EMERGENCY ACTION PLAN (EAP)

FOR

CAMP SPELMAN LAKE DAM
CLASS I DAM

FRANKLIN TOWNSHIP
PORTAGE COUNTY, OHIO

ODNR-DSWR FILE NO: 1112-071
NATIONAL #: OH03217

CLASS I DAM

DAM OWNERS AND EAP COORDINATOR

PORTAGE PARK DISTRICT
705 Oakwood Street, Suite G-4

PREPARED MAY 2022 BY

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CAMP SPELMAN LAKE DAM, PORTAGE COUNTY, OHIO

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Unusual Condition(s) Detected at Dam by Observer

Owner/Owner's Representative
Portage Park District Office: (330) 297-7728 -*or* Craig Alderman Cell: 330-388-5461
Christine Craycroft Cell: 330-388-5460 Arden & Martha Sommers Cell: 330-842-0534

MONITOR
This is an event or a developing condition that is not normally encountered in the routine operation of the structure or necessitates a variation from the operating procedures. The event may be a slowly developing situation that may endanger the structural integrity of the structures. The situation should be closely monitored. There is no need to contact other organizations.

ODNR 24-hour Communication Function
(614) 799-9538 After Hours

ODNR Dam Safety Program
Mon-Fri 8-5 (614) 265-6731
After Hours (614) 799-9538

ODNR Division of Engineering
Office (614) 265-6948
After Hours (614) 799-9538

MONITOR

WATCH
This is an emergency event that is developing and could lead to failure of the structure and flooding downstream. Emergency responders should be notified (see prescripted message) and prepare to evacuate downstream structures.

<u>Prescripted Message</u>
"This is "<u>state your name</u>" notifying you that a Watch alert has been issued for the Salerno Lake Dam. We are performing constant surveillance according to the Emergency Action Plan. We will inform you if a decision to evacuate or to cancel the Watch alert has been made."

911

Portage County Sheriff (330) 296-5100
Emergency Dispatch 911

Ohio State Highway Patrol Post Commander
24-Hour Control (877) 772-8765
City of Ravenna (330) 297-1441

Franklin Twp Police (330) 676-7374

WARNING
Dam failure or flooding downstream of the dam is imminent. Emergency responders should immediately evacuate downstream of Lords Lake Dam (see prescripted message).

<u>Prescripted Message</u>
"This is "<u>state your name</u>" notifying you that a Warning alert has been issued for Camp Spelman Lake Dam. Please evacuate people downstream of the structure according to the County Emergency Operations Plan."

Portage County Department of Emergency Services
Direct Line (330) 297-3607

Portage County Emergency Management Agency (EMA)
24 hr: PCSO Dispatch (330) 296-5100
EMA Director Cell: (330) 697 - 2689

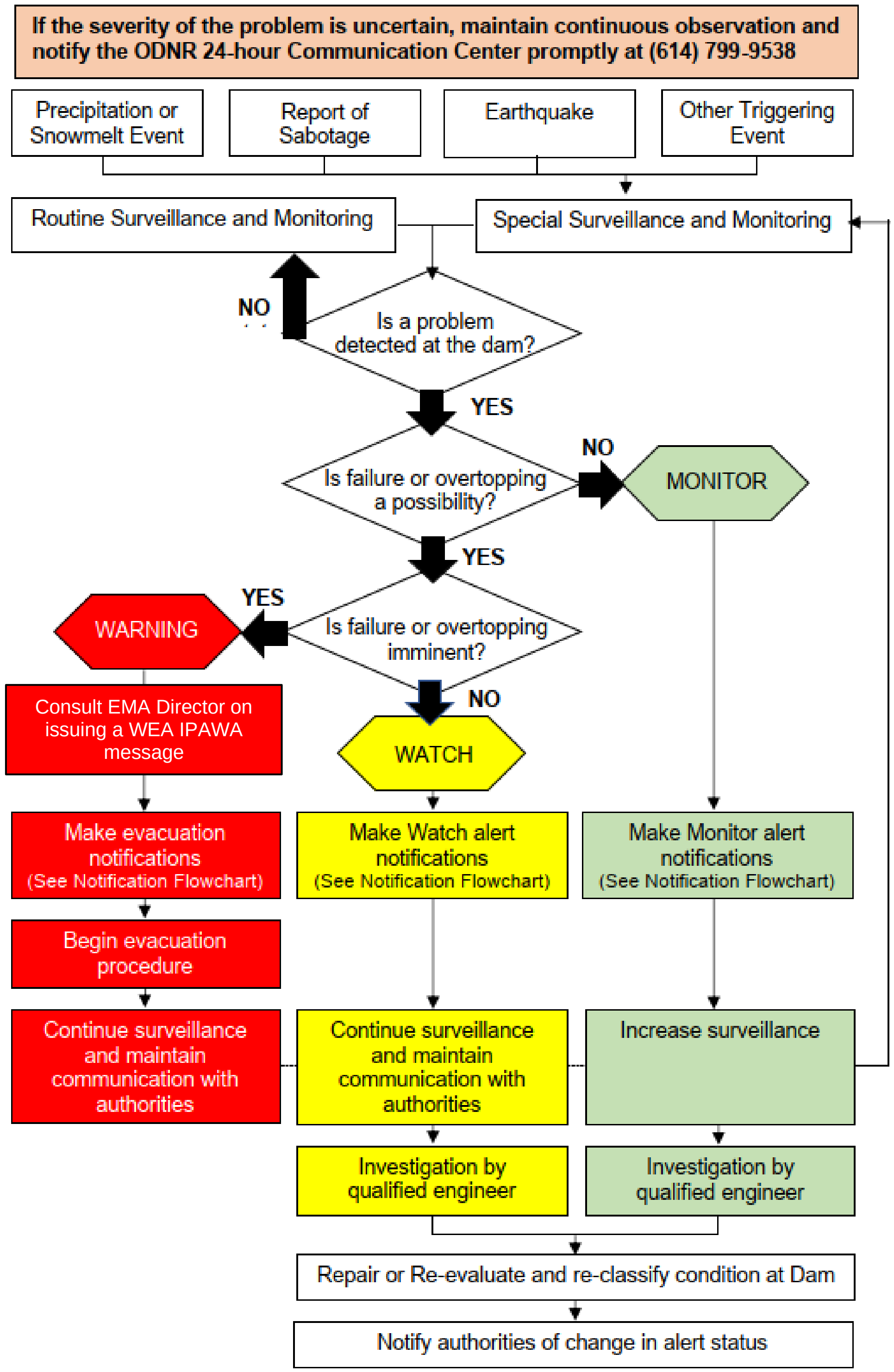
Ohio EMA
24-hr (614) 889-7150

ODOT District 4
Office (330) 786-3100

WARNING / WATCH

If the severity of the problem is uncertain, maintain continuous observation and notify the ODNR 24-hour Communication Center promptly at (614) 799-9538

PROBLEM DETECTION AND RESPONSE FLOWCHART



SECTION II - STATEMENT OF PURPOSE

The purpose of this Emergency Action Plan (EAP) is to:

1. Safeguard the lives as well as to reduce property damage of the citizens living within the potential downstream flood inundation area of the dam;

2. Provide for effective dam surveillance, prompt notification to local emergency management agencies, citizen warning and evacuation response, when required; and

3. Identify emergency actions to be taken by the dam owners, public officials, emergency personnel, and to outline response actions in the event of a potential or imminent failure of the dam.

The Camp Spelman Lake Dam was found by ODNR to be a Class I dam in a letter dated May 29, 2019. As part of that letter, there were several remedial measures required by ODNR to bring the Camp Spelman Lake Dam into compliance with Ohio Revised Code Chapter 1521 and Ohio Administrative Code Chapter 1501:21. These repairs are to be implemented within 5 years from the date of ODNR's letter. The Camp Spelman Lake Dam has two Owners, the Portage Park District and a private resident, Arden and Martha Sommers as shown in **Figure 1**. The owners are currently evaluating the costs associated with the remedial measures required by ODNR and alternative options that may be applicable (ownership change, de-classification of dam, conversion to wetland, etc..) to determine a solution that works for the Camp Spelman Lake Dam and its owners.

This Emergency Action Plan is being submitted to satisfy the required engineering repairs and investigations bullet 1 (Dam Failure Inundation Study) and owner repairs and monitoring bullet 3 (Emergency Action Plan). At this time the inundation study has assumed the improvements required to get Camp Spelman Lake Dam into compliance with ODNR have occurred. This was done because it is anticipated that these improvements would generate a higher peak water surface elevation during storm events and be a worse-case situation.

Figure 1 – Dam Ownership Map

SECTION III - PROJECT DESCRIPTION

Camp Spelman Lake Dam is located at 7650 Ferguson Road in Franklin Township, Portage County, Ohio. The dam is currently owned by Portage Park District and is used for recreational purposes. The design of the dam and its appurtenant structures is unknown, ODOT aerial photography dating back to May 1960 shows the dam constructed. It is an earth fill dam and there are no drawings or other detailed engineering data available for this dam. Camp Spelman Lake Dam is a Class I high hazard dam based on potential downstream hazards. These potential downstream hazards, which create the possibility of loss of life due to dam failure, include various residential homes around Camp Spelman and the Twin Lakes. The location of Camp Spelman Lake Dam is shown at the end of this section in **Figure 2**. Elevations listed in this document refer to the NAVD 88 vertical datum.

Camp Spelman Lake Dam, referred to by ODNR as File No 1112-071, is a Class I earth fill structure. There are no as-built drawings of this dam. The dam is 23 ft tall, 195 ft long, has a crest width of 12 ft, and has an upstream slope face of 3H:1V and downstream slope face of 3H:1V to 2H:1V. Camp Spelman Lake Dam controls drainage from a small upland area, and then both are tributary to the West Lake of the Twin Lakes, which ultimately discharges into the Cuyahoga River just downstream of Lake Rockwell Dam. The dam's current primary outlet is a 24-in x 24-in concrete riser structure with a 12-in diameter PVC outlet pipe. The existing emergency spillway is a grassy open channel with a two-stage cross section (**Figure 3**). The first stage has a bottom width of approximately 8 ft and the second stage has a bottom width of approximately 74 ft. Per EDG's field survey data, normal pool is at an elevation of 1084.66 ft, the existing emergency spillway activates at elevation of 1085.35 ft, and the lowest surveyed top of dam elevation is at 1008.09 ft. The surface area of Camp Spelman Lake at this elevation is 37.1 ac. <u>The inundation maps included with this EAP are based on the recommended improvements being performed that are mentioned in ODNR's inspection report dated 5-29-2019</u>. The improvements would increase the water surface elevation and it is assumed that would cause a larger peak flow for the breach analysis and thus a worse-case scenario for Camp Spelman.

A plan view of the dam and its appurtenances is shown at the end of this section in **Figure 3**. The dam data described above is summarized at the end of this section in **Table 1**.

There are several other dams nearby, ranging from low to high hazard, near where Camp Spelman Lake Dam discharges into the Little Cuyahoga River just downstream of the Lake Rockwell Dam. The Lake Rockwell Dam appears to be the only high hazard dam (Class I structure) located within the vicinity of the Cuyahoga River downstream of Camp Spelman Lake Dam. Some basic information and the location of these dams can be found online using the Ohio Dam Locator map viewer developed by ODNR (https://gis.ohiodnr.gov/MapViewer/?config=OhioDams).

Downstream communities that could be affected by a failure or large operational release at Camp Spelman Lake Dam include Franklin Township, **Section VII, Inundation Maps,** contains a series of maps that show potential inundation extents for three different dam breach scenarios: a non-hydrologic event failure, a 100-yr flood event failure, and a Probable Maximum Flood (PMF) event failure. The mapped inundation extents start near Camp Spelman Lake Dam and extend to the downstream side of East Lake along Overlook Drive, which is near the intersection of Overlook Drive and Woodway Road. These inundation extents should be taken as approximate because they were developed using a specific set of assumed dam breach parameters, baseline flood conditions, and other assumptions for each failure scenario, which are complex and often difficult to accurately predict, and the dam breach may not necessarily occur in the exact way it was assumed to occur. More details regarding these inundation maps and the assumptions made in developing them, are discussed in **Section VII, Inundation Maps, and Section VIII**, **Appendix A, Investigation and Analysis of Dam Break Floods**.

Structures potentially affected by each of the studied failure scenarios include various homes, the Twin Lakes Tavern, garages, barns, sheds, and other accessory structures. These affected structures, along with additional nearby structures, are identified on the series of inundation maps located in **Section VII, Inundation Maps**. Not every structure footprint is shown on the maps, but those affected by the inundation limits or within the vicinity of the inundation limits show the footprint of the structure. Structure footprints were delineated using 2017 county aerial photographs so they should not be construed as exact.

The northern section of W Lake Boulevard and Mockingbird Drive will be inundated to some degree, and it should be assumed they will become inaccessible. There are two spots along State Route 43 where the flood waters will over top the road and restrict vehicular traffic from being able to pass along this road.

Lastly, where West Boulevard and South Boulevard meet will be inundated, and this section of road will become inaccessible.

Many residential driveways are within the inundation area downstream of Camp Spelman Lake Dam, these will be inundated to some degree and may be washed away by flood waters generated during a dam breach. This driveway inundation, and possible destruction, may limit access to various homes during the emergency and after the flood waters have subsided.

Table 1. Camp Spelman Lake Dam Data

ITEM DESCRIPTION	VALUE
Location	Located at 7650 Ferguson Road in Franklin Township, Portage County, Ohio. Latitude: 41 degrees, 11 minutes, 53.5 seconds Longitude: 81 degrees, 20 minutes, 59.9 seconds
Dam Type and Construction Date	Earth fill with an unknown constructed date.
Dam Embankment Data	Height = 23 ft; Length = 195 ft; Top width = 12 ft; US/DS side slope: 3H:1V /3H:1V to 2H:1V;
Drainage Area	0.18 square miles/117 acres
Storage Volume(s)	69 acre-feet to the emergency spillway crest; 199 acre-feet to the top of dam
Spillways and Drains	Camp Spelman Lake Dam controls drainage from a small area that is tributary to the West Lake of the Twin Lakes, which ultimately discharges into the Cuyahoga River just downstream of Lake Rockwell Dam. The dam’s current primary outlet is a 24-in x 24-in concrete riser structure with a 12-in diameter PVC outlet pipe. The existing emergency spillway is a grassy open channel with a two-stage cross section. The first stage has a bottom width of approximately 8 ft and the second stage has a bottom width of approximately 74 ft. The dam component locations are identified in **Figure 3.**
Dam Information	Class I Dam; ODNR File# 1112-071; National Inventory # OH03217
Dam Design Engineer	unknown

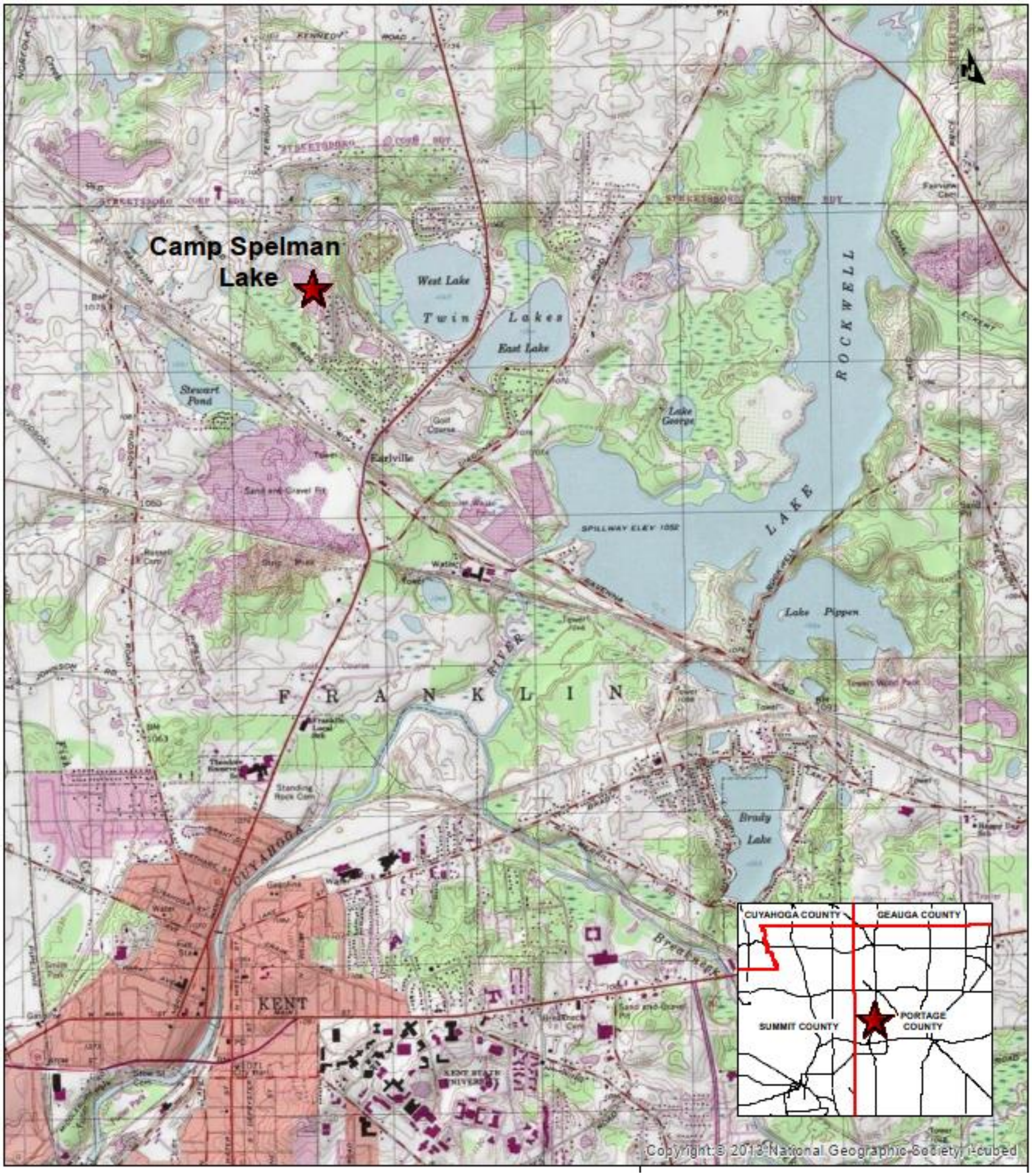


Figure 2 – Dam Location Map

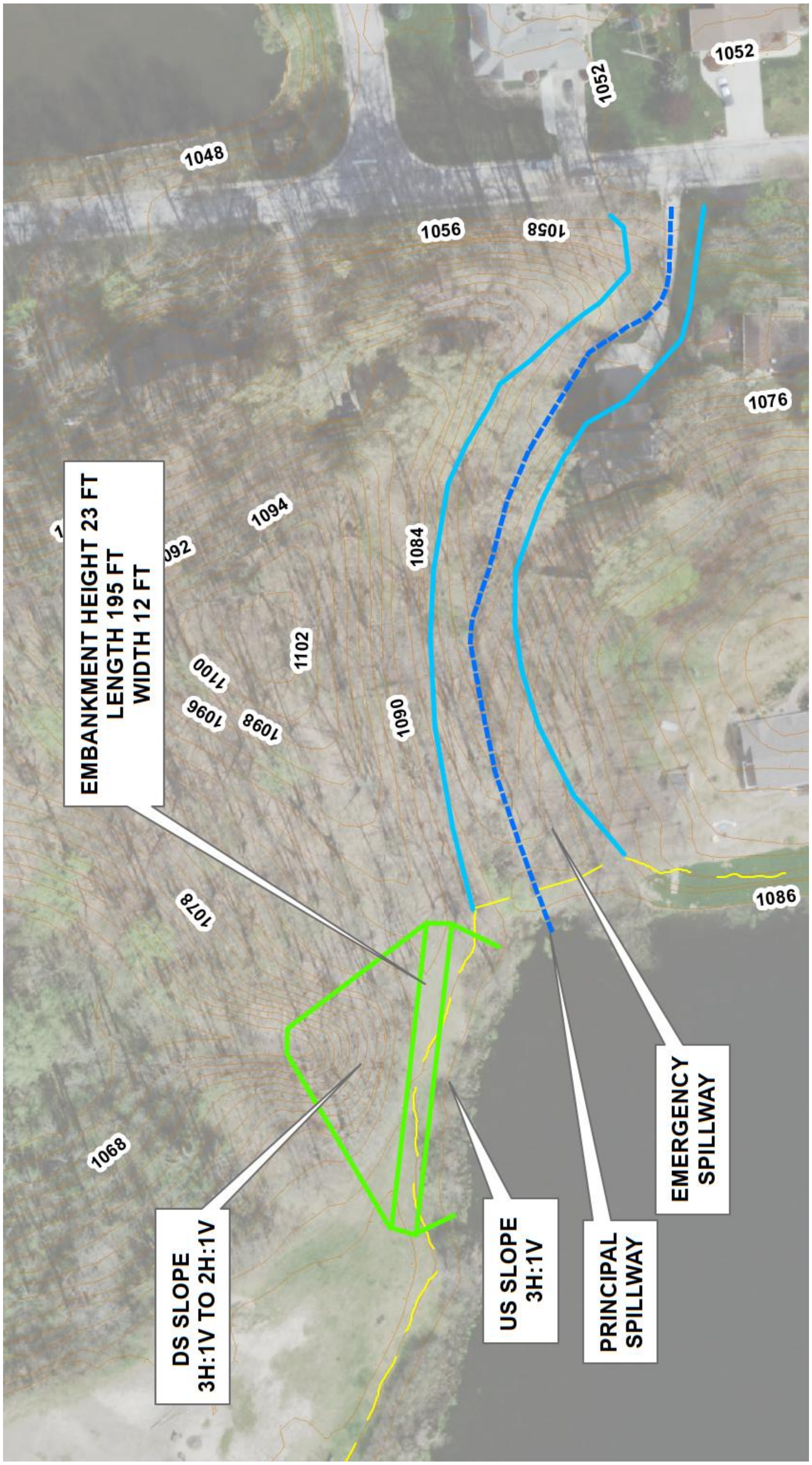


Figure 3 – Dam and Appurtenant Parts of the Dam

SECTION IV - EMERGENCY DETECTION, EVALUATION, AND CLASSIFICATION

This section describes the detection of an unusual or emergency condition and provides information to assist the dam operator in evaluating the dam and determining the appropriate emergency level for the observed condition.

Emergency Detection

The timely and reliable detection of emergency conditions or potential emergency conditions is essential to the successful implementation of an Emergency Action Plan. At the dam, detection of emergency conditions could occur through routine visual surveillance or possibly from a resident.

The dam and spillways should be physically inspected routinely in accordance with the Operation, Maintenance, and Inspection Manual. Inspections should be conducted more frequently during and after periods of heavy or prolonged precipitation, after the occurrence of an earthquake, or after any rapid drawdown of the reservoir pool. Any abnormal or questionable conditions should be noted.

If the severity of the problem is uncertain, maintain continuous observation and notify the ODNR, Division of Water Resources, Dam Safety Program promptly. If the failure of the dam or appurtenances appears to be imminent, notifications for evacuation should be made immediately. **See Section I, Notification Flowchart, for details.**

Evaluation and Classification/Emergency Level Determination

Upon detection of an unusual condition, the conditions should be immediately evaluated, and the owners should determine the appropriate emergency level classification and respond/notify appropriately. Emergencies are classified according to their severity and urgency. According to the Federal Guidelines for Dam Safety, "**Declaration of an emergency can be a very controversial decision; however, an early decision and declaration are critical to maximize available response time."** After an unusual or emergency condition is detected or reported, the dam operator is responsible for evaluating the condition and classifying the event into one of the following three emergency alert levels:

1. **MONITOR (Non-emergency, unusual event, slowly developing)** — Unusual condition has been observed at the dam, which is not likely to result in a dam failure. When a Monitor alert is declared, the frequency of surveillance and level of monitoring is increased and the ODNR, Dam Safety Program is notified. Investigation of the unusual condition by a qualified engineer is often warranted. If surveillance or further investigation reveals that a potential failure situation is developing, a Watch or Warning alert status level is declared. Repairs are often required.

2. **WATCH (Potential dam failure situation, rapidly developing) -** Potential failure situation is developing. When a WATCH alert is declared, authorities are placed on alert for a potential

evacuation. Periodic updates are provided, and a course of action is decided. Immediate remedial action should be taken to prevent further deterioration of the dam structure. Investigation by a qualified engineer is often warranted. If surveillance or further investigation reveals that failure is imminent or has occurred, a WARNING alert status level is declared.

3. **WARNING (Dam failure is imminent or in progress)** - Failure is imminent or has occurred. Imminent failure should be assumed as equivalent to failure. Notifications and evacuation procedures should be initiated immediately. After notifications have been made, if dam failure has not yet occurred, immediate remedial action should be performed to prevent dam failure.

Conditions which are believed to be such that would lead to imminent structural failure shall be reported as a **WARNING** and notifications shall be made immediately as prescribed in **Section I**.

The following table is provided to assist in detecting, evaluating, classifying conditions:

Event	**Situation**	**Emergency Level***
Spillways	Principal spillway severely blocked with debris or structurally damaged	Monitor
	Principal spillway leaking with muddy flows	Monitor
	Principal spillway blocked with debris and pool is rapidly rising	Watch
Flooding	National Weather Service issues a flood warning for the area	Monitor
	The reservoir elevation reaches the predetermined notification trigger elevation of <u>36 inches below dam crest (5” of water over the top of the riser)</u>	Watch
	The reservoir elevation reaches the predetermined notification trigger elevation of <u>24 inches below dam crest (17” of water over the top of the riser)</u>	Warning
	Spillway flow is flooding roads and people downstream	Warning
	Flood flows are overtopping the dam	Warning
Seepage	New seepage areas in or near the dam	Monitor
	Boils observed downstream of dam	Monitor
	Boils observed downstream of dam with cloudy discharge	Watch
	New seepage areas with cloudy discharge or increasing flow rate	Watch
	Cloudy flow and one or more of the following (with constant reservoir level): accelerating rate of flow, expanding flow at exit joint, or buildup of soils.	Warning
Sinkholes	Observation of new sinkhole in reservoir area or on embankment	Watch
	Rapidly enlarging in sinkhole	Warning
Embankment Cracking	New cracks in the embankment greater than 1/2 inch wide and greater than 2 feet deep, without seepage emerging	Watch
	Cracks in the embankment with seepage emerging	Warning

Embankment Movement	Visual movement/slippage of the embankment slope	Watch
	Sudden or rapidly proceeding slides of the embankment slopes	Warning
Instruments	Instrumentation readings beyond predetermined values	Monitor
Earthquake	Measurable earthquake felt or reported within <u>50 miles of the dam</u>	Monitor
	Earthquake resulting in visible damage to the dam appurtenances	Watch
	Earthquake resulting in uncontrolled release of water from the dam	Warning
Security Threat	Verified bomb threat that, if carried out, could result in damage to the dam	Watch
	Detonated bomb that has resulted in damage to the dam or appurtenances	Warning
Beaver Activity	Beaver Dams causing increasing water levels and cause the dam to not function as designed	Monitor
	Rodents tunneling creating seepage pathways	Monitor
Sabotage or Vandalism	Damage to the dam or appurtenances with no impacts to the functioning of the dam	Monitor
	Modification to the dam or appurtenances that could adversely impact the functioning of the dam	Monitor
	Damage to the dam or appurtenances that has resulted in seepage flow	Watch
	Damage to the dam or appurtenances that has resulted in uncontrolled water release	Warning

Almost all dam failures can be directly related to seepage, slope failure, settlement, or problems related to conduits through the embankment. Each of these items will be discussed below in more detail.

SEEPAGE

All dams normally experience a minor degree of seepage as the impounded water seeks paths of least resistance through the dam and its foundation; however, excessive seepage or seepage that is visually different than that previously observed can be indicative of major problems within the dam embankment. Seepage must be controlled in both velocity and quantity. At this dam, seepage is most likely to occur near contacts between the embankment and the outlet conduit, on the downstream embankment slope below the pool elevation, and the area beyond the embankment toe on the outside of the dam.

INDICATORS

- Appearance of wet spots, bogs, or springs in the downstream face of the earth embankment or in areas immediately adjacent to the toe of the embankment.
- Areas that prematurely thaw, or where snow melts prematurely, during the winter.
- Unexpected or unusual drop in the reservoir water surface elevation.
- Boils (fine-grained material being ejected in a stream of water out of a hole in the dam or ground forming a small cone of material) appearing on the downstream face of the embankment or in

the area adjacent to the downstream toe of the dam.

- Sinkholes occurring on the earth embankment or downstream in the area adjacent to the toe of the embankment slope.

- The appearance of a whirlpool (vortex) in the reservoir.

REPORTING

When reporting seepage or boils, unless it is considered an emergency, reference the location of the seepage or boils to an item of known location (e.g. "50 feet north of the southwest corner of the reservoir on the west dam embankment"). Estimate the amount of seepage and whether it is clear or cloudy; the approximate size of the area involved; the reservoir pool elevation when it was first observed, and the present pool elevation. Piping of foundation and/or embankment material is normally indicated by a buildup of materials around the seepage area or a slope failure (e.g. boils, slumps, landslides, sinkhole). Catching some seepage water in a clear glass jar and looking through the water can often indicate particles in suspension during the initial stages of piping. If the seepage velocity is high, the water may just be cloudy or muddy and buildup of materials may be some distance from the actual seepage location. After the seepage is reported, the area should be photographed before any measures are taken to control the problem. Disturbance of any seepage indicator, such as the buildup of sediment around the seepage area, should be kept to a minimum. Any occurrence of a whirlpool in the reservoir is an emergency situation.

CONTROLS

- **Changes in Seepage, Boils, and Whirlpools** – Seepage problems, boils, and whirlpools have their origins on the upstream face or within the dam, in the floor of the reservoir near the dam, or in the dam/foundation interface. In order to reduce seepage, the reservoir must be lowered and the seepage source found, if possible. It should be noted that lowering the reservoir surface too rapidly can cause instability of the upstream face of the dam embankment. Generally, the reservoir elevations should not be lowered any faster than 1.0-foot per week; however, ODNR should be contacted for guidance on the proper discharge rate from the reservoir. If the source of the seepage can be found or a suspected sight identified, a blanket of impervious material such as bentonite clay should be placed over the seepage source before refilling the reservoir. A permanent repair such as a grout curtain should be implemented as soon as possible. If the seepage source cannot be found, the reservoir should not be refilled until permanent seepage control measures can be installed.

- **Boils** – As a temporary control measure, a ring of sand bags or a large diameter pipe can be placed around a boil area. This will cause water to pond above the boil area and reduce the velocity so that piping damage is minimized until a more permanent solution is available. Never dump sand or a similar material into a boil. This may wash out and falsely indicate a more severe problem than actually exists. After an assessment of the sediment associated with the seep or boil, an overlay of an approved granular material may be selected as a control measure.

- **Sinkholes** – Sinkholes are the result of a loss of groundwater pressure or material beneath the ground surface. The cause of any sinkholes should be found through geotechnical investigations conducted by a qualified engineer. The sinkholes should be filled with earth or rocks until more permanent measures can be taken to resolve the problem.

<u>SLOPE FAILURE</u>

In general, slope failures occur gradually, and if detected in the early stages, measures can be taken to prevent total embankment failure. On the upstream embankment slope, failures may occur shortly after rapid drawdown. Slope failures can also occur in multiple areas and at different times but are more likely during special operating or loading conditions. They may be initiated by blasting, excessive vibrations, seepage, earthquakes, or erosion. Massive slides can initiate catastrophic failure of a dam.

<u>INDICATORS</u>

- Slumping, sloughing, or sliding of material on either the upstream or downstream face of the earth embankment.
- Displacement of riprap along the upstream face of the earth embankment at the shoreline.
- Cracks in the earth embankment portion of the dam. Transverse cracks appear across the embankment and might indicate differential settlement within the embankment. Such cracks provide avenues for seepage water and piping could quickly develop. Longitudinal cracks run parallel to the embankment and may signal the early stages of a slide or slump on either face of the embankment.
- Erosion of the upstream or downstream face of the earth embankment caused by rainfall runoff, snow melt, wave action, lack of vegetation, foot-traffic, overtopping, or increased seepage through the dam or its foundation. Deep erosion gullies and shoreline erosion can threaten the structural integrity of the embankment. Erosion along the base of the dam indicates potential deterioration of the foundation that could result in landslides or misalignment of the embankment.

<u>REPORTING</u>

When reporting slides, sloughs, slumps, cracks, and displaced riprap, reference the affected area to some permanent feature on the dam or nearby structure, determine the difference in elevation from one side to the other, note any special loading or operating conditions, note the reservoir water surface elevation, and note the recent weather conditions.

<u>CONTROLS</u>

- *<u>Slumps/Sloughs/Landslides/Erosion/Settlement</u>* – All of these problems are characterized by a loss of material from the earth embankment, the dam foundation, or the area at the toe of the dam. This loss of material can reduce the cross-sectional area of the dam, the length of the seepage path, or the freeboard for wave resistance between the water surface at the top of the dam. For slumps, sloughs, erosion, and settlement on the earth embankment or at the toe of the dam, the affected area should be filled with earth, rockfill, or sandbags until more permanent repairs can be made. On the downstream face of the earth embankment, the repaired area should be covered by plastic sheets or other erosion-resistant materials to prevent subsequent erosion during storms. For landslides, the toe of the slide should be stabilized by weighting with earth, rock, or gravel. If necessary, fill material should be placed at the top of the slide to restore freeboard after the toe is stabilized.
- *<u>Riprap Displacement</u>* – Riprap is placed along the shoreline on the upstream face of the dam

to provide wave and ice protection. Riprap displacement is characterized by a noticeable discontinuity in the slope upon which it is placed. It can be caused by wave action, ice impact or expansion, slumps, settlement, landslides, erosion, or sloughs in the embankment below the riprap. Often, riprap displacement is indicative of a loss of fine material underneath the riprap due to improper grading of the riprap or the lack of a filter material layer. Riprap displacement can expose the surface being protected to wave, ice, and water velocity induced forces that can cause further deterioration of the dam embankment or stream channel. Displaced riprap should be temporarily repaired by filling the affected area with additional riprap or sandbags until the cause of the riprap displacement can be determined and more permanent repairs made. Long term repairs may include removing the riprap, regrading the slope, installing a geotextile fabric, placing a layer of bedding gravel, and replacing the riprap stone.

- *Cracks.*– Cracks are an indicator of excessive loading, overstress, uplift, shrinkage, expansion, foundation movement, seismic activity, or loss of strength. In an earth embankment, cracks are caused by material movement within the embankment as might be caused by seepage, settlement, or seismic activity or by drying and shrinkage of the soils near the surface. Non-leaking cracks in the earth embankment should be filled with earth, rocks, grout, or sandbags until more permanent repairs can be made. In addition, the drainage path running from a crack should be improved (lined) to prevent further erosion. In the earth embankment portion of the dam, a leaking crack should be filled with any available material including bentonite clay, earth, hay bales, sandbags, and rocks to stop or slow the flow of water until the reservoir level can be lowered and a more permanent repair made.

- *Dam Overtopping* – High water surface elevations due to heavy precipitation, large waves, and/or rapid snow melt that overtop the crest of an earth embankment can result in slope failure. If it is apparent that the water level in the reservoir is going to rise to an elevation greater than the crest elevation of the dam embankment, the crest elevation should be raised by using sandbags or earth fill to increase the freeboard and force more water through the outlet pipes and inlet pipe (pump station running in reverse). The downstream face of the earth embankment should be covered with plastic sheets or other erosion resistant materials. If the water continues to rise, consideration should be given to opening a controlled breach in a non-critical area of the earth embankment to increase the discharge capacity. The breaching of the dam should only occur under the guidance of the ODNR.

SETTLEMENT

To a certain degree, settlement is normal and to be expected. Settlement is most likely to occur near concrete structures, thick clay fills, or rockfill areas that have clay layers beneath them. Settlement in the area of a conduit, which could be an indication that material is being removed, is most likely to lead to a critical situation.

INDICATORS

- A noticeable slump in the earth embankment crest.
- Discharge in the outlet pipes when the valves are closed.
- Reverse discharge in the inlet pipe when the pump station is not running.

REPORTING

When reporting settlement, reference the area of concern to a permanent dam feature or adjacent structure, determine the approximate size of the affected area, approximate the average settlement rate, and identify any nearby blasting, earthquake, saturation, or extended rainfall period. Also report any change in the appearance of the discharge detected in the outlet pipe discharge.

CONTROLS

After reporting the occurrence and location of any settlement, photograph the area and try to divert precipitation runoff away from the area. Perform a level survey or install other means of gaging the rate of settlement.

OUTLET CONDUIT

Foundation settlement, inoperative valves, and undermining of conduits are the most common problems with reservoir outlet systems. Undermining typically results from water leaking through pipe joints or seepage along the conduit.

INDICATORS

- Flow in the pipe from the outlet structure, when there is no overflow on the riser, indicates possible seepage through the dam and possible pipe joint separation or deterioration.
- Sinkholes or depressions that form along the course of the outlet pipe could be the result of pipe collapse, undermining, or seepage along the pipe.

REPORTING

- Photographs should be taken along with detailed written records of the location of any sinkholes or depressions; the amount of leakage discharge in the pipe; the appearance of the leakage discharge; and any other notes about the condition of the reservoir outlet system.

CONTROLS

- *Conduit Repair* – Effective repair of the internal surface or joints of a conduit is difficult and should not be attempted without careful planning and proper professional supervision. Various construction techniques can be applied for minor joint repair and conduit leakage, but major repairs require plans developed by a professional engineer experienced in dam outlet system design and construction.

BEAVER ACTIVITY

Area of trees, brush, and open water provide ideal habitat for beavers and burrowing animals. This site has historically always had beaver activity in the area. An overabundance of beavers increases the chance of affecting the water level of the dam (beaver dams) and creating holes/tunnels in the dam embankment or spillway. This can cause internal erosion of the dam, pathways for seepage, collapse of the dam crest, spillways being more susceptible to erosion, or dam failure.

INDICATORS

- Visible beaver lodges, slides, or dams
- Sinkholes or depressions that form along the embankment or spillway
- Holes forming along the internal dam slope

REPORTING

- Photographs should be taken along with detailed written records of the location of any sinkholes, dams, depressions, or holes; the approximate size of area involved; the reservoir pool elevation when first observed and present pool conditions. Reference the location of the to an item of known location (e.g. "50 feet north of the southwest corner of the reservoir on the west dam embankment").

CONTROLS

- Having a Beaver / Rodent control program in place to reduce the population and prevent future damage.
- Removing trees and brush from the beaver dam are and surrounding areas to reduce the attraction of the beaver's/burrowing animals.
- Backfill existing holes with mud-pack (i.e. typically adding water to a mixture of 90% earth and 10% cement mixture until a slurry of thin cement consistency is attained)
- Larger holes may need to be excavated and backfilled with compacted soil

ADDITIONAL COMMENTS

The types of failures described above are often interrelated in a complex manner. For example, uncontrolled seepage may weaken the soil and lead to a slope failure. A slope failure may shorten the seepage path and lead to a piping failure. Minor defects such as cracks in the embankment may be the first visual sign of a major problem that could lead to a failure of the structure. A professional engineer experienced in dam design and construction should evaluate the seriousness of all deficiencies. A qualified professional engineer can recommend appropriate permanent remedial measures.

Whenever an unusual condition is reported, a representative of the Owners should immediately visit the area of concern at the dam and evaluate the situation as described in the preceding paragraphs. If the situation is severe enough that there is any concern that there could be an uncontrolled release of water from the reservoir, the Owners should immediately notify the Portage County Department of Emergency Services and the ODNR Dam Safety Program. If the Owners are unsure of the severity of the problem, the ODNR Dam Safety Program should still be promptly notified. If the situation can be handled without the danger of an uncontrolled release of water from reservoir, the necessary work should be performed and the ODNR Dam Safety Program notified as soon as possible. Potential problems and immediate response actions are noted below and on the following page to assist with responding to situations that may arise.

Once a dam failure emergency situation progresses to the point that the dam is failing, there is little effective remedial action that can be taken. However, there may still be sufficient time to provide ample warning downstream from the dam to allow for the evacuation of persons in the flood inundation zones (see Inundation Map’s included in Appendix F) and a reduction in property damages.

EMERGENCY DETERMINATION DIAGRAM

CONDITION DETECTED	EVALUATION	
OVERTOPPING	Overtopping or near overtopping of the dam crest	1
SEEPAGE	Seepage on downstream slope with muddy water and stable or increasing flow	1
SEEPAGE	Seepage on downstream slope with clear water	2
SEEPAGE	Previously undetected seepage at the toe with clear water and stable flow rate	3
SEEPAGE	Soft zones, bogs, or springs in the downstream slope or toe	3
SEEPAGE	Boils, sinkholes or depressions in the downstream slope, toe or area immediately downstream	2
SEEPAGE	Unexpected or unusual drop in reservoir water level	1
SEEPAGE	Whirpool (vortex) in the reservoir	1
EMABANKMENT STABILITY	Breach or slide below the waterline that reaches the crest	1
EMABANKMENT STABILITY	Cavities or holes that could be attributed to internal erosion	2
EMABANKMENT STABILITY	Slide without seepage that does not reach the crest	2
EMABANKMENT STABILITY	Cracks parallel or transverse to the dam	3
EMABANKMENT STABILITY	Settlement of the dam crest	3
EMABANKMENT STABILITY	Riprap displacement on the upstream slope	3
OUTLET CONDUIT	Sinkholes or depressions along the outlet pipe	2
OUTLET CONDUIT	Inoperative lake drain valve	3
OUTLET CONDUIT	Flow in outlet pipe when all no water is entering the outlet riser	2

ACTION TAKEN

1 — WARNING

1. INITIATE EMERGENCY NOTIFICATION PLAN
2. Contact a qualified engineer immediately
3. Initiate continuous surveillance program

2 — WATCH

1. INITIATE EMERGENCY NOTIFICATION PLAN
2. Contact a qualified engineer immediately
2. Initiate daily surveillance

3 — MONITOR

1. Contact a qualified engineer
2. Check during weekly inspection and note changes in the condition

SECTION V - GENERAL RESPONSIBILITIES

A. RESPOSIBILITY OF DAM OWNERS

Portage Park District and Arden and Martha Sommers are the current owners of Camp Spelman Lake Dam. The dam owners are responsible for:

1. Routine and special surveillance and monitoring.
    - As described in **Section IV**, **Emergency Detection Evaluation and Classification**, the dam owners are responsible for routine visual surveillance and monitoring of the dam. The owners are also responsible for non-routine or special surveillance and monitoring efforts, such as after periods of heavy or prolonged precipitation, after the occurrence of an earthquake, or after any rapid drawdown of the reservoir pool.
    - If any unusual condition is observed during routine dam maintenance or inspection, the owners are responsible for increasing the frequency of surveillance and monitoring. Frequent or continuous surveillance and monitoring is required during declared **MONITOR** and **WATCH** alerts, as directed by ODNR.
2. Identifying the alert level status (**MONITOR, WATCH, OR WARNING**) and selecting the appropriate response, as described in **Section IV**, **Emergency Detection Evaluation and Classification**.
    - If any issue is observed at the dam, the owners are responsible for identifying the alert level status, selecting the appropriate EAP response, and performing the notifications shown in the **Notification Flowchart (Section I)**. **Section I** and **Section IV** may aid in this process. It should be emphasized that if the severity of the problem is uncertain, continuous observation should be maintained and ODNR should be promptly notified. If the failure of the dam appears to be imminent, a **WARNING** alert should be declared and notifications for evacuation should be made.
3. Notifying the appropriate parties in a timely manner.
    - Owners shall notify the appropriate parties according to the **Notification Flowchart in Section I**.
4. Implementing and directing emergency repairs.
    - If warranted, the water level in the lake should be lowered as a precaution. The amount that the lake should be lowered should be sufficient to expose the problem area or to halt the progression of the problem. ODNR should be promptly notified of the lake lowering operation to provide guidance on the proper rate of lowering and to monitor the situation. Other temporary remedial repairs or permanent repairs may be directed by ODNR or their representatives. Remedial measures could include the placement of earthfill, rockfill, sandbags, or grout.

5. Providing security measures at the dam during an emergency.
6. Reporting termination of the emergency at the dam.
7. Implementing actions to de-mobilize and return to pre-alert level conditions, if possible.

In non-emergency situations, the dam owners are responsible for:

8. Routine maintenance and operations.
    - In addition to all other routine maintenance, the owners are responsible for ensuring that the spillways remain free of blockages, especially during flood events. The owners should also ensure that access to the lake drain structure is readily available and that operator cranks are available to enable opening of the drain valve.
9. Routine surveillance of the dam.
10. Routine inspection of the dam.
11. Annually reviewing, updating, and (re)distributing the EAP.

B. RESPONSIBILITY FOR NOTIFICATIONS

In the event of an emergency, it is the owners responsibility to notify the local officials and brief them on the situation. Pre-scripted messages for the owners notification to emergency officials are found in **Section I**. If the local officials are unavailable, the ODNR 24-hr Communication Center should be called and notified of the situation.

The Portage County Emergency Management Agency should prepare and deliver a message for public release based on the existing conditions and information from the owners and other authorities. Preparation of Watch and Warning messages should begin as soon as their potential need is apparent so that they can be issued promptly upon declaration of an emergency condition. Where time is available for their preparation, the initial message should contain all pertinent information. However, in some cases, an emergency condition may be declared with little or no advance notice. The following sample message provides a model for the first announcements in such cases. Subsequent announcements should provide additional details.

WATCH

<u>Prescripted Message</u>

A WATCH alert has been issued for Camp Spelman Lake Dam, which is located at 7650 Ferguson Rd, in Franklin Township, Ohio. We are performing constant surveillance according to the Emergency Action Plan. We will inform you if a decision to evacuate has been made or if the WATCH alert is cancelled.

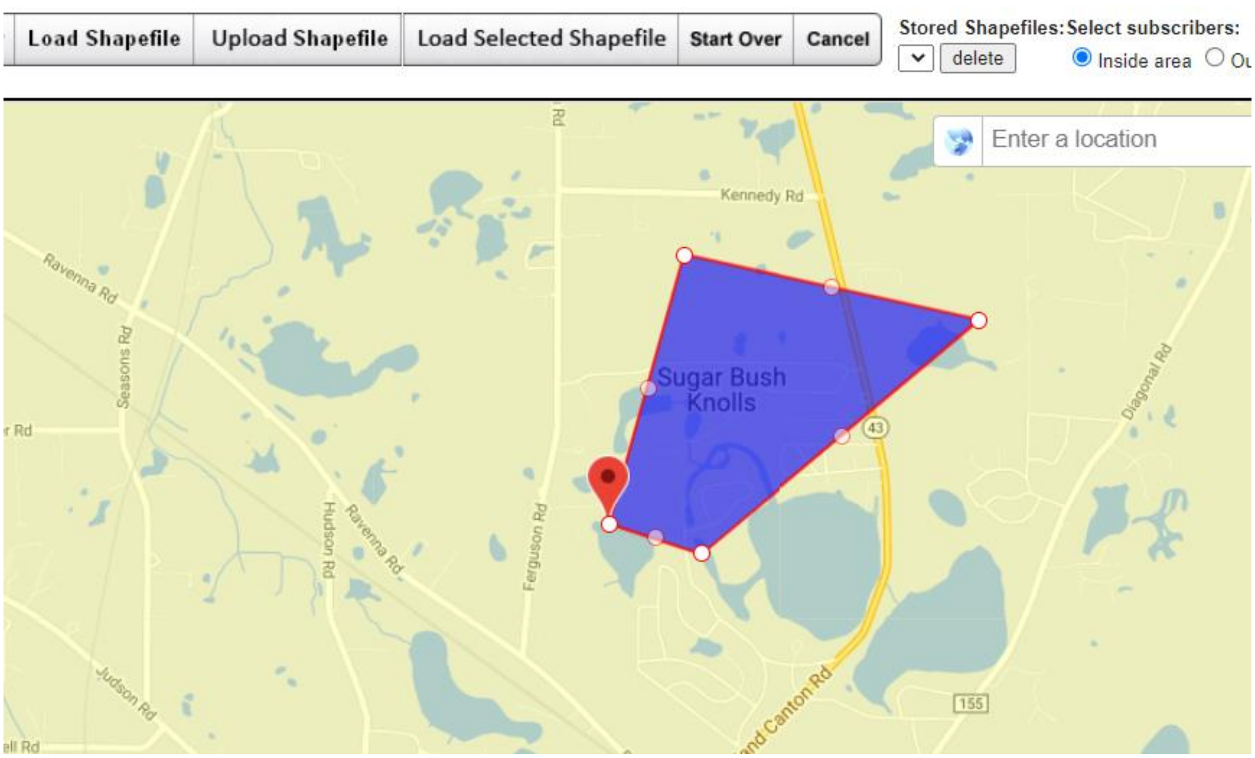
WARNING

<u>Prescripted Message</u>

WARNING! Camp Spelman Lake Dam is failing. Please evacuate low-lying areas adjacent to Twin Lakes. If you are in or near this area downstream from this dam, proceed immediately to high ground away from this area.

The simplest functioning means of communications will be used to maintain communications with authorities and contractors. Notification will normally be by telephone (conventional line or cellular). The telephone for the owners will be manned on a 24-hour basis during an emergency. The Portage County Emergency Management Agency will be the primary source through which emergency announcements are released to the news media.

Another source is though the Portage County Emergency Alert system. Portage County EMA has an Emergency Notification System or WENS, that has a program called Integrated Public Alert & Warning System (IPAWS) through FEMA. IPAWS gives Portage County EMA the capability to send wireless emergency alerts to cellular phones in a designated geographical area without registration of users. It is another tool in the event an evacuation is recommended that the Portage County EMA Director may choose to utilize. The system does have limitations, as not every cell phone has the capability to receive IPAWS alerts. An example of what sending an alert using this system may look like is provided below.



C. RESPONSIBILITY FOR EVACUATION

Agencies with a statutory obligation are responsible for evacuation. The owners <u>should not</u> assume any agency responsibility but <u>should</u> coordinate with the emergency response agency personnel according to **Section I**. Portage County EMA would lead the evacuation notification with the assistance of the

Owner(s) and their staff. Door to door evacuation notification will be the fastest way to get the message out to the community.

D. RESPONSIBILITY FOR DURATION, SECURITY, TERMINATION, AND FOLLOW-UP

The owners, in consultation with an ODNR Dam Safety Representative, are responsible for making the decision, when appropriate, that an alert level status no longer exists on-site/at the dam. The Emergency Management Agency representatives are responsible for declaring termination of an alert level status off-site. As such, it will be the responsibility of the owners to notify the Emergency Management Agency representatives of an alert level status termination at the dam promptly. The owners are also responsible for monitoring the alert level status at the dam and keeping the authorities informed of developing conditions and for specifying security measures at the dam during the alert.

The goal of the follow-up phase is to return to the pre-alert level condition. The owners are responsible for implementing all actions necessary to achieve this goal on-site at the dam. This may include securing access to the site, restoring basic facilities and services, and assessing the damage on-site.

E. RESPONSIBILITY OF EAP COORDINATOR

The EAP coordinator will be the dam owners, Portage Park District and Arden and Martha Sommers. Their contact information may be found in **Section I**. The coordinator will be responsible for revising the EAP, establishing training seminars, coordinating EAP exercises, and serving as contact person for questions regarding the EAP.

SECTION VI - PREPAREDNESS

SURVEILLANCE

Visual inspections of the dam and its appurtenances are to be made by the owners. Routine physical inspection of the earth embankment, the principal spillway and the associated structures are essential to the identification of any emergent conditions at the dam. This system is to be routinely inspected in accordance with the Operations, Maintenance, and Inspection Manual and also inspected during special conditions, such as after periods of heavy precipitation and sustained high lake levels. ODNR Dam Safety personnel will conduct periodic inspections as well as respond to reports of problems with the dam and its appurtenances. During periods of forecasted high flows or following the detection of a possible emergency condition at the structure, more frequent or continuous on-site surveillance may be necessary. Facilities for remote surveillance are not available at Camp Spelman Lake Dam. There are no audible alarms tied to the lake level. Monitoring of the dam is undertaken through physical observations.

RESPONSE DURING PERIODS OF DARKNESS

During periods of darkness, illumination at the dam should be provided by fixed or portable lighting. Power would need to be provided by a portable generator capable of powering any emergency electrical equipment, including emergency lighting, and this generator should have an output capacity that meets or exceeds the power required by all the emergency equipment. The dam is not staffed 24 hours per day and there is no remote surveillance or audible alarms. In case of emergency, timely notification of the conditions at the dam is essential. Cell phone numbers are provided in the **Notification Flow Chart in Section I** for reaching responsible personnel during non-working hours. If all the initial persons on the flow chart are unavailable, the ODNR 24-hour Communication Center should be called and notified of the situation.

ACCESS TO SITE

A potential site access map is included in **Appendix C, Site-Specific Concerns and Site Access Map**. Camp Spelman Lake Dam is located at 7650 Ferguson Rd and the primary route of access to the dam and its appurtenances is via the private drive located at this property. However, this private drive has a locked gate and the drive is approximately 1,350 linear feet long. In case of an emergency, the existing chain lock to the steel gate can be cut for entry. Access to Camp Spelman Lake dam and its appurtenances could also be gained from the Sommers property located at 7598 Birkner Dr. This is a residential drive where the dam embankment can be accessed on foot.

RESPONSE DURING WEEKENDS AND HOLIDAYS

As mentioned previously, the dam and its appurtenances are not continuously monitored. In case of emergency, timely notification of the conditions at the dam is essential. Cell phone numbers are provided in the **Notification Flow Chart in Section I** for reaching responsible personnel during non-working hours. If all the persons on the flow chart are unavailable, the ODNR 24-hour Communication Center should be called and notified of the situation.

RESPONSE DURING PERIODS OF ADVERSE WEATHER

During periods of adverse weather, the owners shall be prepared to isolate and protect areas of potential dam repair from rainfall, ice, and snow. In cases of an emergency, the existing chain lock to the steel gate can be cut for entry to the residential drive located at 7650 Ferguson Rd. If this route or the correct tools to access this route are not available, access to Camp Spelman Lake Dam and its appurtenances could also be gained from the southeast, see the site access map included in **Appendix C, Site-Specific Concerns and Site Access Map**. The access route is accessible by vehicular traffic via 7598 Birkner Dr. During emergency conditions, access to the dam and its appurtenances via the area downstream from the dam should be restricted or prohibited for safety reasons.

ALTERNATE SYSTEMS OF COMMUNICATION

If there is a loss of telephone service, and an emergency condition exists, the owners could use cellular phones or radio communications. The Portage County Sheriff’s dispatch system may also be used as an alternate means of communications. Responsible parties could also drive to Portage County EMA or Portage County Sheriff’s to initiate a response.

EMERGENCY SUPPLIES AND RESOURCES

If the dam failure were to be catastrophic, the lake will mostly likely dewater on its own. Following the emergency, rebuilding of damaged portions of the dam will be undertaken if it appears to be feasible. For emergency use, the owners should have at least the following materials and supplies available at the Camp Spelman Lake Dam site or available at another nearby storage location with sufficient transport vehicles to ensure a timely response to an emergency:

- Flashlights to provide lighting where emergency lighting does not illuminate.
- Portable, gas-fueled generator.
- Extension cords (heavy duty) for use with portable generators and emergency equipment including lights.
- Fire extinguishers (preferably type ABC) for extinguishing any fire that may occur in the emergency equipment.
- One or more portable pumps (submersible) and hoses to assist in lowering lake levels.
- Rope.

- Personal flotation devices.
- Plastic sheeting for temporary crack repair and for protecting the downstream face of the earth embankment.

For emergency use, there are no appropriate materials or equipment stockpiled near the dam to deal with a catastrophic event. The materials and equipment that could be required during or following an emergency may be acquired from the following:

- Fill material (limestone, gravel, and sand) to dump into a dam breach.

Lakeside Sand & Gravel INC 3498 Frost Rd. Mantua, OH 44255 (330) 274-2569	Shelly Materials 1181 Cherry St Kent, OH 44240 +1(800) 219-5478

- Equipment rental including excavating equipment, backhoe/front end loader for hauling and placing fill material, pumps, and lighting.

Advance Excavating Company 1201 Highland Rd Macedonia, OH 44056 (330) 425-7155	United Earthworks LLC. 770 Twin Oaks Dr Deerfield, OH 44411 (330) 557-2181

- Sandbags and sand.

The Home Depot 9585 OH-14 Streetsboro, OH 44241 (330) 422-0401	Lowe’s Home Improvement 1210 OH-303 Streetsboro, OH 44241 (3300 626-2980

- Concrete/grout.

Shelly Materials 1181 Cherry St Kent, OH 44240 +1(800) 219-5478	Jefferson Materials CO. 8505 OH-14, Streetsboro, OH Streetsboro OH 44241 (330) 626-3816

COORDINATION OF INFORMATION ON FLOOD FLOWS

Based on weather and precipitation forecasts, coordination of discharges from the dam may be needed to prevent a catastrophic failure and/or to reduce the risks of flooding downstream of the dam during an emergency. When conditions at the dam are such that the water level in Camp Spelman Lake threatens to overtop the dam (not just the emergency spillway), the lake drain valve should be fully opened if it can be safely accessed. If necessary, portable pumps should be used in lieu of and/or to supplement the lake drain. The owners should coordinate lake lowering with ODNR, Division of Water. If conditions are such that flooding cannot be prevented a WATCH and/or WARNING alert should be initiated.

The owners should coordinate with the Portage County Emergency Management Agency to help bring notice of potentially dangerous storms and floods that could result in the failure of the Camp Spelman

Lake Dam and, if necessary, to monitor storms and flood waves after a dam failure. The National Weather Service may also be used in an emergency to transmit warnings through their own communications system.

RECOMMENDED ACTIONS FOR FAILURE PREVENTION

As shown in the **Problem Detection and Response Flowchart in Section I**, after a potential emergency condition has been identified, it should be evaluated, an alert level status/classification should be decided and then the appropriate notifications should be made. After these notifications have been made, surveillance should be increased, and the condition should be evaluated by a qualified engineer. FEMA and other organizations involved in dam safety provide lists of recommended actions that could be taken to prevent further damage or otherwise postpone failure. These actions are shown in **Section IV**.

OTHER RECOMMENDED ACTIONS

The owners should work in conjunction with the Portage County EMA, ODNR, and other local officials to develop a plan to implement a warning system to alert persons downstream of the dam in the event of a failure. Once such idea is to have potentially impacted/downstream residents utilize the Portage County Emergency Alerts system. An outreach effort to educate and advise potentially impacted residents and downstream residents regarding theses warning signals and appropriate evacuation or safety measures will need to be developed and implemented. Details of the plan should be added to this EAP upon their development, approval, and implementation.

SECTION VII - INUNDATION MAPS

Downstream communities that could be affected by a failure at Camp Spelman Lake Dam include the communities around Twin Lakes, and Franklin Township, which are all in Portage County. There are two maps located at the end of this section that show potential flood inundation extents for three different dam breach scenarios: a non-hydrologic event failure, a 100-yr flood event failure, and a Probable Maximum Flood (PMF) event failure. Approximately 1.5 miles of downstream of Camp Spelman Lake Dam were mapped, starting at the Camp Spelman Lake Dam and ending at Overlook Drive or the southern tip of West Lake of Twin Lakes. There is one key map and two detailed inundation maps prepared. The key map may be used to spatially reference the detailed maps.

These inundation extents should be taken as approximate because they were developed using a specific set of assumed dam breach parameters, baseline flood conditions, and other assumptions for each failure scenario, which are complex and often difficult to accurately predict, and the dam breach may not necessarily occur in the exact way it was assumed to occur. The assumed breach parameters and more details on these assumptions are discussed in **Section VIII**, **Appendix A**.

SECTION VIII - APPENDICES

The following Appendices are provided with this EAP.

- Appendix A: Investigation and Analysis of Dam Break Floods
- Appendix B: Plans for Training, Exercising, Updating, and Posting the EAP
- Appendix C: Site-specific Concerns and Site Access Map
- Appendix D: Owners Certification

CAMP SPELMAN LAKE DAM

PORTAGE COUNTY
FRANKLIN TOWNSHIP

ODNR-DSWR FILE NO: 1112-071

EMERGENCY ACTION PLAN

APPENDIX A

INVESTIGATION AND ANSLYSIS OF DAM BREAK FLOODS

INUNDATION STUDY FOR CAMP SPELMAN LAKE DAM
CLASS I DAM
FILE # 1112-071

PREPARED
MARCH 2022

PREPARED BY

Environmental Design Group
The community impact people.
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Akron, Ohio 44311

STATE OF OHIO
ANDREW M. LONG
E-84478
REGISTERED
PROFESSIONAL ENGINEER

Andrew M Long

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Study Summary

This inundation study (Study) was performed to support the Emergency Action Plan developed for Camp Spelman Lake Dam (file number 1112-071). Camp Spelman Lake Dam is a Class I structure located in Franklin Township of Portage County, Ohio. Camp Spelman Lake Dam controls drainage from a small area that is tributary to the West Lake of the Twin Lakes, which ultimately discharges into the Cuyahoga River just downstream of Lake Rockwell Dam. For this Study, HEC-HMS was utilized to analyze the function of Camp Spelman Lake Dam during both non-breach and breach scenarios. These analyses assumed that the proposed improvements required to get Camp Spelman Lake Dam into compliance with ODNR have been performed. The HEC-HMS model was used to estimate dam breach hydrographs for three different potential piping breach scenarios: a non-hydrologic/sunny day breach, a 100-year storm event breach, and a PMF event breach. The estimated dam breach hydrographs generated by HEC-HMS were routed for nearly 2 miles downstream from Camp Spelman Lake Dam using HEC-RAS. The hydraulic/HEC-RAS analyses performed for this Study began at Camp Spelman Dam and ended just downstream from the pond located at the south end of the golf course, The Fairway at Twin Lakes. The results of the HEC-RAS model were used to develop a set of inundation maps that show potential inundation extents for all three dam breach scenarios. These maps show the inundation limits for all three scenarios from Camp Spelman Lake to the outlet of East Lake (Overlook Road). The following sections discuss this Study in detail.

Camp Spelman Lake Dam Data

Camp Spelman Lake Dam, file number 1112-071, is a Class I dam located in Franklin Township of Portage County, Ohio (**Figure 1**).

Figure 1: Camp Spelman Lake Dam Location from ODNR Dam Locator

It is an earth fill dam and there are no drawings or other detailed engineering data available from this dam's original construction. The dam embankment currently has a total length of approximately 195 ft, top width of approximately 12 ft, and upstream/downstream face slopes ranging from 3H:1V to 2H:1V. The dam's current primary outlet is a 24-in x 24-in concrete riser structure with a 12-in diameter PVC outlet pipe. The 24-in x 24-in riser rim was surveyed to be at an elevation of 1084.66 ft.

Currently, this dam has several deficiencies that must be corrected to get this Class I structure into compliance with dam safety laws. To correct some of these deficiencies, EDG has proposed improvements that would affect the stage-discharge relationship of this dam such raising the emergency spillway invert elevation. This Study is based on the proposed improvements because it is anticipated that the proposed improvements required to get this dam into compliance would generate a higher peak WSE in Camp Spelman Lake during storm events, which would likely also result in higher peak outflows during a hydrologic event breach of Camp Spelman Lake Dam.

The existing emergency spillway is a grassy open channel with a two-stage cross section (Figure 2) with an invert elevation of 1085.35 ft, but previous H&H calculations performed by EDG indicate this emergency spillway currently activates more frequent than what is allowed for a Class I dam; therefore, it has been proposed that this emergency spillway be updated to the configuration depicted in Figure 2, which has an invert elevation of 1086.50 ft. The top of dam elevation currently varies and would overtop at an elevation of 1088.09; however, it has been proposed that the top of dam elevation be raised to be level at an elevation of 1088.50 ft so that it does not overtop during the PMF event.

For this Study, EDG collected limited survey points for the dam and its appurtenances using a Spectra Geospatial GNSS Receiver and its corresponding Survey Pro software, which is connected to the Ohio Department of Transportation's Virtual Reference Station (VRS) system for real-time corrections to be made. Measurements were also performed using a tape measure where satellite coverage was inadequate to collect survey points with the Spectra Geospatial GNSS Receiver. EDG also used publicly available elevation data to supplement our limited field survey data. This publicly available elevation data included 2016 contours obtained from Portage County GIS along with 2006 LiDAR datasets obtained from the Ohio Geographically Reference Information Program (OGIP) website. EDG created a 5'X5' DEM from the 2016 county contours for HEC-RAS modeling and for inundation mapping. This DEM utilized a horizontal project of NAD 1983 2011 State Plane Ohio North FIPS 3401 Feet and vertical datum of NAVD88, which are the datums used for this Study.

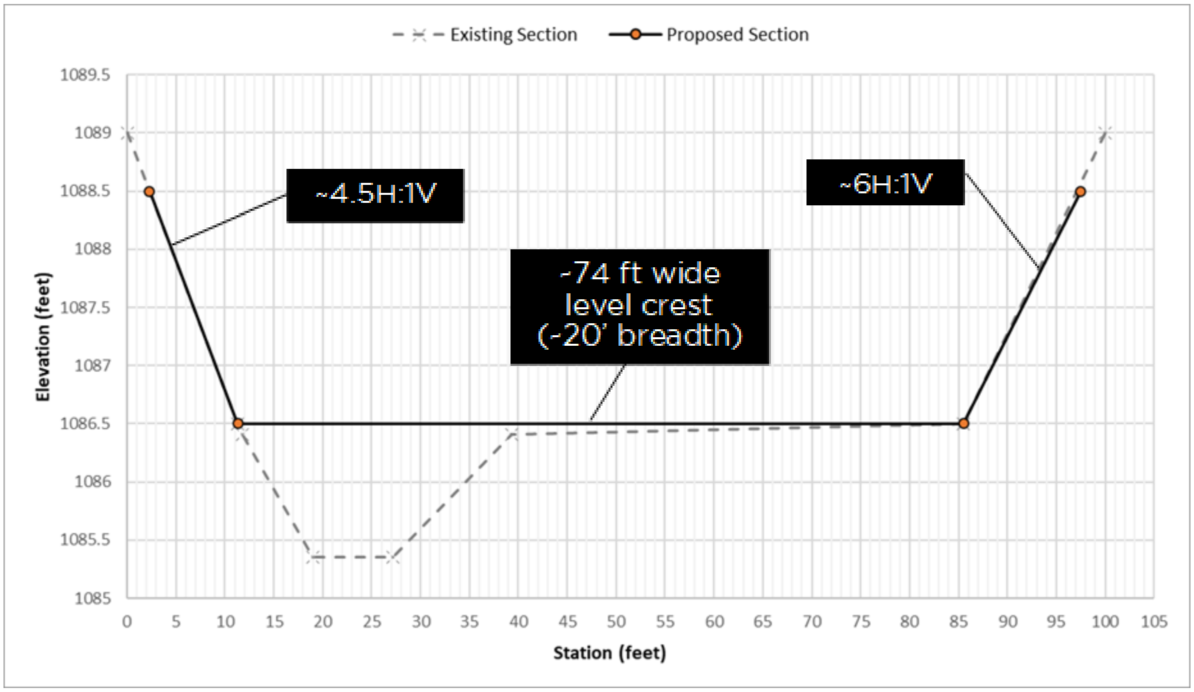


Figure 2: Existing and Proposed Emergency Spillway Configurations

Hydrology of Camp Spelman Lake Dam and Downstream Subbasins

For this Study, detailed hydrologic calculations were performed for Camp Spelman Lake Dam and for three more subbasins that contribute additional runoff to various points downstream of Camp Spelman Lake Dam. These three downstream subbasins include the additional area contributing to West Lake, the additional area contributing to East Lake, and the additional area contributing to the pond located at the south end of the golf course, The Fairway at Twin Lakes (golf course pond).

Detailed drainage area delineations performed for these analyses reveal that approximately 117 acres (0.18 square miles) drain to Camp Spelman Lake and that additional 485 acres (0.76 mi^2), 248 acres (0.39 mi^2), and 73 acres (0.11 mi^2) contribute to West Lake, East Lake, and the golf course pond, respectively (**Figure 3**). The drainage areas are all sparsely developed. The areas contributing to Camp Spelman Lake, West Lake, East Lake, and the golf course pond contain 18.4%, 39.9, 40.9%, and 14.7% impervious surfaces, respectively (**Figure 4**). The impervious surfaces within each drainage area typically consist of roadways, and residential buildings/outbuildings, and water bodies. Typically, the water bodies appear to be the only directly connected impervious areas and make up 10.7%, 23.2%, 30.7%, and 4.68% of the total drainage area to Camp Spelman Lake, West Lake, East Lake, and the golf course pond, respectively. There is a large wetland that is adjacent and hydraulically connected to the main water body of Camp Spelman Lake, but only some portions of the wetland contain standing water according to the 2017 OSIP aerial image for this area.

Camp Spelman Lake primarily collects water that drains from the west/southwest and discharges it east/northeast toward the West Lake of the Twin Lakes. Currently, the principal and emergency spillways of this dam discharge in a separate direction (east) than a flood wave would if the dam were to break (west) as shown in **Figure 5**. West Lake is hydraulically connected to East Lake, which is controlled at its southern end by a roadway culvert at Overlook Road. Discharges from East Lake drain through a wetland area and to the golf course pond. The golf course pond has a taller dam embankment that could impound water. EDG performed a field investigation of this golf course pond to try and determine its outlet. Based on our field investigations, EDG believes that this golf course pond has a primary outlet device that complicated, consisting of a small riser and various outlet pipes which ultimately discharges water from the pond to a downstream open channel (**Figure 6**). This stream is tributary to the Cuyahoga River and discharges into said river, just downstream of Lake Rockwell Dam.

Figure 3: Study Drainage Areas

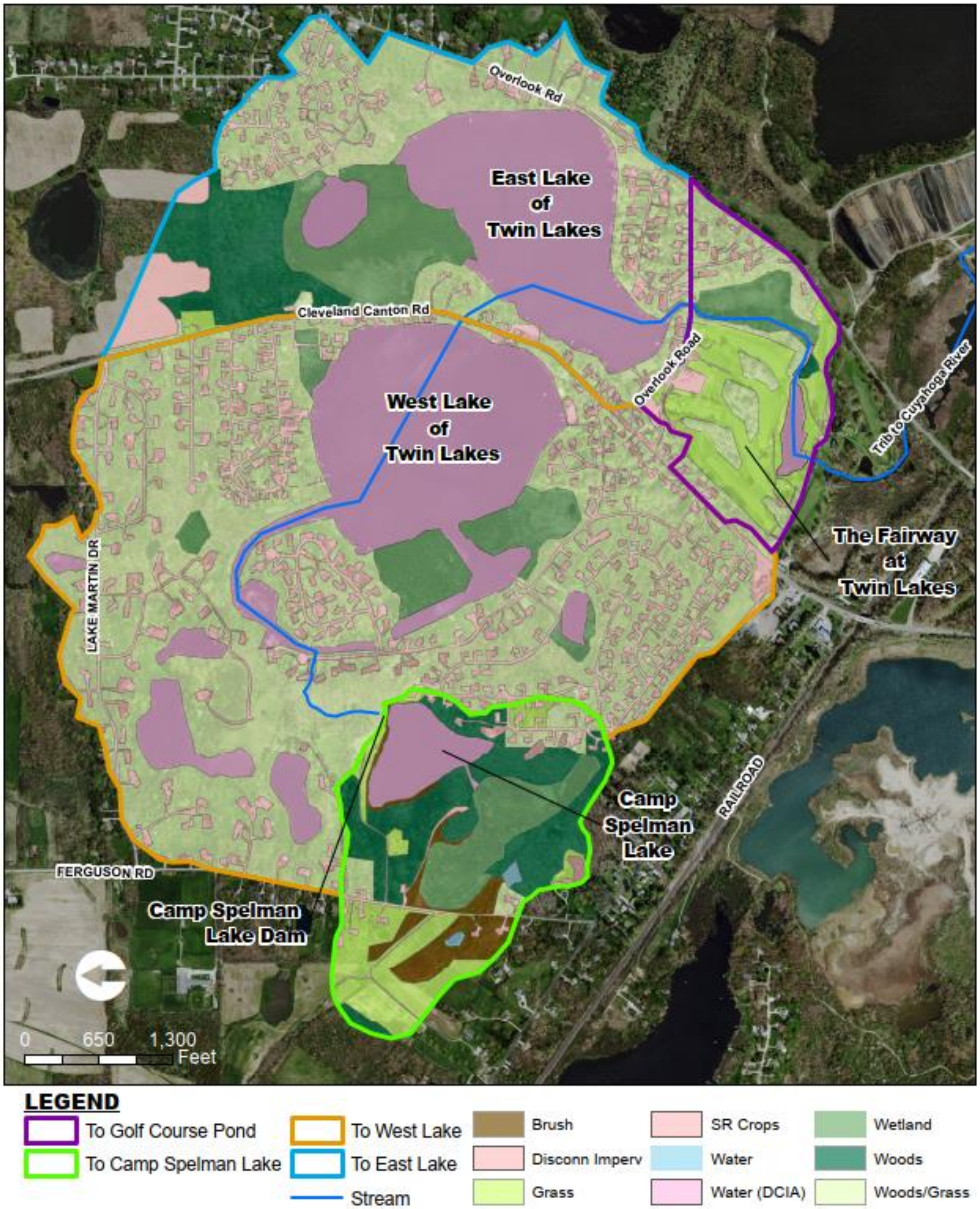


Figure 4: Land Cover

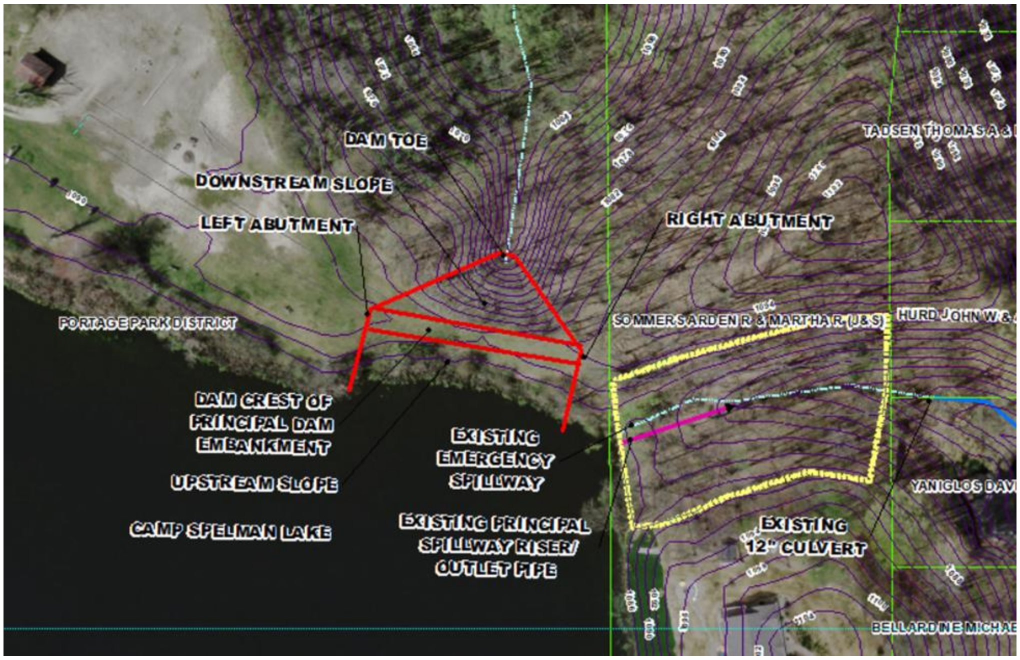


Figure 5: Camp Spelman Lake General Outflow Paths

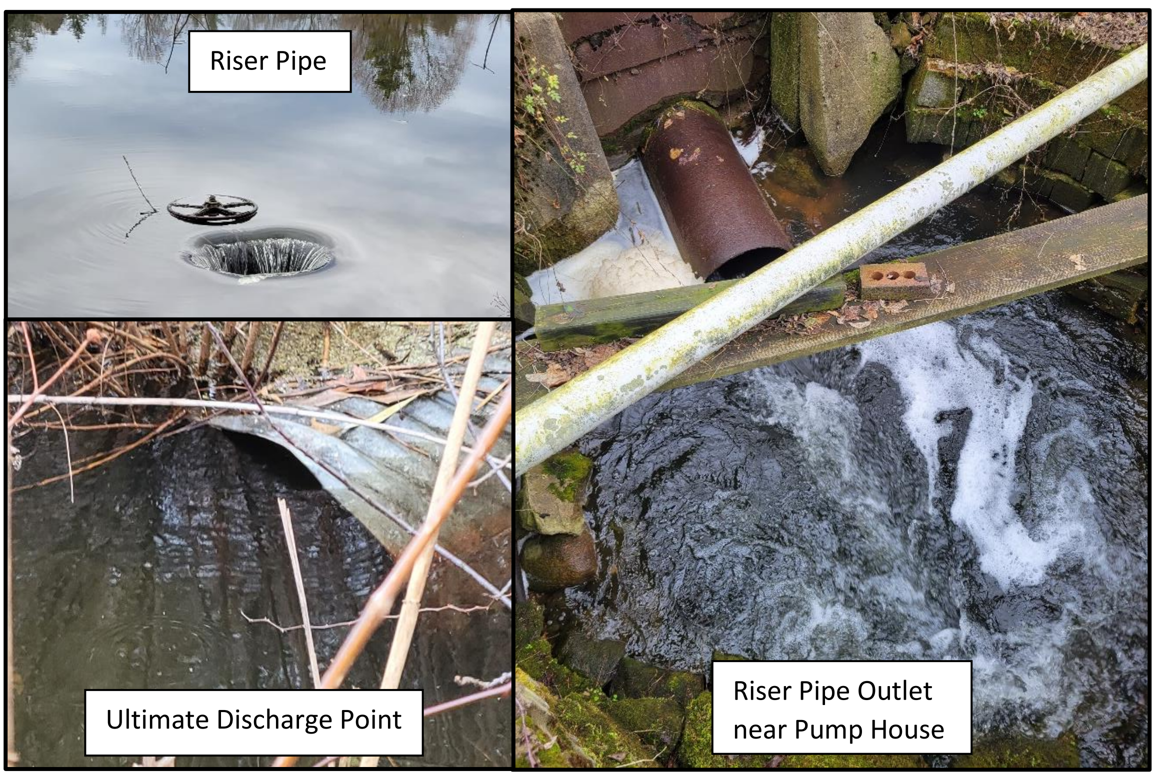


Figure 6: Golf Course Pond Outlet System Photos

The proposed condition stage-discharge capacity of Camp Spelman Lake Dam was investigated for multiple hydrologic events using HEC-HMS, version 4.8. The Probable Maximum Flood (PMF) for Camp Spelman Lake Dam was investigated by analyzing two Probable Maximum Precipitation (PMP) events. The two PMP events analyzed were the 6-hr duration PMP event and the 24-hr duration PMP event. The total rainfall value for each PMP event was obtained from the PMP maps developed in 2013 by Applied Weather Associates for the Probable Maximum Precipitation Study for the State of Ohio. The temporal distribution for each PMP event was obtained from the Probable Maximum Precipitation Application Guidelines (2018 revision) produced by ODNR. **Attachment 1** documents the PMP calculations. The PMP values were determined to be 25.7 in for the 24-hr duration event and 18.4 in for the 6-hr duration event. Additionally, a 100-yr recurrence, 24-hr duration design storm event, a 50-yr recurrence, 24-hr duration storm event, and a 10-yr recurrence, 24-hr duration design storm event were all investigated for Camp Spelman Lake Dam and for the additional downstream subbasins. The 100-yr, 24-hr, 50-yr, 24-hr, and 10-yr, 24-hr total rainfall values used in these design storm analyses were obtained from NOAA Atlas 14 and applied using the SCS Type II temporal distribution. **Attachment 1** also contains the NOAA Atlas 14 data used for these analyses.

The HEC-HMS model contains a subbasin node to represent the Camp Spelman Lake drainage area and a reservoir node to represent Camp Spelman Lake and dam. The model also contains subbasin nodes that represent the additional areas contributing runoff to West Lake, East Lake, and the golf course pond. The hydraulic function of Camp Spelman Lake Dam was analyzed for each hydrologic event by routing the runoff hydrographs generated by the subbasin node through the reservoir node. Runoff hydrographs for each of the subbasins were generated using the NRCS Soil Conservation Service Curve Number (SCS-CN) infiltration and SCS transformation methods. The various watershed land cover data, including directly connected and unconnected impervious surfaces, were delineated in ArcMap utilizing 2017 aerial photos obtained through OSIP. Corresponding hydrologic soil group (HSG) data was obtained from the online Web Soil Survey tool. The majority of the soils are classified as Type D or Type C soils or have combined classifications (i.e. B/D, C/D).

Weighted CN and lag time calculations were performed using HydroCAD. Pervious weighted CN values of 83, 84, 84, and 81 were determined for the areas draining to Camp Spelman Lake, West Lake, East Lake, and the golf course pond, respectively. Lag times of 10.0 minutes, 22.4 minutes, 14.1 minutes, and 11.8 minutes were determined for the areas draining to Camp Spelman Lake, West Lake, East Lake, and the golf course pond, respectively, using the lag/CN method.

The large wetland that is adjacent and hydraulically connected to the main water body of Camp Spelman Lake was given a CN value of 85 (see **Attachment 2** for CN reference). EDG believes this CN is reasonable because the storage curve EDG developed for Camp Spelman Lake Dam, which is discussed later, does not include potential depressions this wetland has according to the contours EDG developed using OSIP LiDAR data. For the lag time calculation to Camp Spelman Lake, EDG utilized the longest flow path as delineated from the drainage boundary to start/upstream end of the wetland and did not include the flow length through the wetland to the main water body of Camp Spelman Lake (See flow path in **Attachment 2**). EDG believes that this shorter flow length would be more appropriate for the larger storm events analyzed because the wetland would likely fill up, thus shortening time of concentration/lag time. **Attachment 2** includes the documentation developed for the weighted CN and lag time calculations for all four subbasins.

Hydrograph routing through Camp Spelman Lake Dam was performed using the elevation-storage curve shown in **Table 1** in conjunction with defined outflow structures. The lake storage volume to the principal spillway was obtained from the Dam Inventory Sheet while the volumes to the emergency spillway and top of dam were determined by adding calculated storage volumes. These incremental increases in storage were calculated using areas indicated by topographic contours EDG created using the 2006 LiDAR data. The initial elevation of the reservoir node was set to an elevation of 1084.66 ft for all analyses. For all analyses, the principal and emergency spillways were modeled together, using a user defined rating curve, while the top of dam was defined separately. EDG developed these rating curves using HydroCAD. In HydroCAD, the principal spillway was modeled as a 24-inch x 24" riser /overflow structure that discharges to/is controlled by a 12-inch diameter PVC outlet pipe (90LF at 0.38% slope) and the emergency spillway was modeled as an asymmetrical weir using the proposed conditions cross section and a weir coefficient of 3.

Table 1: Camp Spelman Lake Dam Elevation Storage Curve

Reference Point	**Elevation (ft)**	Cumulative Storage Provided (ac-ft)
Ex Dam Toe on Downstream End	1065.48	0.0
Invert of 12" PS Outlet Pipe	1081.34	55.0
Ex Principal Spillway (PS)	1084.66	69.0
Ex Emergency Spillway (ES)	1085.35	77.8
Between ES and Top of Dam	1086.00	92.2
Between ES and Top of Dam	1087.00	125.3
Ex Top of Dam	1088.09	164.4
Above Pr Top of Dam	1089.00	199.2

The results for each hydrologic event analyzed in HEC-HMS are summarized in **Tables 2 and 3**. The 6-hr PMP event resulted in a larger peak flow into Camp Spelman Lake, however, the 24-hr PMP event resulted in slighly higher storage volume/peak WSE because of its larger runoff volume. Neither PMP event resulted in overtopping of the dam embankment. According to these results, it is likely that the 24-hr PMP event is the PMF for Camp Spelman Lake Dam as it results in slightly larger storage volume/higher peak WSE, which will likely produce the largest peak outflow during a dam breach. However, a comparison was performed during the breach hydrograph analysis to determine which PMP event would create the largest peak breach flow. The 100-yr, 24hr design storm event produced a peak inflow to Camp Spelman Lake that is approximatly 57% of the 24-hr PMP event peak inflow and 35% of the 6-hr PMP event peak inflow. This HEC-HMS model was also utilized to investigate various dam breach scenarios for this Study as detailed in the following section of this report. The hydrographs simulated for the other three downstream subbasins were utilized to model baseline conditions for this Study as discussed later in the "HEC-RAS Modeling/Dam Breach Hydrograph Routing" section of this report.

Table 2: HEC-HMS Results of Hydrologic Events for Camp Spelman Lake Dam Proposed Conditions

Event	P (in)	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak WSE (ft)	Peak Storage (ac-ft)
6-hr PMP	18.4	1,473.3	374.8	1087.8	155.1
24-hr PMP	25.7	901.5	590.7	1088.3	171.8
100-yr, 24hr design storm	5.51	510.8	6.9	1086.2	97.7
50-yr, 24hr design storm	4.85	431.3	6.7	1086.0	92.5
10-yr, 24hr design storm	3.53	275.0	6.3	1085.6	82.7

Table 3: HEC-HMS Results of Hydrologic Events for Other Subbasins

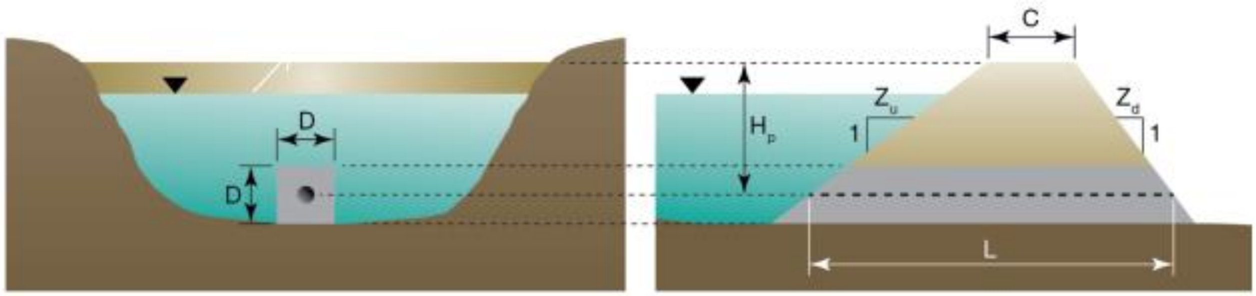
Event	P (in)	Peak Inflow (cfs)		
		West Lake	East Lake	Golf Course Pond
100-yr, 24hr design storm	5.51	1,514	1,020	284
50-yr, 24hr design storm	4.85	1,289	873	237
10-yr, 24hr design storm	3.53	845	581	146

Dam Breach Analyses and Inundation Mapping

The dam breach analyses were performed using both HEC-HMS (version 4.8) and HEC-RAS (version 6.0.0). The dam breach hydrograph for each breach scenario was generated using HEC-HMS, while downstream routing of each dam breach hydrograph was performed using HEC-RAS.

Generation of Dam Breach Hydrographs

The HEC-HMS model was used to simulate a dam breach during a non-hydrologic/sunny day event, a 100-yr, 24-hr storm event, and a PMF storm event. Dam breach simulations for these three events were investigated for Camp Spelman Lake Dam at an assumed breach location. The assumed location for the dam breach was at the middle of the dam. Only a piping failure mode (**Figure 7**) was investigated for this dam because the results of the non-breach scenario modeling indicate that the dam is not expected to be overtopped during any hydrologic event modeled for this Study. HEC-HMS assumes level-pool routing occurs during the dam breach.



D= piping hole width/height assumed square
H_p = breach depth for piping
C = dam top width
L = length of the pipe
Z = horizontal slope of the embankment

Source: Adapted from State of Colorado Department of Natural Resources, Division of Water Resources (2010)

Figure 7: Schematic of Piping Failure Mode During Initial Failure

Each dam breach simulation run in HMS requires the following information to perform the breach:

1. Top Elevation (ft)
2. Bottom Elevation (ft)
3. Bottom Width (ft)
4. Side Slopes (left/right)
5. Piping Elevation (ft)
6. Piping Coefficient
7. Development Time (hr)
8. Trigger Method (WSE, WSE + duration, or set time)
9. Progression Method

For each event, dam breach parameters were initially estimated using the five different regression equation methods contained within HEC-RAS. For the 1990 Von Thun and Gillette (VT&G) and the 2009 Xu and Zhang regression equations, a "Homogeneous/zone-filled dam" was selected for the calculations, while a "fine-homogeneous" dam was selected for the 1984 MacDonald et al regression equations. The breach development time estimated by the VT&G method is affected by the erodibility of the dam material (High, Medium, Low). For this Study, it was assumed that the Camp Spelman Lake Dam has high erodibility potential because there is no data available for this dam.

Of the five methods that were investigated, the VT&G regression equations estimated the largest breach bottom width and quickest breach development time. The MacDonald et al equations estimated the smallest breach bottom width. The Xu and Zhang equations estimated the longest breach development time. After reviewing the initial breach parameter estimates, two of the five methods were not modeled within HEC-HMS. Dam breach parameters that are estimated using the MacDonald et al (1984) and Xu and Zhang (2009) regression equation were not analyzed in HEC-HMS.

Table 4 summarizes the dam breach parameters used in HEC-HMS to investigate various sunny day breach scenarios while **Table 5** summarizes the dam breach parameters used in HEC-HMS to investigate various hydrologic event breach scenarios. **Attachment 3** describes all the various simulation runs contained within the

HEC-HMS model that has been provided with this Study. The breach events selected for hydraulic/HECRAS analyses are indicated in **bold within the tables**. All simulation runs were performed with a computation interval of 1 minute.

The dam breach parameters used in the HEC-HMS model were estimated using the regression equations developed by Von Thun and Gillette (1990) and by Froehlich (1995 and/or 2008). The VT&G parameter estimates (assuming high erodibility) were used as the baseline condition for these breach hydrograph analyses. For all the hydrologic event simulations, the trigger WSE was adjusted to determine the trigger WSE that created the largest peak flow. For the sunny day breach simulation, the breach was simply initiated at a simulation time of 15 minutes.

First, the 24-hr and 6-hr PMP events were investigated to determine which PMP event produced the larger peak breach flow. It was determined that the 24-hr PMP event produced a slightly larger peak breach flow than the 6-hr PMP event, which was expected based upon the unbreached modeling results.

Next, sensitivity to breach development time was investigated for the 24-hr PMP event by varying the assumed erodibility of the dam embankment material used in the VT&G regression equations (VT&G2 run). Assuming low or medium dam erodibility estimates the same breach development time (23.4 min), but assuming high erodibility estimates a breach development time that is much quicker (6 min). This quicker breach development time produced a peak breach flow 1.6 times higher than the baseline estimate. Next, the effect of more gradual side slopes was estimated by increasing the opening side slopes to 1:1. This did not appear to affect the peak breach flow in comparison to the baseline estimate. The starting piping elevation was also raised to study the effects of changing this parameter, which resulted in a smaller peak beach outflow than the baseline produced.

The breach parameters estimated using Froehlich (1995) and Froehlich (2008) also indicate the effect of changing the breach parameters, both of which results in smaller peak breach outflows than the baseline estimate. The Froelich simulation runs were not investigated for the 6-hr PMP event because it was determined in the first few runs that the 24-hr PMP event controls for this Study; however, they were investigated for the 100-yr, 24h-hr event breach scenario.

The dam breach simulations that were selected for hydraulic modeling and inundation mapping are bold within **Tables 4 and 5**. For this Study, the breach parameter estimates produced by the Von Thun and Gillette regression equations were used, assuming a medium dam erodibility. Downstream routing of these selected dam breach hydrographs was performed within HEC-RAS as discussed in the following section.

Table 4: Dam Breach Simulations for Sunny Day Event

Simulation Run	Bottom Elevation (ft)	Bottom Width (ft)	Side Slope (ft/ft)	Development Time (hr)	Breach Flow (cfs)
Sunny Day Breach	**1065.48**	**56**	**0.5**	**0.10**	**6,315**

Top elevation is 1088.50 ft for all simulation runs; Piping elevation is the same as bottom elevation; Piping coefficient of 0.55 used for all simulation runs; All breaches initiated at time 00:15 (15minutes); Linear progression method used for all simulation runs.

Table 5: Dam Breach Simulations for Hydrologic Event Failure Scenarios

Simulation Run	Trigger WSE (ft)	Bottom Elevation/Piping Elevation (ft)	Bottom Width (ft)	Side Slope (ft/ft)	Development Time (hr)	Breach Flow (cfs)
24-hr PMP Breach VT&G1	**1088.26**	**1065.48/ 1065.48**	**66**	**0.5**	**0.10**	**21,622**
24-hr PMP Breach VT&G2	1088.26	1065.48/ 1065.48	66	0.5	0.39	13,680
24-hr PMP Breach VT&G3	1088.26	1065.48/ 1065.48	66	1.0	0.10	21,622
24-hr PMP Breach VT&G4	1088.26	1065.48/ 1070.00	66	0.5	0.10	19,340
24-hr PMP Breach FR08	1088.10	1065.48/ 1065.48	32	0.7	0.37	10,663
24-hr PMP Breach FR95	1088.10	1065.48/ 1065.48	23	0.9	0.29	10,459
6-hr PMP Breach VT&G1	1087.80	1065.48/ 1065.48	64	0.5	0.10	20,681
100-yr, 24-hr Breach VT&G	**1086.16**	**1065.48/ 1065.48**	**60**	**0.5**	**0.10**	**12,015**
100-yr, 24-hr Breach Fr95	1086.16	1065.48/ 1065.48	15	0.9	0.22	5,807
100-yr, 24-hr Breach Fr08	1086.16	1065.48/ 1065.48	24	0.7	0.28	5,376

Top elevation is 1088.50 ft for all simulation runs; Piping coefficient of 0.55 used for all simulation runs; Linear progression method used for all simulation runs

HECRAS Modeling/Dam Breach Hydrograph Routing

HEC-RAS, version 6.0.0 was utilized to perform combined 1-D/2-D hydrodynamic/unsteady flow routing analyses for this Study. These analyses were performed for ~2 mi along the unnamed tributary to the Cuyahoga River, starting just downstream of Camp Spelman Lake Dam and ending just downstream of the golf course pond. A terrain was developed for these hydraulic analyses using the 5'x5' DEM EDG developed using the 2016 county contours. The area from Camp Spelman Lake Dam to East Lake, including the emergency spillway of Camp Spelman Lake Dam, was modeled using a 2-D computational mesh. A 20' x 20' grid spacing was applied to most of this computational mesh. Break lines were created along specific ridge lines that would be overtopped by the breach flood flows and along the emergency spillway. In these areas the grid spacing was refined to a 10'x10' grid spacing. Typically, the 2-D flow area is covered by deciduous forest or low-density residential development where a base Manning's roughness value of 0.10 was applied. Manning's roughness override areas were applied to the normal pool of West Lake (0.04) and the herbaceous wetland areas surrounding West Lake (0.06). This 2D flow area was connected to East Lake using a storage area connection tool to represent the culvert between the two lakes.

The remaining area from East Lake to just downstream from the golf course pond was modeled were modeled using 1-D elements. These 1-D elements are mostly storage areas with storage area connections or inline structures to represent their outlets. The only cross sections used in the HEC-RAS model are located downstream of the golf course pond. East Lake was modeled as a storage area and the downstream wetland and golf course pond were modeled as another storage area. The elevation vs storage curves used for these elements were developed using 2016 county contour data. A schematic of the HEC-RAS model geometry used for this Study in **Attachment 4**.

There are four culverts located within the Study reach downstream of Camp Spelman Lake Dam. The first culvert is located behind the home located just behind the house at 7723 W Lake Blvd and discharges into West Lake. The second culvert is located under Cleveland Massillon Rd and conveys discharges from West Lake to East Lake. The third culvert is located under Overlook Rd and conveys discharges from East Lake to the downstream wetland area that drains to the golf course pond. The last culvert is the principal spillway outlet of the golf course pond as previously discussed.

Field investigations were performed for all four of these culverts to determine their size, shape, and material, and to estimate their inverts. The first culvert is 36" diameter RCP. The entrance of this culvert was at least 50% clogged by sediment/debris during our visit and discussions with the adjacent homeowner revealed this is often the case. Because this is a smaller diameter culvert that was mostly clogged, it was excluded from the model. This is the only culvert of the four not included in the HEC-RAS model. The second and third culverts were modeled using the storage area connection tool. The second culvert was found to be a 6' wide x 3' high concrete box culvert and was at least 50% full of sediment with a water level at 6" below the top of opening. It was modeled with only the 6" high opening because the DEM/terrain used in the model doesn't extend below normal WSE of the Twin Lakes. The third culvert was found to be a 6' wide x 3.25' tall concrete arch culvert. The fourth culvert was described earlier. The golf course pond outlet was modeled as an inline structure and a rating curve defines its discharge capacity. This rating curve was developed using HydroCAD and was modeled as a 24" wide by 36" tall rectangular overflow/riser, which uses weir calculations at lower heads and orifice flow at larger heads. **Table 6** summarizes these culverts.

Table 6: Culverts within Study Area

Location	Size/Type	**Included in Model?**
7723 W Lake Blvd to West Lake	36" circular RCP	No
West Lake to East Lake	6'w x 3'h concrete box	Yes
East Lake to Wetland	6'w x 3.h concrete arch culvert	Yes
Golf Course Pond to Tributary	24"w x 36"h overflow with 24" circular iron pipe	Yes

The hydrographs generated by the HEC-HMS model were used in conjunction with the above geometry to analyze the hydraulics of West Branch Rocky River during the following 5 scenarios:

- Sunny Day Breach
- 100-yr Unbreached
- 100-yr Breach
- PMF Unbreached
- PMF Breach

Dam breach hydrographs were entered as a boundary condition within the 2D flow area just downstream of Camp Spelman Lake Dam while the emergency spillway flows were entered as a separate boundary condition/inflow hydrograph within the 2D flow area at that location. The lateral inflow hydrographs for the three additional contributing areas, West Lake, East Lake, and golf course pond, were entered as lateral inflow hydrographs at those locations. Timing of these lateral inflow hydrographs were not transformed/adjust so that their peaks would match/be concurrent with the peak of the dam breach flow, but rather they were directly entered from the HMS model results. These lateral inflow hydrographs represent the baseline flood conditions downstream of Camp Spelman Lake Dam.

For the sunny day breach scenario, the only initial flow conditions used were lower flows to ensure model stability. For the 100-yr storm event scenarios (unbreached and breached), these lateral inflows/baseline flood conditions were assumed to be those generated during a 10-yr recurrence design storm event. For the PMF event scenarios (unbreached and breached), these lateral inflows/basline flood conditions were assumed to be those generated during a 100-yr recurrence design storm event. These lateral inflows were generated as previously discussed in the “Hydrology of Camp Spelman Lake Dam and Downstream Subbasins” section of this report.

The 2D shallow water equation Eulerian-Lagrangian Method was used for 2D computations. Normal depth was used as the downstream boundary condition assumption for the unnamed tributary to the Cuyahoga River during all modeled scenarios and all plans were run using a computation interval of 0.50 sec so that the courant condition of less than 1 would be obtained during the 2D computations.

Inundation Mapping and Results Discussion

Two individual maps were created to present results from this Study and one key map was created to spatially reference the individual maps (three total maps). These maps depict the estimated inundation extents for all three dam breach scenarios (sunny, 100-yr, PMF) on each individual map. Inundation extents were first created using the “RAS Mapper” tool in HEC-RAS, then updated within ArcMap using the hydraulic modeling results and engineering judgement. For example, roadway overtopping between West Lake and East Lake was modeled using a 1-D element, so the inundation of this roadway had to be manually included.

Buildings inundated by the PMF breach are mapped as impacted buildings. These impacted buildings may not be inundated during every breach scenario. Building footprints were delineated using the 2017 aerial obtained from OSIP because there is no existing GIS data for building footprints in Portage County. Critical cross sections (arrival markers) were mapped to indicate estimated flood depths and flood arrival times at various locations throughout the Study Area. These arrival markers are typically located within the vicinity of an impacted building, a group of impacted buildings, and/or near a roadway crossing. Not every impacted building or road crossing has an arrival marker associated with it.

The maximum depth is the depth, in feet, from the channel thalweg/invert elevation to the maximum WSE estimated by the model at that arrival marker location during that breach scenario. The flood wave arrival time (TA) is the time, in minutes, it takes the leading edge of the inundation to arrive at that arrival marker location after the dam breach has initiated. The time at which this leading edge of inundation occurs was determined by inspecting the stage hydrograph plots (time versus stage) at these marker locations. TA was then calculated by subtracting the time at which the breach was initiated from the time at which the leading edge of inundation occurs.

For a sunny day failure, the time at which the leading edge of inundation occurs was estimated as the time that a notable change in the river stage was observed above normal flow conditions (baseline condition). For arrival markers 1-5, this was estimated as the time at which the water surface elevation at this arrival marker increased by approximately 1-2 ft above baseline condition. For arrival markers 6-8, this was estimated as the time at which the water surface elevation at this arrival marker increased by approximately 0.25 ft (3") above baseline condition.

For the 100-yr and PMF breach scenarios, the time at which the leading edge of the inundation occurs was estimated by comparing two simulations for the same hydrologic event. The first simulation was the non-breach hydrologic event, while the second simulation was the exact same hydrologic event but with the dam breaching. At the arrival marker, the stage hydrographs from both events were overlaid to identify what time the effects of the dam breach would be first observed. For arrival markers 1-5, the time at which there was about a 1-foot separation of the two stage hydrographs was used to indicate the time at which the leading edge of inundation occurs for these scenarios. For arrival markers 6-8, the time at which there was about a 0.25ft (3") separation of the two stage hydrographs was used to indicate the time at which the leading edge of inundation occurs for these scenarios.

The inundation maps developed for this Study are included in **Attachment 5.** The results of the HEC-RAS model are discussed below.

Results for Sunny Day Breach Scenario

The HEC-RAS model indicates that buildings potentially affected by a sunny day dam breach typically include residential homes and outbuildings. A total of 22 impacted buildings are estimated to be inundated by the sunny day breach scenario that was modeled. Of these impacted buildings, 19 were identified as being homes, while the remainder appear to be outbuildings. Modeling results indicate the northern end of West Lake Blvd is expected to be inundated during the sunny day breach scenario that was modeled. This is the main flow path of the flood wave to get to West Lake.

Table 7 summarizes the peak flows, arrival times, and maximum depths at each arrival mark for the sunny day breach scenario that was modeled. The distance from the downstream dam toe to the arrival marker, as measured along the stream channel centerline, is also shown in the table.

For the sunny day breach scenario that was modeled, the first four (4) buildings that would likely become inundated are homes located along the flow path that would convey flood flows from Camp Spelman Lake dam to the inlet channel of West Lake (arrival main marker 2). Once the flood flows enter West Lake, they would be conveyed along the West Lake inlet channel to the main body of West Lake. Flows can go in two different directions along this inlet channel, but there is a road to the south so most of the floodwaters would be conveyed north. While traveling north along this inlet channel to the main body of West Lake it is estimated that an additional 4 homes would be impacted by flood flows from a sunny day breach. After entering the main body of West Lake flows can spread out and be detained by this main body of water. Model results indicate that a sunny day breach will likely be detained by West Lake with minor impacts to normal flow conditions downstream from West Lake. The water surface fluctuations of West Lake will result in the inundation of additional homes that are in lower lying areas around the lake.

Table 7: Results for Sunny Day Breach

Arrival Marker	Distance Below Dam (mi)	Peak Flow* (cfs)	Maximum Depth Averaged Velocity* (ft/s)	TA* (min)	Max Depth* (ft)
1	0.05	NA	NA	NA	NA
2	0.16	4,713	6.47	3	10.69
3	0.28	123	4.80	5	5.86
4	0.48	1,141	4.13	12	3.49
5	0.59	1,016	3.40	16	2.32
6	0.78	543	0.81	27	0.61
7	0.97	110	0.46	50	0.56
8	1.19	0	0.00	NA	0.02

*Measured along arrival marker; NA – No notable difference/rise in WSE.

Results for 100-yr Event Breach Scenario

The HEC-RAS model indicates that buildings potentially affected by a 100-yr event dam breach include residential homes and outbuildings. A total of 42 impacted buildings were identified as being inundated by the 100-yr event dam breach scenario that was modeled. Of these impacted buildings, 36 were identified as being homes and the remainder appear the be outbuildings. Modeling results indicate that West Lake Boulevard, and the intersection of West and South Boulevard would overtop during the 100-yr event dam breach scenario that was modeled. The results show that West Lake Boulevard may become inundated at some lower lying portions and that the many of the residents that live on Mockingbird Drive may not have access to their homes.

Table 8 summarizes the peak flows, arrival times, and maximum depths for each arrival mark for the 100-yr event dam breach scenario that was modeled. The distance from the downstream dam toe to the arrival marker, as measured along the stream channel centerline, is also shown.

For this 100-yr event breach scenario that was modeled, the first four (4) buildings that would likely become inundated are homes located along the flow path that would convey flood flows from Camp Spelman Lake dam to the inlet channel of West Lake (arrival main marker 2). Once the flood flows enter West Lake, they would be conveyed along the West Lake inlet channel to the main body of West Lake. While traveling north along this inlet channel to the main body of West Lake it is estimated that an additional 9 homes would be impacted by flood flows from a 100-yr event breach. After entering the main body of West Lake flows can spread out and be detained by this main body of water. Model results indicate that a 100-yr event breach will likely be detained by

West Lake with minor impacts to normal flow conditions downstream from West Lake. The water surface fluctuations of West Lake will result in the inundation of additional homes that are in lower lying areas around the lake.

Table 8: Results for 100-yr Event Breach

Arrival Marker	Distance Below Dam (mi)	Peak Flow* (cfs)	Maximum Depth Averaged Velocity* (ft/s)	TA* (min)	Max Depth* (ft)
1	0.05	2	0.96	NA	0.66
2	0.16	7,908	8.65	3	11.98
3	0.28	200	5.43	5	7.50
4	0.48	2,128	5.37	9	4.75
5	0.59	1,993	4.54	12	3.14
6	0.78	1,425	0.86	20	1.57
7	0.97	253	0.38	26	1.57
8	1.19	0	0.00	NA	0.37

*Measured along arrival marker; NA – No notable difference/rise in WSE.

Results for PMF Event Breach Scenario

The HEC-RAS model indicates that buildings potentially affected by a PMF event dam breach include residential homes and uninhabited outbuildings. A total of 80 impacted buildings were identified as being inundated by the PMF event dam breach scenario that was modeled. Two of these impacted buildings are located upstream from the dam and would be inundated by Camp Spelman Lake if it were to reach its maximum pool during a PMF events. Of these impacted buildings, 68 were identified as being homes and the remainder appear to be uninhabited outbuildings (one is a concrete vault along Diagonal Road). Modeling results indicate that West Lake Boulevard, State Route 43 in two locations, and the intersection of West and South Boulevard would all be overtopped during the PMF event dam breach scenario that was modeled. These roadway inundations may isolate various homes that sit on higher ground outside of the inundation limits until floodwaters pass and recede.

Table 9 summarizes the peak flows, arrival times, and maximum depths for each arrival mark for the PMF event dam breach scenario that was modeled. The distance from the downstream dam toe to the arrival marker, as measured along the stream channel centerline, is also shown.

For the PMF event breach scenario that was modeled, the first four (4) buildings that would likely become inundated are homes located along the flow path that would convey flood flows from Camp Spelman Lake dam to the inlet channel of West Lake (arrival main marker 2). Once the flood flows enter West Lake, they would be conveyed along the West Lake inlet channel to the main body of West Lake. Flows can go in two different directions along this inlet channel and will inundate homes in both directions. Mockingbird Drive is located south so most of the floodwaters would be conveyed north through the inlet channel to the main body of West Lake.

While traveling north along this inlet channel to the main body of West Lake it is estimated that many more homes would be likely impacted by flood flows from a PMF event breach. After entering the main body of West Lake flows can spread out and be detained by this main body of water. Model results indicate that a PMF breach will likely be mostly detained by West Lake with the remainder of the breach flows being detained within East Lake. The water surface fluctuations of West Lake will result in the inundation of additional homes that are in lower lying areas around the lake. There is also a singular home along East Lake that would become inundated during a PMF Breach.

Table 9: Results for PMF Event Breach

Arrival Marker	Distance Below Dam (mi)	Peak Flow* (cfs)	Maximum Depth Averaged Velocity* (ft/s)	TA* (min)	Max Depth* (ft)
1	0.05	579	5.80	NA	3.96
2	0.16	16,966	12.15	3	13.85
3	0.28	220	3.85	4	10.84
4	0.48	5,900	7.80	7	7.79
5	0.59	6,608	7.20	9	5.47
6	0.78	5,913	1.90	12	3.02
7	0.97	1,288	0.82	16	3.02
8	1.19	0	0.00	163	2.17

*Measured along arrival marker; NA – No notable difference/rise in WSE.

Although there are several other dams that discharge into the reach below Camp Spelman Lake Dam, none are located within inundation zones developed during this Study. The golf course pond appears to have a dam that is not currently regulated; however, it is anticipated that the breach flows for all scenarios will be significantly detained by the Twin Lake prior to reaching this pond and its dam.

The *2020 ODNR Inundation Study and Hazard Classification Guidance* document was referenced for ending this model. The HEC-RAS results show that breach flows will primarily be detained by West Lake for the PMF breach with a 1.22 ft difference in water surface elevation in the lake when comparing the results of a PMF event dam breach scenario a PMF event scenario without a dam breach. Results also show that a sunny day breach is detained by West Lake with little effect to the normal pool WSE in East Lake.

Assumptions

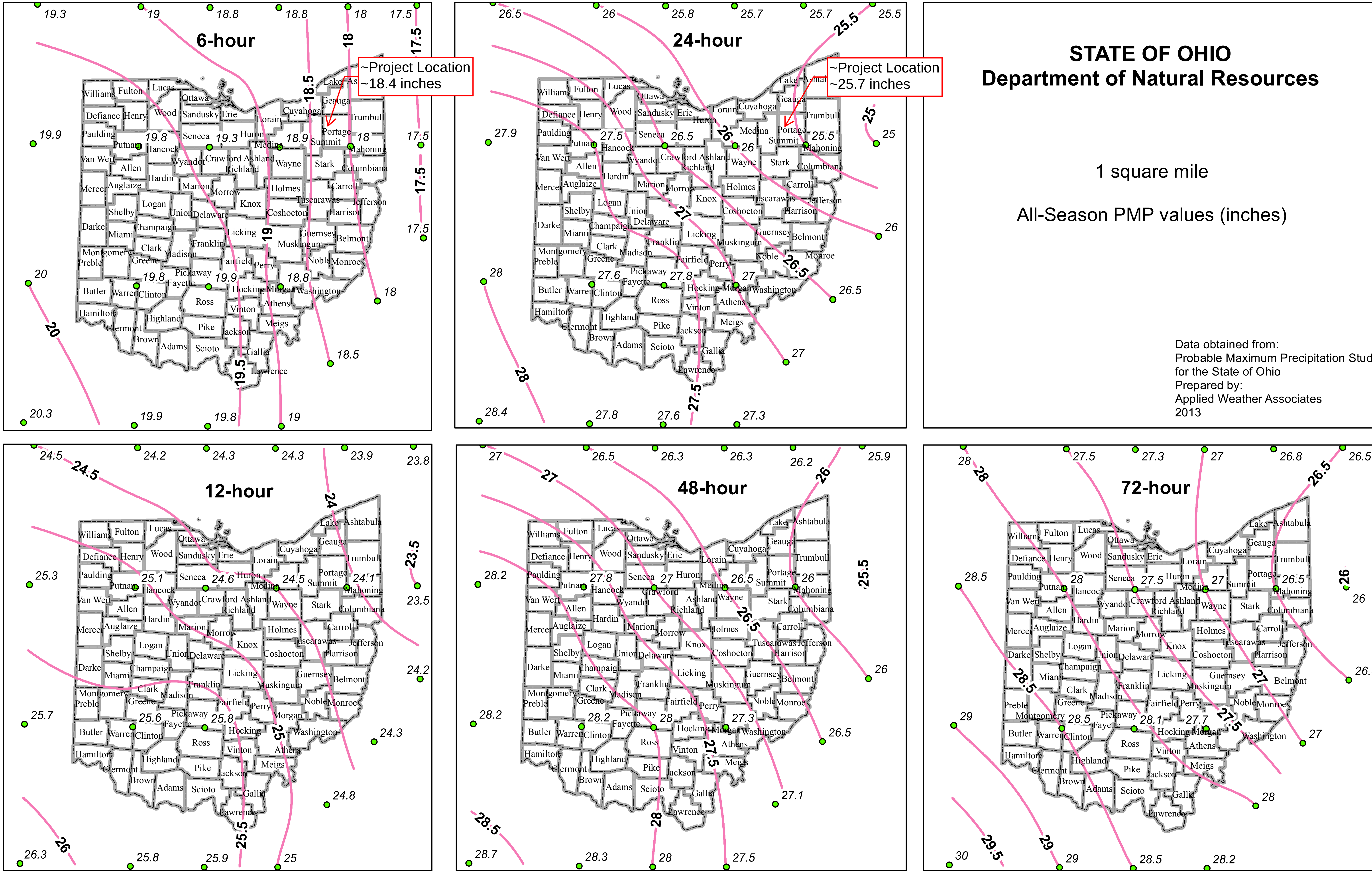
Assumptions were discussed throughout this Study; however, some of the main assumptions of this Study are reiterated below:

- The proposed improvements required to bring this dam into compliance with current dam regulations will be performed. It is the engineer's understanding that these repairs will be performed if the dam is not modified/removed.

- The modeled breach location is an estimate of a potential breach location based on limited information that is available for the dam and dam breach parameters are estimates using existing regression equations.
- Camp Spelman Lake Dam embankment materials at the estimated breach location have high erodibility potential since there is no data available for this dam. No geotechnical investigations were performed as part of this Study.
- Level pool routing was used to estimate dam breach hydrographs for all scenarios and to represent East Lake and the downstream wetland/golf course pond.
- For the sunny day breach scenario, it was assumed that a normal flow condition exists downstream of the dam as the breach occurs.
- For the 100-yr event breach scenario, it was assumed that a 10-yr recurrence flow condition exists downstream of the dam as the breach occurs. This 10-yr recurrence flow condition was estimated using HEC-HMS modeling data.
- For the PMF event breach scenario, it was assumed that a 100-yr recurrence flow condition exists downstream of the dam as the breach occurs. This 100-yr recurrence flow condition was estimated using StreamStats data.
- Model geometry data were typically generated using 2016 county contour data, which typically excludes bathymetric survey data.
- Culvert openings/sizes were typically estimated using field data and measurements, but not survey data.
- Flood inundation extents were generated using a 5’x5’ DEM created using the 2016 county contour data.
- Building footprints were delineated using 2017 aerial photography.

ATTACHMENT 1:

PMP Calculations and NOAA Atlas 14 Data


6-hour
~Project Location
~18.4 inches
24-hour
~Project Location
~25.7 inches
STATE OF OHIO
Department of Natural Resources
1 square mile
All-Season PMP values (inches)
Data obtained from:
Probable Maximum Precipitation Study
for the State of Ohio
Prepared by:
Applied Weather Associates
2013
12-hour
48-hour
72-hour

NOAA Atlas 14, Volume 2, Version 3
Location name: Kent, Ohio, USA*
Latitude: 41.1978°, Longitude: -81.3509°
Elevation: 1081.76 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.323 (0.295-0.355)	0.386 (0.352-0.424)	0.466 (0.425-0.511)	0.528 (0.480-0.578)	0.607 (0.549-0.664)	0.667 (0.600-0.729)	0.726 (0.652-0.793)	0.786 (0.701-0.859)	0.865 (0.766-0.947)	0.924 (0.812-1.01)
10-min	0.502 (0.459-0.551)	0.603 (0.550-0.661)	0.725 (0.660-0.794)	0.815 (0.741-0.892)	0.929 (0.839-1.02)	1.01 (0.910-1.11)	1.09 (0.981-1.19)	1.17 (1.05-1.28)	1.27 (1.13-1.39)	1.35 (1.18-1.47)
15-min	0.615 (0.562-0.675)	0.737 (0.673-0.809)	0.890 (0.810-0.975)	1.00 (0.912-1.10)	1.15 (1.04-1.25)	1.25 (1.13-1.37)	1.36 (1.22-1.48)	1.46 (1.30-1.60)	1.59 (1.41-1.74)	1.68 (1.48-1.84)
30-min	0.814 (0.744-0.894)	0.986 (0.901-1.08)	1.22 (1.11-1.34)	1.39 (1.27-1.53)	1.62 (1.46-1.77)	1.79 (1.61-1.96)	1.96 (1.76-2.14)	2.13 (1.90-2.33)	2.35 (2.08-2.57)	2.52 (2.21-2.76)
60-min	0.994 (0.908-1.09)	1.21 (1.11-1.33)	1.53 (1.39-1.68)	1.77 (1.61-1.94)	2.10 (1.90-2.30)	2.36 (2.12-2.58)	2.62 (2.35-2.86)	2.89 (2.58-3.16)	3.25 (2.88-3.56)	3.54 (3.11-3.88)
2-hr	1.15 (1.05-1.26)	1.40 (1.27-1.54)	1.78 (1.62-1.95)	2.08 (1.89-2.29)	2.51 (2.26-2.75)	2.86 (2.57-3.14)	3.23 (2.89-3.54)	3.63 (3.22-3.97)	4.18 (3.68-4.58)	4.64 (4.05-5.09)
3-hr	1.22 (1.11-1.35)	1.49 (1.35-1.64)	1.89 (1.72-2.09)	2.22 (2.00-2.44)	2.68 (2.41-2.94)	3.07 (2.74-3.36)	3.47 (3.09-3.81)	3.91 (3.45-4.28)	4.54 (3.97-4.97)	5.06 (4.38-5.54)
6-hr	1.47 (1.34-1.62)	1.78 (1.62-1.96)	2.25 (2.04-2.47)	2.63 (2.38-2.89)	3.19 (2.88-3.49)	3.66 (3.28-4.00)	4.17 (3.70-4.56)	4.72 (4.16-5.15)	5.53 (4.81-6.04)	6.21 (5.34-6.80)
12-hr	1.74 (1.58-1.92)	2.09 (1.90-2.31)	2.61 (2.37-2.89)	3.04 (2.76-3.37)	3.69 (3.31-4.07)	4.23 (3.78-4.66)	4.83 (4.28-5.31)	5.48 (4.81-6.02)	6.43 (5.58-7.07)	7.25 (6.22-7.97)
24-hr	2.04 (1.89-2.22)	2.44 (2.26-2.66)	3.03 (2.80-3.29)	3.53 (3.25-3.82)	4.25 (3.88-4.60)	4.85 (4.41-5.25)	5.51 (4.97-5.96)	6.23 (5.57-6.74)	7.28 (6.42-7.89)	8.16 (7.11-8.87)
2-day	2.36 (2.19-2.55)	2.82 (2.62-3.05)	3.46 (3.21-3.74)	4.00 (3.69-4.32)	4.78 (4.38-5.15)	5.42 (4.95-5.85)	6.11 (5.54-6.60)	6.86 (6.16-7.42)	7.94 (7.02-8.62)	8.83 (7.72-9.63)
3-day	2.52 (2.35-2.72)	3.01 (2.80-3.25)	3.68 (3.42-3.97)	4.23 (3.92-4.56)	5.02 (4.63-5.41)	5.67 (5.20-6.11)	6.36 (5.80-6.86)	7.10 (6.42-7.68)	8.16 (7.27-8.84)	9.05 (7.97-9.85)
4-day	2.69 (2.51-2.89)	3.20 (2.98-3.45)	3.90 (3.63-4.20)	4.47 (4.15-4.80)	5.27 (4.87-5.67)	5.93 (5.45-6.37)	6.62 (6.05-7.12)	7.35 (6.67-7.93)	8.38 (7.52-9.07)	9.27 (8.23-10.1)
7-day	3.23 (3.02-3.46)	3.84 (3.60-4.11)	4.64 (4.34-4.97)	5.29 (4.94-5.66)	6.21 (5.76-6.63)	6.95 (6.42-7.43)	7.72 (7.10-8.27)	8.54 (7.79-9.16)	9.68 (8.73-10.4)	10.6 (9.47-11.5)
10-day	3.73 (3.50-3.98)	4.42 (4.15-4.72)	5.29 (4.96-5.64)	5.98 (5.60-6.37)	6.92 (6.46-7.37)	7.67 (7.14-8.18)	8.44 (7.82-9.01)	9.23 (8.51-9.87)	10.3 (9.41-11.1)	11.2 (10.1-12.0)
20-day	5.17 (4.88-5.48)	6.10 (5.77-6.47)	7.18 (6.78-7.62)	8.02 (7.57-8.50)	9.13 (8.59-9.68)	9.98 (9.37-10.6)	10.8 (10.1-11.5)	11.7 (10.9-12.4)	12.7 (11.8-13.6)	13.5 (12.5-14.5)
30-day	6.51 (6.17-6.86)	7.66 (7.27-8.08)	8.91 (8.46-9.40)	9.87 (9.35-10.4)	11.1 (10.5-11.7)	12.1 (11.4-12.7)	13.0 (12.2-13.7)	13.9 (13.0-14.6)	15.0 (14.0-15.9)	15.8 (14.7-16.8)
45-day	8.34 (7.95-8.75)	9.79 (9.33-10.3)	11.2 (10.7-11.8)	12.3 (11.7-12.9)	13.7 (13.0-14.4)	14.7 (14.0-15.5)	15.7 (14.9-16.5)	16.6 (15.7-17.5)	17.8 (16.7-18.7)	18.6 (17.4-19.6)
60-day	10.1 (9.64-10.6)	11.8 (11.3-12.4)	13.4 (12.8-14.1)	14.7 (14.0-15.4)	16.2 (15.4-17.0)	17.3 (16.4-18.1)	18.3 (17.4-19.2)	19.2 (18.2-20.2)	20.4 (19.2-21.5)	21.1 (19.9-22.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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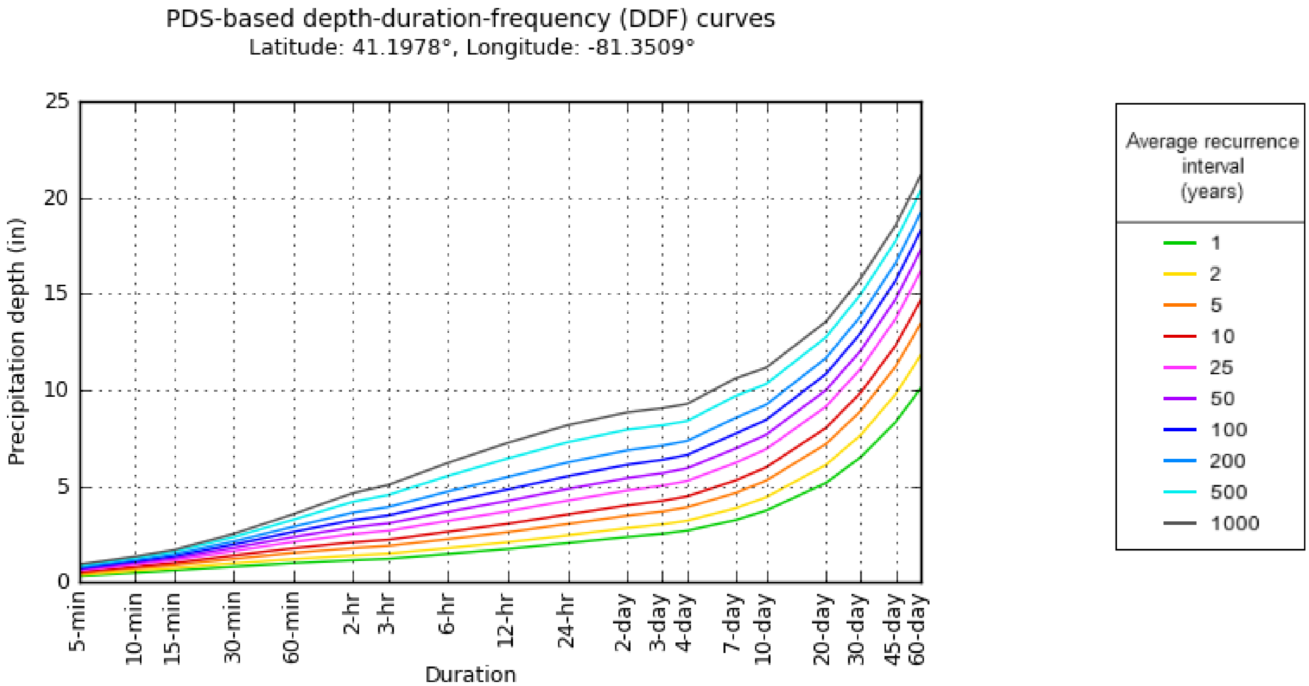
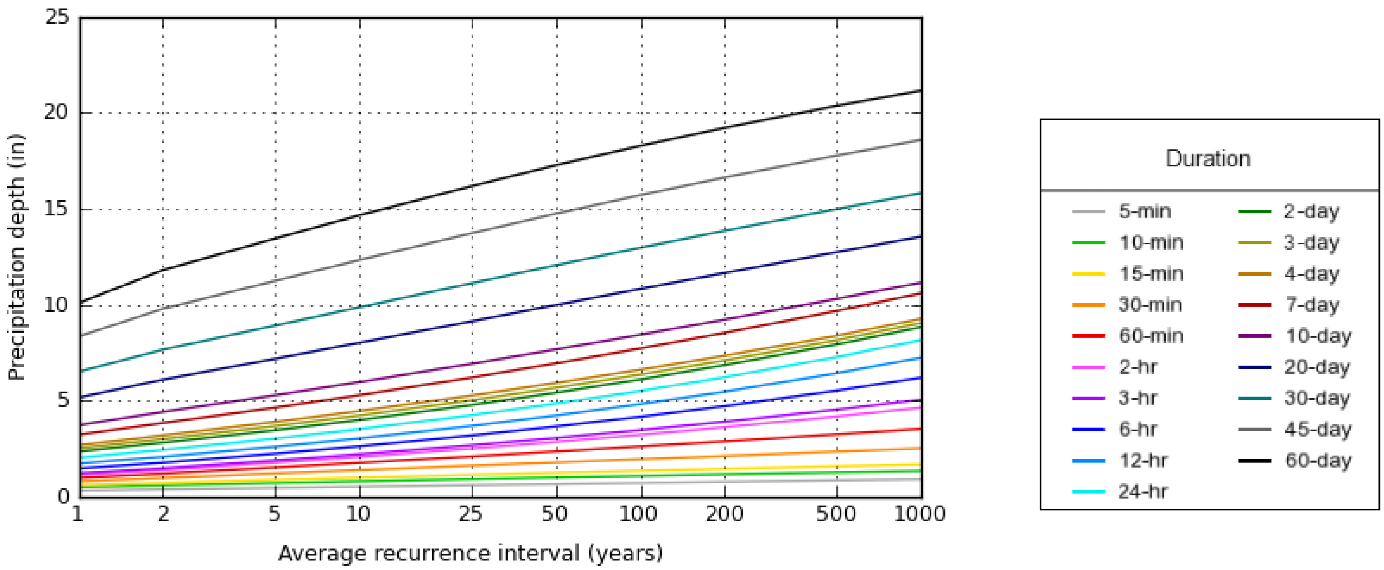
PF graphical





NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Sun Aug 1 21:04:17 2021

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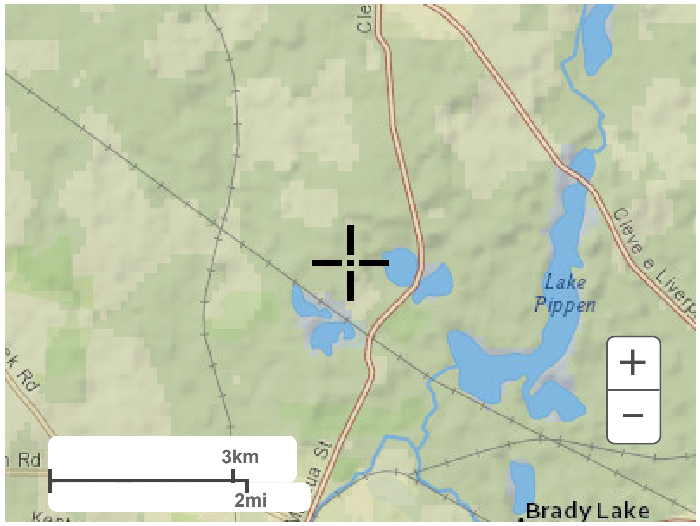
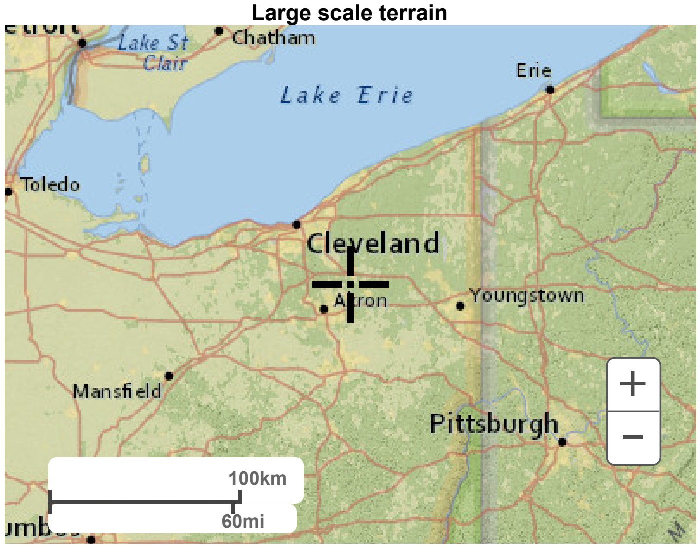
Maps & aerials

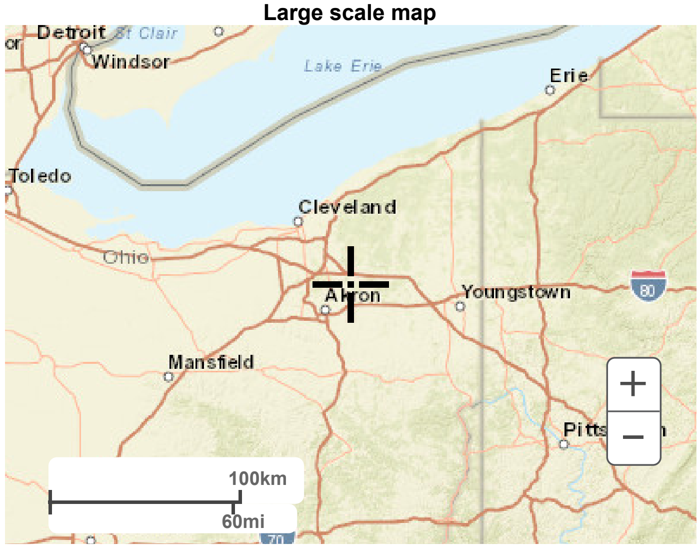
Small scale terrain



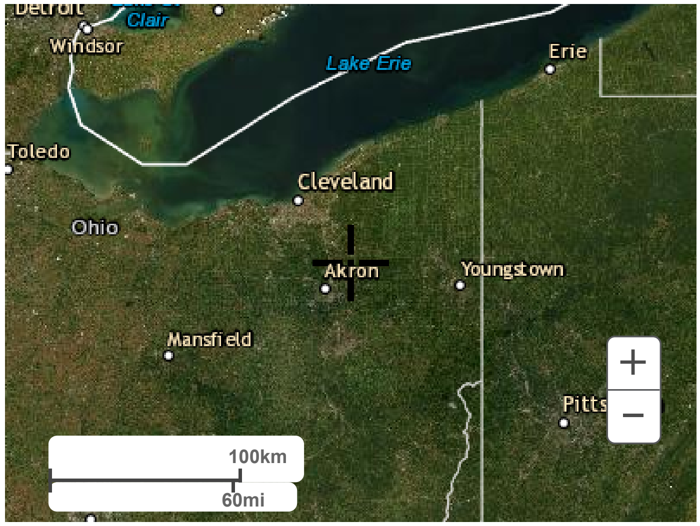
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

ATTACHMENT 2:

CN and Lag Time Calculations

Summary for Subcatchment 25S: To Camp Spelman Lake - w/%imp

Runoff = 117.09 cfs @ 12.09 hrs, Volume= 8.318 af, Depth= 0.85"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious, Time Span= 0.00-72.00 hrs, dt= 0.02 hr
Type II 24-hr 1 Rainfall=2.06", Smoothing=Off

	Area (ac)	CN	Description
	12.500	98	Water Surface, HSG D
	0.829	98	Water Surface, 0% imp, HSG D
	8.192	98	Unconnected pavement, HSG D
	6.521	82	Woods/grass comb., Fair, HSG D
	35.798	79	Woods, Fair, HSG D
	23.645	84	50-75% Grass cover, Fair, HSG D
*	12.388	77	Brush, Fair, HSG D
*	17.041	85	Wetland
	116.914	84	Weighted Average
	104.414	83	89.31% Pervious Area
	12.500	98	10.69% Impervious Area

Pervious CN, includes unconnected impervious areas

DCIA

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.7	1,817	0.0724	1.81		**Lag/CN Method, Data in from GIS**

16.7 min x 0.6 = 10min lag time

HYDROLOGIC SOIL - COVER COMPLEXES

3. Runoff

The Soil-Cover-Complex method is used to estimate runoff from rainfall. A combination of the hydrologic soil group (soil) and the land use and treatment class (cover) is used to determine the hydrologic soil-cover-complex number or runoff curve number (CN). Several guidelines for the determination of runoff curve numbers are as follows:

Condition or Rotation. Ratings as to "Poor" or "Good" are based largely on the proportion of dense vegetation in the rotation. "Good" will generally be used for cultivated land in Minnesota except where land is very droughty or severely abused.

> Pasture will be considered "poor" if it is heavily grazed and has no mulch. "Fair" pasture has between 50 and 75% of the area with plant cover and is moderately grazed. "Good" pasture is lightly grazed and has more than 75% plant cover.
>
> “Poor” woods (farm) are heavily grazed and have no litter or new young growth. “Good” woods are protected from grazing and have good undergrowth. "Fair" is in between.
>
> Commercial forests will be rated according to Forest Service procedures as covered in the National Engineering Handbook – Part 630 – Hydrology.

Practice. Straight row farming on land slopes of 1 to 2% percent which is generally across the slope may be considered the same as contoured. Straight row farming on land of less than 1% may be considered the same as contoured and terraced.

CN used for large wetland

Swamps. For swamps and wetlands, if the site has open water year round such that at least 1/3 of the wetland is water, use RCN = 85 regardless of soil type. If the swamp has no open water and the calculations are for a 25-year frequency or shorter, use RCN=78 regardless of soil type. Exclude swamps from the drainage area if they are land-locked.

Temporary Measures. Composite curve numbers to use for the design of temporary measures during grading and construction should be computed based on the degree of development (impervious area percentage) and the curve numbers for the newly graded pervious areas.

Good Judgment must be used for borderline cases and for those cases not covered on this sheet.

Summary for Subcatchment 28S: To Golf Course Pond

Runoff = 289.22 cfs @ 12.12 hrs, Volume= 21.740 af, Depth= 3.56"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious, Time Span= 0.00-96.00 hrs, dt= 0.02 hr
Type II 24-hr 100 Rainfall=5.55", Smoothing=Off

	Area (ac)	CN	Description
	3.428	98	Water Surface, HSG D
	7.304	98	Unconnected pavement, HSG D
	19.361	76	Woods/grass comb., Fair, HSG C
	3.242	82	Woods/grass comb., Fair, HSG D
	0.456	73	Woods, Fair, HSG C
	0.043	79	Woods, Fair, HSG D
	25.658	79	50-75% Grass cover, Fair, HSG C
	5.338	84	50-75% Grass cover, Fair, HSG D
*	8.411	85	Wetland
	73.241	82	Weighted Average
	69.813	81	95.32% Pervious Area
	3.428	98	4.68% Impervious Area

Pervious CN, includes unconnected impervious areas

DCIA

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.7	1,568	0.0471	1.33		**Lag/CN Method, Data in from GIS**

19.7 min x 0.6 = 11.82 min lag time

Summary for Subcatchment 40S: To West Lake

Runoff = 1,456.26 cfs @ 12.32 hrs, Volume= 167.110 af, Depth= 4.13"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious, Time Span= 0.00-96.00 hrs, dt= 0.02 hr
Type II 24-hr 100 Rainfall=5.55", Smoothing=Off

	Area (ac)	CN	Description
	112.504	98	Water Surface, HSG D
	81.016	98	Unconnected pavement, HSG D
	87.194	76	Woods/grass comb., Fair, HSG C
	180.193	82	Woods/grass comb., Fair, HSG D
*	24.272	85	Wetland
	485.179	87	Weighted Average
	372.675	84	76.81% Pervious Area
	112.504	98	23.19% Impervious Area

Pervious CN, includes unconnected impervious areas

DCIA

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.3	3,960	0.0409	1.77		**Lag/CN Method, Data in from GIS**

37.3 min x 0.6 = 22.38 min lag time

Summary for Subcatchment 26S: To East Lake

Runoff = 1,013.47 cfs @ 12.16 hrs, Volume= 87.818 af, Depth= 4.25"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious, Time Span= 0.00-96.00 hrs, dt= 0.02 hr
Type II 24-hr 100 Rainfall=5.55", Smoothing=Off

	Area (ac)	CN	Description
	76.224	98	Water Surface, HSG D
	25.228	98	Unconnected pavement, HSG D
	33.306	76	Woods/grass comb., Fair, HSG C
	47.378	82	Woods/grass comb., Fair, HSG D
	3.239	73	Woods, Fair, HSG C
	24.351	79	Woods, Fair, HSG D
	0.510	79	50-75% Grass cover, Fair, HSG C
	1.133	84	50-75% Grass cover, Fair, HSG D
	9.922	91	Row crops, straight row, Poor, HSG D
*	26.723	85	Wetland
	248.014	88	Weighted Average
	171.790	84	69.27% Pervious Area
	76.224	98	30.73% Impervious Area

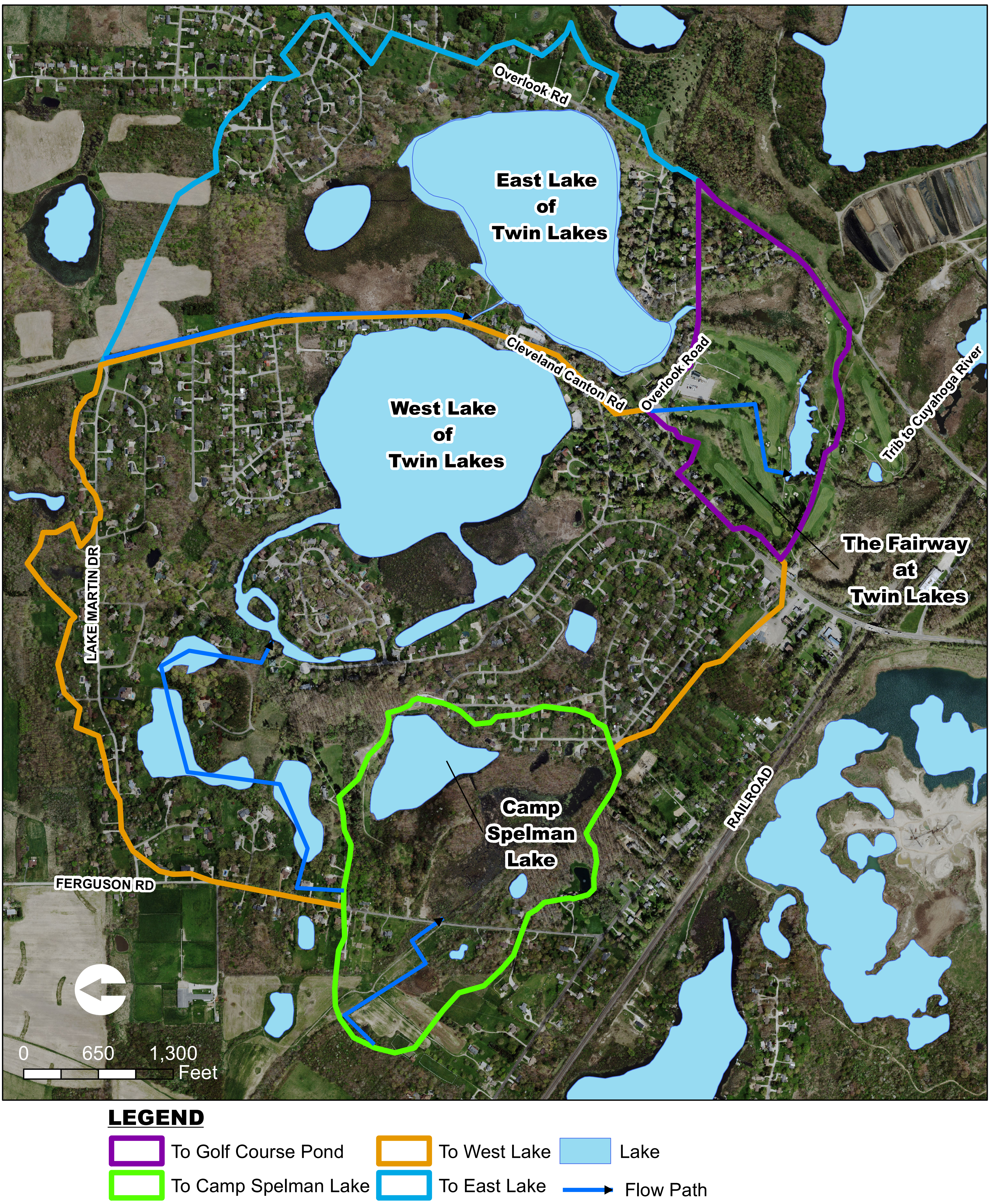
Pervious CN, includes unconnected impervious areas

DCIA

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.5	2,167	0.0363	1.54		**Lag/CN Method, Data in from GIS**

23.5 min x 0.6 = 14.1 min lag time

Lag Time Flow Paths



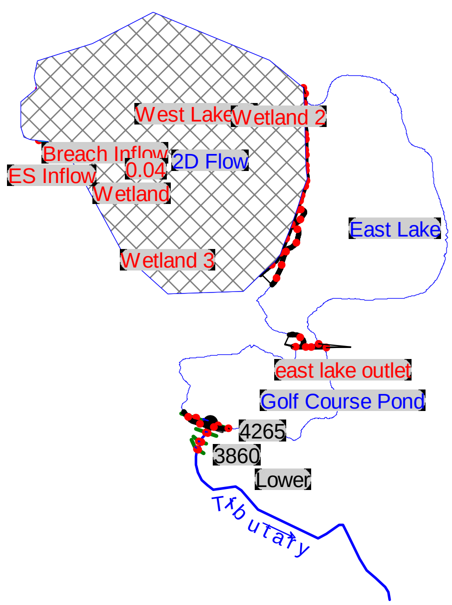
ATTACHMENT 3:

HMS Simulation Runs

Simulation	Description	Peak Discharge (cfs)
Unbreached		
24-hr PMP	**This is the 24-hr PMP run with no dam breach. This has a smaller peak inflow, but creates higher peak WSE and slightly higher volume than the 6-hr PMP (1088.30 ft, 171.8 ac-ft of storage) even. Dam does not overtop.**	**591**
6-hr PMP	This is the 6-hr PMP run with no dam breach. This has a larger peak inflow, but creates lower peak WSE and slightly lower volume than the 24-hr PMP (1087.8 ft, 155.1 ac-ft of storage). Dam does not overtop.	375
100-yr, 24-hr	This is the 100-yr, 24hr storm run with no dam breach. This creates a peak WSE and storage of 1086.20 ft and 97.7 ac-ft, respectively. Dam does not overtop.	7
10-yr, 24-hr	This is the 10-yr, 24hr storm run with no dam breach. This creates a peak WSE and storage of 1085.6 ft and 82.7ac-ft, respectively. Dam does not overtop.	6
Sunny Day Failures		
Sunny Day Breach	**This is a piping breach during a non-hydrologic event. Breach flows are estimated with breach parameters determined by Von Thun and Gillete regression equations assuming high erodible dam material. Breach is set to initiate/trigger after 15 min and piping starts at lake bottom (1065.48 ft).**	**6,315**
Hydrologic Failures		
24-hr PMP Breach VT&G1	**This is a piping breach during the 24-hr PMP event. Breach flows are estimated with breach parameters determined by Von Thun and Gillete regression equations assuming high erodible dam material. Trigger WSE was incrementally adjusted by 0.01 ft near peak WSE to determine the trigger WSE that created largest breach flow (1088.26 ft).**	**21,622**
24-hr PMP Breach VT&G2	This has the same breach width and slopes and trigger WSE as 24hr PMP Breach VT&G1, but longer breach development time because of assuming low erodible material instead of high erodible. Provides variation in breach development time, which produced lower peak flow.	13,680
24-hr PMP Breach VT&G3	This has the same breach width, development time, and trigger WSE as 24hr PMP Breach VT&G1, but more gradual side slopes (larger final breach openeing). Increased opening size had little to no effect, likely because of quick development time.	21,622
24-hr PMP Breach VT&G4	This has the same breach dimentions and trigger as 24hr PMP Breach VT&G1, but higher piping elevation. This produced lower peak flow.	19,340
24-hr PMP Breach FR08	This is a piping breach during the 24-hr PMP event. Breach flows are estimated with breach parameters determined by the 2008 Froehlich regression equations. was incrementally adjusted by 0.1 ft near peak WSE to determine the trigger WSE that created largest breach flow (1088.10 ft) and piping starts at lake bottom (1065.48 ft).	10,663
24-hr PMP Breach FR95	This is a piping breach during the 24-hr PMP event. Breach flows are estimated with breach parameters determined by the 1995 Froehlich regression equations. Trigger WSE was incrementally adjusted by 0.1 ft near peak WSE to determine the trigger WSE that created largest breach flow (1088.10 ft) and piping starts at lake bottom (1065.48 ft).	10,459
6-hr PMP Breach VT&G1	This is a piping breach during the 6-hr PMP event. Breach flows are estimated with breach parameters determined by Von Thun and Gillete regression equations assuming highly erodible dam material. Trigger is near maximum WSE (1087.80 ft) and piping starts at lake bottom (1065.48 ft).	20,681
100-yr, 24-hr Breach VT&G	**This is a piping breach during the 100-yr, 24-hr storm event. Breach flows are estimated with breach parameters determined by Von Thun and Gillete regression equations assuming medium erodible dam material. Trigger is near maximum WSE (1086.16 ft) and piping starts at lake bottom (1065.48 ft). Trigger WSE was incrementally adjusted by 0.01 ft near peak WSE to determine that this trigger WSE created largest breach flows.**	**12,015**
100-yr, 24-hr Breach Fr95	This is a piping breach during the 100-yr, 24-hr storm event. Breach flows are estimated with breach parameters determined by the 1995 Froehlich regression equations. Trigger is near maximum WSE (1086.16 ft) and piping starts at lake bottom (1065.48 ft). Trigger WSE was incrementally adjusted by 0.01 ft to determine that this trigger WSE created largest breach flows.	5,807
100-yr, 24-hr Breach Fr08	This is a piping breach during the 100-yr, 24-hr storm event. Breach flows are estimated with breach parameters determined by the 2008 Froehlich regression equations. Trigger is near maximum WSE (1086.16 ft) and piping starts at lake bottom (1065.48 ft). Trigger WSE was incrementally adjusted by 0.01 ft near peak WSE to determine that this trigger WSE created largest breach flows.	5,376

ATTACHMENT 4:

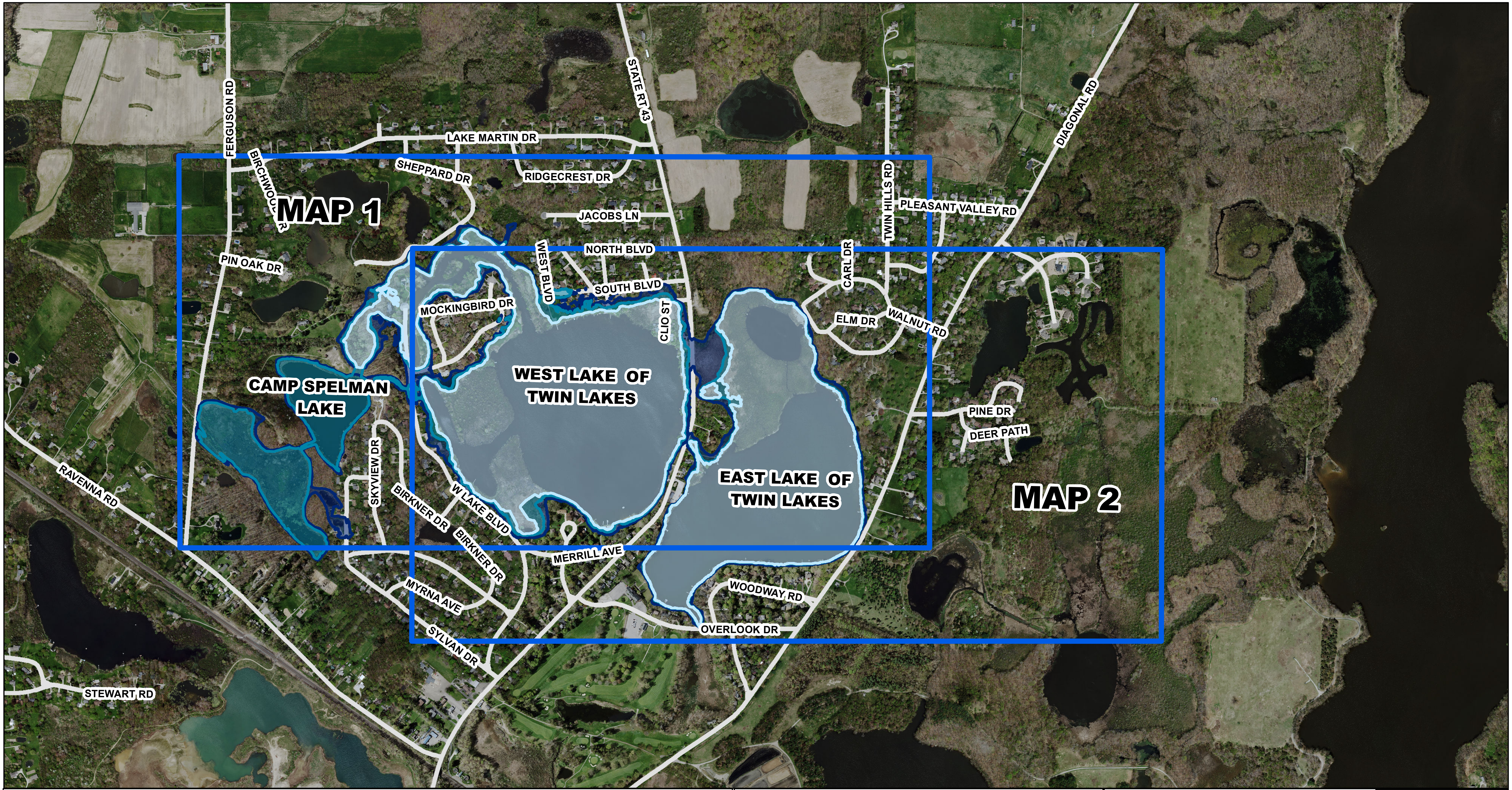
HEC-RAS Model Schematic



West Lake
Wetland 2
Breach Inflow
ES Inflow
0.04
2D Flow
Wetland
East Lake
Wetland 3
east lake outlet
Golf Course Pond
4265
3860
Lower
Tributary

ATTACHMENT 5:

Dam Breach Inundation Maps



LEGEND

- Key Map Boundary
- Sunny Day Breach Flooding Extents
- 100-yr Breach Flooding Extents
- PMF Breach Flooding Extents
- Portage County Roads

0 500 1,000 2,000 Feet

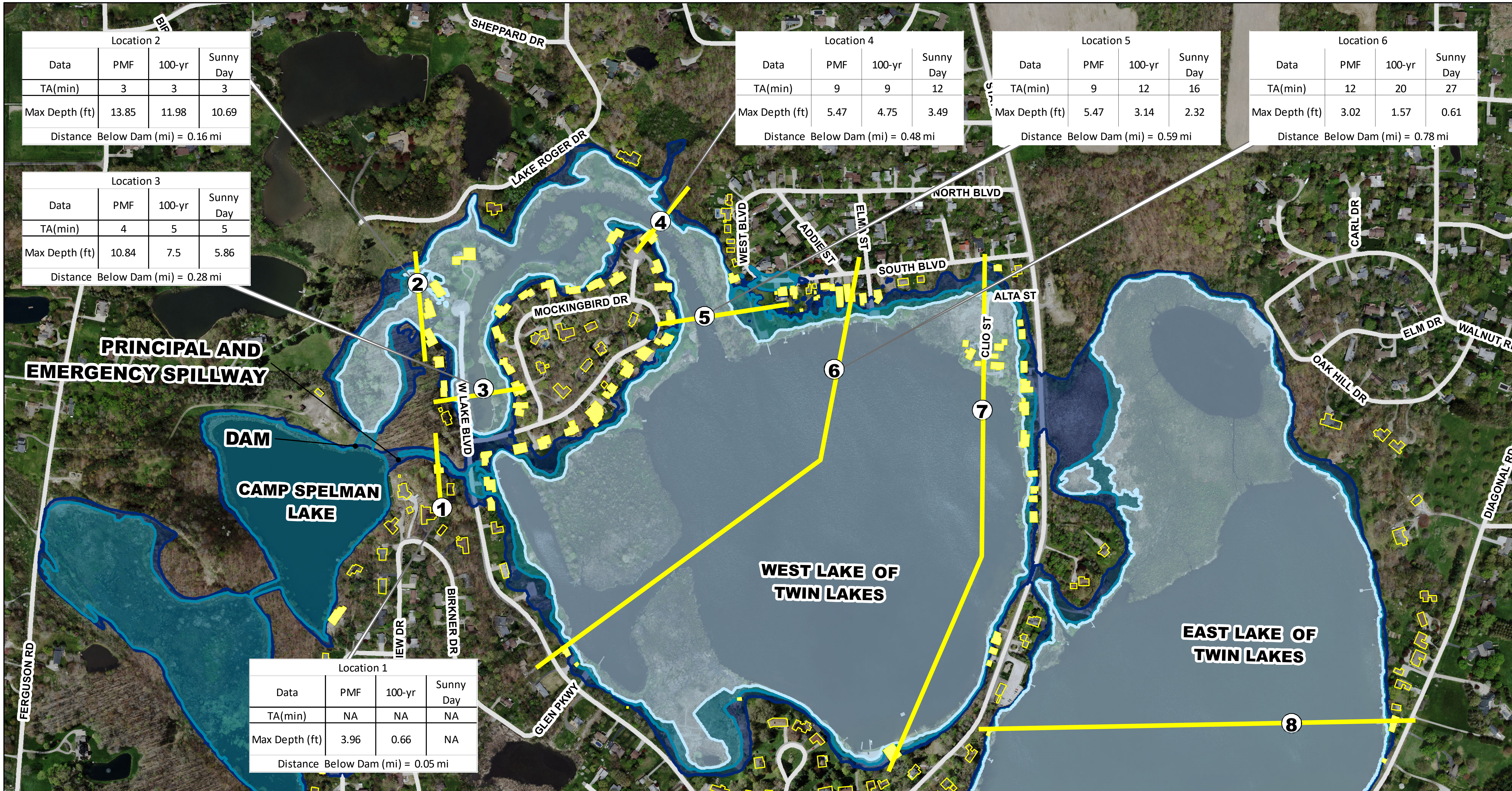
1 inch = 1,000 feet

CAMP SPELMAN LAKE DAM EAP
PORTAGE COUNTY, OHIO

INUNDATION FROM PIPING BREACH MAP KEY

Notes:
1) 2017 Aerial imagery from OSIP; Road centerlines obtained from Portage County GIS.
2) TA: Time of flood arrival from breach initiation;
MAX DEPTH: Maximum water surface depth along cross section.
3) Breach analysis assumes that ODNR's required remedial actions have been performed. Inundation limits are approximate. Assumed initial conditions downstream from Camp Spelman Lake Dam: 100-yr recurrence flows for PMF breach; 10-yr recurrence flows for 100-year breach; normal flow conditions for sunny day breach

Drawn By: Andy Long
Date: 3/2/2022



Location 2			
Data	PMF	100-yr	Sunny Day
TA(min)	3	3	3
Max Depth (ft)	13.85	11.98	10.69
Distance Below Dam (mi) = 0.16 mi			

Location 3			
Data	PMF	100-yr	Sunny Day
TA(min)	4	5	5
Max Depth (ft)	10.84	7.5	5.86
Distance Below Dam (mi) = 0.28 mi			

Location 4			
Data	PMF	100-yr	Sunny Day
TA(min)	9	9	12
Max Depth (ft)	5.47	4.75	3.49
Distance Below Dam (mi) = 0.48 mi			

Location 5			
Data	PMF	100-yr	Sunny Day
TA(min)	9	12	16
Max Depth (ft)	5.47	3.14	2.32
Distance Below Dam (mi) = 0.59 mi			

Location 6			
Data	PMF	100-yr	Sunny Day
TA(min)	12	20	27
Max Depth (ft)	3.02	1.57	0.61
Distance Below Dam (mi) = 0.78 mi			

Location 1			
Data	PMF	100-yr	Sunny Day
TA(min)	NA	NA	NA
Max Depth (ft)	3.96	0.66	NA
Distance Below Dam (mi) = 0.05 mi			

LEGEND

- Arrival_Marker
- Building
- Sunny Day Breach Flooding Extents
- Impacted Building
- 100-yr Breach Flooding Extents
- ① **Cross Section/ Arrival Marker**
- PMF Breach Flooding Extents
- Portage County Roads

0 250 500 1,000 Feet

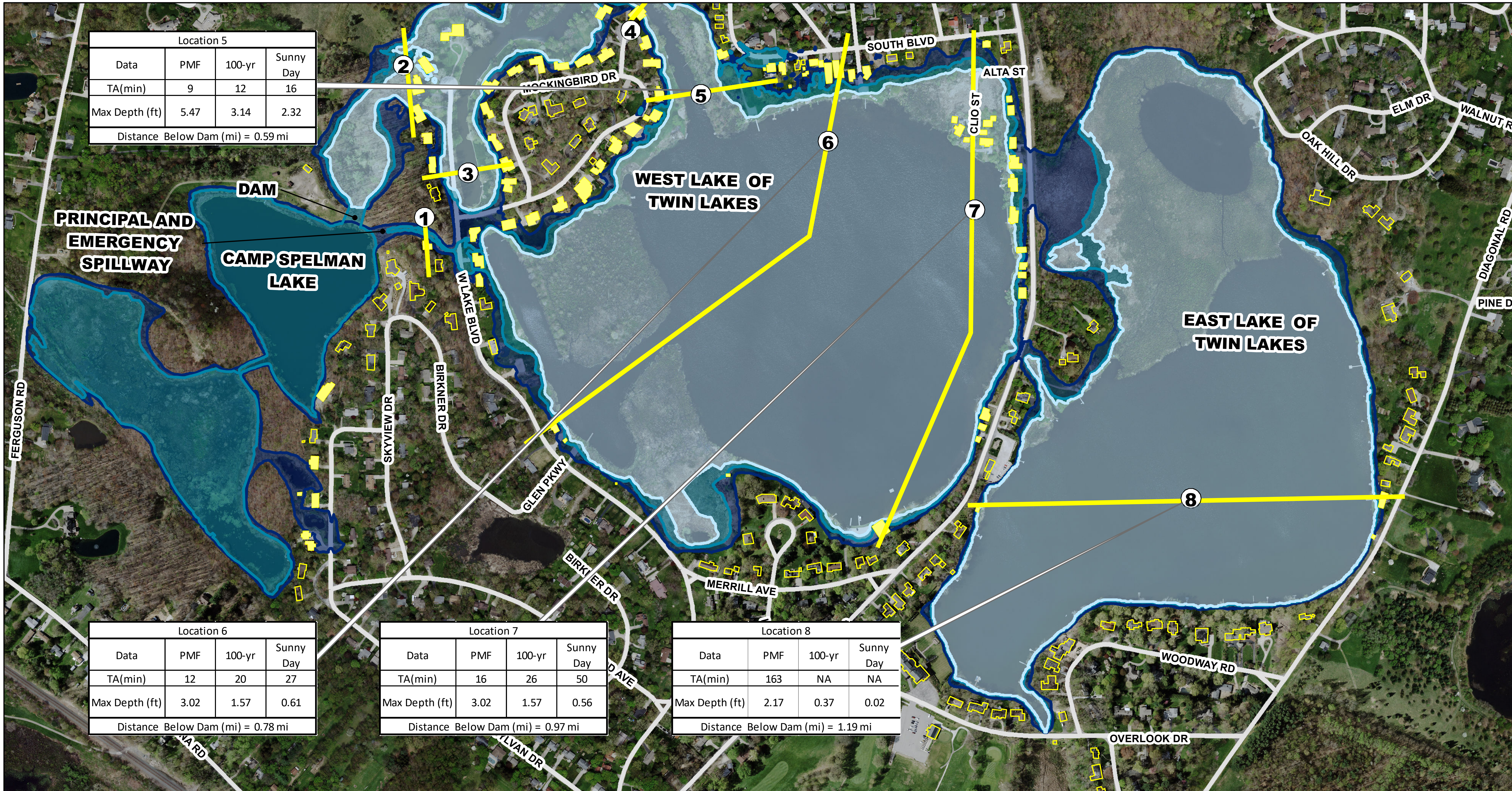
1 inch = 500 feet

CAMP SPELMAN LAKE DAM EAP
PORTAGE COUNTY, OHIO

INUNDATION FROM PIPING BREACH STARTING NEAR TOE OF DAM (MAP 1 OF 2)

Notes:
1) 2017 Aerial imagery from OSIP; Road centerlines obtained from Portage County GIS.
2) TA: Time of flood arrival from breach initiation;
MAX DEPTH: Maximum water surface depth along cross section.
3) Breach analysis assumes that ODNR's required remedial actions have been performed. Inundation limits are approximate. Assumed initial conditions downstream from Camp Spelman Lake Dam: 100-yr recurrence flows for PMF breach; 10-yr recurrence flows for 100-year breach; normal flow conditions for sunny day breach

Drawn By: Andy Long
Date: 3/2/2022



Location 5

Data	PMF	100-yr	Sunny Day
TA(min)	9	12	16
Max Depth (ft)	5.47	3.14	2.32
Distance Below Dam (mi) = 0.59 mi			

Location 6

Data	PMF	100-yr	Sunny Day
TA(min)	12	20	27
Max Depth (ft)	3.02	1.57	0.61
Distance Below Dam (mi) = 0.78 mi			

Location 7

Data	PMF	100-yr	Sunny Day
TA(min)	16	26	50
Max Depth (ft)	3.02	1.57	0.56
Distance Below Dam (mi) = 0.97 mi			

Location 8

Data	PMF	100-yr	Sunny Day
TA(min)	163	NA	NA
Max Depth (ft)	2.17	0.37	0.02
Distance Below Dam (mi) = 1.19 mi			

LEGEND

- Arrival_Marker
- Building
- Sunny Day Breach Flooding Extents
- Impacted Building
- 100-yr Breach Flooding Extents
- (1) Cross Section/ Arrival Marker
- PMF Breach Flooding Extents
- Portage County Roads

0 250 500 1,000 Feet

1 inch = 500 feet

CAMP SPELMAN LAKE DAM EAP PORTAGE COUNTY, OHIO

INUNDATION FROM PIPING BREACH STARTING NEAR TOE OF DAM (MAP 2 OF 2)

Drawn By: Andy Long
Date: 4/6/2022

Notes:
1) 2017 Aerial imagery from OSIP; Road centerlines obtained from Portage County GIS.
2) TA: Time of flood arrival from breach initiation;
MAX DEPTH: Maximum water surface depth along cross section.
3) Breach analysis assumes that ODNR's required remedial actions have been performed. Inundation limits are approximate. Assumed initial conditions downstream from Camp Spelman Lake Dam: 100-yr recurrence flows for PMF breach; 10-yr recurrence flows for 100-year breach; normal flow conditions for sunny day breach

CAMP SPELMAN LAKE DAM

PORTAGE COUNTY
FRANKLIN TOWNSHIP

ODNR-DSWR FILE NO: 1112-071

EMERGENCY ACTION PLAN

APPENDIX B

PLANS FOR TRAINING, EXERCISING, UPDATING, AND POSTING THE EAP

APPENDIX B

PLANS FOR TRAINING, EXERCISING, UPDATING, AND POSTING THE EAP

TRAINING

The owner, ODNR, the Portage County Emergency Management Agency, and the Ohio Emergency Management Agency are responsible for the training of operating and supervisory personnel to ensure timely and adequate assessments of developing situations and performance of their duties in the event of an emergency. Responsible persons in each agency are to be instructed as to what conditions constitute a dam safety emergency and what specific actions are to be executed.

Refresher seminars or reviews of this plan, to be held at least once each year, are the responsibility of the owner, the Portage County Emergency Management Agency, and the Ohio Emergency Management Agency.

EXERCISING

If possible, an annual tabletop exercise of the plan participants should be conducted to ensure that all communications links are operable and that the plan adequately addresses all reasonable emergency possibilities related to a dam failure. The tabletop exercise should be conducted by the owner and the POrtage County Director of Emergency Management. The agencies listed in the **Emergency Notification Flowchart (Section I of this EAP**) should be contacted to verify that all contacts and telephone numbers are current and to verify that every EAP participant is fully aware of their responsibilities under the EAP.

A functional exercise of this EAP should be conducted once every five years. The functional exercise should be coordinated by the owner and the Portage County Director of Emergency Management. The functional exercise shall consist of a drill of the EAP where a dam failure emergency is simulated. The agencies listed in the **Notification Flowchart (Section I)** shall be contacted. The owner and the Portage County Director of Emergency Management shall then terminate the exercise and conduct follow-up telephone calls to verify that every agency listed in the **Notification Flowchart** was contacted, the time of the contact, and the person or agency who made the contact. Any breakdown or miscommunication identified in the exercise should be immediately addressed and rectified by the owners and the Portage County Director of Emergency Management.

UPDATING

At least once each year, the owner should meet with the Portage County Director of Emergency Management to review this EAP to ensure that all portions of the plan, including the names and telephone numbers of all the EAP participants, are current and can be executed with minimal delay. Additionally, downstream development should be assessed to ensure that the plan should be revised accordingly, and the revised pages distributed to each EAP participant.

POSTING THE EAP

This EAP should be kept up to date. A list of revisions and the date of each revision should be maintained with the EAP. The EAP should be kept in a prominent place by the owner and other participants.

CAMP SPELMAN LAKE DAM

PORTAGE COUNTY
FRANKLIN TOWNSHIP

ODNR-DSWR FILE NO: 1112-071

EMERGENCY ACTION PLAN

APPENDIX C

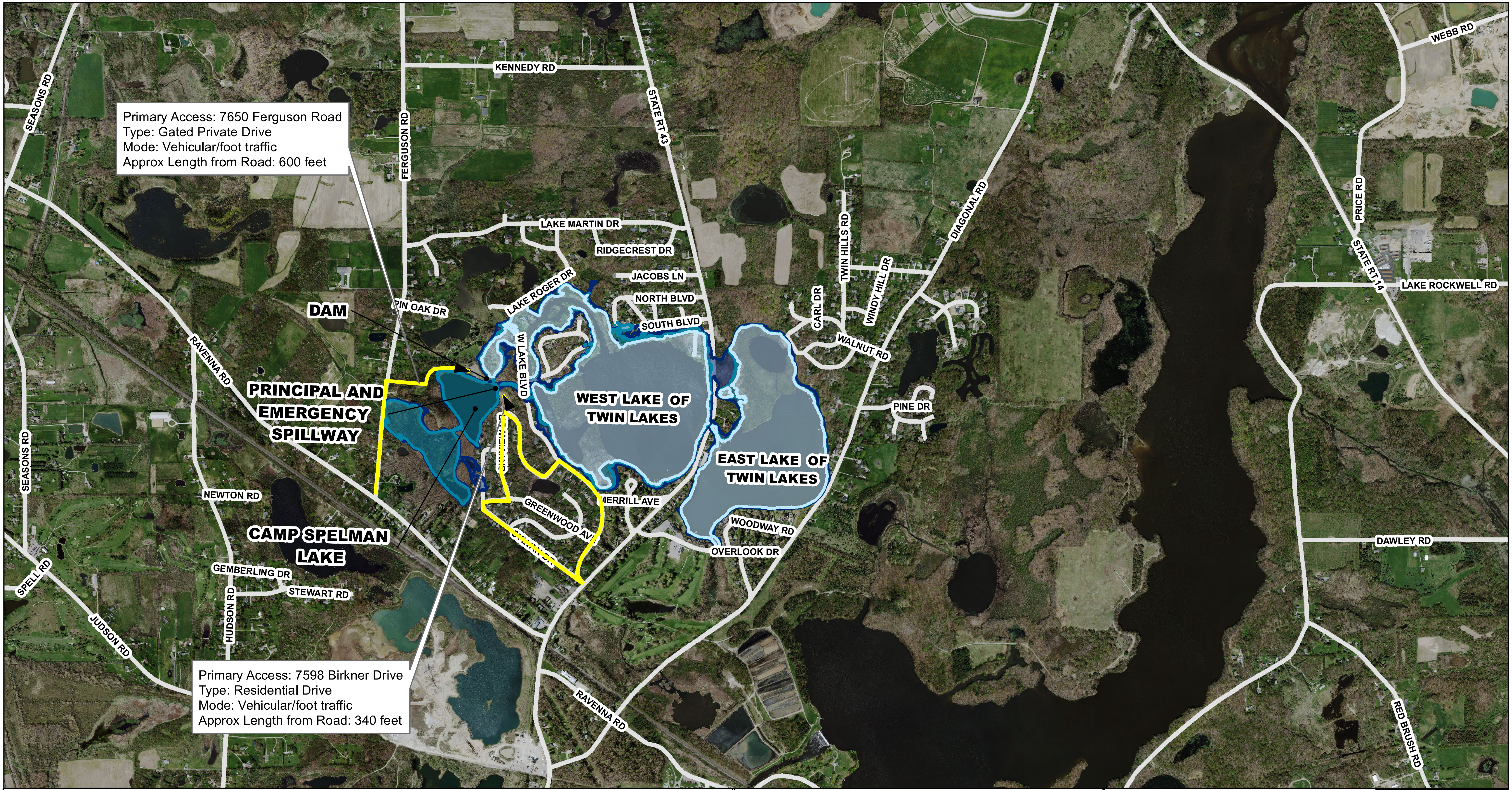
SITE-SPECIFIC CONCERNS AND SITE ACCESS MAP

APPENDIX C

SITE-SPECIFIC CONCERNS AND SITE ACCESS MAP

There are numerous residential homes in the potential inundation area, but there are also a couple of public spaces, including the Twin Lakes Tavern. During a dam failure emergency, the residential areas should be evacuated as quickly as possible and roads crossing the inundation areas (W Lake Blvd, Mockingbird Drive, South Blvd, and St Route 43) should be closely monitored and closed, if necessary. In addition to directly affected structures, there are numerous residential structures that may be temporarily inaccessible during an emergency.

The Twin Lakes are immediately downstream of the Camp Spelman Lake Dam and these should be monitored for any arising problems/conditions or adverse effects resulting from a breach at Camp Spelman Lake Dam. A Site Access Map is provided on the next page to provide potential access routes to the dam. Additional access routes may be developed and should be coordinated with adjacent property owners.



LEGEND

- Sunny Day Breach Flooding Extents
- 100-yr Breach Flooding Extents
- PMF Breach Flooding Extents
- Portage County Roads

0 750 1,500 3,000 Feet

1 inch = 1,500 feet

CAMP SPELMAN LAKE DAM EAP
PORTAGE COUNTY, OHIO

ACCESS TO SITE

Notes:
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Drawn By: Andy Long
Date: 3/2/2022

CAMP SPELMAN LAKE DAM

PORTAGE COUNTY
FRANKLIN TOWNSHIP

ODNR-DSWR FILE NO: 1112-071

EMERGENCY ACTION PLAN

APPENDIX D

OWNERS CERTIFICATION AND APPROVAL

Emergency Action Plan Owner's Certification

For

Dam Name: Camp Spelman Lake Dam

File Number: 1112-071

County: Portage County

In accordance with Section 1501:21-21-04 of the Ohio Administrative Code, I am certifying that I understand my responsibilities as a dam owner for the safe operation of this dam and for executing this Emergency Action Plan. I also understand that this plan must be reviewed and updated annually.

Christine Craycroft | 4-29-2022

Dam Owner's Signature | Date

Christine Craycroft, Executive Director

Portage Park District, owner of earthen dam

`

Emergency Action Plan Owner's Certification

For

Dam Name: Camp Spelman Lake Dam

File Number: 1112-071

County: Portage County

In accordance with Section 1501:21-21-04 of the Ohio Administrative Code, I am certifying that I understand my responsibilities as a dam owner for the safe operation of this dam and for executing this Emergency Action Plan. I also understand that this plan must be reviewed and updated annually.

_______________________________   ____________________

Dam Owner's Signature   Date