

Dam Inspections

The What and Why

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*United States Department of Agriculture
Natural Resources Conservation Service*

Objectives

- Types of inspections
- Preparation for inspection
- Inspection documentation
 - What to look for and why
 - Deficiency condition rating
 - Examples of deficiencies

Why Inspect?

- Ensure safe operation of the dam
- Discover deficiencies early
- Prioritize and schedule maintenance
- Promote good stewardship of funds
- And...



Because I Said So

Regulations and Policies

- State of Kansas
 - K.A.R. 5-40-90 through 5-40-94
- USDA-NRCS
 - NEM 210-503 Subpart D – Dam Safety

Inspection Types

- Formal
- Operation and maintenance
- Surveillance
- Special

Inspection Types

- **Formal**
 - Required for significant and high hazard dams
 - Completed by Professional Engineer
 - Significant hazard dams every 5 years
 - High hazard dams every 3 years

Inspection Types

- **Operation and maintenance**
 - Annual inspection
- **Surveillance**
 - Monitoring an ongoing issue
- **Special**
 - Flood event or spillway flow
 - Seismic events??

Preparation for Inspection



- Materials to review—or have available—prior to inspection
 - Inspection reports from previous year(s)
 - O&M Plan
 - Photos
 - As-built drawings



Preparation for Inspection



- Equipment to have available
 - Inspection forms
 - Camera
 - Tape measure
 - Shovel/spade
 - T-wrench to operate drawdown valve
 - Flashlight
 - Other?

What to Look For and Why

➤ Embankment

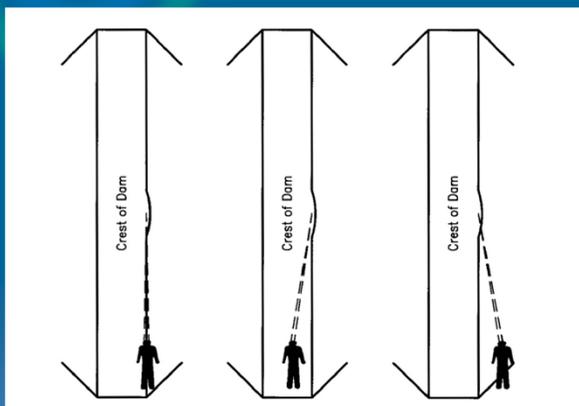
The image shows a technical drawing of an embankment cross-section. The drawing is divided into several layers and features. A red dashed box highlights the topsoil layer. The drawing includes labels for 'Topsoil', 'Subsoil', 'Fill', 'Grass', and 'Trees'. It also shows 'Erosion Control Measures' and 'Vegetation'. The drawing is a technical drawing of an embankment cross-section, showing various layers and features. A red dashed box highlights the topsoil layer. The drawing includes labels for 'Topsoil', 'Subsoil', 'Fill', 'Grass', and 'Trees'. It also shows 'Erosion Control Measures' and 'Vegetation'.

- Damage to embankment by waves, erosion, rodents, livestock, or vehicles
- Sloughing, sliding, or slumping of fill
- Seepage, boils, or wet areas at abutments or along downstream toe
- Cracking and displacement of fill
- Observable settlement of fill
- Presence of trees or shrubs
- Adequacy of grass vegetation

➤ Instability (slides)



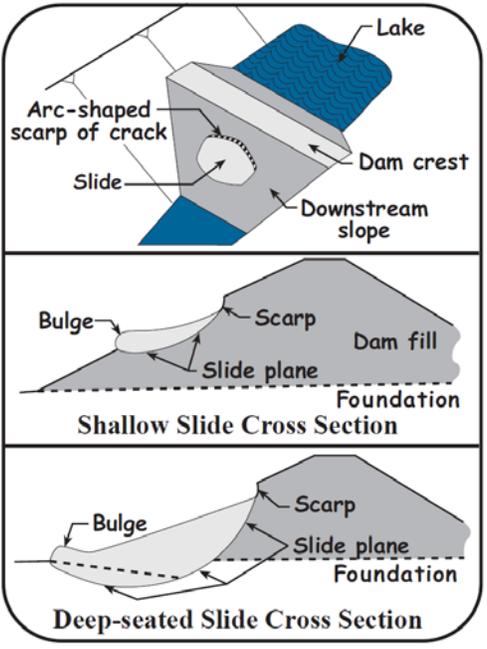
➤ Non-uniform crest & slopes



- Can identify by sighting along dam from one end and from a point partway down the side slope of embankment
- May indicate slides or non-uniform settlement



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The diagram illustrates three types of dam failure:

- Top:** A 3D perspective view of a dam with a lake. It shows an 'Arc-shaped scarp of crack' on the upstream side, a 'Slide' area on the downstream slope, the 'Dam crest', and the 'Downstream slope'.
- Middle:** A cross-section labeled 'Shallow Slide Cross Section'. It shows a 'Bulge' on the upstream side, a 'Scarp' on the downstream side, a 'Slide plane' near the surface, 'Dam fill', and the 'Foundation'.
- Bottom:** A cross-section labeled 'Deep-seated Slide Cross Section'. It shows a 'Bulge' on the upstream side, a 'Scarp' on the downstream side, a 'Slide plane' deeper within the dam fill, 'Dam fill', and the 'Foundation'.

➤ **Instability (slides) caused by:**

- Soil compaction deficiency
- Slope too steep for soil type
- Uncontrolled seepage
- Sudden pool drawdown
- Saturation of embankment

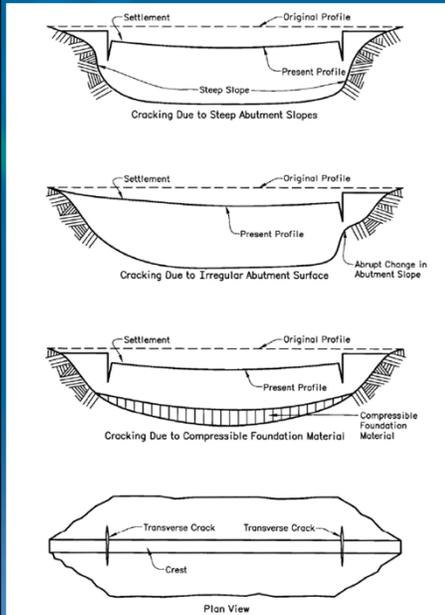


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➤ **Transverse cracks**



A photograph showing a person wearing a hat and light-colored clothing crouching on a dirt embankment. They are inspecting a deep, narrow transverse crack in the soil. The background shows a grassy area with some dry patches.



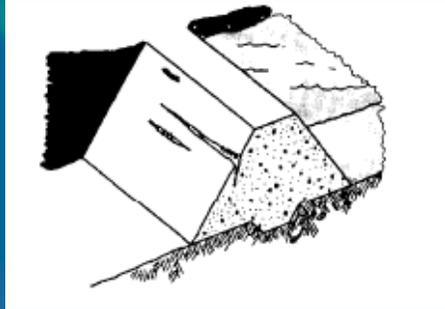
➤ Transverse cracks

- Perpendicular to length of dam
- Caused by differential settlement
- Can result in high seepage rates and piping through dam, especially if they extend into core of dam

➤ Longitudinal cracks



➤ Longitudinal cracks



- Parallel with length of dam
- Caused by drying and shrinkage of surface material or
- Downward movement or settlement of zoned fill
- Can be early warning of potential slide

➤ Seepage



➤ Seepage

- All embankment dams experience movement of water through the embankment and/or foundation soils
- Seepage may be controlled by drains, embankment cores, and cutoff trenches
- Seepage becomes a problem when
 - Embankment or foundation soils are moved by the water flow—results in internal erosion or "piping"
 - Or when excessive pressure builds up within dam or foundation—results in instability

➤ Other signs of seepage problems

- When seepage appears in a location you have not noticed previously or is substantially larger
- When seepage flows appear cloudy, carrying soil particles out of the embankment or a downstream boil point



➤ Vehicle traffic on embankment



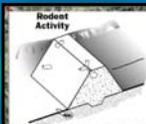
- Should be limited, especially during wet weather
- Results in vegetation damage and erosion
- Ruts that pond water increase embankment saturation, decreasing stability
- ATV's travelling up and down slopes are particularly damaging—dam overtopping will likely breach here.



➤ Burrowing animal activity

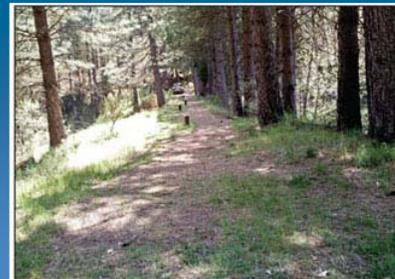


- Eradicate burrowing animals from dam
- May require excavation prior to filling holes with compacted material
- Reseed disturbed area



- **Trees – Public Enemy #1**
 - Hinder inspections (limit visibility)
 - Can cause structural instability
 - Lead to internal erosion and piping, especially as roots decay
 - Can clog subsurface drains
 - Shadow and impede grass vegetation
 - Embankment is vulnerable to damage when trees are uprooted during storms
 - Attract burrowing animals
 - Impede flow when present in auxiliary spillway

- **Trees**
 - Remove all trees on the dam, auxiliary spillway, stilling basin, outlet channel, or within 25 feet of toes
 - Larger trees increase risk of failure
 - Large tree removal should include excavation of roots and proper backfill—consult an engineer



➤ Slope protection



- Vegetation on 12:1 slope (“wave berm”)
 - Requires healthy, water-tolerant vegetation, and livestock exclusion
 - Can be damaged by extended periods of low reservoir levels since vegetation type depends on sufficient water



➤ Slope protection



- Rock riprap



➤ Riprap Slope Protection

- Look for breakdown of rock—may need replacement



➤ Auxiliary spillway



Item #	Description	Actual	Proposed	Remarks
1	Channel			
2	Bank			
3	Structure			
4	Vegetation			
5	Other			
6	Structure			
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- Adequacy of grass vegetation
- Sloughing, sliding, or erosion of slopes
- Damage by livestock, vehicles, or poor drainage
- Erosion of bottom and exit channel
- Obstructions by woody plants or fences

- Auxiliary spillway
 - Vegetation condition



- Auxiliary spillway
 - Obstructions impede flow. Discontinuities cause higher stress during flow—these and bare paths are the first areas to erode during spillway flow.



A Stable Spillway



➤ Principal spillway



Item #	Description	Inspected	Remarks	Inspected
1	Trash Rack			
2	Barrel Entrance			
3	Ladder			
4	Horizontal or Vertical Misalignment of Pipe			
5	Condition of Concrete in Riser			
6	Damage, Corrosion, or Leakage of Drawdown Works			
7	Leaky Pipe Joints and Joint Number			

- Damage, obstruction, or corrosion of trash rack
- Obstruction to barrel entrance
- Damage or corrosion of ladder
- Observable horizontal or vertical misalignment of pipe
- Condition of concrete in riser
- Damage, corrosion, or leakage of drawdown works
- Leaky pipe joints and joint number

➤ Principal spillway

- Debris and timber should be removed promptly



➤ Principal spillway

- Debris and timber should be removed promptly



➤ Principal spillway

- Operate the valve annually if possible
 - Tests the functionality of valve and any stem extension hardware
 - Cleans dirt and debris within valve
 - Helps flush sediment accumulation at inlet of drawdown pipe



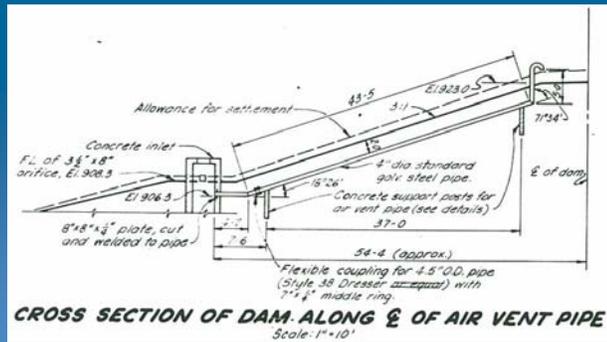
➤ Principal spillway

- Pipe needs some repair patching to prevent corrosion of steel cylinder and reinforcement



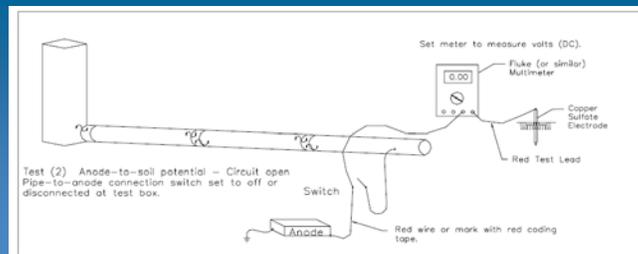
➤ Principal spillway

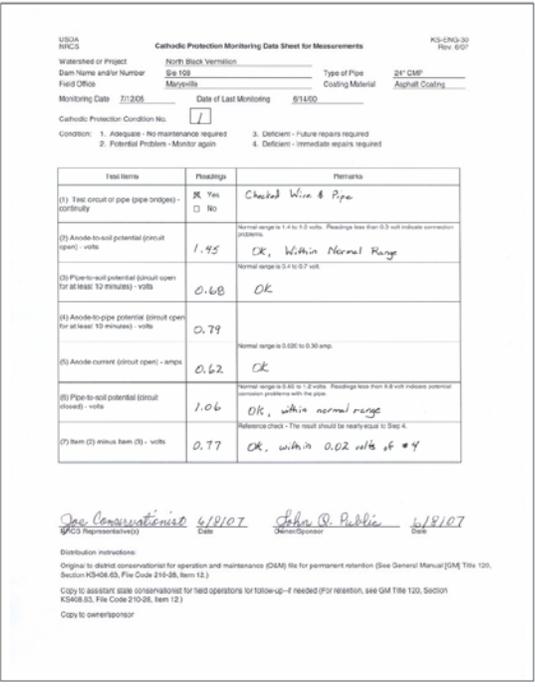
- Some sites have an air vent—typically a 4" galvanized steel pipe extending above top of dam
- This one has been damaged—possibly by a mower. Need to investigate to determine if pipe is kinked, preventing air flow



➤ Principal spillway

- Cathodic protection on corrugated metal pipes
 - Extends life of pipe if kept in functional condition
 - System should be tested once every 5 years (request engineering assistance)—NRCS State Office has equipment available
 - Anode and appurtenances need periodic replacement
 - Reference: NEH 650, *Engineering Field Handbook*, Chapter 6, Kansas Supplement





USDA NRCS **Cathodic Protection Monitoring Data Sheet for Measurements** **KS-ENG-30**
Rev. 6/07

Watershed or Project: North Black Vermilion
 Dam Name and/or Number: Site 109 Type of Pipe: 24" CMP
 Field Office: Meriville Coating Material: Asphalt Coating

Monitoring Date: 7/2/07 Date of Last Monitoring: 6/14/07

Cathodic Protection Condition No.: 7

Condition: 1. Adequate - No maintenance required 3. Deficient - Future repairs required
 2. Potential Problem - Monitor again 4. Deficient - Immediate repairs required

Test Items	Readings	Remarks
(1) Test circuit or pipe (pipe bridges) - continuity	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	<u>Checked Wire & Pipe</u>
(2) Anode-to-soil potential (circuit open) - volts	<u>1.45</u>	<u>OK, Within Normal Range</u> <small>Normal range is 1.4 to 1.5 volts. Readings less than 0.5 volt indicate connection problems.</small>
(3) Pipe-to-soil potential (circuit open for at least 10 minutes) - volts	<u>0.68</u>	<u>OK</u> <small>Normal range is 0.4 to 0.7 volt.</small>
(4) Anode-to-pipe potential (circuit open for at least 10 minutes) - volts	<u>0.79</u>	<small>Normal range is 0.00 to 0.30 amp.</small>
(5) Anode current (circuit open) - amps	<u>0.62</u>	<u>OK</u> <small>Normal range is 0.00 to 1.00 amps. Readings less than 0.8 volt indicate potential connection problems with the pipe.</small>
(6) Pipe-to-soil potential (circuit closed) - volts	<u>1.06</u>	<u>OK, within normal range</u> <small>Reference check - The result should be nearly equal to Sec 4.</small>
(7) Beam (2) anode beam (2) - volts	<u>0.77</u>	<u>OK, within 0.02 volts of #4</u>

Joe Connerath 6/18/07 John D. Public 6/18/07
NRCS Representative(s) Date Owner/Operator Date

Distribution instructions:
 Original to district conditional for operation and maintenance (O&M) file for permanent retention (See General Manual (GM) Title 120, Section 1040-02, File Code 210-06, Item 11.)
 Copy to assistant state representative for field operators for follow-up - if needed (for retention, see GM Title 120, Section 1040-03, File Code 210-06, Item 12.)
 Copy to owner/sponsor



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- Cathodic protection
- Record tests on NRCS Form KS-ENG-30

➤ **Principal spillway**

- Occasionally, the interior of a pipe needs to be accessed to check pipe joints or pipe integrity.





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➤ Stilling basin and outlet channel

USDA NRCS Form 1024-1025, Field Inspection Report. The form includes sections for Project Information, Inspection Date, and a table for 'Inspected Structures and Components'. A red dashed box highlights the row for 'Stilling Basin and Outlet Channel'.

Structure	Inspected	Inspected Date	Inspected By
Stilling Basin and Outlet Channel			

- Slumping or sliding of slopes
- Displacement or excessive breakdown of riprap materials
- Erosion or siltation of outlet channel
- Seepage or surface runoff into basin
- Excessive vegetation in outlet channel
- Pipe support

➤ Stilling basin and outlet channel

- Look for breakdown of rock—may need replacement



➤ **Stilling basin and outlet channel**

- Erosion and sediment deposition blocking outlet channel may signal need for additional rock riprap



➤ **Stilling basin and outlet channel**

- Drain pipe outlet submerged
- Outlet channel likely has debris that is blocking discharge



➤ Drain outlets—importance of recording flow



- No flow could mean there is no seepage in area served by drain
- If it flowed previously but not now with comparable pool level, it could mean that the drain is plugged and could lead to slope instability
- A sudden increase in drain flow may indicate that the embankment is less water-tight, possibly due to transverse cracking
- Recording drain flow rates and reservoir levels over time will help in assessing seepage conditions if problems develop

➤ Drain outlets



Remove rocks and debris so pipes can freely discharge

➤ Drain outlets



Needs to be cleaned out

➤ Drain outlets



Needs to be cleaned out and needs new rodent guard

➤ Drain outlets



Drainfill (sand) should not be present in outlet pipe...could mean that collection pipe is damaged or fine sand is entering collection slots

➤ Drain outlets

- Drain outlet pipe is tilted above its support—can happen if additional rock riprap is dumped on slope, fracturing pipe and tilting it up at the end



➤ Drain outlets

- Know where to look
- Usually located at the stilling basin, but are sometimes located near the base of abutment at a small headwall



➤ Rock fence barriers

- Displacement or excessive breakdown of rock materials
- Tied in to end of fence with sufficient rock



Block #	Condition	Block Dimensions and Description	Remarks
1			
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➤ Fences



➤ Downstream improvements

- Any new houses, roads, utilities, etc., downstream that will affect the dam classification

US-228 (05/07) NRCS-228 (05/07)
 Sheet Inspection Report
 United States Department of Agriculture, Natural Resources Conservation Service

Worksheet Project: _____
 Worksheet Location: _____
 Worksheet Office: _____

Worksheet Date: _____ Date of Last Revision: _____ Worksheet ID: _____
 Type of Inspection: Annual Inspection or Inspection (01) (02) (03) (04) (05) (06) (07) (08) (09) (10) (11) (12) (13) (14) (15) (16) (17) (18) (19) (20) (21) (22) (23) (24) (25) (26) (27) (28) (29) (30) (31) (32) (33) (34) (35) (36) (37) (38) (39) (40) (41) (42) (43) (44) (45) (46) (47) (48) (49) (50) (51) (52) (53) (54) (55) (56) (57) (58) (59) (60) (61) (62) (63) (64) (65) (66) (67) (68) (69) (70) (71) (72) (73) (74) (75) (76) (77) (78) (79) (80) (81) (82) (83) (84) (85) (86) (87) (88) (89) (90) (91) (92) (93) (94) (95) (96) (97) (98) (99) (100)

Item #	Description	Inspected	Compliant	Notes
1	Structure - Foundation			
2	Structure - Sill and			
3	Structure - Wall and			
4	Structure - Roof and			
5	Structure - Floor and			
6	Structure - Other			
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US-228 (05/07) (05/07) NRCS-228 (05/07) (05/07)
 Field to be inspected (check all that apply) _____
 Inspected by _____
 Date _____
 Worksheet Location _____



Inspection Form Completion

➤ KS-ADS-9, Mitigation Area Inspection Report

USDA NRCS Mitigation Area Inspection Report KS-ADS-9 3/09

Watershed or Project: _____ Mitigation Site No./USACE Permit No./Other Identifier: _____
 Date Name and/or Number: _____ Contact Phone No.: _____
 Field Office: _____

Inspection Date: _____ Date of Last Inspection: _____ Photos attached:

Type of Inspection: Annual Special Annual Surveillance Initial structural and Condition: 1. Adequate - no maintenance required 2. Deficient - future reinspection required 3. Fencing problem 4. Deficient - complete reinspection required

Item	Inspected	Inspected	Inspected
Herbaceous Vegetation			
Trees and/or Shrubs			
Fences/Gates/Signage			
Vegetative Filters and/or Buffers adjacent to streams or ponds			
Water Control Structure			
Stream Flow Restrictive Device			
Embankment/Channel			
Designated Wetlands in the Mitigation Area			
Stream Restoration/Protection Areas			
Slope Protection - Riprap or Bank of Restored Area			
Stream Channel of Restored Stream			
Aquatic Habitat of Restored Stream			
Other			

Inspection Date: _____ Date: _____ Comments: _____ Date: _____

Inspection Instructions:
 1. Digital photos recommended for O&M by the permittee retention - See General Manual (2008) Title 120, Section 4340B (9) - File Code 120-12-11-11
 2. Copy to nearest state conservationist for field conditions (if follow-up if needed) - For disposition, see O&M File 120, Section 4340B (9) - File Code 120-12-11-11
 3. Copy to nearest state conservationist for water resources
 4. O&M is recommended
 5. Check to U.S. Army Corps of Engineers to meet requirement of Clean Water Act, Section 404, Permit Special Conditions
 *Stream Visual Assessment Protocol (2004) may be required to aid in determining functional condition.

KS-ADS-9 Page 2

Checklist for Investigations

- Herbaceous Vegetation**
 Species appropriate for site
 Condition and level of stand
 Invasion of undesirable species
 Healthy, no dead present
 Damage by livestock and/or wildlife (burrows, tracks, etc. are excluded)
- Tree and/or Shrub**
 Species appropriate for site
 Invasion of undesirable species
 Damage by livestock and/or wildlife
 Equipped stand appropriate for site (see estimate)
 (20-100 feet high, one specimen for reestablishment)
 Disease affecting stand or individual trees
 Storm, wind, insect infestation
- Fence/Gate/Signage**
 Gate: open or closed
 Posts: clear, bent, or broken
 Tension and condition of wires
 Taint on wires
 Signs in place and readable
 Signage in place and readable
- Vegetative Filters and/or Buffers**
 See Item 1 and 2
- Water Control Structure**
 Damage, obstruction, corrosion, leakage of water
 (20-100 feet high, one specimen for reestablishment)
 Structure in place and ready for use
 Structure in place and ready for use
 Structure in place and ready for use
- Embankment/Channel**
 Damage by erosion, rodents, livestock, or vehicles
- Designated Wetlands in Restored Area**
 Invasive species
 Wetland/riparian habitat
- Stream Restoration/Protection Areas**
 Stream and protected areas ready
 Hard or flexible material in place and protecting bank
 Herbaceous, woody, and grass species
 (See Item 1 and 2)
- Slope Protection**
 Riprap (stone and fabric) in place and not protruding excessively, displaced, or breaking
 Slope erosion and adjacent to site not excessive and causing degradation of structure(s)
 Slope erosion in the stream
 Condition of vegetation
- Stream Channel of Restored Stream**
 Channel functioning as designed
 Accumulated debris or non-designed log jam
 Streambed stability
- Aquatic Habitat of Restored Stream**
 Aquatic structure operating
 Aquatic species present for present substrate type
 Streambank stability accumulation

Additional Notes (attach photos or aerial imagery to this page):

➤ KS-ADS-9, Mitigation Area Inspection Report



- Trees and shrubs
 - Appropriate species with adequate stand
 - Invasion of undesirable species
 - Damage by livestock and/or wildlife
 - Disease affecting stand or individuals
 - Perimeter fence condition

➤ KS-ADS-9, Mitigation Area Inspection Report



- Designed wetlands in reservoir area
 - Invasive species
 - Woody or undesirable debris
 - Damage by vehicles or livestock

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Public Safety Issues?



Hearthstone Lake, August County, VA



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