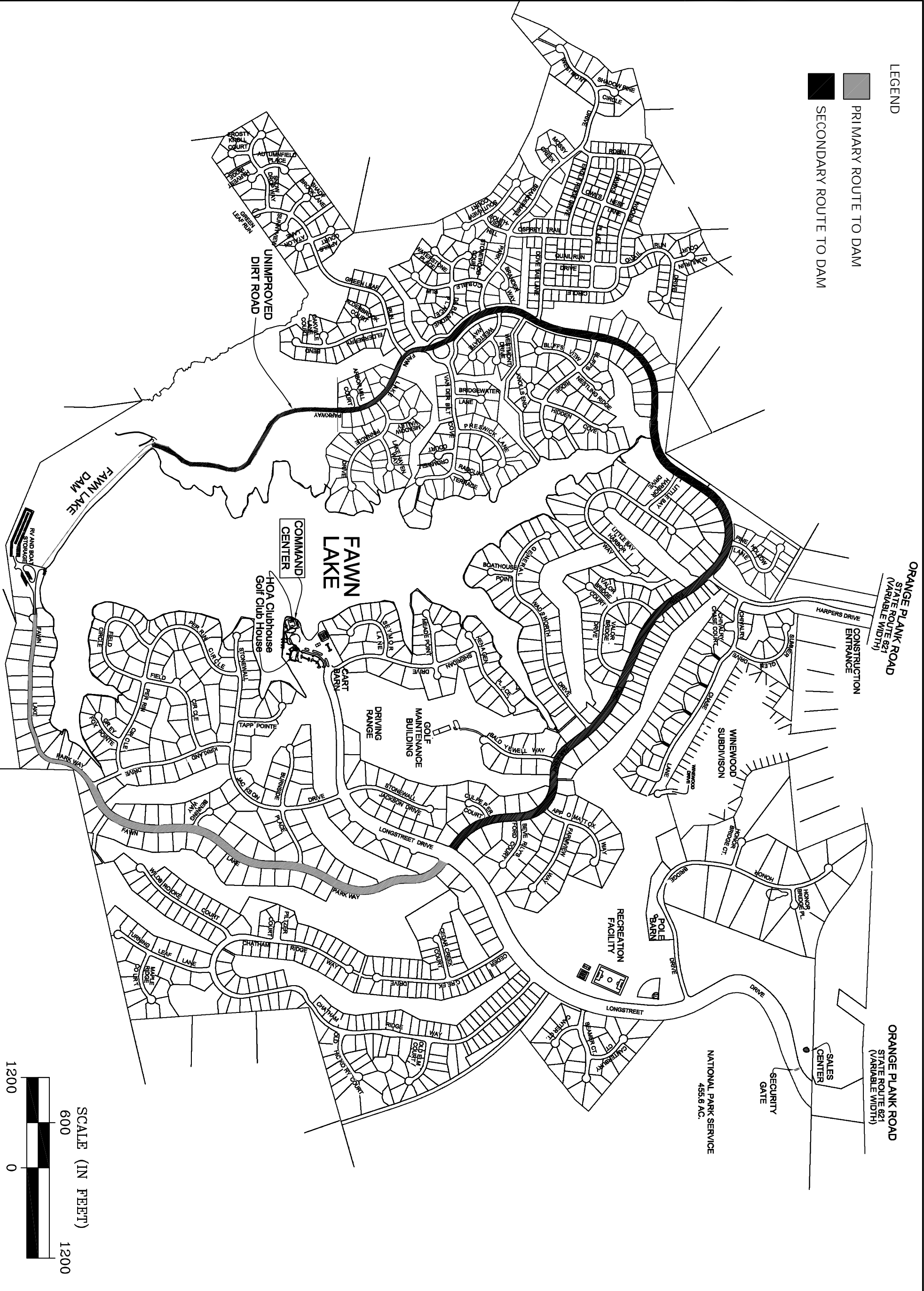
Appendix I – Notification Worksheet

1. Contact Spotsylvania Emergency Communications Center. Tell them that there is a potential emergency at Fawn Lake Dam and request that the Emergency Services Manager call the Owner's Engineer (Pete O'Hara) at 540-785-6070 (O) or 540-379-4670 (C). If the Engineer is not available, have the Emergency Services Manager make contact with Helen Bradley or Chief Rikki Johnson.
2. Start a log of all communications and actions until FLCA establishes a Command Center.

Log of Actions Taken

Time **Action**

Appendix J – Fawn Lake Area Map



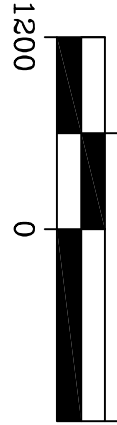
LEGEND

-  PRIMARY ROUTE TO DAM
-  SECONDARY ROUTE TO DAM

ORANGE PLANK ROAD
STATE ROUTE 821
(VARIABLE WIDTH)

ORANGE PLANK ROAD
STATE ROUTE 821
(VARIABLE WIDTH)

SCALE (IN FEET)
600 1200



<p>FAWN LAKE AREA MAP NTS DEVELOPMENT</p>		<p>FAWN LAKE EMERGENCY ACTION PLAN SPOTSYLVANIA COUNTY, VIRGINIA</p>
<p>ECS REVISIONS</p>		
<p>ENGINEER MTC</p>	<p>DRAFTING CLL</p>	
<p>SCALE 1"=1,200'</p>		
<p>PROJECT NO. 1815-G</p>		
<p>SHEET 1 OF 1</p>		
<p>DATE 8/23/10</p>		

Appendix K - Plans for Training, Exercising, Updating and Posting the EAP

Training

Training Sessions should be conducted annually for participants located on the property. The content for these sessions should orientation to the EAP and detection and evaluation of emergency events and conditions.

Exercising

In conjunction with the training sessions, either a drill or a table top exercise will be conducted as required by 4VAC50-20-175.

Updating

This plan shall be reviewed annually and changes distributed to all plan holders. Potential changes might include:

1. Changes in personnel.
2. Changes in telephone numbers.
3. Additions or deletions of structures and critical facilities within the danger reach.
4. New conditions that would affect flood flows or the extent of damage due to a dam failure.
5. Update 911 mapping overlay on inundation map.

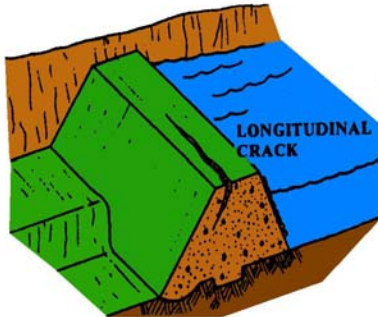
Appendix L - Investigation and Analysis of Impounding Structure Failure Floods

A dam breach analysis was performed for Fawn Lake Dam in accordance with the following procedures. Inflow and outflow hydrographs for Fawn Lake Dam and runoff hydrographs from downstream sub-basins were determined using the Corps of Engineers HEC-1 computer program. PMP rainfall amounts were taken from the National Weather Service (NWS) publication HMR-51 and distributed temporally in accordance with the Natural Resources Conservation Service (NRCS) publication TR-60 and spatially in accordance with NWS HMR-52. The resulting rainfall hyetographs were converted to runoff hydrographs using NRCS procedures for determination of runoff curve number, lag time, and unit hydrographs. The NRCS 24-hour, 5-point temporal rainfall distribution was determined to be the most conservative of all the NRCS temporal storm distributions and was selected for PMF development and subsequent dam break analysis. Dam breach simulation and determination of dam breach hydrographs was performed within HEC-1. The dam breach and no-breach hydrographs from HEC-1 were input into the Corps of Engineers HEC-RAS computer program (unsteady model simulation) to simulate passage of the flood waves through the stream valley downstream of the dam. Cross sections for the unsteady HEC-RAS model were developed based on USGS DRG topographic mapping. Peak water surface elevations from the unsteady HEC-RAS model for the dam breach and no-breach simulations were plotted on the USGS DRG topography in order to map the inundation zones. Spotsylvania GIS data was used to identify structures within the inundation zones.

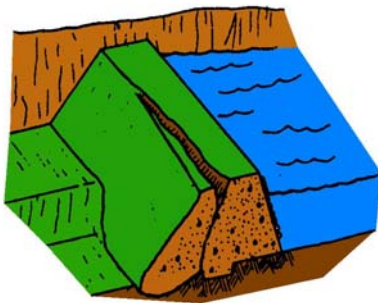
Appendix M – Potential Problems and Actions

PROBLEMS

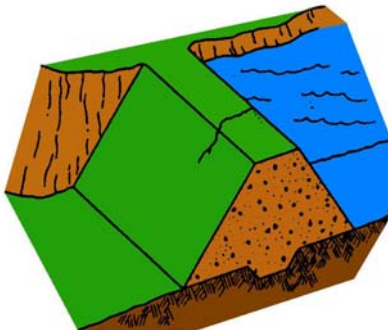
LONGITUDINAL CRACKING



VERTICAL DISPLACEMENT



TRANSVERSE CRACKING



CAUSES & HARM DONE

Probable Cause:

1. Uneven settlement between adjacent sections or zones within the embankment.
2. Foundation failure causing loss of support to embankment.

Harm:

1. Creates local area of low strength within embankment. Could be the point of initiation of future structural movement, deformation, or failure.
2. Provides entrance point for surface run-off into embankment, allowing saturation of adjacent embankment area and possible lubrication which could lead to localized failure.

Probable Cause:

1. Vertical movement between adjacent sections of the embankment.
2. Structural deformation or failure caused by structural stress or instability, or by failure of the foundation.

Harm:

1. Provides local area of low strength within embankment which could cause future movement.
2. Leads to structural instability or failure.
3. Provides entrance point for surface water that could further lubricate failure plane.
4. Reduces available embankment cross section.

Probable Cause:

1. Uneven movement between adjacent segments of the embankment.
2. Deformation caused by structural stress or instability.

Harm:

1. Can provide a path for seepage through the embankment cross section.
2. Provides local area of low strength within embankment. Future structural movement, deformation, or failure could begin at this point.
3. Provides entrance point for surface run-off to enter embankment.

ACTION REQUIRED

Potential Action:

1. Inspect crack and carefully record location, length, depth, width, alignment, and other pertinent physical features. Immediately stake out limits of cracking. Monitor frequently.
2. Engineer should determine cause of cracking and supervise steps necessary to reduce danger of dam and correct condition.
3. Effectively seal the cracks at the crest's surface to prevent infiltration by surface water.
4. Continue to routinely monitor crest for evidence of further cracking.

Qualified Dam Safety Professional Required

Potential Action:

1. Carefully inspect displacement and record its location, vertical and horizontal displacement, length, and other physical features. Immediately stake out limits of cracking.
2. Engineer should determine cause of displacement and supervise all steps necessary to reduce danger to dam and correct condition.
3. Excavate area to the bottom of the displacement. Backfill excavation, using competent material and correct construction techniques, under supervision of engineer.
4. Continue to monitor areas routinely for evidence of future cracking or movement.

Qualified Dam Safety Professional Required

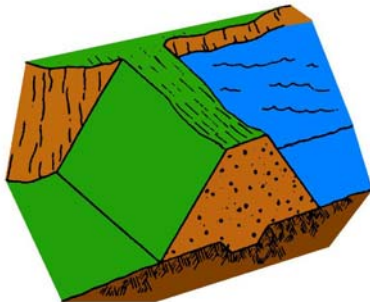
Potential Action:

1. Inspect crack and carefully record crack location, length, depth, width, and other pertinent physical features. Stake out limits of cracking.
2. Engineer should determine cause of cracking and supervise all steps necessary to reduce danger to dam and correct condition.
3. Excavate crest along crack to a point below the bottom of the crack. Then backfill excavation using competent material and correct construction techniques. This will seal the crack against seepage and surface run-off. This should be supervised by engineer.
4. Continue to monitor crest routinely for evidence of future cracking.

Qualified Dam Safety Professional Required

PROBLEMS

CREST ALIGNMENT



CAUSES & HARM DONE

Probable Cause:

1. Movement between adjacent portions of the structure.
2. Uneven deflection of dam under loading by reservoir.
3. Structural deformation or failure near area of misalignment.

Harm:

1. Area of misalignment is usually accompanied by low area in crest which reduces free board.
2. Can produce local areas of low embankment strength which may lead to failure.

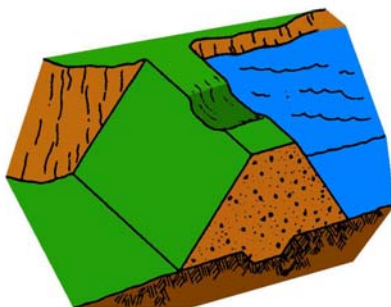
ACTION REQUIRED

Potential Action:

1. Establish monuments across crest to determine exact amount, location, and extent of misalignment.
2. Engineer should determine cause of misalignment and supervise all steps necessary to reduce threat to dam and correct condition.
3. Monitor crest monuments on a schedule basis following remedial action to detect possible future movement.

Qualified Dam Safety Professional Required

LOW AREA IN CREST OF DAM



Probable Cause:

1. Excessive settlement in the embankment or foundation directly beneath the low area in the crest.
2. Internal erosion of embankment material.
3. Foundation spreading toward upstream and/or downstream direction.
4. Prolonged wind erosion of crest area.
5. Improper final grading following construction.

Harm:

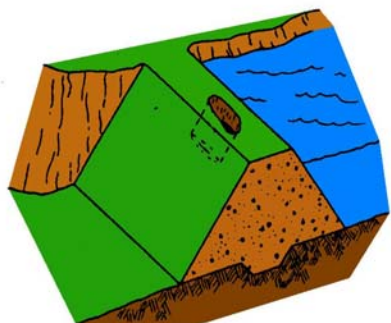
Reduces freeboard available to pass flood flows safely through spillway.

Potential Action:

1. Establish monuments along length of crest to determine exact amount, location, and extent of settlement in crest.
2. Engineer should determine cause of low area and supervise all steps necessary to reduce possible threat to the dam and correct condition.
3. Re-establish uniform crest elevation over crest length by placing fill in low area using proper construction techniques. This should be supervised by engineer.
4. Re-establish monuments across crest of dam and monitor monuments on a routine basis to detect possible future settlement.

Qualified Dam Safety Professional Required

SINKHOLE IN CREST



Probable Cause:

1. Rodent activity.
2. Hole in outlet conduit is causing erosion of embankment material.
3. Internal erosion or piping of embankment material by seepage.
4. Breakdown of dispersive clays within embankment by seepage waters.

Harm:

1. Void within dam could cause localized caving, sloughing, instability, or reduced embankment cross section.
2. Entrance point for surface water.

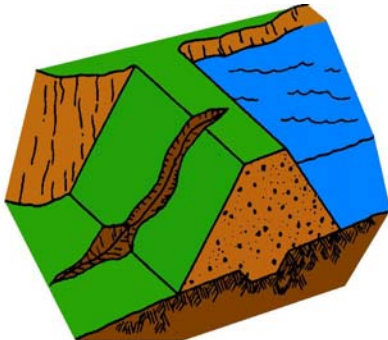
Potential Action:

1. Carefully inspect and record location and physical characteristics (depth, width, length) of sinkhole.
2. Engineer should determine cause of sinkhole and supervise all steps necessary to reduce threat to dam and correct condition.
3. Excavate sinkhole, slope sides of excavation, and backfill hole with competent material using proper construction techniques. This should be supervised by an engineer.

Qualified Dam Safety Professional Required

PROBLEMS

GULLY ON CREST



CAUSES & HARM DONE

Probable Cause:

1. Poor grading and improper drainage of crest. Improper drainage causes surface run-off to collect and drain off crest at low point in upstream or downstream shoulder.
2. Inadequate spillway capacity which has caused dam to overtop.

Harm:

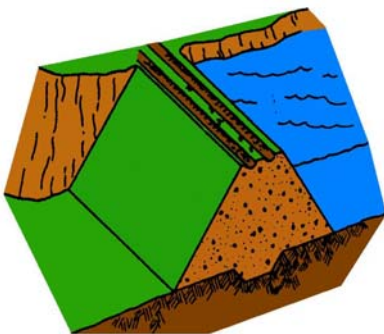
1. Can reduce available freeboard.
2. Reduces cross-sectional area of dam.
3. Inhibits access to all parts of the crest and dam.

ACTION REQUIRED

Potential Action:

1. Restore freeboard to dam by adding fill material in low area, using proper construction techniques.
2. Re-grade crest to provide proper drainage of surface run-off.
3. If gully was caused by over-topping, provide adequate spillway which meets current design standards. This should be done by engineer.
4. Re-establish protective cover.

RUTS ALONG CREST



Probable Cause:

Heavy vehicular traffic without adequate or proper maintenance or proper crest surfacing.

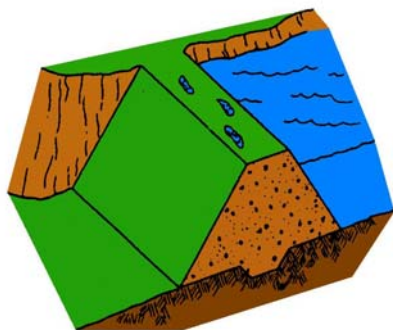
Harm:

1. Inhibits easy access to all parts of crest.
2. Allows continued development of rutting.
3. Allows standing water to collect and saturate crest of dam.
4. Operating and maintenance vehicles can get stuck.

Potential Action:

1. Drain standing water from ruts.
2. Re-grade and re-compact crest to restore integrity and provide proper drainage toward upstream slope.
3. Provide gravel or road base material to accommodate traffic.
4. Perform periodic maintenance and re-grading to prevent reformation of ruts.

PUDDLING ON CREST; POOR DRAINAGE



Probable Cause:

1. Poor grading and improper drainage of crest.
2. Localized consolidation or settlement on crest allows puddles to develop.

Harm:

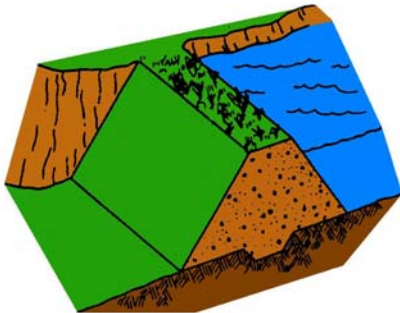
1. Causes localized saturation of the crest.
2. Inhibits access to all portions of the dam and crest.
3. Becomes progressively worse if not corrected.

Potential Action:

1. Drain standing water from puddles.
2. Re-grade and re-compact crest to restore integrity and provide proper drainage toward upstream slope.
3. Provide gravel or road base material to accommodate traffic.
4. Perform periodic maintenance and re-grading to prevent reformation of ruts.

PROBLEMS

OBSCURING VEGETATION



CAUSES & HARM DONE

Probable Cause:

Neglect of dam and lack of proper maintenance procedures.

Harm:

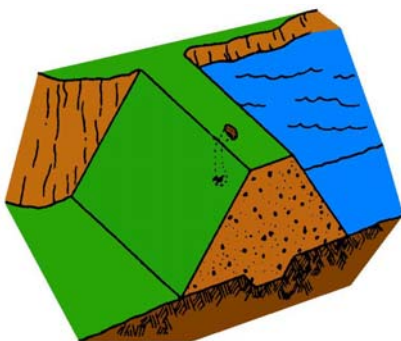
1. Obscure large portions of the dam, preventing adequate, accurate visual inspection of all portions of the dam. Problems that threaten the integrity of the dam can develop and remain undetected until they progress to a point where the dam's safety is threatened.
2. Associated root systems develop and penetrate into the dam's cross section. When the vegetation dies, the decaying root systems can provide paths for seepage. This reduces the effective seepage path through the embankment and could lead to possible piping situations.
3. Prevents easy access to all portions of the dam for operation, maintenance, and inspection.
4. Provides habitat for rodents.

ACTION REQUIRED

Potential Action:

1. Remove all detrimental growth from the dam. This would include removal of trees, bushes, brush, conifers, and growth other than grass. Grass should be encouraged on all segments of the dam to prevent erosion by surface run-off. Root systems should also be removed to the maximum practical extent. The void which results from removing the root system should be backfilled with competent, well-compacted material.
2. Future undesirable growth should be removed by cutting or spraying, as part of an annual maintenance program.
3. All cuttings or debris resulting from the vegetative removal should be immediately taken from the dam and properly disposed of outside the reservoir basin.

RODENT ACTIVITY ON CREST



Probable Cause:

Burrowing animals.

Harm:

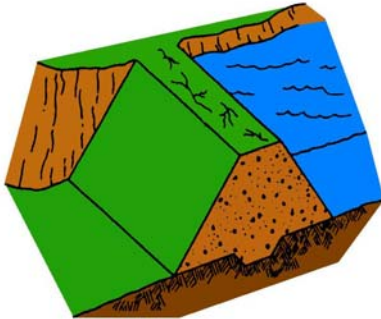
1. Entrance point for surface runoff to enter dam. Could saturate adjacent portions of the dam.
2. Especially dangerous if hole penetrates dam below phreatic line. During periods of high storage, seepage path through the dam would be greatly reduced and a piping situation could develop.

Potential Action:

1. Completely backfill the hold with competent, well compacted material.
2. Initiate a rodent control program to prevent the propagation of the burrowing animal population and to prevent future damage to the dam.

PROBLEMS

DRYING CRACKS



CAUSES & HARM DONE

Probable Cause:

Material on the crest of dam expands and contracts with alternate wetting and drying of weather cycles. Drying cracks are usually short, shallow, narrow, and numerous.

Harm:

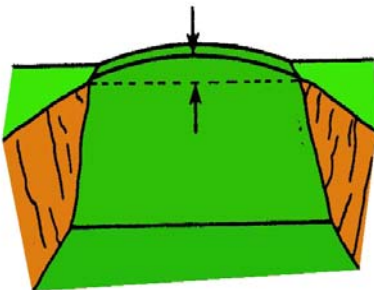
Provides point of entrance for surface run-off and surface moisture, causing saturation of adjacent embankment areas. This saturation and subsequent drying of the dam could cause further cracking.

ACTION REQUIRED

Potential Action:

1. Seal surface of cracks with a tight, impervious material.
- or...
2. Routinely grade crest to provide proper drainage and till cracks.
- or...
3. Cover crest with non-plastic (not clay) material to prevent large moisture content variations with respect to time.
4. Draw the reservoir down if safety of dam is threatened.

CREST CAMBER



Probable Cause:

Results from construction. Proportionally more fill is placed on crest in higher segments of the embankment during construction to compensate for anticipated settlement within the dam and foundation.

Harm:

None.

Potential Action:

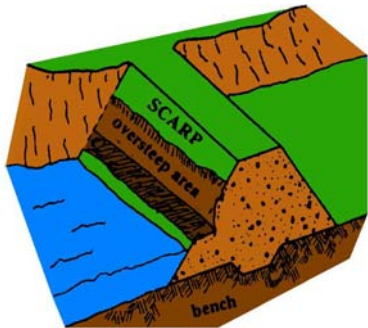
None.

PROBLEMS

CAUSES & HARM DONE

ACTION REQUIRED

SCARPS, BENCHES, OVERSTEEP AREAS



Probable Cause:

Wave action, local settlement, or ice action cause soil and rock to erode and slide to the lower part of the slope forming a bench.

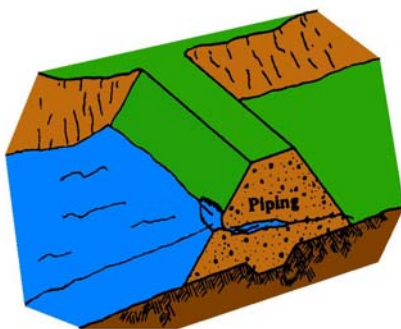
Harm:

This eroded area lessens the width and possible height of the embankment and could lead to increased seepage or overtopping of the dam.

Potential Action:

Determine exact cause of scarps. Do necessary earthwork, restore embankment to original slope, provide adequate protection (bedding and riprap).

SINKHOLE



Probable Cause:

The piping of embankment material or foundation material causes a sink hole. The cave-in of an eroded cavern can result in a sink hole. A small hole in the wall of an outlet pipe can develop a sink hole.

Harm:

This condition can empty a reservoir through a small hole in the wall of an outlet pipe or can lead to failure of a dam as soil pipes through the foundation or a pervious portion of the dam.

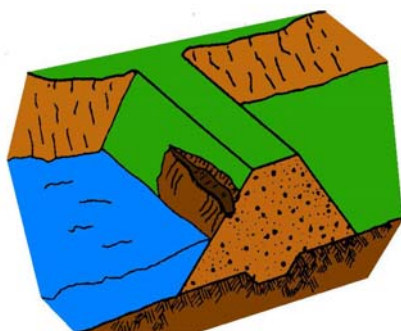
Potential Action:

Inspect other portions of the dam for seepage or additional sink holes. Identify exact cause of sink holes. Check seepage and leakage outflows for dirty water.

A qualified engineer should inspect the conditions and recommend further actions to be taken.

Qualified Dam Safety Professional Required

SLIDE, SLUMP, OR SLIP



Probable Cause:

Earth or rocks move down the slope along a slippage surface because they were on too steep a slope, or the foundation moves. Also, look for slides in reservoir basin.

Harm:

A series of slides can lead to obstruction of the outlet or failure of the dam.

Potential Action:

Evaluate extent of the slide. Monitor slide. Draw the reservoir level down if safety of dam is threatened.

A qualified engineer should inspect the conditions and recommend further actions to be taken.

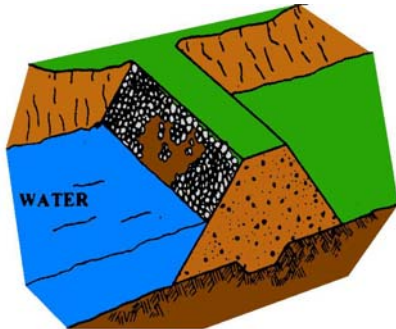
Qualified Dam Safety Professional Required

PROBLEMS

CAUSES & HARM DONE

ACTION REQUIRED

BROKEN DOWN, MISSING RIPRAP



Probable Cause:

Poor quality riprap has deteriorated. Wave action or ice action has displaced riprap. Round and similar sized rocks have rolled downhill.

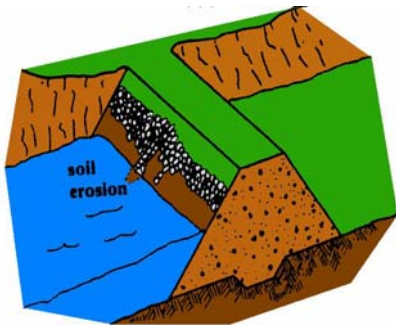
Potential Action:

Re-establish normal slope. Place bedding and competent riprap.

Harm:

Wave action against these unprotected areas decreases embankment width.

EROSION BEHIND POORLY GRADED RIPRAP



Probable Cause:

Similar-sized rocks allow waves to pass between them and erode small gravel particles and soil.

Potential Action:

Re-establish effective slope protection. Place bedding material **ENGINEER REQUIRED** for design of gradation and size of rock for bedding and riprap.

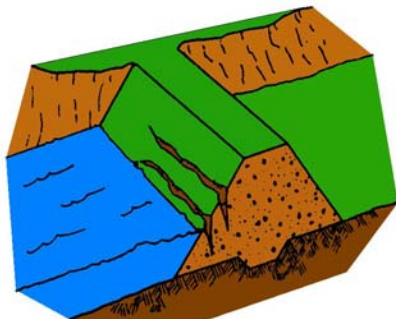
Harm:

Soil is eroded away from behind the riprap. This allows riprap to settle, providing less protection and decreased embankment width.

A qualified engineer should inspect the conditions and recommend further actions to be taken.

Qualified Dam Safety Professional Required

LARGE CRACKS ON SLOPE



Probable Cause:

A portion of the embankment has moved due to loss of strength, or the foundation may have moved, causing embankment movement.

Potential Action:

Depending on the amount of embankment involved, draw reservoir level down. A qualified engineer should inspect the conditions and recommend further actions to be taken.

Harm:

Can lead to failure of the dam.

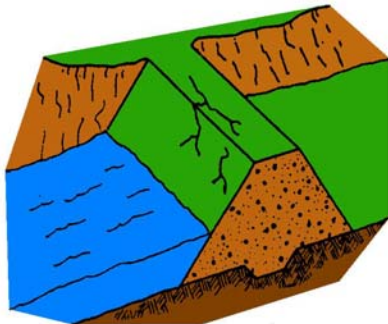
Qualified Dam Safety Professional Required

PROBLEMS

CAUSES & HARM DONE

ACTION REQUIRED

CRACKS DUE TO DRYING



Probable Cause:

The soil loses its moisture and shrinks, causing cracks.

Note:

Usually seen on crest and downstream slope mostly.

Harm:

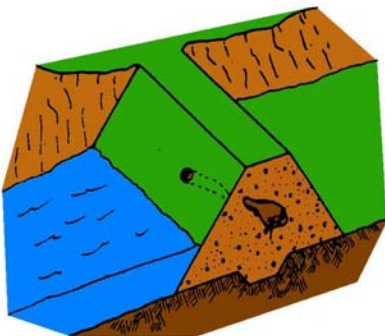
Heavy rains can fill up cracks and cause small portions of embankment to move along internal slip surface.

Potential Action:

1. Monitor cracks for increases in width, depth, or length.
2. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

BEAVER OR MUSKRAT ACTIVITY



Probable Cause:

Holes, tunnels, and caverns are caused by animal burrows. Certain habitats like cattail-type plants and trees close to the reservoir encourage these animals.

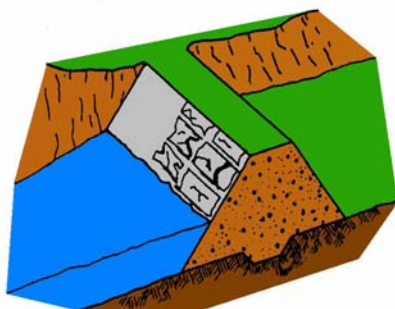
Harm:

If a tunnel exists through most of the dam, it can lead to failure of the dam.

Potential Action:

Remove rodents. Determine exact location of digging and extent of tunneling. Remove habitat. Repair damages.

CRACKED DETERIORATED CONCRETE FACE



Probable Cause:

Concrete deteriorated due to weathering. Joint filler deteriorated or displaced.

Harm:

Soil is eroded behind the face and caverns can be formed. Unsupported sections of concrete crack. Ice action may displace concrete.

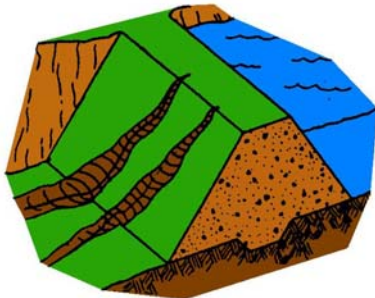
Potential Action:

1. Determine cause. Either patch with grout or contact engineer for permanent repair method.
2. If damage is extensive, a qualified engineer should inspect the conditions and recommend further actions to be taken.

Qualified Dam Safety Professional Required

PROBLEMS

EROSION



CAUSES & HARM DONE

Probable Cause:

Water from intense rainstorms or snow-melt carries surface material down the slope, resulting in continuous troughs.

Harm:

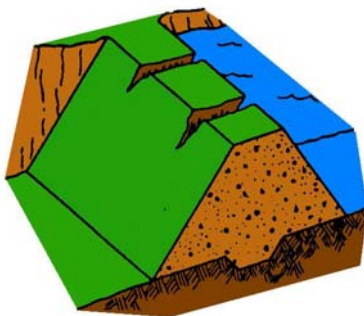
If allowed to continue, erosion can lead to eventual deterioration of the downstream slope which can shorten the seepage path.

ACTION REQUIRED

Potential Action:

1. The preferred method to protect eroded areas is rock or riprap.
2. Re-establishing protective grasses can be adequate if the problem is detected early.

TRANSVERSE CRACKING AFFECTING SLOPE



Probable Cause:

1. Drying and shrinkage of surface material is most common.
2. Differential settlement of the embankment also leads to transverse cracking (e.g., center settles more than abutments).

Harm:

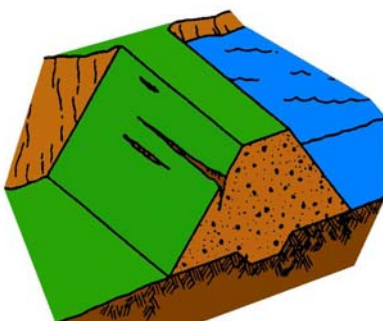
1. Shrinkage cracks allow water to enter the embankment. This promotes saturation and increases freeze thaw action.
2. Settlement cracks can lead to seepage of reservoir water through the dam.
3. Can lead to uncontrolled breach.

Potential Action:

1. If necessary plug upstream end of crack to prevent flows from the reservoir.
2. A qualified engineer should inspect the conditions and recommend further actions to be taken.

Qualified Dam Safety Professional Required

LONGITUDINAL CRACKING ON SLOPE



Probable Cause:

1. Drying and shrinkage of surface material.
2. Downstream movement or settlement of embankment.

Harm:

1. Can be an early warning of a potential slide.
2. Shrinkage cracks allow water to enter the embankment and freezing will further crack the embankment.
3. Settlement or slide indicating loss of strength in embankment can lead to failure.

Potential Action:

1. If cracks are from drying, dress area with well-compacted material to keep surface water out and natural moisture in.
2. If cracks are extensive, a qualified engineer should inspect the conditions and recommend further actions to be taken.

Qualified Dam Safety Professional Required

PROBLEMS

CAUSES & HARM DONE

ACTION REQUIRED

SLIDE/SLOUGH



Probable Cause:

1. Lack of or loss of strength of embankment material.
2. Loss of strength can be attributed to infiltration of water into the embankment or loss of support by the foundation.

Harm:

Can lead to failure of the dam.

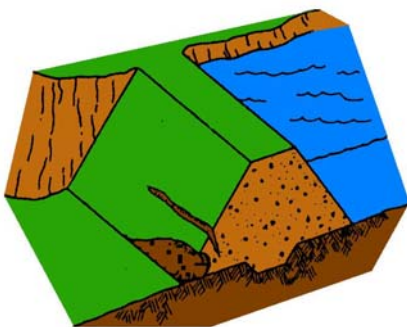
Potential Action:

HAZARDOUS!

1. Measure extent and displacement of slide.
2. If continued movement is seen, begin lowering water level until movement stops.
3. Have a qualified engineer inspect the condition and recommend further action.

Qualified Dam Safety Professional Required

SLUMP (LOCALIZED CONDITION)



Probable Cause:

Preceded by erosion undercutting a portion of the slope. Can also be found on relatively steep slopes.

Harm:

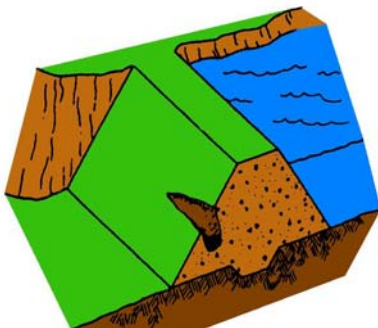
Can expose impervious zone to erosion.

Potential Action:

1. Inspect area for seepage.
2. Monitor for progressive failure.
3. Have a qualified engineer inspect the condition and recommend further action.

Qualified Dam Safety Professional Required

SINK HOLE/COLLAPSE



Probable Cause:

Lack of adequate compaction; rodent hole below; piping through embankment or foundation.

Harm:

Shortens seepage path, can lead to washout of embankment and uncontrolled breach.

Potential Action:

1. Inspect for and immediately repair rodent holes. Control rodents to prevent future damage.
2. Have a qualified engineer inspect the condition and recommend further action.

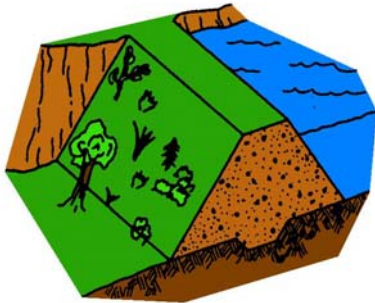
Qualified Dam Safety Professional Required

PROBLEMS

CAUSES & HARM DONE

ACTION REQUIRED

TREES/OBSCURING BRUSH



Probable Cause:

Natural vegetation in area.

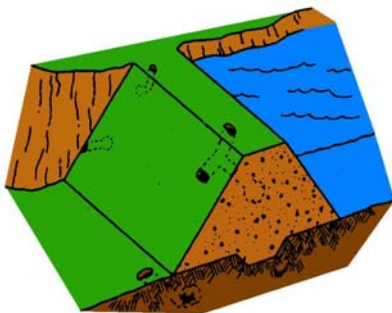
Harm:

Large tree roots can create seepage paths. Brushes can obscure visual inspection and harbor rodents.

Potential Action:

1. Remove all large, deep-rooted trees and shrubs on or near the embankment. Properly backfill void.
2. Control all other vegetation on the embankment that obscures visual inspection.

RODENT ACTIVITY ON SLOPE



Probable Cause:

Overabundance of rodents.

Harm:

Reduces length of seepage path. Can lead to piping failure.

Potential Action:

1. Control rodents to prevent additional damage.
2. Backfill existing rodent holes.

LIVESTOCK/CATTLE TRAFFIC



Probable Cause:

Excessive travel by livestock especially harmful to slope when wet.

Harm:

Creates areas bare of erosion protection and causes erosion channels. Allows water to stand. Area susceptible to drying cracks.

Potential Action:

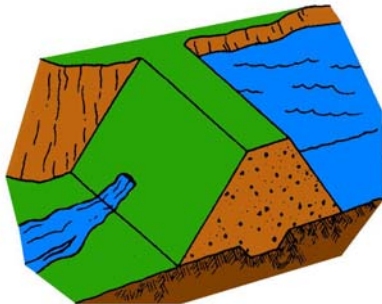
1. Fence livestock outside embankment area.
2. Repair erosion protection, i.e., riprap, grass.

PROBLEMS

CAUSES & HARM DONE

ACTION REQUIRED

MUDDY WATER EXITING FROM A POINT SOURCE



Probable Cause:

1. Water has created an open pathway, channel, or pipe through the dam. The water is eroding and carrying embankment material.
2. Large amounts of water have accumulated in the downstream slope. Water and embankment materials are exiting at one point. Surface agitation may be causing the muddy water.

Harm:

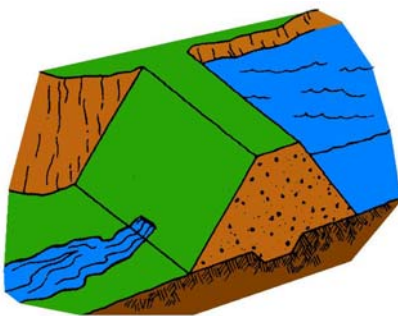
Continued flows can further erode embankment materials. This can lead to failure of the dam.

Potential Action:

1. Begin measuring outflow quantity and establishing whether water is getting muddier, staying the same, or clearing up.
2. If quantity of flow is increasing, the water level in the reservoir should be lowered until the flow stabilizes or stops.
3. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

WATER EXITING FROM A POINT SOURCE



Probable Cause:

Water has created an open pathway or pipe through the dam.

Harm:

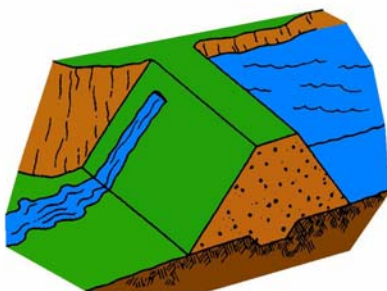
Continued flows can further erode embankment materials. This can lead to failure of the dam.

Potential Action:

1. Begin measuring outflow quantity.
2. If quantity of flow is increasing, the water level in the reservoir should be lowered until the flow stabilizes or stops.
3. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

WATER EXITING FROM A POINT SOURCE HIGH ON THE EMBANKMENT



Probable Cause:

1. Rodents, frost action, or poor construction have allowed water to create an open pathway or pipe through the embankment.

Harm:

1. Continued flows can saturate portions of the embankment and lead to slides in the area.
2. Continued flows can further erode embankment materials and lead to failure of the dam.

Potential Action:

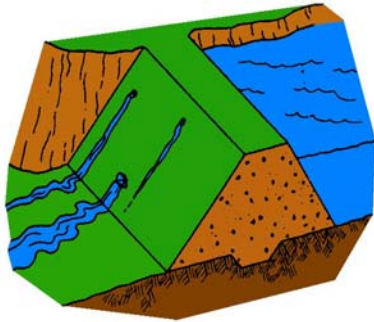
1. Begin measuring outflow quantity.
2. If quantity of flow is increasing, the water level in the reservoir needs to be lowered until the leak stops.
3. Search for opening on upstream side and plug it if possible.
4. A qualified engineer should immediately inspect the condition and recommend further action to be taken.

Qualified Dam Safety Professional Required

All problems are potentially hazardous.

PROBLEMS

WATER EXITING FROM RODENT HOLES



CAUSES & HARM DONE

Probable Cause:

Diggings by the rodent have shortened the flow path.

Harm:

Continued flows can further erode embankment material and lead to failure of the dam.

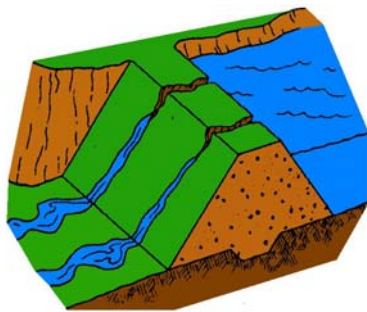
ACTION REQUIRED

Potential Action:

1. Locate any entrance points on the upstream slope and plug them.
2. If the quantity of flow is increasing, the water level in the reservoir needs to be lowered until the leak stops.
3. Bring a halt to the rodent activity.
4. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

STREAM OF WATER EXITING THROUGH CRACKS NEAR THE CREST



Probable Cause:

1. Severe drying has caused shrinkage of embankment material.
2. Settlement in the embankment or foundation is causing the transverse cracks.

Harm:

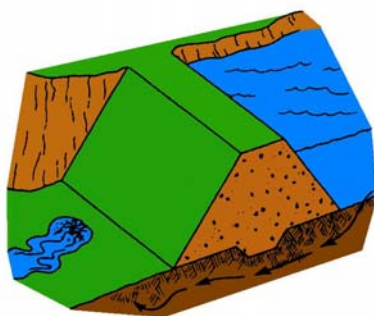
Flow through the crack can cause failure of the dam.

Potential Action:

1. Plug the upstream side of the crack to stop the flow.
2. The water level in the reservoir should be lowered until it is below the level of the cracks.
3. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

SEEPAGE WATER EXITING AS A BOIL IN THE FOUNDATION



Probable Cause:

Some portion of the foundation material is providing a flow path. This could be caused by a sand or gravel layer in the foundation.

Harm:

Increased flows can lead to erosion of the foundation and failure of the dam.

Potential Action:

1. Examine the boil for transportation of foundation materials.
2. If soil particles are moving downstream, sandbags or earth should be used to create a dike around the boil. The pressure created by the water level within the dike may control flow velocities and temporarily prevent further erosion.
3. If erosion is becoming greater, the reservoir level should be lowered.
4. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

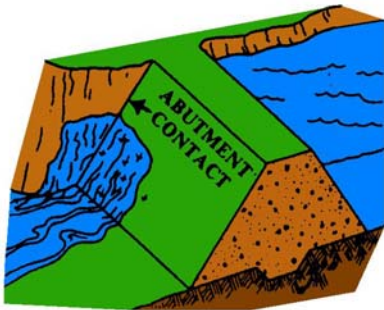
All problems are potentially hazardous.

PROBLEMS

CAUSES & HARM DONE

ACTION REQUIRED

SEEPAGE EXITING AT ABUTMENT CONTACT



Probable Cause:

1. Water flowing through pathways in the abutment.
2. Water flowing through the embankment.

Harm:

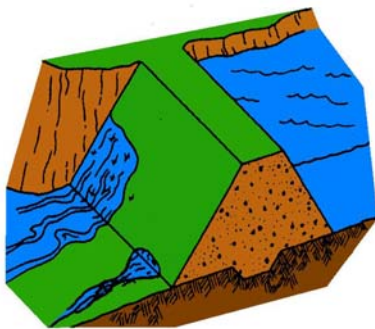
Can lead to erosion of embankment materials and failure of the dam.

Potential Action:

1. Investigate leakage area to determine quantity of flow and extent of saturation.
2. Inspect daily for developing slides.
3. Water level in reservoir may need to be lowered to assure the safety of the embankment.
4. A qualified engineer should inspect the conditions and recommend further actions to be taken.

Qualified Dam Safety Professional Required

LARGE AREA WET OR PRODUCING FLOW



Probable Cause:

A seepage path has developed through the abutment or embankment.

Harm:

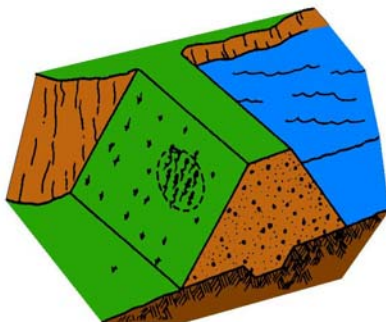
1. Increased flows could lead to erosion of embankment material and failure of the dam.
2. Saturation of the embankment can lead to local slides which could cause failure of the dam.

Potential Action:

1. Stake out the saturated area and monitor for growth or shrinking.
2. Measure any outflows as accurately as possible.
3. Reservoir level may need to be lowered if saturated areas increase in size at a fixed storage level or if flow increases.
4. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

MARKED CHANGED IN VEGETATION



Probable Cause:

1. Embankment materials are providing flow paths.
2. Natural seeding by wind.
3. Change in seed type during initial post construction seeding.

Harm:

Can indicate a saturated area.

Potential Action:

1. Use probe and shovel to establish if the materials in this area are wetter than in surrounding areas.
2. If area shows wetness when surrounding areas do not, a qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

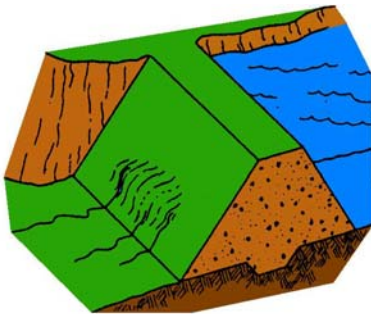
All problems are potentially hazardous.

PROBLEMS

CAUSES & HARM DONE

ACTION REQUIRED

BULGE IN LARGE WET AREA



Probable Cause:

Downstream embankment materials have begun to move.

Harm:

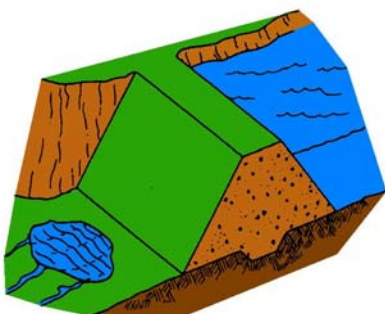
Failure of the embankment due to massive sliding can follow these initial movements.

Potential Action:

1. Compare embankment cross-section to the end of construction condition to see if observed condition may reflect end of construction.
2. Stake out affected area and accurately measure outflow.
3. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

TRAMPOLINE EFFECT IN LARGE SOGGY AREA



Probable Cause:

Water moving rapidly through the embankment or foundation is being controlled or contained by a well-established turf root system.

Harm:

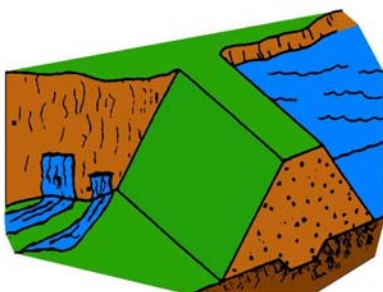
Condition indicates excessive seepage in the area. If control layer of turf is destroyed, rapid erosion of foundation materials could result in failure of the dam.

Potential Action:

1. Carefully inspect the area for outflow quantity and any transported materials.
2. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

LEAKAGE FROM ABUTMENTS BEYOND THE DAM



Probable Cause:

Water moving through cracks and fissures in the abutment materials.

Harm:

1. Can lead to rapid erosion of abutment and evacuation of the reservoir.
2. Can lead to massive slides near or downstream from the dam.

Potential Action:

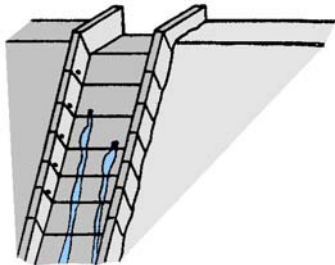
1. Carefully inspect the area to determine quantity of flow and amount of transported material.
2. A qualified engineer or geologist should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

All problems are potentially hazardous.

PROBLEMS

TOO MUCH LEAKAGE FROM SPILLWAY UNDER DRAINS



CAUSES & HARM DONE

Probable Cause:

Drain or cutoff may have failed.

Harm:

1. Excessive flows under the spillway could lead to erosion of foundation material and collapse of portions of the spillway.
2. Uncontrolled flows could lead to loss of stored water.

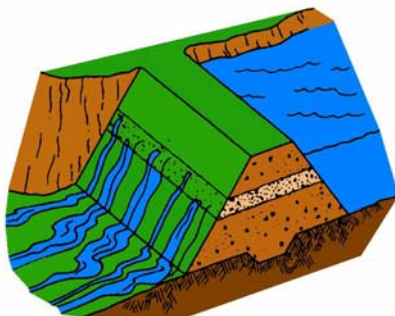
ACTION REQUIRED

Potential Action:

1. Immediately measure flow quantity and check flows for transported drain material.
2. If flows are accelerating at a fixed storage level, the reservoir level should be lowered until the flow stabilizes or stops.
3. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

WET AREA IN HORIZONTAL BAND



Probable Cause:

Frost layer or layer of sandy material in original construction.

Harm:

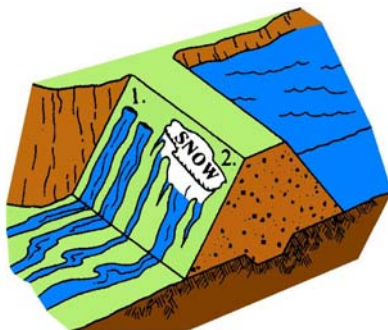
1. Wetting of areas below the area of excessive seepage can lead to localized instability of the embankment. (SLIDES)
2. Excessive flows can lead to accelerated erosion of embankment materials and failure of the dam.

Potential Action:

1. Determine as closely as possible the amount of flow being produced.
2. If flow increases, reservoir level should be reduced until flow stabilizes or stops.
3. Stake out the exact area involved.
4. Using hand tools, try to identify the material allowing the flow.
5. A qualified engineer should inspect the condition and recommend further actions to be taken.

Qualified Dam Safety Professional Required

LARGE AREA SATURATED FROM ABOVE



Probable Cause:

1. Water flowing through the embankment.
2. Snowdrifts melting slowly during mild spring temperatures.

Harm:

Can lead to saturation of embankment materials and local or massive slides which could cause failure of the dam.

Potential Action:

1. Investigate saturated area to determine depth and extent of saturation.
2. Inspect daily for developing slides.
3. Water level in reservoir may need to be lowered to assure the safety of the embankment.
4. A qualified engineer should inspect the conditions and recommend further actions to be taken.

Qualified Dam Safety Professional Required

All problems are potentially hazardous.