**Columbia River Regional Forum**
**Water Quality Team Meeting**
**June 12, 2007**

## *1. Welcome and Introductions*

Today's WQT meeting was co-chaired by Mark Schneider (NOAA) and Agnes Lut (ODEQ) and facilitated by Robin Harkless, with representatives from NOAA, COE, USFWS, FPC, BPA, ODEQ, USACE, BOR, CRITFC, LCREP and others attending. The following is a summary (not a verbatim transcript) of the topics discussed and decisions made at the meeting. Anyone with questions or comments about these notes should contact Kathy Ceballos (503) 230-5420, or bring them to the next meeting.

## *2. Bonneville Spill Fish Survival Issues*

Mike Langeslay (NWP), Dennis Schwartz (NWP) and Gene Ploskey (Battelle) gave a presentation regarding operational changes in the Bonneville spillway from 200 to 2007, including the effects of spill on fish passage. The 2002-03 Adult Fish Passage Study looked at alternating spill to the spill cap vs. 75 kcfs daytime spill, comparing passage times and fallback rates.

The study led to several findings:

1. Spill above 100 kcfs during daytime affects adult migrants at Bonneville adversely and increases their fallback rates. Passage times were faster during low spill conditions, a statistically significant difference. In 2006 as a result of this study, 100 kcfs was established as a regional limit on controlled spring spill.

2. Spillway passage efficiency has a 1 to 1 relationship in terms of percent spill and percent fish passage.

3. Deeper deflectors showed improved passage rates. Survival for juveniles is low for Chinook, especially during daytime and in locations with higher elevations and shallower deflectors.

Next year, the COE Portland Division is planning a balloon tag study to evaluate factors such as deflector elevations, gate openings and erosion, Langeslay said. Also, the Division is conducting a system-wide spillway injury study, including the Bonneville spillway. The purpose is to identify conditions that result in injury and develop spillway design criteria for safe fish passage.

Margaret Filardo (FPC) asked, were all deflectors shallow prior to 2002? In what way has survival been correlated to shallow deflectors? Yes, they were, and the reason for the correlation is unknown – it could be a combination of shallow gate openings and deflectors, or just the gate openings, Langeslay said.

Filardo asked, wasn't 2002 the year we began seeing higher TDG levels at the Bonneville tailwater because of spillway patterns? In 2006, when there was no transect across the spillway channel, TDG levels were uncertain, Jim Adams (COE) said. There were a number of unusual findings at Bonneville that year. For example, at 80 kcfs spill, TDG levels were 117-18% in the tailrace. Increasing spill by only 10 kcfs would cause TDG levels to shoot up to 124% in the tailrace. Possibly the outer spill bays were generating high amounts of gas, which followed the shoreline of Cascade Island to the gage, Adams said. There have not been corresponding readings of TDG levels at Camas Washougal gage.

Filardo asked, what's being proposed for 2007? We've been releasing active tagged fish during daytime upstream of the spillway, Langeslay said. Tom Lorz (CRITFC) asked about the status of a summer evaluation involving a 75 kcfs gas cap at Bonneville. For summer operations, the date for the change is July 1, Langeslay said. However, half the subyearlings have passed the project already, so the date has been changed to June 21.

### *3. TDG Monitoring on Chum Salmon Redds: 2007 Preliminary Results*

Evan Arntzen (Battelle) along with Dr. Dave Geist (Battelle) and Dennis Schwartz (COE), gave a presentation on TDG levels at chum salmon redd monitoring sites below Ives Island and Multnomah Falls. The presentation covered 2006 findings from the two sites as well as preliminary 2007 study results. Arntzen described the three main study objectives and results:

1. Determine TDG levels at chum redd sites. Early in the 2007 season, uncompensated TDG results at Ives Island in the hyphorrheic (egg pocket) zone were actually higher than in the river, a phenomenon the researchers aren't able to explain. The response at Multnomah Falls was similar to Ives Island with lower TDG levels. There was more depth compensation available in March of 2007, so TDG levels were correspondingly low. After spill began, they increased. To date, the average TDG levels of exposure for chum redds in 2007 remain under 103%. (The state standard is 105% because that's the level at which negative effects begin to appear.) The year 2006 offered more runoff and depth compensation than this year, so TDG levels were 20-30% less this year than this year. As elevation increases, so does TDG exposure.

2. Conduct toxicity tests. A hundred post-hatch fry were placed in the dark side of emergence tubes and allowed to emerge into the light side when ready. The fry were exposed to stable background TDG levels of 93%,

103%, 108%, and 113%. Statistical analysis of the findings is not completed. Preliminary results indicate that at the 113% exposure level, emergence was accelerated by a few days. The final statistical analysis will be presented in a report at the end of this year. There were no differences in fry weight or length as a result of the various TDG exposure levels. However, bubbles were found in the guts and eye sockets of several sac fry that were dissected. The finding of bubbles in the control group indicates that the act of probing for bubbles might have caused them to form.

3. Sample naturally occurring fry in the field at the Ives Island site and inspect them for signs of GBT. On a March 23 sampling trip, researchers sampled 10 locations mostly on the south side of the bar. Three of the locations were successfully sampled. Researchers used pressurized water to disturb the gravel in the redds and get fry to swim up, then used nets to catch 84 samples, including 3 mortalities. All of the samples were inspected for signs of GBT in the mobile lab at the site. Depth compensated TDG levels at the site were less than 95% for several days before the sampling. However, TDG levels rose to 105% when the tailwater elevation was dropped from 20 to 12.5 feet for the purpose of sampling the redds.

Adams asked whether this type of ongoing effort will be funded in future years to get a comprehensive look at a wide range of conditions. Another year of data sampling at the same sites will be funded under the SRWG program, Schwartz said. Also, a second year of lab work has been proposed.

Joe Carroll (contractor) asked, how deep were the sensors placed in the river? The sensors near the riverbed were within 10 centimeters of it, Antzen replied. Variations in the water surface elevation were 1.5 meters or greater. This year, the salmon spawned at higher elevations, so sensors were deployed at higher elevations than in a normal water year.

The researchers have not yet analyzed compensation depth for this year's findings. Results suggest that TDG levels in the Multnomah Falls area are more stable than at Ives Island. Analysis of the data from this study is ongoing, and further insights can be expected to come from it.

### *4. Bonneville Spill Hydraulic Modeling Results*

Randy Lee (COE) gave a description of the tools the COE and FFDRWG use to work toward consensus on recommended spill patterns. The traditional method uses physical hydraulic models at ERDC to look at dye patterns produced by certain flows.

A basic assumption is that fish will follow the dye patterns as they move through the project. Lee showed videos of a 1:55 scale spillway model at ERDC with dye patterns. Mike Schneider (COE) incorporated this hydraulic modeling into a numerical model that can produce TDG estimates. Schneider's model showed that gate openings of 2 to 4 feet were fine in terms of TDG levels. These tools are used to find patterns that would promote good downstream egress as well as meet gas production requirements. Specific flow patterns have been recommended for different flows and tailwaters, including 85 and 100 kcfs.

A second issue the COE and FFDRWG are dealing with is evidence of spillway erosion issues in bays 9, 12 and 14 at Bonneville Dam. It appears that the spillway surface at spill bay 9 has eroded to 5 foot thickness above a gallery that holds vital instrumentation for drainage.

Jim Adams asked how long this erosion took. Between 1987 and '97, there was essentially no change in erosion, Lee said. Between 1997 and 2006 there was 2.6 feet of erosion. Adams asked, is this affecting the hydraulics of the spillway channel, causing fish to slam into concrete? We don't know, Lee said. The COE has short term and long term erosion solutions. In the short term, continue to spill but do hydro surveys to monitor erosion. When spill season is over, fill erosion holes in spill bays 9, 12 and 14 with concrete. For the longer term, look at erosion concerns with fish passage in mind. The team is recommending 85 kcfs spill in summer, but that hasn't been approved yet.

Margaret Filardo (FPC) asked, what's the recommended pattern for summer spill at night? Distribution is fairly uniform, bulked up on the outer bays during times of lower flow, Lee said. As discharges increase, the flow pattern flattens out on the sides and crowns in the middle. The current 75 kcfs spill pattern has two bays closed, so there's a significant difference between 75 kcfs and 85 kcfs of spill in terms of the spill patterns produced. Lee showed WQT some footage demonstrating that, with bays closed off, major re-circulation cells tend to form, which aren't good for fish passage. The next step in this study process will be looking at the model data side by side with the prototype to see how well the model is tracking, Schwartz said.

### *5. Bonneville Spill TDG Production, Fate and Transport*

Mike Schneider (ERDC) described a 2006 experiment at Bonneville and how ERDC functioned in reviewing new patterns that are now in place at Bonneville. Typically, elevated TDG saturation is identified as the result of spillway releases upstream. But there are additional sources of TDG such as lock discharges and the Bonneville 2$^{nd}$ powerhouse corner collector, which seems to create elevated TDG saturation at low flows without much aeration. There have been drastic changes in the level of gas production at Bonneville since its inception. The most recent change (2002) was addition of spillway flow deflectors on bays 1-3 and bays 116-118.

Gas levels in the forebay are typically residual from sources up stream. In the past several years, there has been a 40% spill policy at The Dalles for this reason. Levels in the forebay at Bonneville are therefore extremely variable, which greatly affects TDG levels below Bonneville and the spill capacities that result from those variations.

Adams asked about the impact of strong wind on TDG levels in the river. Long durations of strong wind are associated with declining gas pressures in the forebay at The Dalles, Schneider said. WQT discussed the interaction between wind speed and TDG levels in the river. Joe Carroll (contractor) estimated that winds of around 15 to 18 miles per hour bring sustained decreases in TDG.

Filardo advocated changing the 7 foot deflectors to 14 feet now that the COE is operating a voluntary spill program. There's a tradeoff in terms of TDG performance for levels during voluntary spill, Schneider said. With low or moderate flow, the deeper deflectors will give good performance with low gas production. However, really high flow years will require compromises and could lead to TDG levels of 125%, Adams said. This Ives Island gage is probably closer to the TMDL than any of the tailwater gages on the Columbia River. (WHST ARE THE TMDL?) As the tailwater elevation rises, more and more flow is needed through the outer bays to provide near-shore velocities. One of the most important parameters in gas production is how much flow passes through the spill bay. The practice of bulking spill to outside bays has created conditions that generate high levels of gas, Schneider said. The numbers at the tailwater station are probably caused by local production of gas and may over-represent what the spillway is producing. Therein lies the whole point of developing new patterns that both meet the gas cap and create good egress patterns on the spillway.

WQT attendees discussed TDG contributions from the Bonneville 2nd powerhouse corner collector. We don't really know what happens when tailwaters rise, Schneider said. What's clear is that, from tailwater elevations of 13 to 16 feet, the corner collector causes a few percentage points of TDG increase in average river conditions. Once higher tailwater conditions are in place, with spillways running and gas moving downstream, its gets difficult to discern the contribution the corner collector is making. The philosophy for developing this year's spill pattern was to try to provide more uniform distribution at Bonneville with some bulking of spill to the outer bays. In general, higher tailwater elevations translate to higher gas levels, a condition that tends to happen regardless of forebay conditions.

Mike Schneider (COE) presented a 2002 data set indicating that, when flows go above 110 kcfs, average TDG conditions tend consistently to be higher across the river than those measured at the CCIW/Cascade Island station monitor. ERDC is developing analytic models of these systems, and the forebay stations have generated observations that are representative of mixed waters.

Thermally induced events are rare, and there are ways of correcting for these events in terms of the reliability of data.

Filardo asked for a definition of representativeness. There's an array of 6 instruments across the channel, Mike Schneider (COE) said. Mixed stations respond to a wide range of conditions much as the river does, while tailwater stations do not. There appears to be a strong correlation between TDG levels produced at Bonneville and readings at the Camas Washougal gage. Sixty percent of the Bonneville flow comes through the powerhouse, so Bonneville inherits a large component of what's been released upstream. Mark Schneider (NOAA) pointed out that the point of today's meeting is to determine how and why TDG is monitored, and what to do with the results.

The spillway capacity (spill cap) at Bonneville, as limited by TDG criteria, is more complex than a single number, Mike Schneider (ERDC) said. This concept is often misunderstood. The first principle is, powerhouse releases pass through what comes from upstream. If the project is inheriting high levels of TDG, that means gas can't be added to the river without exceeding water quality criteria. The B2 corner collector is an additional source, but ERDC researchers believe it's a minor one, especially when tailwater conditions are high and there's less of a plunging flow.

Adams asked for a historic definition of CCIW. Data were first gathered at that location in 2002 and have been pooled at CCIW since then, Mike Schneider (COE) said. When flows were less than 100 kcfs, CCIW measured gas levels of 120 to 125%, but that was a spill pattern issue unique to 2006. This year, CCIW has seen no TDG levels above 120%.

Mike Schneider presented a plot based on real Bonneville numbers, with forebay saturation levels on the X axis and spill discharge levels on the Y axis. The plot makes it possible to estimate the percentage exceedance of criteria at Camas Washougal gage that will result from a given spill discharge when the Bonneville forebay level is at a given elevation. For example, if forebay levels are 113.8% and spill is 90 kcfs, there's a 110% chance of an exceedance at Camas Washougal gage. Mixed stations respond to a wide range of influences such as loading from upstream dams, loss of gas through river movements, and changes in temperature, to name a few. Mike Schneider emphasized that, when the river heats up more quickly than it can rid itself of gas, the whole habitat is seeing these water quality conditions, not just the monitor.

Adams asked about the depth and configuration of the Camas Washougal gage. It hangs about 15 feet below the surface of a floating dock, but was placed near the water surface during the 2001 study. It was later submerged because no stagnant conditions exist in that location when flows are strong.

Mark Schneider (NOAA) asked whether ERDC did calculations like this for the whole scope of research. No, only one as an example, Mike Schneider (ERDC) said. His full presentation can be found at http://www.nwd-wc.usace.army.mil/tmt/wq/briefing/20070612/BON_TDG_Production.pdf.

### *6. Cross Sectional TDG Sampling at Cascades Island Spillway Channel: 2007 Preliminary Results*

Joe Carroll gave a presentation on this TDG monitoring study using submersible pumps and 700 feet of pipe to measure TDG levels in the 800-foot channel between Bradford and Cascade Islands. Pump sampling started on April 12, with good data collected from April 19-30, or 8 days of data from 2 sites at a constant spill rate of 100 kcfs. The submersible pumps avoided thermal issues and degassing by pushing the gas rather than sucking it through the pipe to be measured. The study reached three major conclusions:

1. The submersible pump method gave comparable statistical data to that of the fixed monitor at Cascade Island (CCIW).
2. TDG saturation levels were 1-2% higher in the middle of the channel than near the shore.
3. The station on Bradford Island averaged 7% less saturation than the Cascade Island station.

There was discussion of why TDG levels might be lower near shore. The water degasses better in shallow conditions, Adams said. He asked, given data form this study regarding higher gas levels in the middle of the channel, is it reasonable to assume that the gage at Cascade Island on the outside of the channel may be underestimating the average net production of gas in the channel? Carroll said he'd expect higher gas saturations associated with the bulk of the flow in the center of the spillway channel, based on this data and others.

Mark Schneider (NOAA) asked about the effect of the river depth profile on gas levels found in the study. The concentrations seen are in response to what happened upstream – in this case, 2,000 feet upstream, Carroll said. When bubbles are forced high into the water column, it can result in a higher gas exchange resulting in lower TDG levels. More degassing is associated with the turnover of water bubbles to the surface in shallower areas near shore. By contrast, there is less vertical mixing in the center of the river channel.

Cascade Island gage has been showing high gas levels over 120%TDG at night with no spill, Adams said. TDG levels go down again in the morning when spill is turned back on – the opposite of what one would expect. In March 2005, just the daytime spill of 1.5 kcfs out of bays 1 and 18 plus whatever came from the fish ladder was enough to create TDG levels of 127% at the Cascade Island gage. Measurements of TDG levels on 3 different gages showed the same diurnal effects at each gage. That says the increased TDG levels aren't just a

localized effect from the fish ladder to the gage, they represent a phenomenon happening all through the channel. Adams speculated that gas comes out of the fish ladder into the channel and circulates there until spill pushes it out.

Carroll's full presentation is available online at http://www.nwd-wc.usace.army.mil/tmt/wq/briefing/20070612/BON_TDG_Production.pdf.

### *7. Monitoring of Powerhouse 1 at Bradford Island*

Kathryn Barko (COE) gave a presentation (not initially part of today's agenda) on TDG monitoring at the north and south ends of the Bradford Island fish ladder. Monitoring locations include the ladder itself, the fish entrance, tailrace and forebay at Bradford Island, as well as the fish ladder and entrance to the tailrace at Cascade Island. Forebay elevations fluctuated from 71.5 to 76.5 feet during the monitoring, with tailwater elevations fluctuating from 5.5 to 24 feet.

Many times over the course of the sampling period during April and May, TDG levels spiked at over 150%, Barko said. The instrumentation was replaced and still high gas levels were found. Of the 8 sampling locations, the highest TDG levels (160%) were found at Bradford Island entrance. Nevertheless, fish are passing through the ladders and seem to be unaffected by the high TDG levels, perhaps because their exposure is so brief.

Adams said, a key question is: what are the biological impacts of TDG? Are fish being harmed as they pass through those areas? Sampling will continue through the end of September, Barko said, and possibly again next year.

### *8. 2006 TDG TMDL Load Allocation Compliance Locations*

Tailrace monitors are not currently at their load allocation locations, Agnes Lut (ODEQ) said. For example, Bonneville is supposed to be at 1,700 feet from the dam, with USGS saying it's at 1,350 feet and the COE, 600 feet. There are two problems with this:

1. When ODEQ moves into the long term implementation of TMDL standards, the tailrace monitors are to move to their load allocation positions, which have been identified using extensive modeling.
2. There's a discrepancy between USGS and COE measurements of the distance from TDG fixed monitoring stations to the dam.

The TMDL standards allow for algorithms to be developed to identify what the TDG levels would be at the edge of their rated zone as part of their load allocation, Lut said. Adams suggested reconvening the TDG monitoring subgroup to reexamine these issues. The vision of the TMDL adaptive management group at the next meeting can be further refined, Lut suggested. This meeting summary prepared by consultant and writer Pat Vivian.

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|---|---|
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| Agnes Lut | ODEQ, WQT co-chair |
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