RECLAMATION

Managing Water in the West

TR-2010-02

Tracy Fish Collection Facility: Alternative Operations Evaluations

Dates of travel: June 7-10, 2010

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Hydraulic Investigations and Laboratory Services Group
Denver, Colorado

BUREAU OF RECLAMATION
Technical Service Center
Denver, Colorado

TRAVEL REPORT

TR-2010-02

Date: June 16, 2010

Code: 86-68460

To: Robert Einhellig, Group Manager
Hydraulic Investigations and Laboratory services Group (84-68460)

From: Bryan Heiner, Hydraulic Engineer
Connie Svoboda, Hydraulic Engineer
Hydraulic Investigations and Laboratory services Group (84-68460)

Subject: Tracy Fish Collection Facility Alternative Operations Evaluations

1. *Travel period:* June 7 – 10, 2010

2. *Places or offices visited:* Tracy Fish Collection Facility (TFCF), Tracy, CA

3. *Purpose of trip:* This trip originated from an ongoing research study investigating alternative facility operations involving closing bypass lines to increase primary bypass ratios (BR). As the trip approached several additional objectives were identified and requested from other research engineers at the Denver Office. The main objectives can be identified as follows:

I. Alternative Operations:
   a. Obtain velocity profiles 10 ft upstream of each bypass for different operational conditions.
   b. Determine if closing bypasses is an acceptable alternative operations to keep BRs above 1 and keep secondary hydraulic conditions within operational criteria.

II. Large Fish Holding Tank Design
   a. Become familiar with the facility and operations.
   b. Determine the relative elevation differences at the facility where the large fish holding tanks will be located.

III. Fish Friendly Pumps (primary bypass)
   a. Obtain the location and size for the access vaults on the primary bypass lines.
   b. Determine what flow meters are currently installed and operational on each primary bypass.

IV. Traveling Fish Screen
   a. Learn and understand the techniques used to set the screened water bypass flow.
   b. Investigate valve and sump layouts and operational considerations.

c. Investigate the existence and operations of the venturi meter in the screened bypass line.
d. Obtain a flow measurement on the screened bypass if possible.
e. Obtain the pump curves for the current screened bypass pump.
f. Determine which pumps in the screened bypass are operational and the frequency each unit is operated.

V. Electric Barrier Tests
a. View the fiberglass flume available at the TFCF.
b. Get dimensions of flume for developing a test plan.

VI. Miscellaneous
a. Measure velocity profiles in front of all four bypasses to see differences and compare them to the primary channel velocity meter.
b. Determine if the primary channel velocity meter accurately calculates discharge.
c. Determine the open and closing times for the primary bypass control valves and determine at which flow rate the secondary displays stop working.
d. Determine changes in velocity profiles downstream of the trashrack due to various trashrack differentials.
e. Work with Tom Moser (Tracy C&I Mechanic, TO-437) on data collection with the new M9 SonTek RiverSurveyor equipment.
f. Discuss the CVACS system with Ron Silva and Brent Bridges.

4. *Synopsis of trip:*

Upon arrival, Connie Svoboda and Bryan Heiner went to the Tracy field office to pick up instrumentation including the Qliner and some surveying equipment that was borrowed from the field office. While there Connie was able to introduce Bryan to Tom Moser (TO-4437). Tom is responsible for communications and mechanical instrumentation at the Tracy Fish Collection Facility (TFCF). After introductions were complete, Connie and Bryan headed to the TFCF where they met Brent Bridges. As this was Bryan's first visit to TFCF, Brent (TO-411) gave an extensive tour of the facility and its operations. Before leaving for the day Brent, Connie and Bryan discussed the objectives and arranged with facility operations to complete each task. As many different activities commenced simultaneously, a chronological synopsis will not be included, instead each completed task will be explained individually.

I. <u>Alternative Operations:</u>

To evaluate the alternative operations, hydraulic data including velocity profiles upstream of individual bypasses were recorded for different operating conditions. To obtain velocity profiles an OTT Qliner Acoustic Doppler Current Profiler (ADCP) was fixed to a rope and floated approximately 12 feet upstream of each bypass intake as in Figure 1. Velocity profiles were averaged over a 60 second interval at 2000 kHz allowing the effects of outliers and boat movement to be minimal.

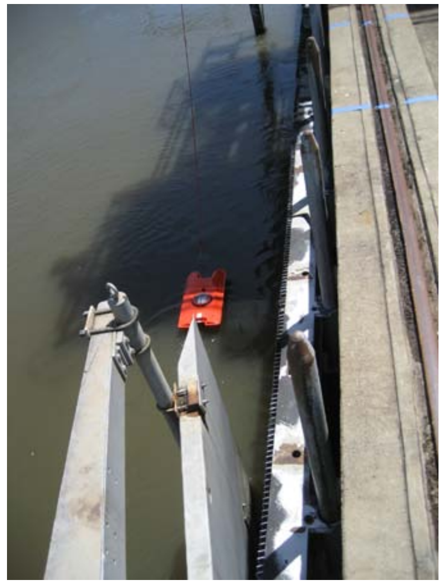

Figure 1 - OTT Qliner floating upstream of bypass intake.

The first velocity profile and hydraulic data were collected on bypass 1 during an outgoing tide with the TFCF operating under standard procedures. All bypasses were fully open and the secondary flow was 85.6 cfs with a velocity of 2.14 ft/s at 5.0 ft deep with VC pumps 3, 4 and 5 operating. At this configuration the average BR in the primary was approximately 1.11. Velocity profiles were collected at 12 and 15 feet upstream of the bypass. It was the original intent to collect the profiles at 10 and 15 feet. Unfortunately when attempting measurements at 10 feet upstream of the bypass, poor signal to noise ratios were achieved and no reliable velocity data could be collected.

The second velocity profile and hydraulic data were collected in the same locations as the first with bypass 1 being completely closed instead of open. After bypass 1 was closed, no adjustments were made to the system hydraulics to adjust for changes incurred by closing bypass 1. When bypass 1 was closed the secondary flow was 86.1 cfs, the secondary velocity was 2.41 ft/s and the depth was 4.47 feet with the average primary BR approximately 1.39. Although the primary BR increased, the secondary velocity increased by 0.3 ft/s and the flow depth was reduced by 0.5 ft.

To provide further insight on the facility impact caused from closing one bypass, the third set of velocity profiles and hydraulic data were collected with VC pumps modified to standard operating conditions while leaving bypass 1 closed. When this was complete VC pumps 3, 5 and 6 were in operation and the flow in the secondary was 80.3 cfs with a velocity of 2.08 ft/s at 4.82 ft deep, with the average primary BR approximately 1.17.

It appears that closing primary bypasses can either be used to increase the primary BR (however the secondary depth declines and secondary velocity increases) or it can be used to reduce the secondary velocity while maintaining the same primary BR. Additional data was collected to detail this phenomenon. Results and discussions will be presented in a technical memorandum written by research engineers from the Denver Office.

A fourth test was conducted to determine the extent that the velocity profile entering bypass 1 changed if all bypasses were closed and the VC pumps were progressively turned on forcing more water to pass through bypass 1 with each VC pump that is put into operation. Four different VC configurations were tested including: only VC 1; VC 1 and 2; VC 1, 2 and 3; and VC 5 with the bypass valve set at 45 degrees.

Preliminary review of the velocity profiles were created but are not included in this trip report but will be presented in a technical memorandum. Visual comparison of preliminary profiles provided assurance that no more velocity profiles were needed to complete the alternative operations project. In general the velocity profile distribution did not change in shape regardless of the hydraulic configurations that were being tested. When more flow enters a bypass the velocity profile shifts to a larger velocity magnitude but the profile keeps the same basic shape.

The future needs for the alternative bypass operations includes collecting TFCF hydraulic data at the lowest low tide possible, and under several tidal conditions when 5 pumps are in operation at the C.W. "Bill" Jones Pumping Plant.

II. Large Fish Holding Tank Design

In order to meet the previously mentioned objectives in regards to the large holding tank design Brent Bridges took Connie Svoboda and Bryan Heiner on an extensive tour of the facility. Included in the tour was an explanation of operating procedures, valve, meter and piping locations and operational and facility requirements.

To properly design the inflow and discharge of the new large temporary fish holding tank it was necessary to obtain the relative elevation where the tank will be located. Surveying equipment borrowed from the Tracy area office was used to collect these elevations. Figure 2 shows the proposed location of the new tank along with the ground surface elevations relative to the top of the current holding.

Figure 2 - Elevations for the new large temporary holding tank design

III. Fish Friendly Pumps (primary bypass)

The size and location of the access vaults for the primary bypass control valves and flow meters were measured using a tape measure. To determine the layout of the interior of the vaults photos were taken from the man access hole because confined space requirements prevented research engineers from entering the pits.

There are 3 pits total, 2 of the pits hold bypass line 1 and 2 individually then bypass lines 3 and 4 are contained in a single vault. Measurements of the size of the vaults are found in Figure 3. Figure 4 is an example of the interior of the vaults. Each bypass line has 2 control valves, an access port and a flow meter. The flow meters for each of the bypass lines are Panametrics DigitalFlow DF868 ultrasonic meters. One of the bypass access vaults was full of water during investigation which indicates that the flow meters have submersible transducers attached to the pipes.

Figure 3 - Primary bypass lines access vaults with dimensions

Figure 4 - Primary bypass access vault control valve, access port and ultrasonic transducer

IV. Traveling Fish Screen

New Hydrolox traveling fish screens are to be installed in the secondary channel. These screens will replace both the secondary louvers with one traveling screen that will span a larger distance at a steeper angle to the flow. In order to properly size the screened water bypass that was designed to minimize the amount of debris entering the holding tanks, a flow measurement of the supply water was needed. Drawings indicate that a venturi meter was designated on the supply line; however this meter is not currently installed. Instead, the pit where the meter should have been has a straight section of pipe with ultrasonic transducers installed. Unfortunately the ultrasonic transducers are not currently operational. Tom Moser indicated that he has new transducers and a controller available to install on this pipe, but has not been able to begin the installation.

In addition to obtaining a flow measurement from the screened bypass it was important to understand the operations. Pump curves for the screened water bypass were collected from Ron Silva (TO-410) a supervisory civil engineer from the Tracy field office. The pump is a constant speed pump designed to pump 8100 gpm at 690 RPM and 8 ft of head. Flow passes through the pump and into a collection sump by means of a flapper valve. The flow is either sent to the screened water system by means of a 24 inch pipe and valve or recirculated by means of a gate valve that allows the water to reenter the sump.

V. Electric Barrier Tests

Investigations are underway to test the effectiveness of using electrodes to remove predators from the primary and secondary channels. A recirculating flume available at the TFCF may be used to observe fish response to electrical fields in moving water. Figure 5 provides an overview of the flumes dimensions and a Figure 6 gives a photograph of the flume.

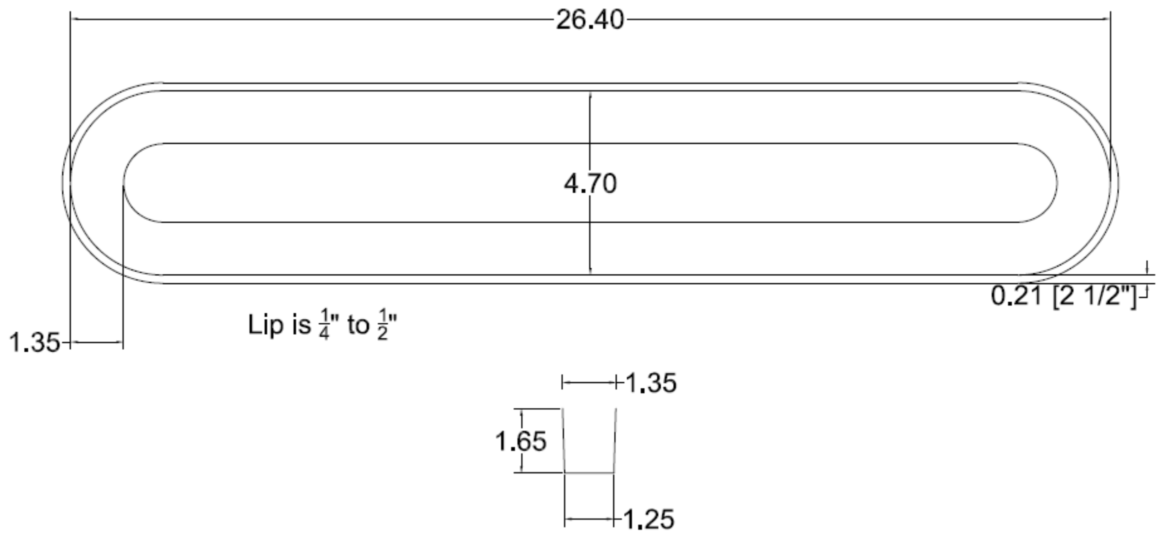

Figure 5 - Recirculating flume dimensions

Figure 6 - Photograph of the recirculating flume

Currently the generator that runs the pump has a leaking fuel line which prevents it from being operated. In order to develop a test plan for these experiments, the flume needs to be repaired so the maximum velocity and discharge can be determined.

VI. Miscellaneous

a. *Measure velocity profiles in front of all four bypasses to see differences and compare them to the primary channel velocity meter*

Velocity measurements were taken about 12 feet upstream of each bypass during a high tide to see how well distributed the velocities were when compared to each other. In addition the average velocity at each bypass entrance was compared to the RD Instruments Channel Master acoustic Doppler current profiler that is installed in the primary channel. The reason for this research is to determine if the current method for calculating the BR in the primary is adequate. Currently the discharge in each bypass is summed from the bypass flowmeters and then divided by the flow area (bypass width of 0.5 ft times the flow depth in the primary channel times 4 bypasses) to obtain the velocities entering each bypass. The BR is then calculated by dividing the average bypass velocity by the mean velocity in the primary channel from the primary channel flowmeter. This assumes that an even distribution of velocity is found at each of the bypasses. This calculation will be an accurate estimate as long as a particular bypass does not have a mean entrance velocity significantly higher than the others. If one average velocity entering a bypass is greater, the BR estimate will be higher than the actual BR, and must be adjusted to ensure that the BR is not below 1. Velocity profiles were taken with the OTT Qliner attached to a 15 foot pole to allow easy movement and accurate positioning at each of the bypass entrances. This was convenient because there was no need for an operator to assist the researchers while they collected velocity profiles. Hydraulics in the primary and secondary were set to standard operating conditions. VC pumps 1, 3 and 4 were on and the flow in the secondary was 114.1 cfs at 5.56 ft depth. Depth in the primary upstream of the louvers was 17.66 ft. Figure 7 shows the average velocity profile upstream of each primary bypass.

Table 1 provides a summary of the findings where column 1 is the bypass; column 2 is average velocity entering the bypass as measured by the Qliner instrument; column 3 is the flow in the bypass as measured by the bypass flowmeters; column 4 is the average channel velocity from the primary channel velocity meter; and column 5 is the percent deviation from the average of the velocities from all four bypasses.

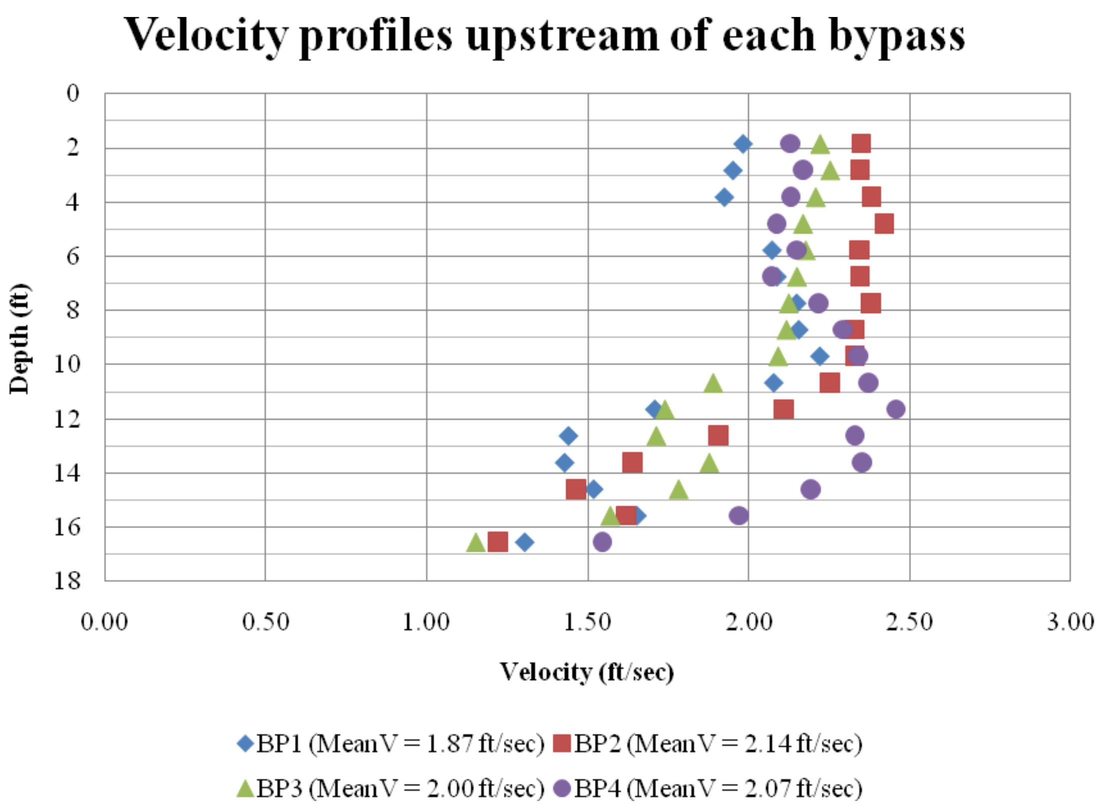

Figure 7 - Velocity profiles upstream of each bypass with the same hydraulic conditions in the secondary channel.

Table 1- Summary of primary bypass velocity distributions

Bypass	Measured Velocity Upstream of Bypass	Flow in Bypass	Primary Channel Velocity Meter	Difference from avg. upstream velocity
(#)	(ft/sec)	(cfs)	(ft/sec)	(%)
1	1.87	31.03	2.10	8%
2	2.14	28.93	2.10	-6%
3	2.00	27.63	2.10	1%
4	2.07	25.40	2.10	-2%
Average	2.02		2.10	4%

All individual average bypass velocities were within ±8 percent of the overall average bypass velocity. From this it can be assumed that calculating the BR using the previously mentioned method will provide an accurate representation of the BR for all of the bypasses. The largest deviation in velocity profile occurs at bypass 1, which if the current method to calculate BR is conducted will result in a BR lower than the actual BR.

b. *Determine if the primary channel velocity meter accurately calculates discharge and velocity.*

Row 5 in

Table 1 gives the average velocity found in the primary channel 12 feet upstream of each primary bypass. This average velocity was compared to the primary channel velocity meter and a 4 percent difference was found between the two measurements. During this test at high tide, the primary channel flowmeter provided an accurate measurement of the average channel velocity. However, this verification was for a single water stage and tidal condition, and does not validate the velocity measurements across the complete tidal operating conditions.

Due to tidal fluctuations at the TFCF, the relative depth of the Channel Master instrument changes with the tide. To account for tidal fluctuations, the channel can be indexed to create a relationship between the meter-indicated velocity and the actual primary velocity. The primary depth and velocities can be collected using the new ADCP, the M9 RiverSurveyor. The relationship coefficients created can be input into the meter to allow an accurate velocity measurement to be obtained.

Due to filling and draining of the channel during incoming and outgoing tides, two equations relating the indexed velocities may be required. The allowable input parameters for the Channel Master instrument must be checked to see if multiple regressions can be entered.

In addition to indexing the velocity measurements across the expected range of tidal fluctuations, the equation for calculating the discharge needs to be changed to reflect the geometry of the primary channel (maximum channel width is 84 ft).

c. *Determine the open and closing times for the primary bypass control valves and determine at which flow rate the secondary primary flow meter displays stop working.*

Table 2 contains a summary of the closing and opening times for each primary bypass control valves. By closing all bypasses but one and then increasing VC pumping, the maximum discharge through each bypass line at the given primary water depth was run. Included in the table are the maximum readings that the bypass flow meter displays located in cabinet 1 (cabinet with the depth readings) will display. It was assumed that the bypass flow meters were not operating when the flows were above 50 cfs, however this is not the case. The flow meters will operate up to 40 ft/sec in the pipes but the display screens in cabinet 1 will only output up to around 50 cfs. When flows are higher than this only the display screens located in cabinet 2 (by the bypass pits) will display the flow.

Table 2 - Summary of primary bypass opening and closing times and max flow meter readouts

Bypass (#)	1	2	3	4
Cabinet 1 MaxQ (cfs)	51.50	50.30	49.20	46.20
Cabinet 2 MaxQ (cfs)	53.90	51.80	49.10	45.10
Time to close (min'sec")	2'20"	2'30"	2'22"	NA
Time to open (min'sec")	NA	2'32"	2'24"	2'24"
Primary Depth (ft)	17.20	17.20	17.22	17.24
Secondary Depth (ft)	2.44	2.23	2.33	2.51

d. Determine changes in the velocity profiles downstream of the trashrack due to various water surface differentials

Brent Bridges requested that velocity profiles be taken directly downstream of the trashrack to see how uniform the velocity profiles are when the trashrack is clean and how those profiles change as a water surface differential builds across the trashrack. Two different instruments were used to measure the velocity profiles downstream of the trashrack. First the Qliner ADCP was used to obtain velocity profiles directly downstream of each bridge bay centerline. Velocity profiles were collected over 60 second time interval at 2000 kHz.

Figure 8 overlays velocity profiles when the differential across the trashrack was at 0.06 ft, 0.47 ft and 1.61 ft for each of the 5 bridge bays. The velocity head increases with increasing water surface differential. Notice how with 0.47 ft of differential across the trashrack velocity profiles become more skewed over the water depth.

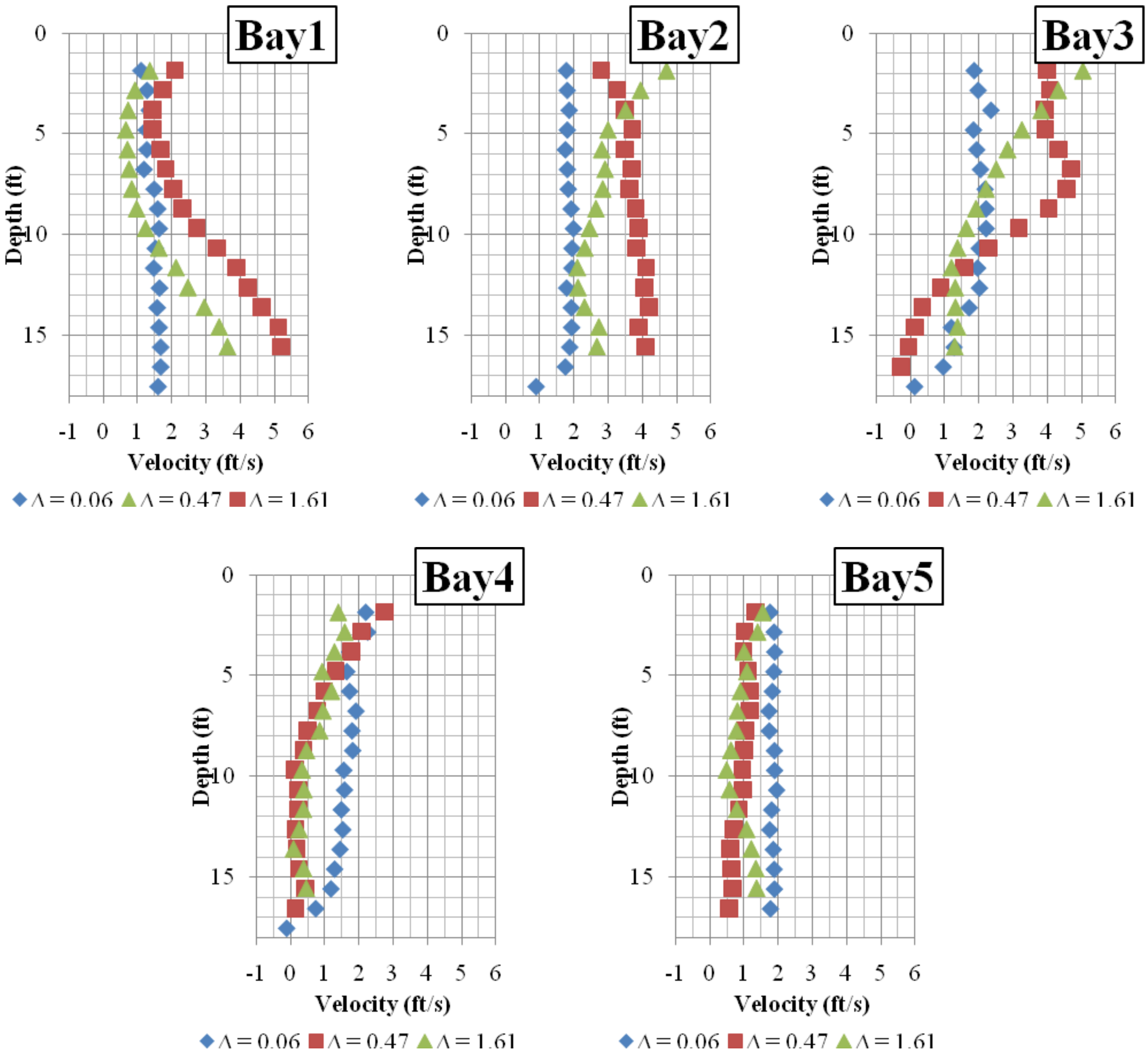

Figure 8 - Velocity profiles downstream of trashrack for each bay with increasing trashrack differential

The second method for obtaining velocity profiles was using the M9 RiverSurveyor provided by Tom Moser. Using this system complete velocity profiles across the entire section of the channel were obtained. Figure 9 and Figure 10 provide a comparison of how the whole channel velocity profiles changes when the differential is increased from 0.06 ft to 1.9 ft. Velocity profiles are given as a colored grid with a maximum velocity of 6 ft/sec to allow comparison (flow is into the page). Note the localized 'hot spots' in the velocity displayed in red occur at the top of the profile. These 'hot spots' are the locations where the trashrack did not have as heavy debris buildup. Downstream of these locations the water was incredibly turbulent with large undulating white capped waves.

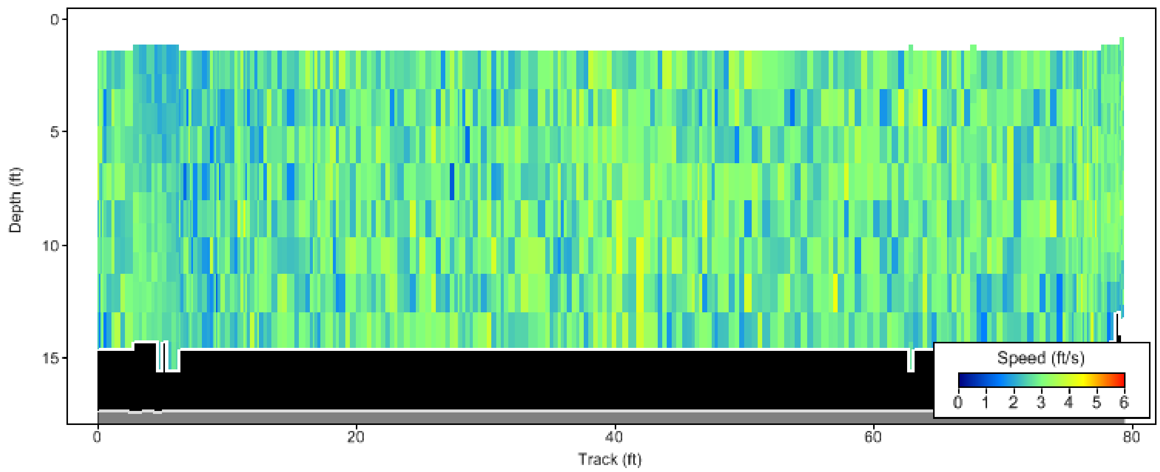

Figure 9 - Complete velocity profile downstream of trashrack with 0.06 ft of differential across the trashrack (flow is into the page)

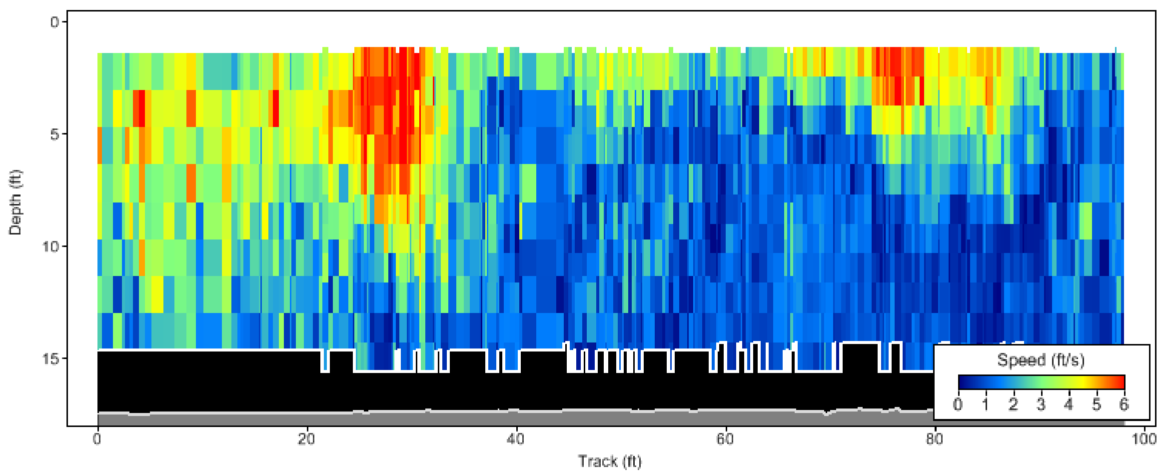

Figure 10 - Complete velocity profile downstream of trashrack with 1.90 ft of differential across the trashrack (flow is into the page)

As trashrack differential increased, time and total differential were collected. Figure 11 is a plot of trashrack differential vs time with a exponential trendline fit to the data. Once debris begins to pile up on the trashrack, more debris is retained due to the smaller flow openings such that the trashrack differential increases exponentially with time. In order to predict debris buildup over time, times were normalized by assuming that at 0.06 ft trashrack differential the time was zero.

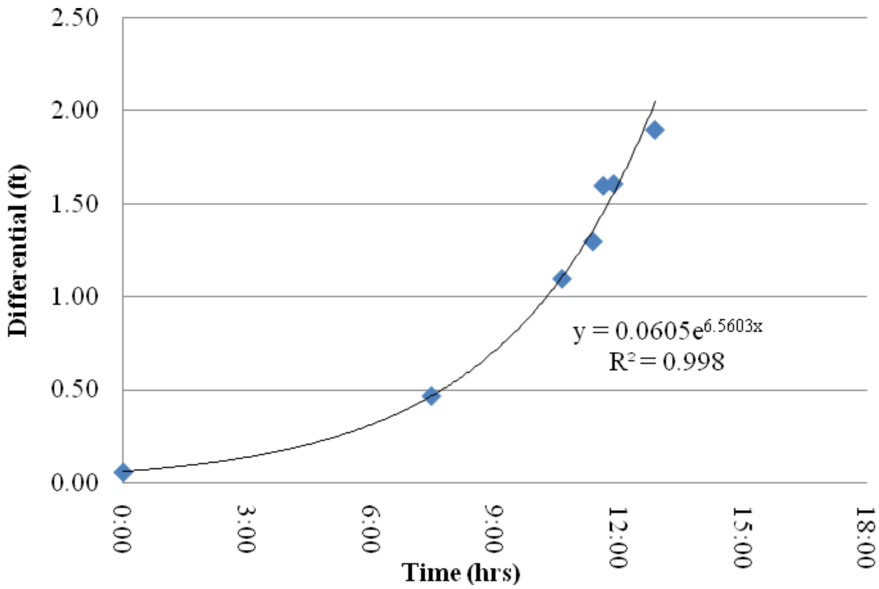

Figure 11 - Trashrack differential vs time

e. *Work withTom Moser (Tracy C&I Mechanic, TO-437) on data collection with the new M9 RiverSurveyor equipment.*

Tom was already well prepared for using the M9 RiverSurveyor before research engineers arrived. A few measurements were taken by Tom to demonstrate the equipment. Detailed analysis of the data provided by the instrument will be done by research engineers from the Denver office. Recommendations included setting up a permanent cable and tagline will allow ease of use and accurate discharge measurements. Unfortunately collecting a single velocity profile at a specified location is difficult to do with the RiverSurveyor.

f. *CVACS system with Ron Silva and Brent Bridges.*

A short meeting involving Connie Svoboda, Ron Silva and Brent Bridges commenced on June 10, 2010 to discuss the CVACS system, its current status and to assign future tasks that need to be completed. Currently the graphical user interface screens are completed. The status of the instrumentation that is currently connected to the CVACS system was undetermined because the computer system would not allow Ron to login. Future work that needs to be competed includes:

1. Send the users manual and functional descriptions electronically to Ron Silva
2. Finalize manual and function descriptions or note which sections are incomplete.
3. Discuss with Tom Moser what parameters are connected.
4. Talk to Brent Mefford (86-68460) about incorporating a touch screen 10-minute count computer into the re-design of the 10-min count station.
5. Determine from Joel Imai (TO-460) and Mike Wiseman if all TFCF operators have CVACS accounts.