ERCOL Hydrological & Hydraulic study

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Antrim County USACE

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Three Lakes Association Intermediate Lake Association Six Mile Lake Association Elk-Skegemog Lake Association Friends of Rapid River

HOBO U20L-04 Water Level Logger

Level Accuracy: +/- 0.1% FS (0.03 ft) Pressure Accuracy +/- 0.3% FS (0.09 psi) Resolution: 0.003 psi / 0.007 ft.(water)





- Level logger location
- Level logger & rain gage location









Average rainfall (in.) recoded by ERCOL volunteers (5 gage locations) April 20 to November 30, 2020



Rules of the road

- USACE model is the investigative tool to identify problems & management options
- Level logger data documents current dynamic conditions
- Trends observed in logger data can help identify where model and data agree
- Where they agree, confidence in predictive capability is higher
- Model can be calibrated to improve overall agreement

Interpreting relative lake level data

- Plots show change in lake level from their individual level on April 20th
- Differences between individual lake levels on April 20th is unknown
- Plots of multiple lakes show when changes occurred in relation to other lakes
- Comparisons limited to range of variation

Change of lake level (ft.) relative to level on April 20, 2020



	Lake	high date	low date	range(ft.)
	Six Mile Lake	5/2/20	9/27/20	2.6
	Lake St. Clair	5/2/20	9/27/20	2.6
	Ellsworth Lake	5/2/20	9/25/20	2.1
Upstream of Bellaire Dam	Benway Lake	5/3/20	9/25/20	1.8
	Intermediate	10/28/20	9/25/20	1.4
Downstream of Bellaire Dam	Lake Bellaire	10/24/20	7/15/20	1.4
	Clam Lake	10/23/20	9/25/20	0.8
	Torch Lake	5/29/20	9/8/20	0.8

Change of individual lake level (ft.) relative to April 20, 2020 Upstream of Bellaire Dam

Shaded area indicates Bellaire Dam gates in operation

Area between lines indicates period of maximum gate closure (4 of the 5 gates closed)



Falling water levels with & without dam gate operation



Average rainfall recorded

Change of individual lake level (ft.) relative to April 20, 2020 Downstream of Bellaire Dam

Shaded area indicates Bellaire Dam gates in operation

Area between lines indicates period of maximum gate closure (4 of the 5 gates closed)



Change of individual lake level (ft.) relative to April 20, 2020 Bellaire Dam Impoundment

Shaded area indicates Bellaire Dam gates in operation

Area between lines indicates period of maximum gate closure (4 of the 5 gates closed)



Sea level datum

- Height of worlds oceans without forces such as wind or climate
- Earth not exactly spherical and gravitational force varies by location
- NGVD29: National Geodetic Vertical Datum of 1929
 Discrete observations at 26 tide stations and 100,000 benchmarks
- NAVD88: North American Vertical Datum of 1988 Includes observed gravity, entire tidal epoch from 1970 to 1988 and 450,000 benchmarks

NGVD29

Intermediate Lake level Court order Antrim County flood plain limit line benchmarks Intermediate Lake level sight gage datum in Central Lake Design drawings for Bellaire Dam

NAVD88

USACE hydrological and hydraulic models 2020 GTEC survey USGS electronic gage datum in Central Lake





GTEC survey vs. Level Loggers & County benchmarks

Lake Bellaire

GTEC: at Grass River on 8/14 - 2:18 pm	590.45 ft
Logger: W. shoreline at North Arm 8/14 - 4:00 pm	590.35 ft

Torch Lake

GTEC: at Dockside on 8/13 - 9:21 am Logger: South of Stoney Point 8/13 - 8:00 am 589.70 ft 589.66 ft

Intermediate Lake

GTEC: at State St bridge on 8/11 - 2:31 pm Logger: at Recreation Point 8/11 - 4:00 pm 606.76 ft 606.67 ft

Average deviation 0.08 ft (around 1 inch)

Note: Elevations shown are to NAVD88





Interpreting absolute lake level data

- Plots show elevation of lake surface above sea level datum
- Lake level comparison includes topographical elevation differences
- If a lake had lower surface elevation than the next lake downstream, river flow between them would reverse direction
- When the difference in surface elevation between adjacent lakes is greater, connecting river flow velocity must also be greater

Change of lake surface elevation (ft.) above sea level Upstream of Bellaire Dam

Shaded area indicates Bellaire Dam gates in operation

Area between lines indicates period of maximum gate closure (4 of the 5 gates closed)

NOTE: Surface elevation of Ellsworth and Benway Lakes estimated from GTEC river survey measurements made at Clay Pit Rd. and Mohrmon Rd., respectively.



Change of lake surface elevation (ft.) above sea level Downstream of Bellaire dam

Shaded area indicates Bellaire Dam gates in operation

Area between lines indicates period of maximum gate closure (4 of the 5 gates closed)



Change of lake surface elevation (ft.) above sea level Bellaire Dam Impoundment vs. Intermediate Lake

Shaded area indicates Bellaire Dam gates in operation

Area between lines indicates period of maximum gate closure (4 of the 5 gates closed)



Next steps

- April 2021: Level loggers and rain gages will be redeployed
- June 2021: Training available for HEC-RAS modeling software
- October 2021: USACE presents results of their hydrological modeling

Question & Answer