TECHNICAL MEMORANDUM

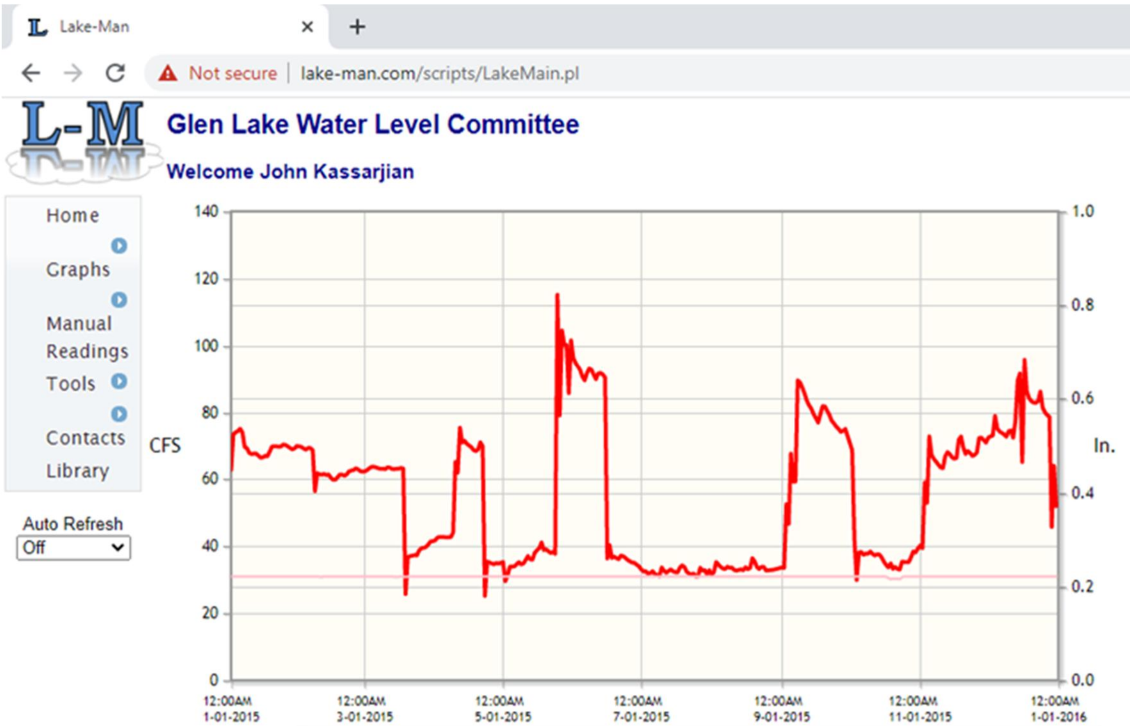
CR 675 Crossings Supplemental Information

To:	Leelanau County Road Commission GT Band of Ottawa & Chippewa Indians USDA-NRCS	Date:	January 27, 2022
From:	Robert Verschaeve	Re:	CR 675 Crossings Supplemental Information
cc:	Martin Graf		

This memo is provided to supplement the CR 675 Crossings Preliminary Engineering Report dated December 22, 2020. During review by the project partners, several questions arose requiring further attention or explanation. This memo provides documented responses to those questions.

The first item presented for further clarification is the base flow within the Crystal River used for the HEC-RAS analysis. As described in the report, it is understood that EGLE uses the rainfall-runoff methodology to calculate flood flows. Base flow is typically not included in those flood flows provided. As described in the report, a base flow of 1 cfs per square mile of drainage area was added to the flood flows analyzed in the HEC-RAS model. The drainage areas provided by EGLE for each crossing were 34.5 square miles for crossings 1 and 2; 33 square miles for crossing 3; and 2.5 square miles for crossing 4. The Base flows used in the analysis based on 1 cfs per square mile were 35 cfs for Crossings 1, 2, and 3 and 3 cfs for Crossing 4.

The original report notes the existence of extensive flow data collected over the years at the Fisher Lake Dam. The report also noted these flows generally in the 60-80 cfs range with peaks of 110 cfs and lows of 25 cfs. The data supporting this information was provided to us in graph form. The graphs from 2015-2017 are shown below.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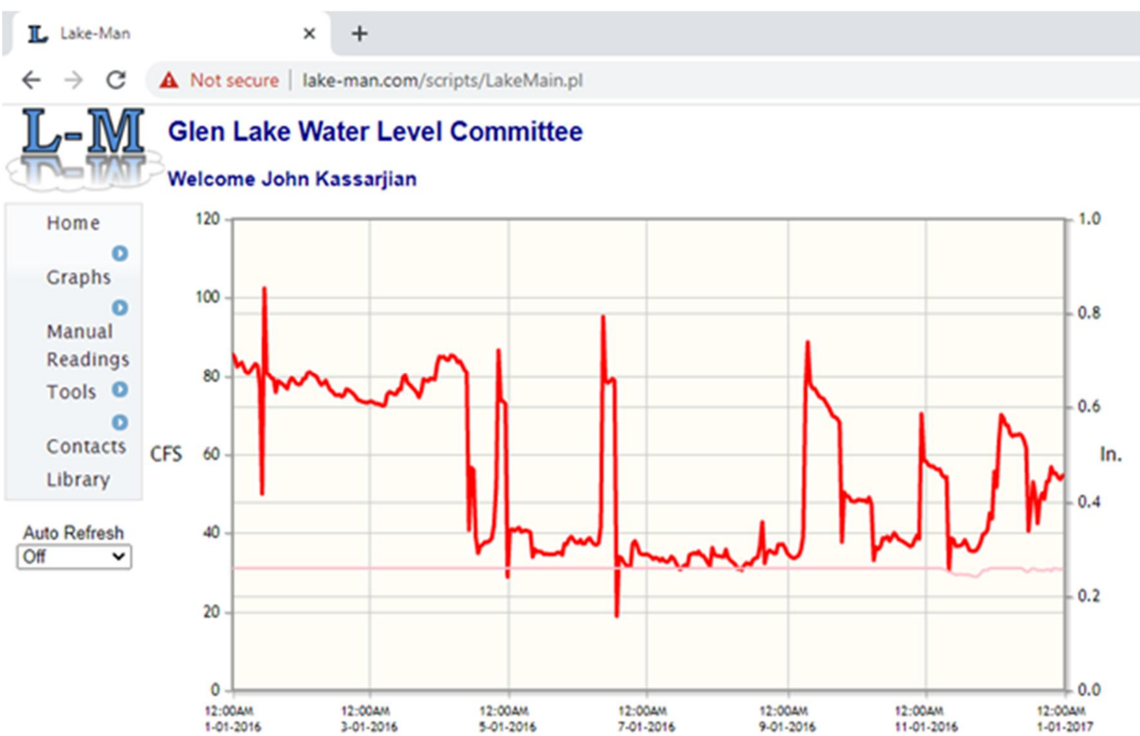
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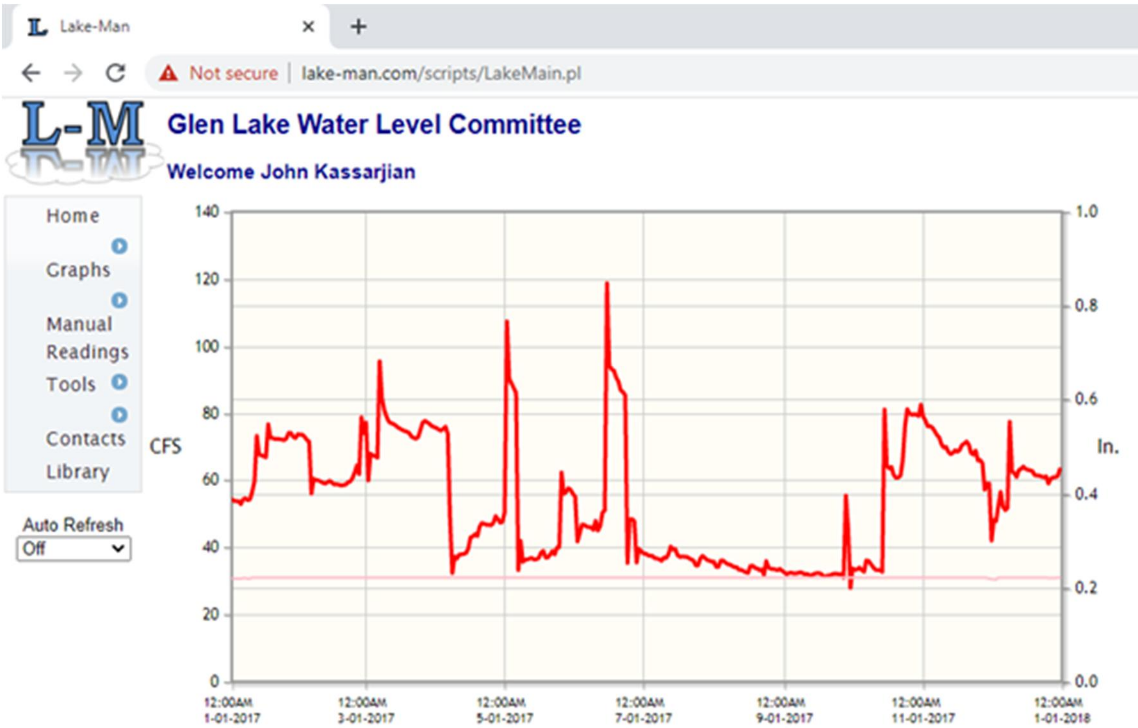

An older report dated November 2009 prepared for the Leelanau County Circuit Court – Technical Committee titled "Glen Lake – Crystal River Hydrological Assessment" was also recently provided by USDA-NRCS. An item of interest in this report is the system water balance calculations for surface water discharging over the dam to the Crystal River. Calculations of the following monthly flows over the dam for the 2006 (Average) System Water Balance were presented in this report as: April = 35.5 cfs, May = 69.5 cfs, June = 48.2 cfs, July = 33.1 cfs, August = 32.9 cfs, September = 30.9 cfs, and October = 45.9 cfs.

It is also understood that a court ordered minimum flow of 31 cfs has been established for the Crystal River system. The court order also established the normal lake level of Glen Lake at 596.75. The dam is used to maintain Glen Lake's lake level within a few inches of that elevation with the water level being slightly higher in the summer and slightly lower in the winter. These varying lake levels correspond to the higher and lower flows identified from the previous two sources as water is released in the winter for lower lake levels and retained in the summer for higher lake levels. The data from these available sources coupled with the court ordered minimum flow of 31 cfs corroborate the 35 cfs baseflow used in the HEC-RAS analysis as a valid estimate to be used with flood flows provided by EGLE for comparing changes between existing and proposed structures.

The second item presented for further clarification is the water surface elevations related to the bankfull ground elevations. Comments noted that bankfull ground elevations and water surface elevations from the 2-year event should closely match in a typical well-functioning river system. Results from the HEC-RAS models showed a consistent difference of the 2-year + base flow being about 1 foot below the bankfull ground elevation in the representative cross sections. The fact that the flow through the Crystal River is managed by the dam is likely the primary factor. The HEC-RAS modeling used a base flow of 35 cfs just above the court ordered minimum flow of 31 cfs in the river. The higher flows in the 60 – 80 cfs range released during other seasons may better align with observed bankfull elevations.

The other factor is the overall vastness of the river modeling compared to the survey data collected. There are three or four fully surveyed cross sections up and downstream of each crossing. The HEC-RAS models are generally built with cross sections approximately every 100 to 200 feet. These additional cross sections are set to the surveyed river profile with cross section floodplain data interpolated between the surveyed sections and digital model.

Following discussions with project partners and review of the original HEC-RAS modeling assumptions, it was decided that adjustments to the original model were warranted. Incremental adjustments to the Manning's roughness coefficients for the channel and overbank/floodplain areas were made in an effort to better align the 2-year flood plus base flow profile to the surveyed bankfull markers at the surveyed cross sections. The roughness coefficients adjustments were kept within the acceptable range for channel conditions that were previously observed. The HEC-RAS model for all the crossings were also updated with a separate flow regime of 35 cfs representing only the base flow without a storm event to show the low water elevations.

The updated 2 year + base flow elevation and bankfull survey elevation at the representative cross sections are as follows:

Crossing 1 (Sta 20+27)	2+Base: 583.83	Survey: 584.4
Crossing 2 (Sta 12+08)	2+Base: 586.06	Survey: 586.06
Crossing 3 (Sta 16+87)	2+Base: 587.53	Survey: 587.7

The updated hydraulic analysis table for each site are below:

Crossing 1

SUMMARY OF HYDRAULIC ANALYSIS											
		EXISTING				PROPOSED					
		WATER SURF. ELEV. (FT)		VELOCITY (FPS)		WATER SURF. ELEV. (FT)		VELOCITY (FPS)			
FLOOD DATA	BASE + FLOOD (CFS)	U/S FACE OF CULVERTS	D/S FACE OF CULVERTS	U/S CHANNEL (200 FT) (FPS)	D/S CHANNEL (@ STR) (FPS)	U/S FACE OF BRIDGE	D/S FACE OF BRIDGE	U/S CHANNEL (200 FT) (FPS)	D/S CHANNEL (@ STR) (FPS)	WATERWAY AREA (SFT) AT D/S FACE	CHANGE IN WS ELEV. U/S OF PROPOSED STRUCTURE (FT)
BASE	35	583.36	583.23	0.3	0.6	583.24	583.23	0.3	0.2	146.7	-0.12
2-YR	70	584.20	583.93	0.4	0.9	583.93	583.93	0.4	0.4	215.2	-0.27
50-YR	145	585.71	584.99	0.6	1.6	585.00	584.99	0.7	0.6	242.9	-0.71
100-YR	165	586.18	585.22	0.6	1.7	585.24	585.23	0.7	0.7	256	-0.94

THE BASE + FLOOD FLOW ASSUMES A 35 CFS BASE FLOW FROM WATERSHED.

THE MAXIMUM AREA BELOW LOW CHORD IS 335.8.2 SQUARE FEET.

THE CONTRIBUTING DRAINAGE AREA TO THIS CROSSING IS 34.5 SQUARE MILES.

THE WATER SURFACE AND/OR ENERGY GRADE ELEVATIONS SHOWN ON THIS HYDRAULIC TABLE AR TO BE USED FOR COMPARISON PURPOSES ONLY AND ARE NOT TO BE USED FOR ESTABLISHING A REGULATORY FLOOD PLAIN.

Crossing 2

SUMMARY OF HYDRAULIC ANALYSIS											
		EXISTING				PROPOSED					
		WATER SURF. ELEV. (FT)		VELOCITY (FPS)		WATER SURF. ELEV. (FT)		VELOCITY (FPS)			
FLOOD DATA	BASE + FLOOD (CFS)	U/S FACE OF CULVERTS	D/S FACE OF CULVERTS	U/S CHANNEL (170 FT) (FPS)	D/S CHANNEL (@ STR) (FPS)	U/S FACE OF BRIDGE	D/S FACE OF BRIDGE	U/S CHANNEL (170 FT) (FPS)	D/S CHANNEL (@ STR) (FPS)	WATERWAY AREA (SFT) AT D/S FACE	CHANGE IN WS ELEV. U/S OF PROPOSED STRUCTURE (FT)
BASE	35	585.00	584.93	0.3	0.5	585.00	584.93	0.3	0.3	204.2	0.00
2-YR	70	586.03	585.78	0.4	0.8	585.92	585.75	0.4	0.4	241	-0.11
50-YR	145	588.17	587.15	0.6	1.3	587.23	586.99	0.6	0.6	629.9	-0.94
100-YR	165	588.92	587.49	0.7	1.4	587.50	587.26	0.7	0.7	344.4	-1.42

THE BASE + FLOOD FLOW ASSUMES A 35 CFS BASE FLOW FROM WATERSHED.

THE MAXIMUM AREA BELOW LOW CHORD IS 513.2 SQUARE FEET.

THE CONTRIBUTING DRAINAGE AREA TO THIS CROSSING IS 34.5 SQUARE MILES.

THE WATER SURFACE AND/OR ENERGY GRADE ELEVATIONS SHOWN ON THIS HYDRAULIC TABLE AR TO BE USED FOR COMPARISON PURPOSES ONLY AND ARE NOT TO BE USED FOR ESTABLISHING A REGULATORY FLOOD PLAIN.

Crossing 3

SUMMARY OF HYDRAULIC ANALYSIS											
		EXISTING				PROPOSED					
		WATER SURF. ELEV. (FT)		VELOCITY (FPS)		WATER SURF. ELEV. (FT)		VELOCITY (FPS)			
FLOOD DATA	BASE + FLOOD (CFS)	U/S FACE OF CULVERTS	D/S FACE OF CULVERTS	U/S CHANNEL (170 FT) (FPS)	D/S CHANNEL (@ STR) (FPS)	U/S FACE OF BRIDGE	D/S FACE OF BRIDGE	U/S CHANNEL (170 FT) (FPS)	D/S CHANNEL (@ STR) (FPS)	WATERWAY AREA (SFT) AT D/S FACE	CHANGE IN WS ELEV. U/S OF PROPOSED STRUCTURE (FT)
BASE	35	588.46	587.10	0.5	1.5	587.85	587.11	0.7	0.7	69.9	-0.61
2-YR	70	589.13	587.74	0.7	2.1	588.62	587.75	0.8	1.0	113.4	-0.51
50-YR	145	590.20	588.85	0.9	2.9	589.81	588.88	1.0	1.3	195.1	-0.39
100-YR	165	590.47	589.10	0.9	3.1	590.07	589.14	1.0	1.4	214.1	-0.40

THE BASE + FLOOD FLOW ASSUMES A 35 CFS BASE FLOW FROM WATERSHED.

THE MAXIMUM AREA BELOW LOW CHORD IS 556.0 SQUARE FEET.

THE CONTRIBUTING DRAINAGE AREA TO THIS CROSSING IS 34.5 SQUARE MILES.

THE WATER SURFACE AND/OR ENERGY GRADE ELEVATIONS SHOWN ON THIS HYDRAULIC TABLE AR TO BE USED FOR COMPARISON PURPOSES ONLY AND ARE NOT TO BE USED FOR ESTABLISHING A REGULATORY FLOOD PLAIN.

Crossing 4

SUMMARY OF HYDRAULIC ANALYSIS							
EXISTING				PROPOSED			
FLOOD DATA	DISCHARGE (CFS)	WATER SURFACE ELEV. AT U/S FACE OF STRUCTURE (FT)	VELOCITY IN D/S CHANNEL (FPS)	WATER SURFACE ELEV. AT U/S FACE OF STRUCTURE (FT)	VELOCITY IN D/S CHANNEL (FPS)	WATERWAY AREA (SFT) AT D/S FACE	CHANGE IN WS ELEV. U/S OF PROPOSED STRUCTURE (FT)
BASE	3	596.52	0.2	596.50	0.1	55.0	-0.02
2-YEAR	4	596.53	0.3	596.50	0.1	55.0	-0.03
50-YEAR	38	599.33	1.4	596.75	0.7	58.8	-2.58
100-YEAR	63	600.94	1.9	597.07	1.0	63.6	-3.87

THE CONTRIBUTING DRAINAGE AREA TO THIS CROSSING IS 2.5 SQUARE MILES.

THE MAXIMUM AREA BELOW LOW CHORD IS 78.3 SQUARE FEET.

THE WATER SURFACE AND/OR ENERGY GRADE ELEVATIONS SHOWN ON THIS HYDRAULIC TABLE ARE TO BE USED FOR COMPARISON PURPOSES ONLY AND ARE NOT TO BE USED FOR ESTABLISHING A REGULATORY FLOODPLAIN.

The structure size for the Tucker Lake Outlet crossing was selected based on a review of standard aluminum box sizes that best fit the site constraints. In order to maintain adequate cover over the culvert structure and provide a buried invert, the 16’6” x 6’-8” structure was determined to fit best vertically while maximizing the span. The HEC-RAS analysis shows the flood flows all pass through the structure adequately. Discussion with Luke Golden from EGLE during a site visit confirmed that this was the main criteria he would want to see for this crossing in a permit application.

The streambed elevations at the structures were determined from the existing culvert and channel elevations in the immediate vicinity of each crossing. The differences between higher and lower culvert inverts at the crossings were split to set a stream bed elevation for the construction plans.