



# Ecological Research Partners LLC

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Duffy Dillon | Attorney  
Brennan Steil S.C.  
1 E. Milwaukee St.  
Janesville, WI 53545

Re: Review Comments on the USGS report titled “*Estimation of Natural Historical Flows for the Manitowish River near Manitowish Waters, Wisconsin*” (Scientific Investigations Report 2012–5135)

Dear Mr. Dillon:

The following are the comments concerning the U. S. Geological Survey (USGS) report titled “*Estimation of Natural Historical Flows for the Manitowish River near Manitowish Waters, Wisconsin*” (Scientific Investigations Report 2012–5135) In the USGS report the agency was contracted by the Wisconsin Department of Natural Resources (WDNR) to estimate natural flows on the Manitowish River on the outlet of the Rest Lake Dam. Natural flows would be the flow conditions if the Rest Lake Dam was not managed for varying water level conditions between summer and winter, and inflow water was discharged unimpeded.

The USGS staff estimated the natural flow based on two methods; the first method was an adjusted drainage-area ratio method, and the second was a water-budget approach.

The adjusted drainage-area ratio method is an approach where they used regression analysis to compare flows measured at a series of gauging stations and developed a relationship to use one to predict the other. This is a well-accepted method in hydrology and, based on their reasonable correlation between the monitored sites ( $R^2 = 0.75$ ), they have a good match for small and moderate flow with some variance at higher flows.

The water budget method used lake stage and dam outflow data provided by the dam operator to estimate inflow and outflow using the equation:

$$\text{DamQnat} = \text{DamQout} + \Delta S$$

Where:

- $\Delta S$  is change in storage of the Manitowish Chain of Lakes and is positive when flows entering the Chain of Lakes exceed flows leaving the Chain of Lakes (the lake stage rises), and is negative when flows leaving the Chain of Lakes exceed flows entering the Chain of Lakes (the lake stage falls),
- DamQout is the dam outflow, and
- DamQnat is natural flow at the Rest Lake Dam.

The purpose of the USGS work was only to estimate natural flow at the outlet of the system. USGS was not asked by WDNR to do any work related to current or future water levels on the system under various flow regimes. However to check the applicability of the USGS numbers I did a comparison of their results with the flows measured by Excel Energy at the Rest Lake Dam. When we compare the flow measured at the dam versus the estimated natural flows by the adjusted drainage-area ratio method and water budget methods they do not match well (see Figure 1). The adjusted drainage-area ratio method has a  $R^2$  of 0.35, and water budget method has a  $R^2$  of 0.58. A  $R^2$  value of 1.0 will indicate a perfect fit and value of 0.5 indicates that the relationship only explains for 50% of the variance. That these two data sets do not match is not surprising as actual water flows are artificially influenced by the operation of the dam.

Figure 2 is a plot of the median monthly flow measured at the Rest Lake Dam for the period of 1973 through 2011. Monthly median flows were used to eliminate some of the daily noise in the original data set. Figure 2 illustrates that major deviations from natural flows takes place in May when the dam is operated to refill the reservoir system from the winter drawdown and October when the reservoir is drained down for the winter. If we remove the months of May and October from the data set and re-plot natural flows by the water budget method versus measured flow at the Rest Lake Dam we see a much better relationship with at  $R^2$  of 0.83. Figure 2 illustrates two conclusions:

1. With the exception of May and October when artificial opening and closing of the Rest Lake Dam influences flows, the USGS water budget method matches well with the measured data. This is not surprising since the water budget method was calibrated to the measured flow and lake stage data.
2. With the exception of May and October, Excel Energy is currently operating the dam in such a manner as to pass through close to natural flow conditions.

The Environmental Assessment (EA) for the Proposed New Operation Order for Rest Lake Dam, Manitowish Waters, WI, prepared by the Wisconsin Department of Natural Resources and dated September 11, 2012 states, "*When water levels drop below 8' 4", flows over the dam are quickly reduced to minimum flows.*" The EA implies that during extended periods of the summer the minimum flow of 40 cfs is routine. A review of the data provided by Xcel Energy, and used in the USGS's analysis (Figure 2), illustrates that during most years this drop to 40 cfs does not take place. Mean monthly flows approaching 40 cfs have only occurred in August and September or 1976 and 2005, two severe draught years.

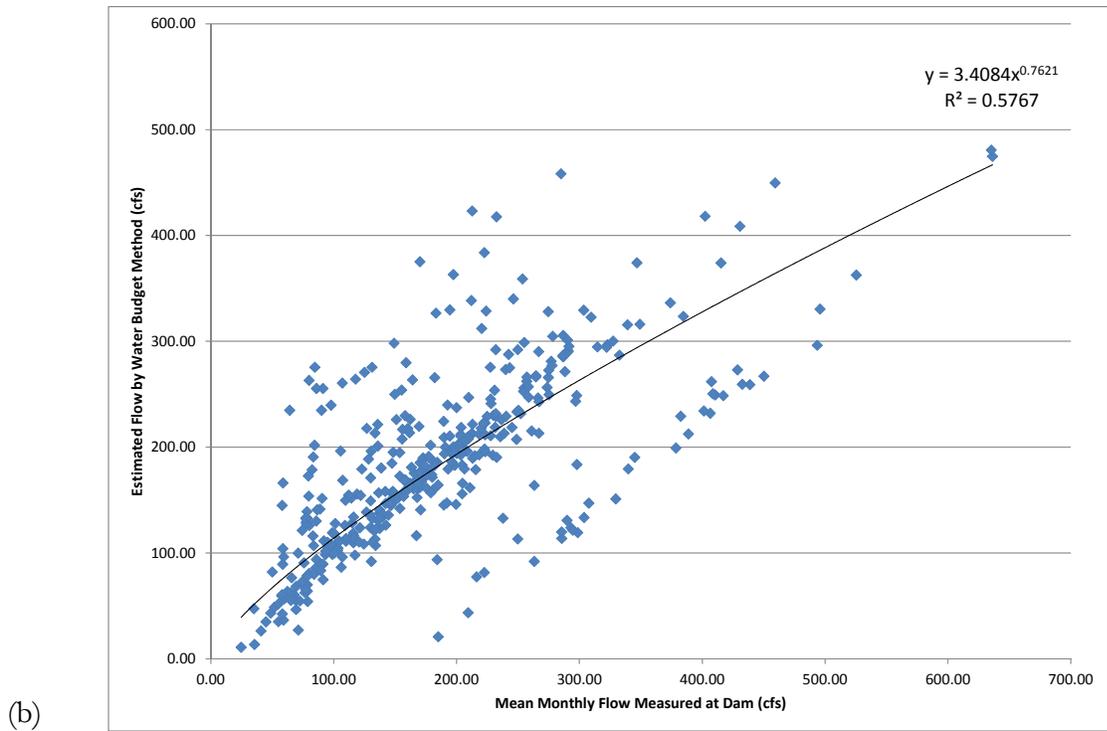
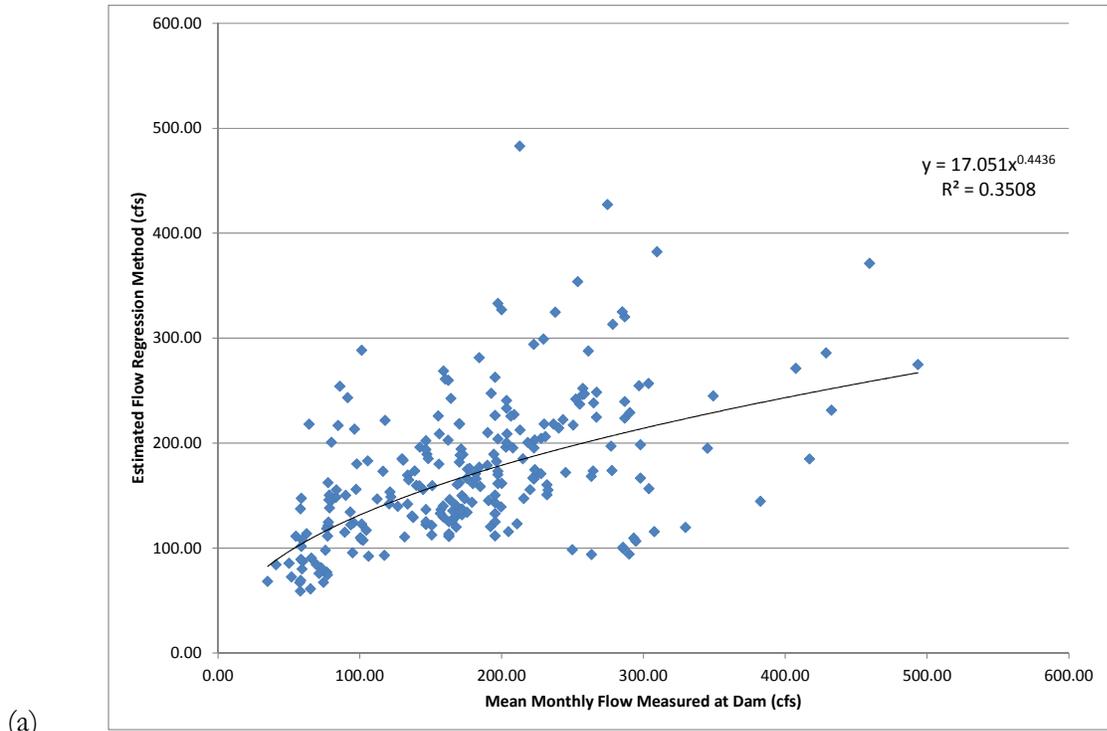


Figure 1 - Plots of Estimated Natural Flows versus Measured Flow at Dam (a) adjusted drainage-area ratio method, (b) water budget method

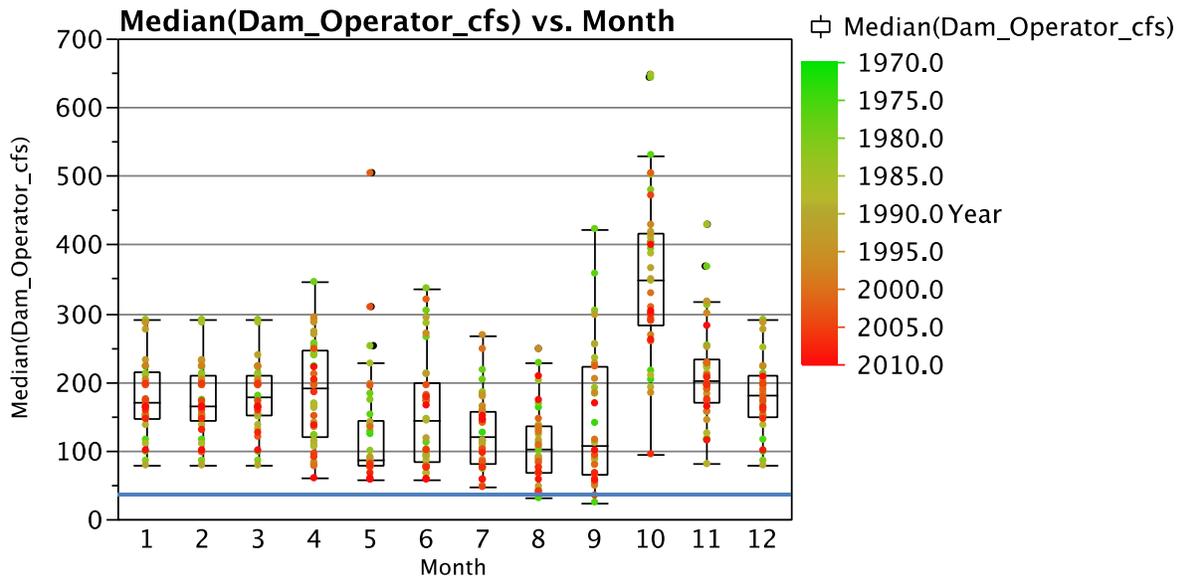


Figure 2 – Plot of Median Monthly Measured Flow at the Rest Lake Dam

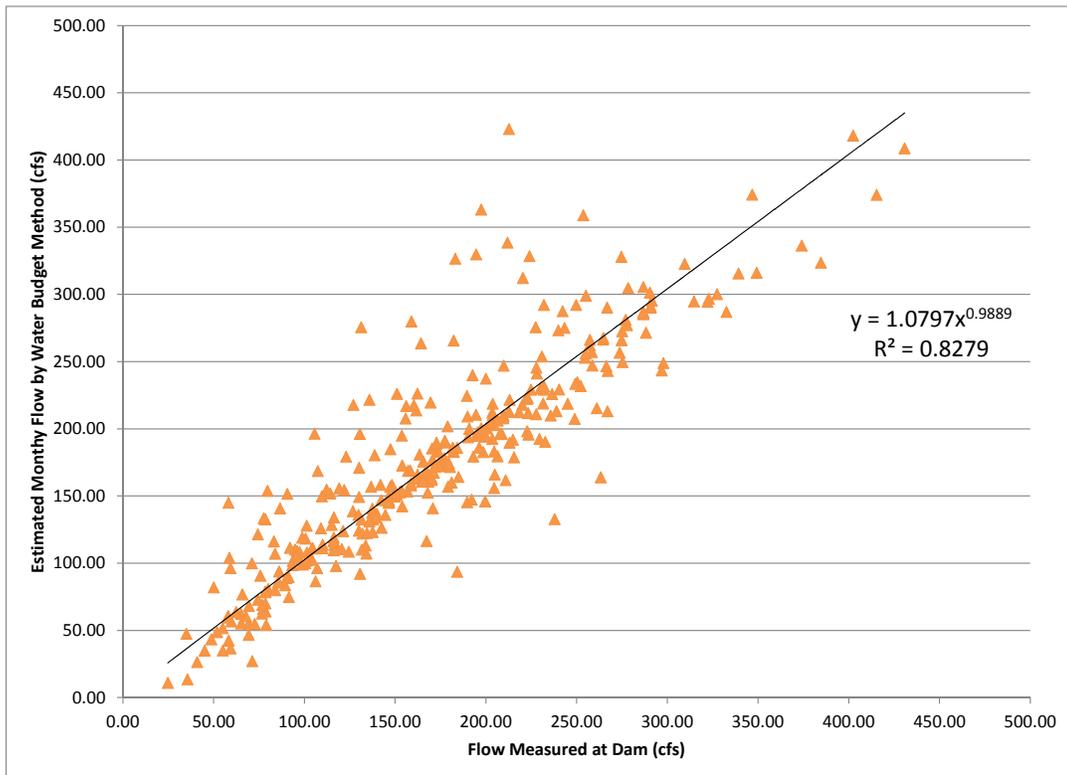


Figure 3 - Plots of Estimated Natural Flows by Water Budget Method versus Measured Flow at Dam (excluding the months of May and October)

The USGS in its preparation of the report titled “*Estimation of Natural Historical Flows for the Manitowish River near Manitowish Waters, Wisconsin*” (Scientific Investigations Report 2012–5135) followed standard hydrology methods and prepared a reasonable estimation of “Natural Historic Flows”. Within the limited scope of USGS’s contract they produced a very good product. The more important take away from the USGS work is that with the exception of May and October the current dam operation is following the natural flow regime very closely.

I would be available to discuss my opinions with you at your convenience.

Sincerely;

Neal O’Reilly, Ph.D., PH