2012 Update on the Thermal Impact from the Farmers Irrigation District Hydroelectric Facility on the Hood River

Introduction

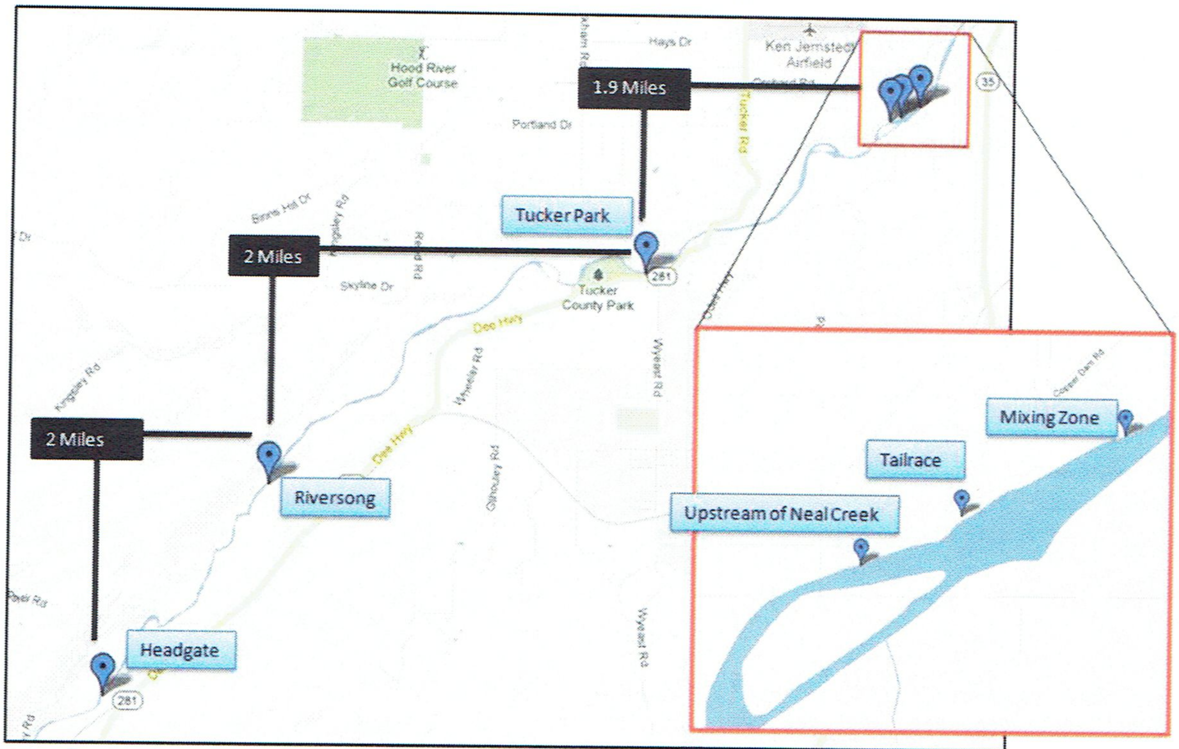
This report is an update to Farmers Irrigation District's (FID) *Thermal Impact on the Hood River from the Farmers Irrigation District Hydroelectric Facility* paper released in January 2012. Temperature monitoring in the Hood River has continued through 2012 to continue assessment of the thermal impact of FID's hydroelectric system operations on the bypass reach and of tailrace water inputs on the mainstem Hood River. This extended voluntary study supports a 2011 MOA with Oregon Department of Fish and Wildlife (ODFW) and Oregon Department of Environmental Quality (ODEQ) providing support for Low Impact Hydro Institute certification. Data presented in this report were collected and assessed by the Hood River Watershed Group (HRWG) in an effort to gain third-party assessment and corroboration.

Methods

The HRWG Technician took over data collection and analysis from FID Technicians starting May 8, 2012. Throughout the year, water temperature data were collected at 6 points along the Hood River, beginning at the upstream end of the project at the Farmers Canal diversion and ending at the Mixing Zone below the FID Hydroelectric Plant #2 tailrace return flow. Temperature data were collected at relatively uniform intervals (~2 miles each) along the Hood River (Figure 1). Temperature data collection sites (and the rationale for site selection) on the Hood River are as follows:

1. Headgate, at the Farmers Canal diversion inlet on the Hood River, located at river mile 11.4 – to establish the ambient, baseline Hood River water temperatures independent of any influence from FID hydroelectric plant operation.
2. Riversong, located approximately 2 linear miles from the Headgate site – to provide temperature data along the project bypass reach below the point of diversion and above the FID facility tailrace in an effort to discern the natural thermal response along the project bypass reach, as well as the thermal impact of FID hydroelectric project diversion.
3. Tucker Park, located approximately 4 linear miles from the Headgate site – to provide temperature data along the project bypass reach below the point of diversion and above the FID facility tailrace in an effort to discern the natural thermal response along the project bypass reach, as well as the thermal impact of FID hydroelectric project diversion.
4. Upstream of Neal Creek on the Hood River, located downstream of the Odell Creek convergence, but approximately 40 meters above the Neal Creek convergence – to provide temperature data near the end of the project bypass reach, but upstream of the FID hydroelectric plant tailrace flows, in an effort to discern the natural thermal response along the project bypass reach, as well as the thermal impact of FID hydroelectric project diversion.
5. Tailrace of the FID hydroelectric plant, prior to tailrace flow entering the Hood River at approximately 7.45 river miles downstream of the Farmers Canal inlet – to assess the thermal impact of water diverted through the Farmers Canal and discharged at the hydroelectric plant tailrace.
6. Mixing Zone, located approximately 500 feet downstream of the FID hydroelectric plant tailrace, in a sample area where the hydroelectric plant discharge is approximately 25% of the total Hood River flow amount during the late summer months – to assess the comprehensive thermal impact of FID hydroelectric plant operation on the Hood River compared to the natural thermal response absent hydroelectric plant diversion.

FID Thermistor Locations for 2012 Temperature Study



Note: Thermistor locations in linear distances are approximations.

Figure 1: Temperature data collection points for 2012.

Water temperature data were collected hourly throughout the year. All temperature data were collected and recorded using HOBOware Pro software v.3.4.0, as well as HOBO U22 Water Temp Pro v2 Data Loggers. The operation range for the sensors is -40°C to 70°C in air with a maximum sustained temperature of 50°C in water. Over a range 0°C to 50°C, sensor accuracy is +/-0.2°C and sensor resolution is 0.02°C at 25°C. For this study, the loggers were secured in place so that the risk of lost data was minimized. Care was taken to ensure that the loggers would withstand flood flows and the loggers were inspected on a regular basis to ensure that they did not become buried in sediment. Data retrieval before May 8th was sporadic. After May 8th, with a few exceptions, data were retrieved, downloaded, and plotted on a monthly basis (so as to detect and correct any anomalies related to faulty equipment or placement in the field). On these same monthly checks, the logger temperature readings were audited by a temperature reading from the HRWG's NIST thermometer (DEQ SN 51021 through August and SN 53065 after August). For all comparisons, the logger readings and field readings met DEQ's highest data quality level. The loggers were also calibrated using DEQ's water bath method on June 7, 2012. At the end of 2012, the data were compiled, checked for quality, and plotted. The 7-Day Maximum Moving Average water temperatures were generated utilizing the worksheet developed by the ODEQ Laboratory Quality Assurance Section.

The mean daily air temperature values were obtained from the US Bureau of Reclamation (BOR) Agrimet station at the Mid-Columbia Agricultural Research and Extension Center within the FID territory, a short distance from the FID hydroelectric facility. The average daily flow values (Q) in the Hood River were obtained from the USGS gauge site at Tucker Bridge, within the project bypass reach. The data for all of these parameters are stored electronically by HRWG and available upon request.

Results

Stream temperatures are highest at all monitoring sites in late summer. In general, stream temperatures at the downstream sites are warmer than sites upstream. Based on the 7-Day Maximum Moving Average water temperatures, the Upstream of Neal Creek site is warmer than the Mixing Zone site, especially during the summer months. The tailrace temperature is often colder than both the Upstream of Neal Creek and Mixing Zone temperatures (Figure 2). The temperature at the Upstream of Neal Creek site and Mixing Zone site are similar during the period of no diversion, but much less so during other parts of the year, especially summer (Figure 3).

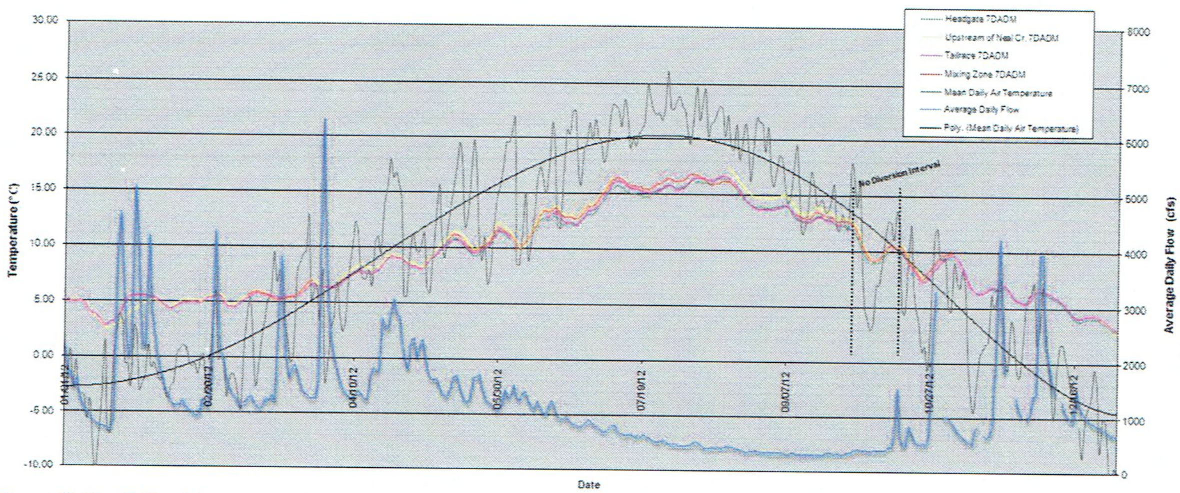


Figure 2: The 7-Day Maximum Moving Average water temperatures (°C) at the Headgate, Upstream of Neal Creek, Tailrace, and Mixing Zone sites for 2012. Mean daily air temperature (°C) and average daily flow (cfs) in the Hood River at Tucker Bridge are also shown. The vertical dotted lines delineate the period when the FID diversion was closed and therefore no water was diverted from the Hood River into the Farmers Canal.

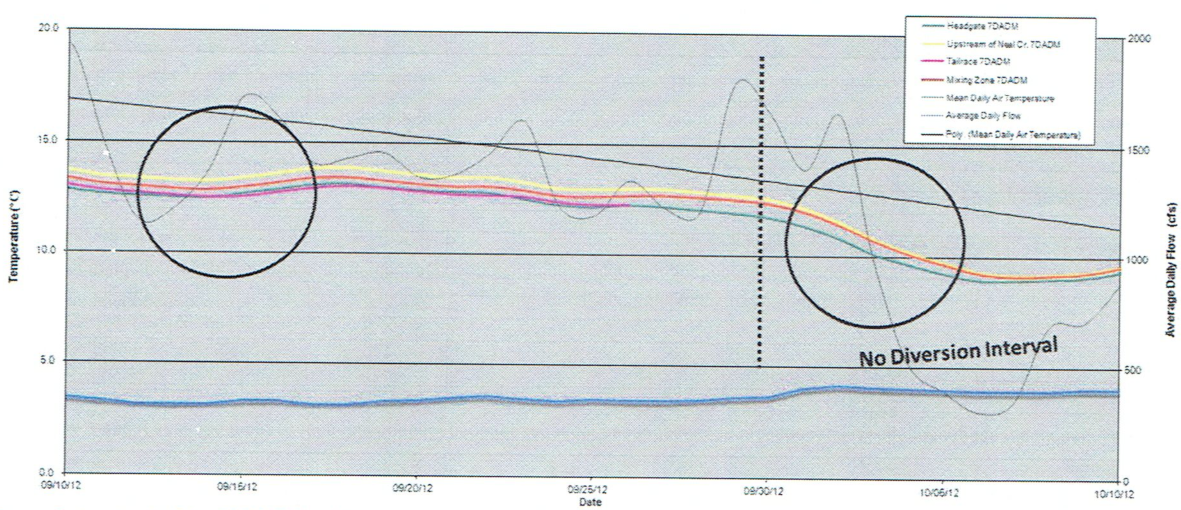


Figure 3: A subset of the 2012 7-Day Maximum Moving Average water temperatures (°C) at the Headgate, Upstream of Neal Creek, Tailrace, and Mixing Zone sites from September 10th to October 10th. Circles highlight a period of high diversion and a period of no diversion for comparison. The vertical dotted line delineates the beginning of the period when the FID diversion was closed and therefore no water was diverted from the Hood River into the Farmers Canal. Mean daily air temperature (°C) and average daily flow (cfs) in the Hood River at Tucker Bridge are also shown.

The temperature deltas between sites appear to spread during late summer and converge in the winter. The same pattern of Upstream of Neal Creek temperatures being warmer than Mixing Zone temperatures can also be seen in the temperature differential calculations (Figure 4). The delta between Upstream of Neal Creek and Mixing Zone temperatures reduces during the period of no diversion, although the delta between the temperatures at all sites also reduces during a part of this same period. A sudden ambient air temperature drop was also observed during this period (Figure 5).

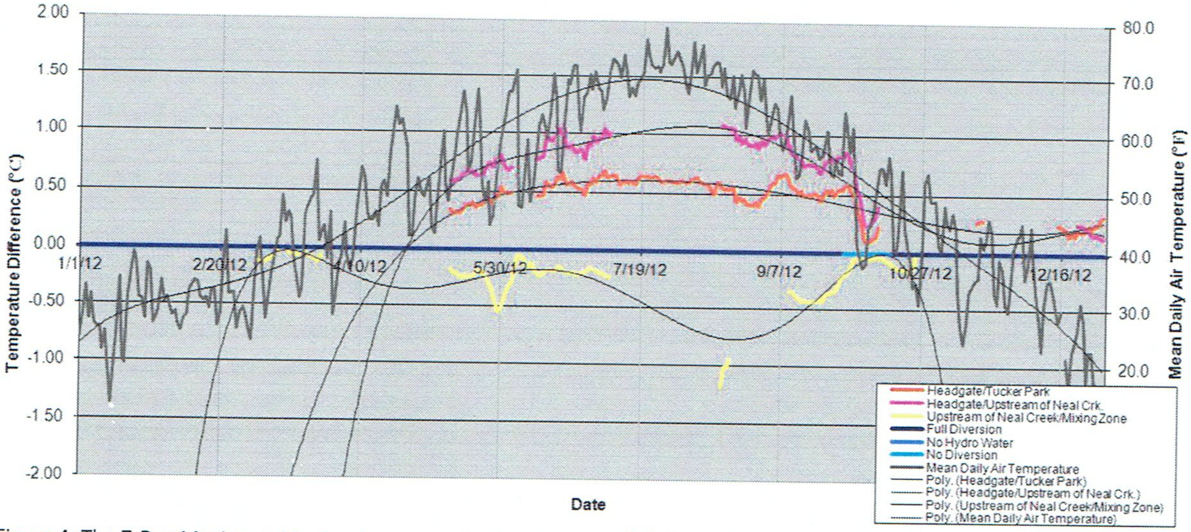


Figure 4: The 7-Day Maximum Moving Average water temperature (°C) deltas for the Headgate to Tucker Park, Headgate to Upstream of Neal Creek, and Upstream of Neal Creek to Mixing Zone sites for 2012. Mean daily air temperature (°F) is also shown.

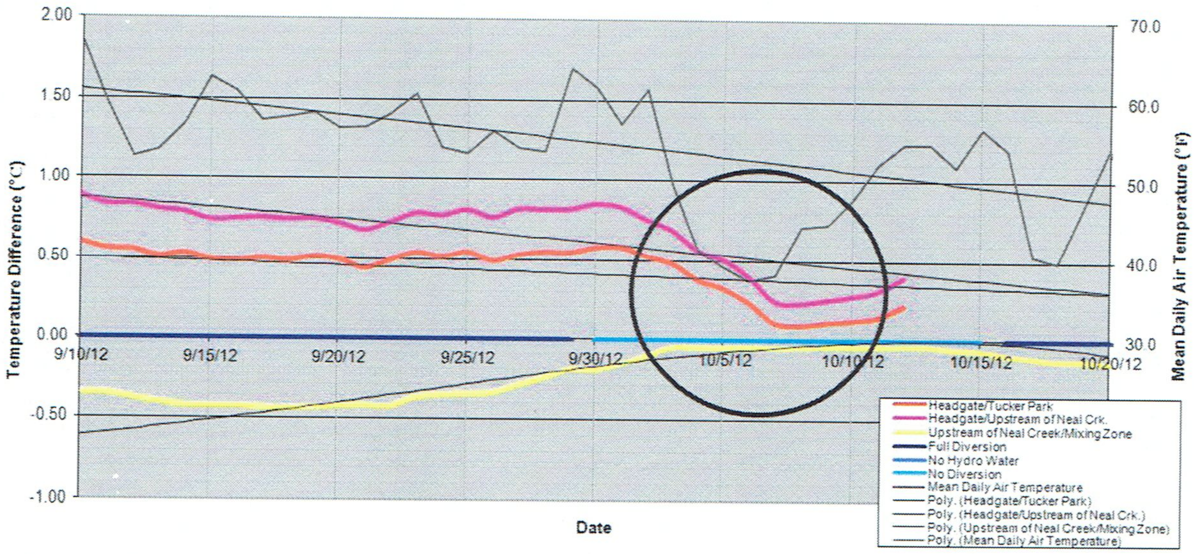


Figure 5: A subset of the 2012 7-Day Maximum Moving Average water temperature (°C) deltas for the Headgate to Tucker Park, Headgate to Upstream of Neal Creek, and Upstream of Neal Creek to Mixing Zone sites from September 10th to October 20th. The circle highlights a period of no diversion. Mean daily air temperature (°F) is also shown.

Discussion

Like the pattern seen in the 2009-2011 study, stream temperatures at all monitoring sites follow air temperature (peaking in late summer and decreasing in the winter) over the year. In addition, river temperatures tend to increase as river flows decrease, although this is likely due to lack of precipitation (and increased usage from irrigators) during the same time as peak air and water temperature.

Increased river temperatures in summer months are likely due to a natural summertime increase in solar radiation since peak usage and diversion levels don't substantially change from July to September. This can be substantiated in observations of river flow continuing to decrease through August and September while stream temperatures decrease and generally trend with ambient air temperature.

Water temperatures are generally warmer downstream than they are upstream. Temperatures would be expected to be higher at downstream sites given that lower sites have been exposed to ambient air temperatures for longer, as well as being exposed to solar radiation for longer durations. An exception to this general pattern is that the Mixing Zone temperatures are lower than temperatures at the Upstream of Neal Creek site, showing the same pattern as in the 2009-2011 data. The lower temperatures at the Mixing Zone site seem to be due to the lower temperatures entering the Hood River from the FID hydroelectric tailrace. The tailrace water is colder than the mainstem Hood River water at the Upstream of Neal Creek site, which given the short distance from the tailrace water can be assumed to be about the same as the mainstem Hood River water where the tailrace water enters and mixes. This assumption is likely given that temperatures at the Upstream of Neal Creek and Mixing Zones are nearly identical during the period of no diversion (September 30th-October 15th) when there is no tailrace water input. The temperature change over the distance from the Upstream of Neal Creek site to the Mixing Zone site without tailrace water inputs seems to be minimal, although it is recognized that the warmer (based on 2009-2011 data) Neal Creek water enters the mainstem in this stretch.

The FID tailrace water is consistently cooler than the Upstream of Neal Creek and Mixing Zone sites, especially in the summer. The tailrace water is likely cooler because it travels through buried pipe and is therefore not exposed to solar radiation like the in-channel water. The temperature difference between the mainstem Hood River water (Upstream of Neal Creek) and the tailrace water is generally less than 1°C. While it does seem to have a cooling impact on mainstem temperatures, it hopefully isn't enough to thermally shock aquatic inhabitants. It is probable, with the input of warmer Neal Creek water above the site of the FID tailrace, that the FID tailrace water may mitigate for warmer in-stream temperatures not associated with hydroelectric plant operations, providing a net benefit to the natural system.

Although data is limited, temperature deltas between sites seem to peak in the late summer when stream temperatures also peak. This is likely due to the higher air temperature, increased solar radiation, and lower stream flows during that time. Water temperatures would increase more quickly over the same distance because of all three factors. Increased temperature could also be partly due to the lower flows in the bypass reach as a result of FID's water diversion for hydroelectric operations, although this is unlikely given the differences seen during the no-diversion interval. The temperature deltas between sites (excluding the Upstream of Neal Creek to Mixing Zone difference) do not considerably change during most of FID's no-diversion interval, suggesting that the majority of temperature increase between sites is natural and not due to FID diversion. The smaller temperature difference between the Upstream of Neal Creek and Mixing Zone sites during the no-diversion interval suggests that the input of tailrace water is a substantial factor in explaining why the Mixing Zone is cooler during other parts of the year. There is a drop in the temperature deltas between all sites during the middle part of the no-diversion interval that could suggest that without diversion the temperature increase within the bypass reach would be lower. However, this decrease in temperature delta is more likely natural given that the trend is not consistent over the entire no-diversion interval and that it also coincides with a large drop (about 11°C) in ambient air temperature. River temperature deltas consistently follow ambient air temperature.

The major limitation to the 2012 study was a loss of data due to broken, buried, and lost loggers. Due to the HRWG monthly download versus the past FID weekly download intervals, there are data gaps when a malfunction (physical or technical) occurred. Such losses due to river sediment fluctuations or computer malfunction will continue to be hard to avoid. Data limitations over 2012 limit the confidence of the conclusions reached from the data, but combined with the patterns seen in the 2009-2011 study years and the use of polynomial trendlines, a similar pattern of low or no impacts from FID's hydroelectric plant operations is seen. Given the data available, the tailrace flows from the FID hydroelectric plant seem to cool the mainstem Hood River water (generally by 0.5°C or less). Additionally, the available data suggests that FID's water diversion does not measurably increase stream temperatures in the bypass reach. A period of no-diversion during late summer would provide better data to evaluate FID's diversion impacts on bypass temperatures, but this will be very difficult to obtain given the irrigation needs of FID's customers during that critical pre-harvest time period. Continued monitoring would provide more data to confirm if the temperature regimes seen in 2009-2012 remain consistent. FID management has agreed to support the continued study of the thermal impacts of their hydroelectric plant operations until such analyses are deemed conclusive.