(12/17/15) Public Workshop
Emergency Reg for Measuring & Reporting Diversions
Deadline: 12/17/15 by 12:00 noon

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12-15-15
SWRCB Clerk

November 23, 2015

State Water Resources Control Board
dwr-measurement@waterboards.ca.gov

Subject: Comments on the Emergency Regulation for Measurement and Reporting

Dear Sir or Madam:

Paradise Irrigation District (PID) has been following the development of the new measurement and reporting requirements contained in SB 88. PID writes to express its concern with the stated requirements and their application. Even with the use of best available technology it is impossible to achieve the required measurement accuracy over time intervals of one hour or less at PID facilities.

Background

SB 88 has created the requirement that water users begin new water measurement and recording efforts that include making hourly measurements of the rate of direct diversion, the rate of collection to storage, and the rate of withdrawal or release from storage. It further requires that these measurements must be "accurate measurements within an acceptable range of error." When asked to define what constitutes an acceptable range of error, Water Board staff indicated that the DWR standard would be applied. This standard apparently requires that a measurement should be accurate to within 10 percent for new measuring equipment, and within 12 percent for used equipment.

Article 3 of SB 88 lists 5 devices and methods for conducting these measurements. Considering these:

- The first method involves measuring pump output. For water right holders, like PID, that divert large flows of water by gravity, without pumping, this method is neither applicable nor practicable.
- Three methods involve making staff gage measurements. Measurements by staff gage are limited by various physical and practical conditions to a maximum accuracy of about ±0.01 feet. For water right holders, such as PID, that divert continuously throughout the year, making hourly staff gage measurements is impractical due to the cost of providing the number of personnel necessary to carry out these measurements 24 hours per day/7 days per week/365 days per year. Also, in mountainous terrain, such as the territory in and around PID, at certain times of the year areas of the watershed and potential measurement points are inaccessible due to weather and other factors.

- The final method involves making stage measurements using a pressure transducer. When asked what level of error constitutes "best available technology" in pressure transducer equipment, State Board staff stated that an error of ±0.1 percent could be considered to meet the best available technology standard. The sections that follow explain why hourly measurements are not feasible using best available pressure transducer technology.

Flow Measurement

Any method of measurement that uses water level data falls into one of two basic categories: stage/storage measurements or stage/flow-rate measurements. The use of stage/flow-rate measurements is problematic in PID's case because it owns and operates open, on-stream storage reservoirs. When measurements of stream flow are made there are several inflows that are not captured including overland flows, subsurface inflows, direct precipitation, and flows in streams judged too small to be feasible to instrument. Subsurface outflows and evaporation are also difficult to estimate and subsurface flows are impossible to measure.

Approximately 20 percent of the runoff from PID's watershed drains directly to one or the other of its two reservoirs. Since this is all water that cannot be measured by stream gages (since it does not flow in a stream) any stream flow measurement will necessarily understate the volume of water delivered to the reservoirs by at least 20 percent. This means that the error due to overland flow alone exceeds 10 percent of the measured flow and thus does not provide the mandated accuracy. While it is possible to apply a correction factor to *estimate* the overland flow (and other non-streamflow contributions) into the reservoirs it will not be possible to *measure* the total inflow. Once this estimate is formed it will be impossible to know whether the resulting data provide the required ±10 percent accuracy.

Finally, there is the difficulty of accurately measuring flows across a wide range of values. Inflows to PID's reservoirs typically range from 0.1 cfs to 1,000 cfs. We are not aware of any practical metering device that can measure water flows, with the required accuracy, for flows that vary across four orders of magnitude.

Storage Measurement

PID has pressure transducers installed at each of its two reservoirs and the SCADA facilities to log this data, although telemetry is problematic due to the rugged terrain and heavy tree cover. These pressure transducers measure the water level over a range of 40 feet of elevation. Calculations of reservoir inflow have been prepared by solving mass balance equations on storage and outflow. Even for a thirty day measurement interval these calculations have been hindered by the limited accuracy of storage volume measurements. This is particularly true when flows are relatively low, as is typical during the months immediately preceding the interval of significant precipitation. The new regulation now requires that the measurement interval be reduced by a factor of 720, from monthly readings to hourly readings.

Considering 0.1 percent accuracy to represent best available technology in pressure transducer water level measurement, the magnitude of error for pressure transducers operating over the 40 foot measuring interval mentioned above is ±0.04 feet. But for the moment let us assume that it is possible to reduce the measurement error to ±0.01 feet, consistent with careful staff gage readings. Even this level of accuracy is incapable of producing inflow rate measurements consistently in the range of ±10% error at flow rates below about 135,000 gpm (300 cfs) at PID's Paradise Lake reservoir, as shall be discussed below.

Paradise Lake reservoir has a surface area of about 240 acres when the water level is near spillway elevation. If the accuracy of a reading of water level is ±0.01 feet this equates to an accuracy in volume measurement of ±782,000 gallons. District staff has modeled reservoir performance under various typical flow conditions and analyzed the ability of best available technology equipment to measure these flows. The results reveal that hourly readings will often produce data values of no meaning whatsoever, with hundreds to even thousands of percent errors under various typical conditions.

For example, if the water level in the reservoir is falling at a rate of 0.0025 ft/hour during a time when rate of inflow is 725 gpm and 4,000 gpm is being withdrawn for use, the hourly inflow calculation will overstate the inflow by 3,275 gpm for three hours (450% error) while the total reservoir level change remains too small to be detectable by best available technology. Then in the fourth hour, when the change in reservoir level finally becomes large enough to be detected, the inflow will be vastly understated (by 9,812 gpm, or 1350% error). Under these flow conditions the reservoir inflow calculation produces negative stream inflows; a physical impossibility.

Smoothing

District staff discussed their concerns regarding accuracy with water board staff at one of the measurement and reporting information meetings. Water board staff acknowledged that reservoir water level data will move in a stepwise manner and suggested smoothing the data to avoid the problems involved in performing a calculation that is inherently unstable.

While this may seem like a solution to the problem it is actually an admission that hourly measurements are generally not meaningful. The smoothing process would make use of reservoir level data collected over a longer time frame and attempt to interpolate reservoir levels in the intervening time steps. The result is not an hourly measurement, but an estimate of reservoir levels and flow rates. There is no way to know that the actual water level was indeed the same as the value estimated for any particular time step, and the flow rate will no longer represent the value for a particular interval, but it will instead represent an average flow that fits the longer time interval.

Furthermore, the error in measurement is not simply a matter of being able to determine readings to a sufficiently small resolution. There is also the potential for a certain amount of random error in the resulting level data. An error of 782,000 gallons in an hourly measurement equates to an error in flow rate of almost 19,000,000 gallons per day, or 13,000 gpm. An error of 782,000 gallons in a daily measurement equates to an error of only 540 gpm. Random error will give the impression that reservoir volume is changing, when in fact the indicated change is not occurring. Random measurement errors can occur on any time scale but they will increase the magnitude of error in flow calculations as the reporting time scale becomes shorter.

Smoothing Interval

Based on the limitation on accuracy of the measurement of reservoir volume and on the allowable error in flow measurement, it is possible to calculate the time interval needed for smoothing. First, the required accuracy of flow measurement, A_F, (dimensionless) is:

$$A_F = \frac{|Q_a - Q_m|}{Q_a}$$

where: Q_a = Actual rate of inflow, gpm

Q_m = Measured rate of inflow, gpm

Then, the measured rate of inflow differs from the actual rate of inflow by:

$$Q_m = Q_a \pm \frac{E_V}{T_S}$$

where: E_V = Volumetric error, gallons

T_S = Smoothing Interval, minutes

Rearranging, and combining the two equations gives:

$$A_F = \frac{|Q_a - Q_m|}{Q_a} = \frac{E_V}{T_S Q_a}$$

Then, solving for the smoothing interval, T_S:

$$T_S = \frac{E_V}{A_F Q_a}$$

Analyzing the Paradise Lake reservoir, for a required 10 percent accuracy of flow measurement, an accuracy of volume measurement of ±782,000 gallons and an actual flow rate of 1 cfs (449 gpm) the smoothing interval is 290 hours, that is, 12 days. At an inflow rate of 12 cfs the smoothing interval is 24 hours.

At a smoothing interval of 1 hour or less (that is to say, with no smoothing of hourly readings) the inflow rate must be 300 cfs or more. Inflows in this range occur extremely infrequently. This demonstrates that most hourly measurements cannot provide the required ±10% accuracy. Since the value of Q_a is unknown in practice, it will not be possible to use the analysis above to make a determination of the appropriate smoothing interval to be used for calculating Q_m to the required level of accuracy.

Considering the technical obstacles to getting meaningful measurements on an hourly time scale, PID urges water board staff to reconsider the requirement to collect and report hourly diversion data for reservoir operations. Installation of best available technology for measurement of water diversions, while expensive, makes sense because the calculation of diversions will be hindered without good measurements of key parameters. However, an attempt to extend the accuracy of the resulting data beyond its natural limits does not make sense and is unscientific. Such an effort will be costly, without consequent benefit, and the data obtained will be misleading at best.

Reporting

The amendment to Section 5103 requires: "Each statement shall be prepared on a form provided by the board." Presumably this means an internet form on the board's website, as is the current practice. Assuming that a diverter provides hourly measurements, in compliance with the minimum requirement, this will comprise 8,760 points in time per year. Since the regulation requires that the date, time, rate of direct diversion, rate of collection to storage and rate of withdrawal from storage be reported, this means that, at a minimum, water right holders will be required to report 43,800 numerical values to the state each year, for each water right they hold.

Currently, the board's data reporting protocol requires that each data point be keyed into individual cells in an internet form. PID has three water rights to report. At a rate of 12,000 keystrokes per hour, a preliminary estimate of the time necessary for PID to complete the data entry task, under these conditions, for one year's measurements is 511 hours, or three person-months of fulltime employment.

If the proposed expansion in reporting is to take place, a streamlined process for data entry needs to be provided. A means must be available for diverters to upload the measurement data to the water board without re-keying it. This could be accomplished through the use of an electronic form (for example, a spreadsheet form) or by using a standard file format to upload and automatically populate the fields of the form on the board's website.

Conclusion

PID submits the following recommendations for implementation of the measurement and reporting regulations:

1. Remove the requirement for hourly measurement and reporting for any water rights holders for whom compliance with this requirement is impossible. This would include owners and operators of reservoir facilities where this requirement for reporting frequency, combined with the stated reporting accuracy of ±10 percent, cannot be accomplished using best available technology.

2. Provide a streamlined method for reporting diversions data to the State. Eliminate the requirement for water rights holders to re-key data into the State's data collection system.

Thank you for giving consideration to our concerns regarding the development of the new measurement and reporting regulations. Paradise Irrigation District is committed to cooperating with the state water board to the extent possible. However, it would be unfortunate if the new regulations were implemented in a manner which makes compliance impossible.

If you have questions regarding these comments please contact the undersigned. Thank you.

Sincerely,

George Barber
General Manager, Paradise Irrigation District