

Memorandum

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To: Dave Kepler, FLTF
From: Troy Naperala, P.E., Bill Walton, P.E. – GEI Consultants of MI, P.C.
Date: October 6, 2024
Re: Shut Down and Need for Continued Dam Safety Improvements
Four Lakes Task Force
Project No.: 2002879

This memo describes the dam deficiencies known shortly after failure and summarizes deficiency status at the point of temporary shutdown, and at completion. A summary of key points is:

1. Each dam must achieve the safe stopping points designated. Edenville achieved this in June 2024, Secord and Smallwood are expected to hit this milestone in October 2024, and Sanford will be at a safe stopping point in February 2025. Stopping prior to this will leave the dams in an unsafe condition.
2. At the temporary suspension condition the dams will be in a safe and stabilized condition. However, they will not meet the design criteria established and permitted by EGLE.
3. At completion of construction the dams will have identified deficiencies corrected and pass a risk-based inflow design flood that meets modern criteria. In all cases, the design capacity and durability of each dam is greater than the pre-failure condition. Designs were developed in accordance with the FEMA and ASDSO Model Dam Safety Program.

Summary of Deficiencies Known After Failure during GEI and EGLE Inspection

A description of the dam safety issues and deficiencies that could lead to an uncontrolled release of the adjacent impoundment and environmental issues was summarized on April 15, 2021, in an Executive Summary by GEI to FLTF titled, “Executive Summary of Flood Study and Conceptual Design Basis Reports by GEI.” A summary of deficiencies follows:

Secord Dam - Dam toe erosion, lack of seepage controls, concrete deterioration, steep embankment slopes, inadequate spillway capacity for design storm event, and lowered run-of-river pool limited to top of ogee spillway sill with two (2) Tainter gates open.

Smallwood Dam – Dam toe erosion downstream of primary and auxiliary spillways, concrete deterioration, steep embankment slopes, inadequate spillway capacity for design storm event, and lowered the run-of-river pool limited to top of the ogee spillway sill with two (2) Tainter gates open.

Edenville and Tobacco Dams - Dam breached the entire embankment left of powerhouse with all of Tobacco and Tittabawassee Rivers flowing over exposed glacial till on private property that had active head cutting back toward the remaining reservoir. Significant toe erosion of the embankment around spillways occurred during the pre-breach flood discharges. There was concrete deterioration on both

Tittabawassee and Tobacco spillways with exposed rebar and undermined walls. There was a right downstream embankment slide that occurred next to Tobacco spillway. Tobacco River flow was not passing through the Tobacco spillway but was flowing under the collapsed M30 roadway bridge over to the Tittabawassee Rivers causing scour and sloughing to the upstream toe of the Tittabawassee right embankment. There were no river controls at that time, other than the three (3) Tainter gates in raised position at the two (2) spillway locations, with no water flowing over the ogee sills. The remaining dikes were steep and lacked seepage control barrier.

Sanford Dam – Edenville Dam breach overwhelmed the 6-bay spillway and did not trigger the emergency fuse plug spillway to operate. This excess flow caused a full breach and loss of the right embankment dam. The Tittabawassee River was now flowing over exposed glacial till with active head cutting working its way upstream. The six (6) Tainter gates are fully open and there is no flow over the spillway ogee or through the three (3) turbine units. A design Storm in this condition would result in further erosion of the dam foundation and destabilizing of the remaining spillway and powerhouse structure.

For a complete description of dam safety deficiencies, we reference the GEI external and internal dam inspection reports issued for Secord and Smallwood Dams on February 22, 2021, and for Edenville and Sanford Dams on March 10, 2021.

Risk Based Design Flood Update

The Michigan Dams Safety Task Force recommended that the Michigan rules and regulations be updated to follow the FEMA and ASDSO Model Dam Safety Program (MDSP) approach to developing the Design Flood. Given the failures, and risk concerns, it was proposed by FLTF and agreed to by EGLE, that FLTF would use an incremental consequence analysis or, risk-informed decision making, to evaluate the potential of selecting a design flood other than the ½ PMF. All dams, therefore, would need auxiliary spillways and be able to pass the design flows of the dams upstream. The approach means the dams meet minimum state standards and will be compliant with future legislative changes.

Studies including prediction of the probable maximum precipitation (PMP), and a Semi-Quantitative Risk Assessment (SQRA) are part of the design basis for the spillway configurations with selected Inflow Design Flood (IDF). The new primary and secondary spillways at Secord and Smallwood Dams are designed to pass floods up to an annual exceedance probability (AEP) of 10,000-years and Edenville and Sanford Dams are designed to pass floods up to a 5,000-year AEP. At each dam site, the design IDF flows are greater than the ½ Probable Maximum Flood (PMF), which is part of the minimum EGLE dam safety criteria for high hazard dams. All dams also meet the minimum EGLE freeboard requirements at the IDF peak headwater elevation and discharge. As shown in Table 1 below, design zero-freeboard spillway capacities exceed the original or pre-flood condition in all four dams by greater than 40% up to 316%.

Table 1. Inflow design flood (IDF) and zero freeboard discharge for each dam pre and post restoration.

Parameter	Secord Dam		Smallwood Dam		Edenville Dam		Sanford Dam	
	Pre-Flood Spillway	Restoration Spillway	Pre-Flood Spillway	Restoration Spillway	Pre-Flood Spillway	Restoration Spillway	Pre-Flood Spillway	Restoration Spillway
IDF Inflow (cfs)	18,200		28,300		55,400		54,900	
Zero-Freeboard Tainter Gate Spillway Capacity (cfs)	8,000	13,500	10,000	20,800	20,650	49,300	29,700	37,800
Zero-Freeboard Auxiliary Spillway Capacity (cfs)	0	19,000	18,000	18,300	0	36,700	6,500	39,700
Zero-Freeboard Total Spillway Capacity (cfs)	8,000	32,500	28,000	39,100	20,650	86,000	36,200	77,500
Zero-Freeboard Spillway Capacity Increase (cfs)	24,500		11,100		65,350		41,300	
Increase percentage	306%		40%		316%		115%	

Status of Dam Safety After EGLE and NRCS Required Stabilization Construction

The goal of the stabilization effort was to move the Tittabawassee river back to the river path and reduce or eliminate ongoing erosion and silt transport. The design criteria by EGLE and NRCS required at least a safe impoundment for floods up to the 100-year AEP. Repair of the dams beyond these goals were not completed and the identified dam safety deficiencies were not addressed or repaired.

Status of Dam Safety at 2024 Shutdown

GEI developed the final design basis reports including designed repairs to address each dam’s deficiencies and allow the reservoirs to be safely filled back to their pre-flood 2020 design pool elevation. The design basis reports were issued by GEI, reviewed by AECOM, and permitted by EGLE. Table 2 lists the key design elements to address the dam safety deficiencies and their expected status at the start of the shutdown.

Table 2. Status of construction for each dam and primary work item.

Dam	Current Pool El. (ft)	Spillway w/ Crest Gates (number of gates)	Auxiliary Spillway Operational	Seepage Cutoff Wall w/ Added Filter/Drains	Dam Slopes Flattened	Low-Level Outlet Gates Operational
Secord	744.5	In progress (2)	Complete	Complete	Complete	Not Started (1)
Smallwood	696.1	In progress (2)	Complete	Complete	Complete	Complete
Tittabawassee /Tobacco	~642/ ~648	Not Started(5)	Not Started	In progress	In progress	Not Started (2)
Sanford	614	In progress (6)	Not Started	In Progress	In Progress	Installed, not powered

Based on elements that have/will be completed at the time of shutdown, Table 3 compares the ability for the dams to pass floods without overtopping and risking a failure of the dam.

Table 3. Spillway capacity for pre-failure, at suspension, and post restoration for each dam (with freeboard).

	Pre-Failure			At Suspension			Dams at Completion (Selected IDF)	
	Flow (cfs)	% of IDF	Annual Exceedance Probability (Years)	Flow (cfs)	% of IDF	Annual Exceedance Probability (Years)	Flow (cfs)	Annual Exceedance Probability (Years)
Secord	7,500	41	150	10,865	60	800	16,385	10,000
Smallwood	23,000	82	3,500	24,115	85	4,900	28,000	10,000
Edenville / Tobacco	13,500*	24	20	27,300	49	200	55,400	5,000
Sanford	20,000*	36	50	28,000	51	200	54,900	5,000

* Estimated using same design conditions as Dams at Completion

The table shown above highlights we have not met design intent to repair the dams to a safe condition and able to pass the EGLE design storm at all four dam sites. However, at suspension we will meet at least the 200-year event at each dam.

Each dam is on schedule to be suspended at a safe condition. These dates are mid-October 2024 for Secord and Smallwood, June 2024 for Edenville, and February 2025 for Sanford Dam. Given the current date, condition of the dam today, and expected progress at Secord, Smallwood and Edenville it appears likely that these dams will achieve the dam safety goals set for the temporary suspension. It will take several more months of construction activities for Sanford to reach the milestones set by the design and construction teams for a safe pause. It is imperative that construction proceeds until the safe stopping point is reached.

Closing

EGLE approved design for Secord and Smallwood were granted in 2022 and the team of FLTF, GEI, Spicer, Fisher Contracting and Spence Brothers went to work constructing improvements and have made significant progress increasing the discharge capacity at the dam and threat of overtopping causing an uncontrolled reservoir release at the two-dam sites. Edenville construction work was slowed down due to ecological concerns and pending environmental permitting. The only work done at Edenville was above headwater levels. Dam safety improvement designs for Sanford were approved by EGLE in 2023 and construction began immediately thereafter by Fisher and Spence to dewater the foundation of the spillway dam, constructing the 6-bay spillway foundation, adding two low-level outlet gates, filling in the old powerhouse with concrete, and stabilizing the left embankment dam. Whipps has manufactured low-level sluice gates and Fisher has installed them at Smallwood and Sanford Dams. In addition, Steel Fab, Inc. is manufacturing 15 new hydraulic crest gates for the five spillway dams. Crest gates are a long-lead item that are to be made by a well-respected American gate manufacturer.

Assuming each dam reaches its designated stopping point, progress will have been made in terms of improved dam safety and will have reduced risk of dam breach from future flooding. However, we have not met the final design intended to repair the dams to a safe condition and pass the design storm at all four dam sites. Our work is not done yet, as the Dams cannot be left in the suspended condition.

References:

GEI Inspection Reports:

1. GEI Inspection Report for Secord Dam, Exterior 10/15/2021 and Interior 1/18/2021
2. GEI Inspection Report for Smallwood Dam, Exterior 10/15/2021 and Interior 1/18/2021
3. GEI Inspection Report for Edenville Dam, Exterior 10/15/2021 and Interior 1/18/2021
4. GEI Inspection Report for Sanford Dam, Exterior 10/15/2021 and Interior 1/18/2021

GEI Design Basis Reports: Review and Approved by AECOM and EGLE

5. Design Basis Report, Secord Dam Restoration Project, Gladwin County, MI, 9/2/2022
6. Design Basis Report, Smallwood Dam Restoration Project, Gladwin County, MI, 9/2/2022
7. Design Basis Report, Edenville Dam Restoration Project, Gladwin County, MI, 1/16/2024
8. Design Basis Report, Sandford Dam Restoration Project, Midland County, MI, 4/18/2023

Other References

9. Model Dam Safety Program, FEMA and ASDSO, September 2022