

MEMORANDUM

TO: Basin 71 and 72 IDF&G Fish Bypass Permit Files

FROM: Corey Skinner

DATE: August 24, 2011

SUBJECT: Methodology for Flow Measurements

Recently Benny Walker and I conducted several licensing bypass permits in Basins 71 and 72. In general, these permits are for consumptive flow that is diverted from a stream through existing diversion structures. Diverted water flows down a ditch, into a fish screen structure, and then through a bypass pipe back to the original stream source at a point downstream of the diversion. The purpose of this flow is to flush fish back to the stream and prevent them from being trapped in the ditch. The fish screen structures include a slide gate opening that allows water to flow through the plate into the bypass pipe and back to the stream. Due to the variability in diverted flows, difficulty in measuring flows through these structures due to the way they were constructed, distance between structures, and other variables a methodology is needed to estimate maximum flows that can be utilized by the IDF&G bypass permits.

After examining several of the structures and bypass systems and reviewing several different sources of water measurement literature, it was determined that the most appropriate method would be to utilize an orifice flow equation that can estimate flow through orifice openings in tanks. Attachment "A" discusses the equation and the associated orifice coefficient, in particular C_d (coefficient of discharge) and the equation is as follows...

$$Q = C_d A_o (2gh)^{1/2}$$

Where C_d = coefficient of discharge for orifice
 A_o = Area of orifice opening in feet²
 g = 32.2 ft per second²
 h = measured head above center of orifice

All variables can be measured in the field except for C_d (coefficient of discharge). Based on water measurement literature, this particular coefficient can range from around 0.6 to approximately 1.0 as shown in Table 3.10 in "Attachment A" which shows the exact geometry of the opening (orifice) in the various slide gate plates. The geometry I observed is not shown in Table 3.10 in "Attachment A". Examination of various sources of water measurement literature and websites on the internet

more in the way or appropriate C_d (coefficient of discharge) value published source indicated that " C_d values can vary, but are generally

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Due to the uncertainty in the possible C_d values, but considering the opening (orifice) in the various slide gate plates and the overall flow observed, it was determined that if an accurate measurement of flow through a bypass system could be obtained, and using the orifice head reading at the time of measurement, the orifice discharge equation could be used to obtain an actual C_d (coefficient of discharge) value for the opening in the various slide gate plates Benny and I were observing. This calculated (coefficient of discharge) value could then be used in the same equation, for other bypass systems, and would result in more accurate calculated results. In addition, it could be utilized to estimate maximum flows through the bypass system at high water marks on the fish screen structures even if very little, or no flow was flowing through the bypass at the time of the exam.

Yesterday, Benny and I found a fish screen bypass system that was accurately measured and was very typical of the various systems. It was located on Fourth of July Creek, and happened to be one of the permits that needed to be examined for licensing. A Sparling Meter, mounted in a box (Idaho ID# 4335) that could be mounted on the bypass discharge pipe, was used to obtain flow measurements at a given head reading. Two separate, trials were conducted with both measurements resulting in measured flows. The following photo shows one of these measurements being conducted...





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Using this measured flow, the orifice discharge equation, an orifice diameter, and head measurements, finds that the C_d (coefficient of discharge) is 0.67 as shown below...

$$Q = C_d A_o (2gh)^{1/2}$$

Where C_d = coefficient of discharge for orifice
 $A_o = 0.087 \text{ feet}^2$ (based on measured 4 inch diameter)
 $g = 32.2 \text{ ft per second}^2$
 $h = 2.125 \text{ feet}$ (measured at 25.5 inches)

$$0.68 \text{ cfs} = C_d (0.087 \text{ ft}^2) [2(32.2 \text{ ft per second}^2)(2.125 \text{ ft})]^{1/2}$$

$$C_d = 0.67$$

It is appropriate to use a C_d (coefficient of discharge) value of 0.67 in the orifice discharge equation to estimate the maximum flow for the permits for IDF&G in Basins 71 and 72.

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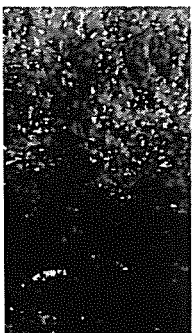
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PHOTOGRAPHER AND DATE OF PHOTOS DANIEL A NELSON 5/22/2012

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The photo above shows the fish screen for this permit.