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October 3, 2011

Mr. Kip R. Cronk, Environmental Quality Analyst
MDEQ - Water Resources Division
Saginaw Bay District Office
401 Ketchum St., Suite B
Bay City, MI 48708

Re: Lake Isabella Dam - MDEQ File No. 11-37-0017-P
Water Level Control Study

Dear Mr. Cronk:

Our office has completed a study of the flow and level control devices in the Lake Isabella Dam. The findings of the study are presented below in this letter report.

There are three flow and level control devices in the dam. Those devices are; a 130 feet long, 41'-6" radius, half circle fixed concrete Ogee weir at an elevation of 895.0 feet; a submerged approximately 4' x 4' sluice gate over a 4' x 4' square opening to the main spillway chute at a centerline elevation of approximately 883 feet; and a submerged 1' x 1' sluice gate over a 1' diameter opening to the main spillway chute at a centerline elevation of approximately 882 feet. A 60' length of 60 inch diameter corrugated metal pipe submerged in Lake Isabella is the inlet to the sluice gate structure.

The fixed Ogee weir is the primary level control device of the dam. The crest of the weir is fixed at an elevation of 895.0 so the level of Lake Isabella cannot drop below that level unless the 4' x 4' sluice gate is opened. Fixed weirs are excellent level control devices for maintaining a minimum level in an upstream reservoir while allowing the level to rise at higher flows. The lake level above the weir is directly proportional to the flow of the river over the weir and the length of the weir. At a flow of 234 cfs the lake elevation is approximately 895.6' and at a flow of 2,353 cfs the lake elevation is expected to be 898.0', according to hydraulic calculations provided by Lapham Associates in their dam safety inspection report dated November 6, 2007. That is an increase of 2.4 feet. That is a relatively minor difference in elevation for such a wide variation in flow. However, fixed weirs, such as found in the Lake Isabella Dam, are poor flow control devices because flow is allowed to overflow the crest of the weir at whatever rate it is flowing with a corresponding increase in water level over the weir.

The sluice gate mounted over the 1' diameter opening to the main spillway is left opened continuously to provide colder water to the Chippewa River below the dam. When Lake Isabella is at the normal summer level of approximately 895.6', flow through the open 1' x 1' sluice gate is approximately 14 cfs. Flow through this open sluice gate would only

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decrease as the lake level dropped. Even the maximum flow through this sluice gate is below the minimum flow of the river so this device is not a useful level or flow control device.

The sluice gate mounted over the 4' x 4' square opening into the main spillway is the secondary flow and level control device of the dam when the level of Lake Isabella is above an elevation of 895.0'. It becomes the primary level and flow control device when the lake level is below the elevation of the crest of the weir. This sluice gate was included in the design of the dam for emergency purposes such as flood control and lowering the lake level for dam repairs. The flow through a submerged sluice gate is directly proportional to the elevation of the upstream water surface and the area of the opening. The area of the opening is controlled by manually raising and lowering the sluice gate with a pedestal gear operator at the top of the sluice gate structure. Sluice gates are poor level control devices when the flow through them is highly variable, such as the Chippewa River. The flow in the river can range from less than 110 cfs to a maximum observed event flow of 6,600 cfs on September 12, 1986. Hydraulic calculations provided for this sluice gate by Lapham Associates in their abovementioned report demonstrate why this sluice gate is a poor primary level and flow control device. For example, according to those calculations, if the water level of Lake Isabella is at 891' the flow through the sluice gate will vary from 24 cfs when opened 10%, to 114 cfs when opened 50%, and 213 cfs when opened 100%. If the sluice gate is left 50% open and the flow in the river exceeds the flow through the sluice gate, the water level in the lake will rise. If the flow in the river falls below the flow through the sluice gate, the water level in the lake will fall. Unless there is steady flow, the lake level will continue to rise and fall as the river flow varies. Previous dam inspection reports have indicated problems with wedges and rails in the sluice gates and repairs have been made in recent years to both sluice gates. Operation of these repaired gates in a partially opened configuration will make them more susceptible to vibration damage as has been seen in the past.

As the dam is currently configured, with only the weir and 4' x 4' sluice gate as flow and level control devices, it would be difficult to try to maintain a near constant level in Lake Isabella below 895.0' without considerable operator attention. Additionally, using the large sluice gate as a flow and level control device would allow silt, sediment and lake bottom debris to flow through the 60 inch corrugated metal pipe which serves as the inlet to the sluice gate structure. The silt, sediment and bottom debris would impact the river below the dam.

I can be reached in the office at (616) 988-3540, or on my cell phone at (616) 644-8520 or via email at mieras@williams-works.com if you have any questions or comments regarding this letter report.

Sincerely,

Williams & Works

Brandon Mieras, P.E.
Principal

Cc: Jim Pawloski, MDEQ Dam Safety
Rick Jakubiec, Isabella County Drain Commissioner
Bill Dunham, Lake Isabella resident
File