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Prior to the May 19th, 2020 flood event, the Four Lakes Task Force (FLTF) was evaluating the spillway capacity of the dams in the Four Lakes system. The Federal Energy Regulatory Commission (FERC) licenses and regulates hydroelectric projects and administers dam safety requirements for these projects, including spillway capacity requirements. Sanford, Smallwood and Secord Dam within the Four Lakes system have FERC licenses. The FERC license for the Edenville Dam to generate hydroelectric power was revoked in September 2018, which shifted the jurisdiction of dam safety to the Michigan Department of Environment, Great Lakes & Energy (EGLE). Key points with respect to current dam safety hydrologic and hydraulic (spillway) requirements for the Four Lakes systems are as follows:

- The spillway requirements for Smallwood and Secord Dams are to safely pass the Probable Maximum Flood (PMF) per FERC standards. The FERC defines the PMF as "the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area." The calculation of a PMF is defined from the establishment of a Probable Maximum Precipitation (PMP) event. The PMP is developed from the 1993 Wisconsin-Michigan Probable Maximum Precipitation Study. A very generalized summary of the PMP one-day rainfall amount is 16 inches of rain across the watershed.

- The spillway requirement for the Edenville Dam is to safely pass the ½ PMF per State of Michigan requirements administered by the EGLE Hydrologic and Dam safety unit.

- The spillway for the Sanford Dam must have sufficient capacity to safely pass the Inflow Design Flood (IDF). The IDF is the flood flow rate for which increases in flow due to a dam failure is considered and present no significant additional threat to downstream life and property, relative to the pre-existing flood. To derive the IDF, a PMF is calculated and various fractions of the PMF are tested in a dam failure simulation model. Then, the dam capacity requirement is calculated based on the determination that at a certain level of flow, failure poses no significant incremental hazard, beyond the hazard caused by the pre-failure flow. For Sanford, the prior accepted IDF flow rate based the past study was 37,000 cubic feet per second (cfs) which was 49 percent of the previously accepted PMF flow rate.

- The above-mentioned studies provide the hydrologic basis which is used for Federal Emergency Management Agency (FEMA) studies.

Upon pursuing the purchase of the Four Lakes system, FLTF was aware that the Secord and Edenville Dam did not meet FERC or EGLE regulations with respect to their ability to safely pass the PMF and ½ PMF, respectively. The FLTF intended to implement spillway improvement projects to bring the Four Lakes system into compliance with State and Federal Dam Safety regulations. The initial step for spillway improvements was updating the existing PMF study. The original study was completed in 1994 by Mead & Hunt Engineering. The FLTF directed that

the PMF study be updated. This update was lead by Ayres Associates. A draft of the updated study is available from the FLTF for review and comment. The newly calculated PMF inflows to the Secord, Smallwood, Edenville and Sanford reservoirs are 29,400 cfs, 41,200 cfs, 80,900 cfs and 80,600 cfs, respectively. This represents increases of 10 percent, 0.5 percent, 30 percent, and 7 percent over previously accepted values, respectively. FERC and EGLE were informed of these conclusions; however, the formal report has not yet been submitted.

It should also be noted that, while the meteorological and forensics studies have not yet been completed on the May 19th event, it is assumed this flood event was less than a PMF event. Preliminary observations suggest the water level at the Edenville Dam was approximately 18 inches below the crest of the dam. Based on rating curves developed for the Edenville Dam and assuming operations were consistent with rating curves assumptions, the flow rate at the time of dam failure was in the range of 20,000 cfs or roughly 25 percent of the recently calculated PMF flow rate.

The FLTF was set to begin hydraulic evaluations and spillway design. However, efforts were halted after the May 19th, 2020 flood event.

Given the failures at Edenville and Sanford, the FLTF is in the process of updating the approach for hydrologic and hydraulic modeling of the system. At this point, the FLTF is pursuing the restoration of the lakes. With this restoration effort, it is anticipated that Sanford and Edenville Dams will require reconstruction and the Smallwood and Secord Dams will require major upgrades and repairs. At this point in time, the FLTF believes the most feasible path for restoration of the lakes is dam reconstruction and repair without hydroelectric power generation capabilities. On this path, the dam reconstruction would be regulated by the State of Michigan pursuant to Part 315 and Part 307 of Public Act 451 of 1994.

The FLTF anticipates that all dams will certainly need to pass the ½ PMF, which is the State design requirement for high head, high hazard dams. Given the May 19th failures, this requirement may increase. It is prudent for the community to consider future analysis of both State and Federal standards. The FLTF believes a next step in the restoration effort is to update the hydrologic and hydraulic analysis, starting with the PMF study. The PMF study should be amended to give consideration for the May 19th, 2020 storm and amended to calculate new full and ½ PMF flow rates. It is anticipated that ½ PMF flow rates will increase from previously accepted values. In addition, the flow rates determined by the updated PMF study may influence the existing floodplain models for areas downstream of the dams for 100-year, 200-year, and 500-year events. These events have a higher likelihood of occurrence and will be important to understand how the dams will impact floodplains, both upstream and downstream. Also, a cascading analysis study must be conducted to determine the impact of one dam on another for extreme flood events.

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For effective spillway and new dam design, the FLTF believes that new hydraulic models are required. In review of past hydraulic models completed in connection with the dams, it is believed that data included in these models should be updated. After May 19th, 2020, field conditions have changed due to the dam failures. Also, with the availability of Light Detecting and Ranging (LiDAR) ground contours, and two-dimensional modeling, significant improvements in modeling, flooding mapping and emergency preparedness can be made.

The FLTF understands there are many discussions regarding regional flood control, especially areas downstream of the Four Lakes systems including Midland and Saginaw Counties along the Tittabawassee River. While the USACE is reviewing the effects that changes to the river system has on flooding in the downstream areas, we do not anticipate a significant difference in downstream 100-year elevations from previous river conditions. While there is confidence the new dams can be operated safely, it is not clear how much downstream flood mitigation can be provided with the only reconstruction of the dams. The watershed area contributing to the dam system is only about 40 percent of the watershed area contributing to the Tittabawassee River at Midland.

Achieving future flood control with the dams is a balance which should not expand flooding upstream of the dams, selects lake levels to maintain lake front property and recreational values, and operates dams in a manner that optimizes downstream flood control while providing for a stable environment upstream and downstream of the dams.

In the interest of regional cooperation, the FLTF believes various alternatives should be evaluated for future dam operations, lakes levels and flood control alternatives. Downstream of the lakes, flood mitigation and flood control may be considered, and be implemented in steps, starting with the dams. Then planning other immediate, short term and long-term steps for Midland and other downstream stakeholders.

Downstream stakeholders that desire greater flood protection are encouraged to look at alternatives beyond the dam reconstruction. The reconstruction or operations of the dams could contribute to downstream flood control, but other measures will be needed. Stakeholders will need to come together to explore all available alternatives. These alternatives will need to be screened and evaluated for cost and benefit. Updating of hydrologic and hydraulic models will be required for this alternative analysis.

The FLTF understands that past flood studies have been completed by and for various agencies including FEMA, USACE, and FERC. Appendix A include a list of previous studies completed for the Tobacco and Tittabawassee River System within the Gladwin, Midland and Saginaw Counties.

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Appendix A – Summary of Past Studies

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Existing FEMA Model Summaries of Tittabawassee River Watershed

GLADWIN COUNTY – Countywide effective date 8/2/2018

WATERCOURSE	STUDY TYPE[1]	Extents	1% FLOOD ZONE	HYDROLOGIC[2,3]	HYDRAULIC[4]
Tittabawassee River	Approximate	Edenville Dam (Wixom Lake) to northern limits of Sugar River, West, Middle, and Eastern Branch of Tittabawassee River or County Boundary	A	Ratio of Probable Maximum Flood (PMF) model storm hydrographs for Edenville Dam (described in Midland County FIS pg. 10). Tributaries use storm hydrographs by State Hydrologists formula for peak sub-basin flow	HEC-RAS 3.1.3 (2018) – watershed model with tributaries
Tobacco River	Approximate	Edenville Dam (Wixom Lake) to northern tributary extents or County Boundary	A	Ratio of Probable Maximum Flood (PMF) model storm hydrographs for Edenville Dam (described in Midland County FIS pg. 10). Tributaries use storm hydrographs by State Hydrologists formula for peak sub-basin flow	HEC-RAS 3.1.3 (2018) – modeled jointly with Tittabawassee River to Beaverton Dam; modeled independently upstream of Beaverton Dam

Notes:

[1]See Table 1, pg. 3 in FIS Report

[2]PMF Study refers to FERC project numbers 10809, 10810, 10808, and 2785 performed by Mead and Hunt, Inc. Explanations for the hydrologic analyses are described in *FEMA Flood study for Tittabawassee and Tobacco Rivers Upstream of the Edenville Dam to the Gladwin County Line, Michigan, Rev 2* conducted by Mill Road Engineering and EGLE.

[3]See Section 3.1 (pages 6-7) in FIS Report

[4]See Section 3.2 (pages 7-9) in FIS Report

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MIDLAND COUNTY – Countywide effective date 5/4/2009, Revised 1/16/2013

WATERCOURSE	STUDY TYPE[1]	Extents[1]	1% FLOOD ZONE	HYDROLOGIC[2]	HYDRAULIC[3]
Tittabawassee River	Detailed	Approx. 1000 ft downstream of Consumers Power RR (re-delineated 2009) to approx. 2.7 miles upstream of confluence with Sturgeon Creek	AE with Floodway	Ratio of Probable Maximum Flood (PMF) model storm hydrographs for Edenville Dam. Tributaries use storm hydrographs by State Hydrologists formula for peak sub-basin flow. (2013 revision) USGS Regional Regression Equation Report 94-2004 (2009) Log-Pearson Type II and HEC-1 (pre-countywide 1984)	Unsteady HEC-RAS 3.1.3 watershed model (2013 revision) HEC-RAS 3.1.2 (2009) HEC-2 (pre-countywide, 1984)
	Limited Detailed	Just downstream of Sanford Dam to the Midland-Gladwin County boundary, and all of Sanford Lake	AE without Floodway		
	Approximate	Saginaw-Midland County boundary to approx. 5990 ft upstream of Gordonville Rd; 14050 ft US of confluence with Sturgeon Creek to Sanford Lake Dam	A	Taken from USACE Report "Special Study: Tittabawassee, Chippewa, and Pine Rivers, Midland County, Michigan" (1996)	Taken from USACE Report "Special Study: Tittabawassee, Chippewa, and Pine Rivers, Midland County, Michigan" (1996)
Tobacco River	Limited Detailed	Confluence with Tittabawassee River to the Midland-Gladwin County boundary	AE without Floodway	Ratio of Probable Maximum Flood (PMF) model storm hydrographs for Edenville Dam. Tributaries use storm hydrographs by State Hydrologists formula for peak sub-basin flow. (2013 revision)	Unsteady HEC-RAS 3.1.3 watershed model (2013 revision)

Notes:
[1]See pages 4-5 in effective countywide FIS Report
[2]See Section 3.1 (pages 8-10) in FIS Report effective countywide FIS Report
[3]See Section 3.2 (pages 10-13) in FIS Report effective countywide FIS Report
Refer to LOMR case no. 10-05-5374P for more in-depth information on engineering analysis (stated on pg. 13 in FIS Report) – Not available on FEMA Map Service Center.

SAGINAW COUNTY – Countywide effective date 10/16/1997

WATERCOURSE	STUDY TYPE[1]	Extents[1]	1% FLOOD ZONE[1]	HYDROLOGIC[2,4]	HYDRAULIC[3,4]
Tittabawassee River	Detailed	From mouth to southern Township of Tittabawassee boundary	AE with Floodway	log-Pearson Type III Bulletin 17B. Gage information taken from Midland gage 1876-1907 and 1910-1975. Flows calculated using USGS Water Supply Paper No. 1677 (1979)	HEC-2 (1979)
	Approximate	Township of Tittabawassee boundary to Saginaw-Midland County boundary.	A		

Notes:
The Midland County FIS effective 2009 states the Saginaw County FIS was revised concurrently with the Midland County study. Saginaw County FIS revisions are currently ongoing. However, the current effective FIS for Saginaw County remains to be the 1997 countywide study.
[1]See FIRM panels 26145C0070D and 26145C0020D and Flood Profiles panels 25-26.
[2]See section 3.1 (pages 14-21) in effective countywide FIS report.
[3]See Section 3.2 (pages 22-25) in effective countywide FIS report
[4]The Hydrologic and Hydraulic analyses in the effective countywide FIS report were carried forward by historical FIS products for the City of Saginaw (1983), Township of James (1991), and Township of Saginaw (1979). The Tittabawassee River analysis was completed in the Township of Saginaw (1979) report for the Federal Insurance Agency by Johnson & Anderson, Inc. under contract No. H-3816. Report not available on the FEMA Map Service Center.

External Studies Referenced in FIS Reports:

1. PMF Study (FERC project numbers 10809, 10810, 10808, and 2785) performed by Meade and Hunt, Inc.
2. Mill Road Engineering, FEMA Flood Study for Tittabawassee and Tobacco Rivers Upstream of the Edenville Dam to the Gladwin County Line, Gladwin County, Michigan, Rev 2 w-figures Final, Westborough, Massachusetts, December 24, 2012, pdf revised July 6, 2015.
3. U.S. Army Corps of Engineers, Detroit District, Flood Control on Saginaw River, Michigan and Tributaries, Tittabawassee River at Midland, Phase I, Design Memorandum No. 8, January 1977.
4. U.S. Army Corps of Engineers, Detroit District, Special Study: Tittabawassee, Chippewa, and Pine Rivers, Midland County, Michigan, July 1996.
5. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Saginaw, Saginaw County, Michigan, January 1979.
6. U.S. Department of the Interior, Geological Survey, Water-Supply Paper 1677, Magnitude and Frequency of Floods in the United States, Part 4. St. Lawrence River Basin, 1965
7. U.S. Water Resources Council, Bulletin 17B, Flood Flow Frequency, September 1981, Revised March 1982

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Summary of Previous FERC Studies

No.	Year	Name	By	Source	Copy Obtained
Sanford Dam					
1	1989	1D Probable Maximum Storm	A R Blystra	1989 CSIR	Partial (Report from HMR52)
2	1989	Dam Break Analysis	A R Blystra	1989 CSIR	Partial (Report from DAMBRK)
3	1990	Spillway Stress Analysis	A R Blystra & Associates	STID	Yes
4	1994	IDF Study	Mead & Hunt	STID	Yes
5	1994	PMF Study	Mead & Hunt	STID	Yes
6	1995	PMF Review	Mead & Hunt	STID	Yes
7	1996	Spillway Discharge Rating Curve Report	Barr Engineering	STID	Yes
Edenville Dam					
1	1990	Spillway Stress Analysis	A R Blystra & Associates	STID	No
2	1994	IDF Study	Mead & Hunt	STID	No
3	1994	PMF Study	Mead & Hunt	STID	Yes
4	1995	PMF Review	Mead & Hunt	STID	Yes
5	1996	PMF Restudy – Phase 1	Mead & Hunt	STID	No
6	2004	Design Report for Edenville Dam Auxiliary Spillway	Sigma Engineering	STID	No
7	2011	Probable Maximum Flood Reanalysis	Mill Road Engineering	CSIR	No
8	2013	IDF Determination	Ayes Associates	CSIR	No
9	2015	Edenville Spillway Discharge Curve	Boyce Hydro	CSIR	No

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No.	Year	Name	By	Source	Copy Obtained
Smallwood Dam					
1	1989	Design Report for Spillway Modifications	Mead & Hunt	STID	No
2	1991	Dam Break Analysis	A R Blystra	1991 CSIR	Partial (Report from DAMBRK)
3	1994	IDF Study	Mead & Hunt	STID	Yes
3	1994	PMF Study	Mead & Hunt	STID	Yes
4	1995	PMF Review	Mead & Hunt	STID	Yes
5	1996	Flood Report	Wolverine Power Corporation	CSIR	No
6	1998	Design Report Dam Modifications for Upgrading Spillway Adequacy Smallwood		CSIR	No
7	2013	Probable Maximum Flood Reanalysis	Mill Road Engineering	CSIR	No
Secord Dam					
1	1994	IDF Study	Mead & Hunt	STID	No
2	1994	PMF Study	Mead & Hunt	STID	Yes
3	1996	Flood Report	Wolverine Power Corporation	STID	No
4	2006	Secord Dam Flood Routing	A. Rieli & Associates	STID	No
5	2016	2D Analysis of Eastern Ridgeline along Secord Lake	Purkeypile Consulting	STID	Yes
6	2016	Secord Lake Flood Frequency Analysis 1930 to 2015	Purkeypile Consulting	STID	Yes
7	2016	Secord Dam Inflow Design Flood Analysis	Purkeypile Consulting	STID	No

Flood studies summary compiled from review of available FERC Consultant Safety Independent Report (CSIR) and Standard Technical Information Document (STID)