PROPOSAL TO COLLECT AND PROVIDE DIVERSION FLOW DATA AT SELECT DELTA SIPHONS

Watermark Engineering, Inc.

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TO: Michael George
Select Delta Consortium Members

FROM: Patrick Stiehr, PE
Gary Baker, FTS

RE: Proposal to Collect and Provide Diversion Flow Data at Select Delta Siphons

INTRODUCTION

The following provides a general road map to develop a methodology and protocol to provide flow data at several delta diversions. While Watermark is available to provide the needed services, it is hoped that the various consortium members will be active participants, and that Watermark will provide guidance and technical support as needed. I hope you can convince the various groups to step forward.

The goal near the end of 2021 is to have a standardized methodology and several siphon flow records presented in a format acceptable to the reviewing agencies. This would provide a path forward to begin the process of comparing diversion data with ET, an important next step.

OVERVIEW

To date, there have been several diverters and engineers that have tried a variety of programs to determine diversions. It seems most everyone started at ground zero and went to manufacturers for guidance. The results have been mixed at best. Reliable stream gaging is never cheap, and in the delta, not easy.

Two separate data needs were confirmed during the 2017 irrigation season at the TNC siphon: channel water level (upstream head) and siphon pressure on the land side of the siphon (downstream head). These provide a pressure differential that is needed to determine flow. The Pressure Sensor Measuring Methodology is explained later in this document.

3153 Jenna Court
Roseville, CA 95747
Phone: 916- 774- 1111, Fax: 916- 774- 1181
Mobile: 916- 715- 1167, email: pstiehr@wtrmark.com

During the 2018 irrigation season, a new site was established by WEI to evaluate the pressure sensor methodology. At the Dante Weir, a delta channel (channel) water side elevation monitor and a pressure sensor in the pipe were installed. The weir downstream of the siphon was used for calibration and comparison.

Based on the testing result at the Dante-Weir on Empire Cut, the pressure differential approach is cost-effective, and appears to be reliable and accurate. In addition, it has not experienced many of the problems encountered by the other methodologies, e.g. power issues, data gaps, and data outliers. Note that the weir is a stand-alone measuring device at this siphon, so the pressure sensor (ps) methodology is redundant. However, the site does provide an optimum location to test the ps methodology because the weir flow data are readily available from a proven measuring methodology.

It is my opinion that the results were acceptable but only as a first step. After two years of mixed reviews from other teams, I may have underrated the results. Figure 1 shows the two pressures during periods when the siphon was open, charged but not flowing, and flowing. It is easily shown when the siphon is being used.

This information was used to create a rating that was then used to compute siphon flow. Figure 4 shows the comparison of flow measured at the downstream weir compared to flow computed with the pressure differential rating. Datum was not established, and so the comparison was not as accurate as it could be. The resulting correlation between measured flow at the weir and computed flow from the rating appears to be well within the required accuracy goals.

This information is provided to show a solid first step and the basis for further data collection and analyses.

Three different data collection platforms were used at this site out of expediency and readily available equipment. In the future, all monitoring equipment will be from FTS, connected to the FTS cloud. FTS is a 40-year old company that manufactures and supports environmental monitoring worldwide. It is approved by the USGS, the godfather of environmental monitoring.

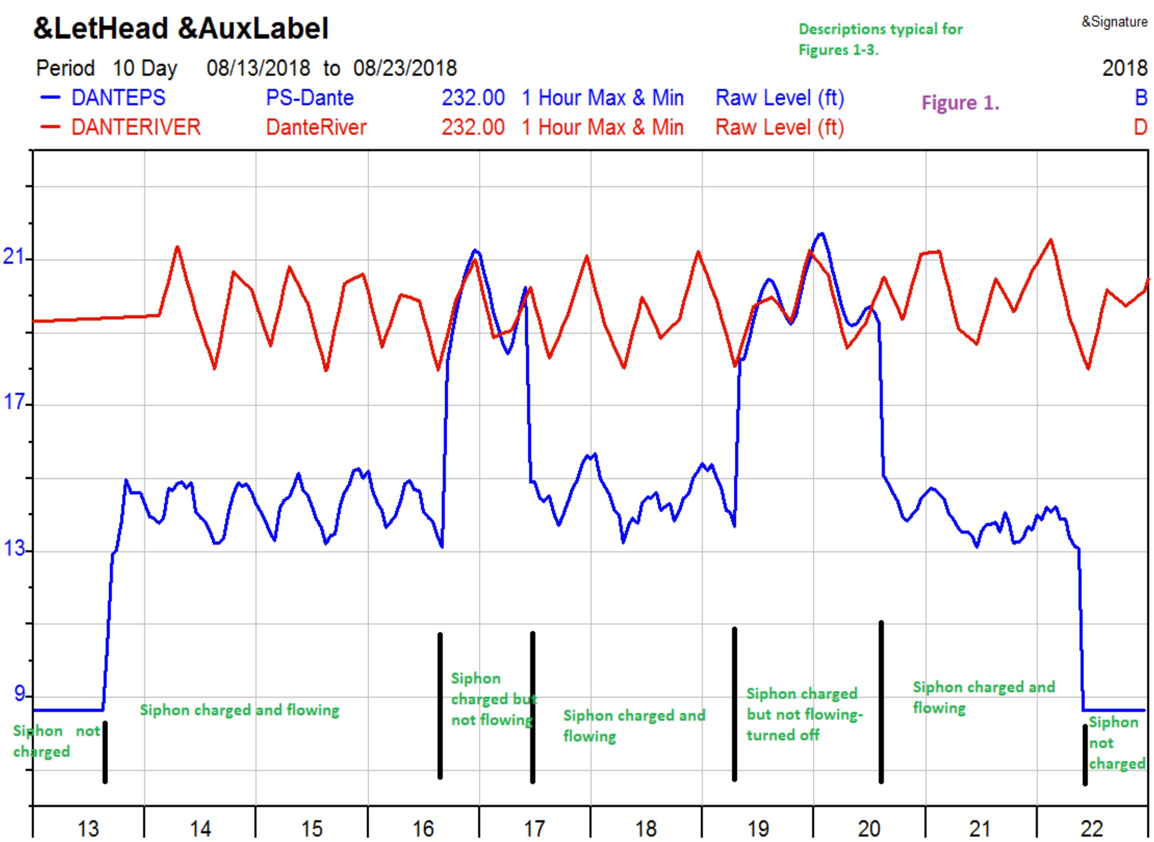

Figure 1. Plots of Water Elevations (or pressures) of Water Side and Within Siphon. No datum.

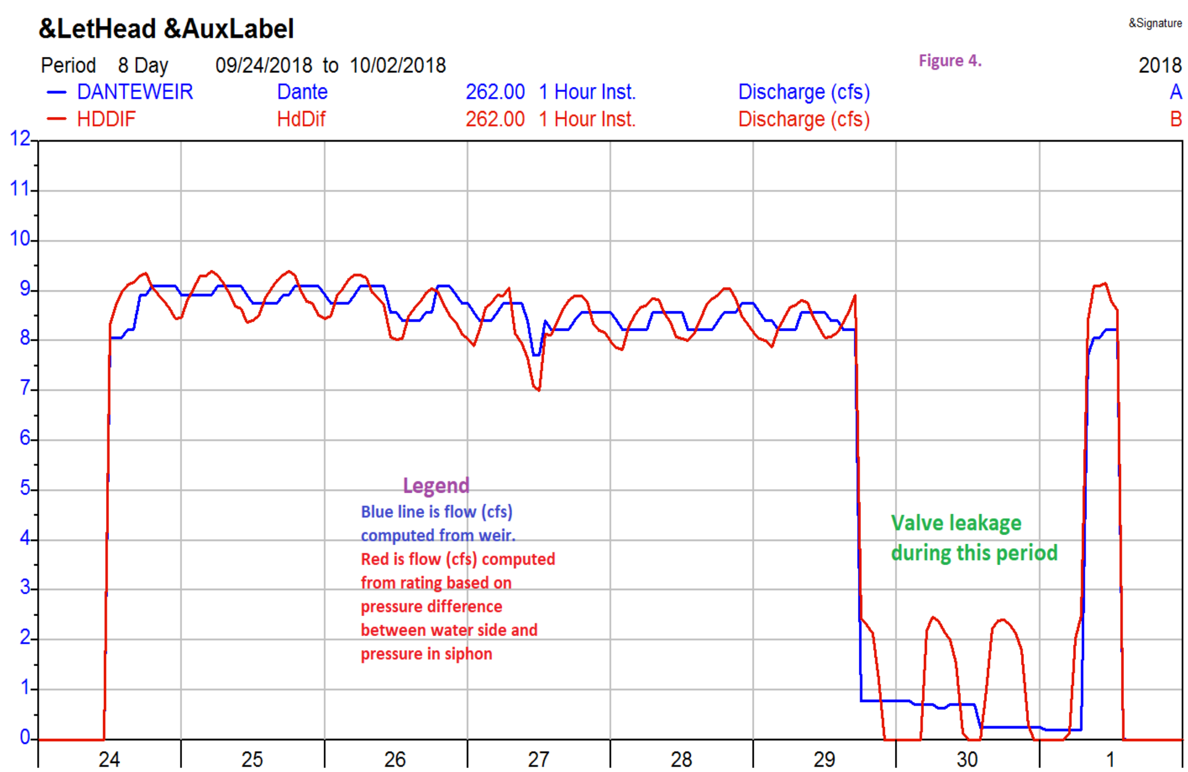

Figure 2. Comparison of Measured Flow at Weir vs Computed Flow Using Pressure Differential

DATA COLLECTION PROGRAM

The proposed program will be based on up to four independent collection pods. Each pod will consist of a channel side water-level sensor and a pressure sensor installed on the land side at 2 to 3 nearby siphons. Each data collection point will include all appurtenances necessary to record and transmit water level data to the FTS cloud. The website can be accessed at FTS360.

The channel side data will be used as one of data sources for each of the nearby siphons being monitored. In addition to the data collection, there is also a calibration process associated with each siphon. More information is provided later.

Ideally, there would be a pod within each area managed by the major participants of the consortium, the South and Central Delta group, TNC, MET, DWR, and The Freshwater Trust. I believe it would be very helpful if these groups were fully invested as a team to determine if this will become the preferred method to correlate actual river diversions with ET information.

APPROXIMATE COST PER POD

The cost estimate is based on approximately 12 siphons clustered within four groups so that only four channel gages are needed to provide data for the 12 siphon gages.

Siphon Monitoring Equipment	3 sites @ $2,200 ea	$ 6,600
Channel side Monitoring Equipment	1 site @ $3,800 ea	3,800
Gage Installations	4 @ $500 ea	2,000
Two calibrations each siphon	6 @ $400 ea	2,400
Rating preparation and flow computations	3 @ 800 ea	2,400
	Total Cost per Pod	$ 17,200

There is an additional cost of $7,000 that would add the Cap Poly SLO irrigation expertise to the group effort. Their expertise will be valuable, help ensure efficiency, and will add credibility to our efforts.

All of these costs are based on new installation and could be reduced by using previously prepared sites, or a reduced number of siphons at each pod. Based on the spottiness of siphon use, it is recommended to monitor at least three siphons at each pod.

PRESSURE SENSOR MEASURING METHODOLOGY

There are a lot of details that are not included, but an overview of the methodology is provided. As noted above, the methodology requires collecting data on two variables –delta channel (channel) water level and valve settings.

Channel water level is affected by flow and tidal effects. It is constantly changing. Higher channel level produces greater flow. The simplest way would be to measure channel water level at each siphon intake, but that is not cost-effective. The alternative is to select a central channel measuring site at each pod and use that data at the nearby siphons- not the most accurate but certainly acceptable at this stage.

Note that there may be an opportunity to incorporate the Delta Simulation Model II (DSM2) sometime in the future, but that is beyond the current scope of this effort.

The second variable that affects siphon flow is valve setting. The more open the valve, the greater the flow. Measuring the valve setting accurately is difficult because of the "play" in the screw assembly, unlimited variation of settings, and the inaccuracies trying to record the actual valve setting. The reliance on accurate valve setting information is probably unrealistic.

The pressure sensor on the land side of the siphon is the surrogate for the valve setting. It generally will account for the actual valve setting as well as downstream backwater at the siphon outfall.

The measuring process is as follows when the siphon is charged. (Naturally, there is no flow unless the siphon is charged.)

1. Valve is closed. At this condition, both the channel water level reading (ft.) and the pressure sensor reading in the pipe (psi) are reading the same hydrostatic head. This establishes the zero flow condition and allows the hydrographer or technician to confirm that both readings are similar and accurate.
2. Valve opened slightly. (¼ to ¾ turn) At this condition, there will be a head differential between the channel water level and the pressure sensor reading. The pressure sensor will read less because of the head loss (energy loss) or energy used to push the flow through the siphon.
3. Valve opened incrementally more. The head differential will increase because it takes more energy (head) to push a greater flow through the siphon.
4. Valve fully open. This would show the maximum head loss at maximum flow for this channel stage. The maximum siphon flow with the valve fully open will change, dependent on upstream channel level, i.e. high tide vs low tide.

While most of the siphons are similar, there are several sizes, and each siphon has its own hydraulic characteristics. To define these characteristics, each siphon would be field calibrated. The calibration will define the relationship between the head loss between the two data points (channel water level and pressure in the pipe), and the measured flow in the siphon. The measured flow readings will be obtained from a portable "strap-on" ultrasonic meter or similar device. This approach is the typical and usually the most cost-effective way to develop and define this relationship to compute flow.

The actual calibration process is as follows:

1. Install the channel and siphon monitoring devices and start recording data.
2. Charge the siphon for at least 24 hours to establish and confirm that the channel level readings and the siphon pressure readings are consistent. Both will show the tidal water level changes.
3. Thereafter, set up the portable measuring device at the site.
4. Make at least 10 valve settings through the full range from closed to fully open.
5. Record water level, pressure in the siphon, and flow from the portable flowmeter at each valve setting.
6. Repeat.

This process should be completed at least twice at each siphon to evaluate the accuracy and reproducibility of the calibration process.

The flow information will then be plotted (x-axis) versus the head differential (y-axis) to define the relationship (identified as a rating) between head loss and flow rate specifically for that siphon. The rating is then used during periods of diversion to convert hourly head differential readings to hourly flows.

SUMMARY

Watermark Engineering has specialized software to efficiently review and clean data, prepare ratings based on the calibrations, and compute flow records based on USGS standard methodologies. This effort will be open and provided to all of the involved in the process. The goal is that every sub-group could continue with the data collection, analyses, and preparation of flow records at these sites or other sites going forward.

I did stream gaging for the USGS for about 5 years early in my career, and have since installed, operated, and produced flow records of various durations and purposes at more than 50 gage sites. Since 1998, I continue to work for TRI-DAM on their FERC and downstream canal gage sites.

Gary Baker of FTS is also available to provide technical expertise related to data collection, storage, and management. He has about 30 years of experience providing sales and service of environmental monitoring equipment. He has also been instrumental in the development of the FTS website.

Both of us would like to will to be gainfully employed on this effort, but are also willing to devote a significant amount of time to fully evaluate the pressure differential approach. The goal is to determine if this approach is both technically and economically superior compared to the other current efforts.

Please call or email if there are questions or if additional is needed.

Thank you for your consideration and support.