State of Oregon
Department of Environmental Quality Memorandum

Date: Dec. 18, 2014

To: Environmental Quality Commission

From: Dick Pedersen, Director

Subject: Agenda item C, Informational item: Response to the commission's questions on the request from U.S. Army Corps of Engineers for a renewal of the total dissolved gas water quality standard modification on the Columbia River for fish passage
Jan. 7-8, 2015, EQC meeting

Purpose of item

The purpose of this report is to provide information and address the commission's questions about the U.S. Army Corps of Engineers' spill program, including the history of gas bubble trauma monitoring.

Background

On April 2, 2014, the U.S. Army Corps of Engineers requested a renewal of the modification to Oregon's total dissolved gas standard for voluntary spill operations at the four lower Columbia River dams: McNary, John Day, The Dalles and Bonneville. The Corps conducts voluntary spill to improve survivorship of Endangered Species Act-listed salmonids by assisting downstream migration of smolts. EQC approved the most recent total dissolved gas standard modification in 2009 for a five-year period. The standard modification expired for the purpose of juvenile salmonid migration at midnight on Aug. 31, 2014. The requested modification must be in place by April 1, 2015, to allow voluntary spill for juvenile salmonid migration. The Corps did not request substantial changes to the standard modification affecting the 2010-2014 spill season.

DEQ presented an informational item during the June EQC meeting on the Corps' request. Following DEQ's presentation, the commission posed questions regarding implementation of the total dissolved gas total maximum daily load, potential regulatory actions at the conclusion of the TMDL implementation phase, causes of spill, historical monitoring results, and requirements of previous total dissolved gas standard modifications. To address the commission's questions, DEQ presented a second informational item during the August EQC meeting. Additionally, the Corps and other entities associated with the spill operations and biological monitoring, including Bonneville Power Administration, Fish Passage Center and Oregon Department of Fish and Wildlife, were available during the August meeting to discuss the commission's concerns. The commission deferred the decision to early 2015, after the Corps submits its annual report to DEQ and DEQ presents an informational item to the commission to further address topics of concern

while the public is given an additional opportunity to comment on new information that may be presented during the January 2015 EQC meeting.

Gas bubble trauma monitoring

The Fish Passage Center plans and implements the annual Smolt Monitoring Program and the Gas Bubble Trauma study. The Fish Passage Center 2009 document "GBT Monitoring Program Protocol for Juvenile Salmonids," describes the current protocol for biological monitoring and can be found at ftp://ftp.fpc.org/gbtprogram/

Biological monitoring will occur twice a week at Bonneville and McNary Dams during seasonal spill for fish passage. The target daily sample size is 100 juveniles. Juvenile salmonids will be collected and examined for incidence of gas bubble trauma using a variable magnification, from 6X to 40X, dissecting microscope. Each occurrence of gas bubble trauma will be assigned ranks based on severity. Ranking is from 0 to 4, where 0 is no observable bubbles and 4 is greater than 50 percent area, of either an eye or fin, covered with bubbles.

The action criteria for which the DEQ director will halt the spill program is defined in the EQC order as either 15 percent of examined fish showing signs of gas bubble trauma in their non-paired fins, or five percent of the fish examined show signs of gas bubble trauma in their non-paired fins where more than 25 percent of the surface area of the fin is occluded by gas bubbles, corresponding to ranks greater than 2. The draft order is attachment A.

The Fish Passage Center summarized historical results from the gas bubble monitoring program in attachment B. Twenty years of monitoring show minimal signs of gas bubble trauma when total dissolved gas is managed based on modified standards used to implement spill levels according to the Biological Opinion. The historical summary also shows Figure L-10, which is a graph contrasting upstream tailwater total dissolved gas with percent of fish with fin gas bubble trauma and the associated rank. The Fish Passage Center will provide information on the evolution of biological monitoring methods for gas bubble trauma and current biological monitoring protocol during the EQC meeting.

Total Dissolved Gas TMDL

The Total Dissolved Gas TMDL[1] implementation plan specifies different operational and structural modifications to mitigate total didsolved gas increases. Implementation of the TMDL will end in 2020.

[1] Picket, P.J. and Harding, 2002. Total Maximum Daily Load for Lower Columbia River Total Dissolved Gas. Prepared jointly by Oregon Department of Environmental Quality, Portland, OR, and the Washington State

Current information indicates that Total Dissolved Gas TMDL implementation efforts are not successful for the four lower Columbia River dams operated by the Corps. These dams are not expected to meet the total dissolved gas water quality standard during voluntary spill as required by the Federal Columbia River Power System Biological Opinion or during involuntary spill events. DEQ participated in a regulator and operator meeting in July 2014 to discuss options for addressing this situation.

The TMDL does recognize that the effectiveness of implementing structural or operational modifications can only be estimated and because of this, long-term compliance with the TMDL will take a significant length of time and must take into account a certain level of inherent uncertainty. Although some stakeholders expressed interest in revising the total dissolved gas standard, efforts to revise the standard will largely depend on EPA's and states' priorities and resources. Any total dissolved gas water quality standard change is likely to be very resource intensive. A less resource-intensive approach is an amendment of the TMDL through reevaluating implementation activities for adaptive management considering a system wide approach and realistic targets.

The Corps will present information on structural and operational modifications for management and reduction of total dissolved gas. The Corps will also provide an overview of how they operate with respect to managing total dissolved gas.

Five-year order

Prior to 2003, the commission annually considered approval of the total dissolved gas standard modification. The commission approved multi-year modifications beginning with the order affecting the 2003-2007 seasonal spill seasons. The commission's approval was based on past results of biological and physical monitoring showing no significant adverse impacts on fish survival.

The EQC order affecting the 2010-2014 spill season and the draft order include safety measures allowing the DEQ director to halt the spill program if the action criteria are met and the commission to terminate or modify the order at any time.

Department of Ecology, Olympia WA. Washington State Department of Ecology Publication No. 02-03-004. http://www.deq.state.or.us/wq/tmdls/docs/columbiariver/tdg/tmdlwqmp.pdf

Next steps DEQ will issue a public notice reopening a public comment period for 21 days beginning Jan. 5, 2015. This comment period will coincide with the Jan. 7-8, 2015, EQC meeting. DEQ anticipates presenting the standard modification request during a special meeting, to be conducted by telephone for the purpose of commission action on this item, in February 2015.

Attachments
A. Draft EQC Order for Total Dissolved Gas Standard Modification
B. Historical Summary (1995-2014) of the Gas Bubble Trauma Monitoring Program prepared by the Fish Passage Center

Approved:

Division: _____
Wendy Wiles, Solutions administrator

Section: _____
Gene Foster, Watershed Management manager

Report prepared by Paula Calvert
Columbia River Coordinator

Draft Order Approving the U.S. Army Corps of Engineers' Request for a Modification to the State's Total Dissolved Gas Water Quality Standard

BEFORE THE ENVIRONMENTAL QUALITY COMMISSION

In the matter of the U.S. Army Corps of Engineers' request to spill water to assist out-migrating threatened and endangered salmon smolts	))))	FINDINGS and ORDER

Findings

1. The Department of Environmental Quality received a request from the U.S. Army Corps of Engineers (Corps) dated April 2, 2014, to adjust the 110 percent total dissolved gas water quality standard as necessary to spill water over McNary, John Day, The Dalles and Bonneville dams on the Lower Columbia River to assist out-migrating threatened and endangered salmonid smolts during the fish passage season of Apr. 10 to Aug. 31. The application sought approval for five years. The public was notified of the request on Sep. 10, 2014, and given the opportunity to provide written comments until 5:00 p.m. on Oct. 10, 2014.

2. Acting under **OAR 340-041-0104(3)** the commission finds that:

   (a) *Failure to act would result in greater harm to salmonid stock survival through in-river migration than would occur by increased spill:*

   Biological assessments and opinions have concluded that providing project spill for fish passage at levels that result in exceeding the 110 percent total dissolved gas water quality standard is necessary to assure adequate passage conditions for Endangered Species Act listed fish species. Voluntary fish passage spill is a low risk method for fish to move downstream. Depending on the dam and species, spill passes approximately 55 to 80 percent of juvenile salmonids. Although structural and operational modifications have improved survival through turbines, spill has greater survival of approximately 95 percent compared to turbine passage at approximately 90 percent survival. The Independent Science Advisory Board and National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) continue to support transport in conjunction with spill to spread the risk of negative outcomes due the different types of passage. However, transportation is associated with greater likelihood of adult straying, in which adults do not return to spawn in their natal streams. Straying inhibits recovery of endangered and threatened salmonid species. The experience of in-river migration contributes to genetic adaptation of the species to altered conditions. The Biological Opinion incorporates hatcheries as a means of supplementing salmonid numbers until the species can sustain itself. The presence of in-stream migrating hatchery smolts reduces

the amount of wild smolts subject to predation and mitigates a portion of wild smolts lost to turbines or other causes during dam passage. However, hatchery fish can compete with wild fish for food and habitat and interfere with the wild fish's genetic adaptation to its environment.

(b) *The modified total dissolved gas criteria associated with the increased spill provides a reasonable balance of the risk of impairment due to elevated total dissolved gas to both resident biological communities and other migrating fish and to migrating adult and juvenile salmonids when compared to other options for in-river migration of salmon:*

Fish Passage Center data estimate a 1.1 percent incidence of gas bubble trauma in salmon smolts in the Columbia River when total dissolved gas levels are managed to 120 percent in the tailrace. This estimate is based on smolt monitoring information collected between 1995 and 2014.

When the in-river total dissolved gas levels are below 120 percent, few adult fish (in some cases none) display signs of gas bubble trauma. Investigators have observed adult tolerance to total dissolved gas and hypothesized that it was attributable to the migration depth of adult salmonids. Depth-sensitive radio tags used in adult migration studies confirmed that adults migrate at depths up to 4 meters and find depth compensation protection from gas bubble trauma. For every meter below the surface water, a reduction of 10 percent total dissolved gas is measured in the water column. Resident fish and aquatic invertebrates in the Columbia River downstream of Bonneville Dam have been monitored by NOAA Fisheries for signs of gas bubble disease from 1993 to 1998. There were no signs of gas bubble disease observed in the aquatic invertebrates examined. There was a low incidence of gas bubble disease (less than one percent) in resident fish examined in 1993 and 1995 while in 1994, 1997 and 1998 none of the fish observed had signs of gas bubble disease. Signs of gas bubble disease were prevalent in 1996 but this was a high flow year with large volumes of involuntary spill and total dissolved gas levels above 120 percent in the tail races of dams. Given the past monitoring of gas bubble disease, the level requested in this petition strikes a reasonable balance between increased survival due to reduced turbine mortality and the risk of mortality from gas bubble disease.

c) *Adequate data will exist to determine compliance with the standards:*

Physical in-river total dissolved gas monitoring will be conducted at the tailraces of McNary, John Day, The Dalles and Bonneville Dams. Hourly data will be available on the Corps' website. The Corps has submitted a total dissolved gas monitoring plan available at: http://www.nwd-wc.usace.army.mil/tmt/wqnew/tdg_monitoring/2015-18.pdf Implementation of the physical monitoring plan will ensure that data will exist to determine compliance with the standards for the voluntary spill program identified in this Order. The Corps will report each year's physical monitoring results to DEQ.

d) *Biological monitoring is occurring to document that the migratory salmonid and resident biological communities are being protected:*

The Corps has submitted a biological monitoring plan. Biological monitoring will occur according to the Fish Passage Center 2009 document "GBT Monitoring Program Protocol for Juvenile Salmonids," available at: ftp://ftp.fpc.org/gbtprogram/ . Juvenile salmonids will be collected at Bonneville and McNary Dams and examined and evaluated for incidence of gas bubble trauma, and will be assigned ranks based on severity of their symptoms. The Corps will report each year's biological monitoring results to DEQ.

Order

1. The Environmental Quality Commission approves a modification to the 110 percent total dissolved gas water quality standard for voluntary fish passage spill at McNary, John Day, The Dalles and Bonneville Dams on the Lower Columbia River, subject to the following conditions:

   (i) The modified total dissolved gas standard for the Columbia River applies during the voluntary spill period from 00:00 Apr. 1 to 24:00 Aug. 31 for the purpose of fish passage.

   (ii) The DEQ Director may approve additional periods of modified total dissolved gas standard for the Columbia River for voluntary spill to benefit fish passage, including the Spring Creek Hatchery fish release, maintenance activities, and biological or physical studies of spillway structures and prototype fish passage devices. The Corps must notify DEQ in writing describing the purposed action, the purpose of the action and dates of action at least one week prior to the voluntary spill. The Corps must obtain approval from the Director prior to such spill.

   (iii) The modified total dissolved gas criteria will apply for five years, 2015, 2016, 2017, 2018 and 2019.

   (iv) The Corps must conduct physical and biological monitoring during all periods of voluntary spill. The monitoring must be adequate to implement the requirements set out in subsections (v) to (x) below.

   (v) Spill must be reduced when the average total dissolved gas concentration of the 12 highest hourly measurements per calendar day exceeds 120 percent of saturation in the tailraces of McNary, John Day, The Dalles and Bonneville Dams monitoring stations.

   (vi) Spill must be reduced when instantaneous total dissolved gas levels exceed 125 percent of saturation for any 2 hours during the 12 highest hourly measurements per calendar day in the tailraces of McNary, John Day, The Dalles and Bonneville Dams monitoring stations.

(vii) If either 15 percent of the fish examined show signs of gas bubble disease in their non-paired fins, or five percent of the fish examined show signs of gas bubble trauma in their non-paired fins where more than 25 percent of the surface area of the fin is occluded by gas bubbles, the DEQ Director will halt the spill program.

(viii) The Corps must provide written notice to DEQ within 24 hours of any violations of the conditions in the modification as it relates to voluntary spill. Such notice must include actions proposed to reduce total dissolved gas levels or the reason(s) for no action.

(ix) No later than Jan. 31 following each year of this modification, the Corps must provide an annual written report to DEQ detailing the following:

a) flow and runoff descriptions for the spill season;
b) spill quantities and durations;
c) quantities of water spilled for fish versus spill for other reasons for each project;
d) data results from the physical and biological monitoring programs, including incidences of gas bubble trauma;
e) description and results of any biological or physical studies of spillway structures and prototype fish passage devices to test spill at operational levels; and
f) progress on implementing the gas abatement measures contained in the 2002 Total Maximum Daily Load (TMDL) for Lower Columbia River Total Dissolved Gas and other gas abatement activities identified through adaptive management.

(x) If requested, the Corps must report to the commission on any of the above matters or other matters relevant to this order.

(xi) The commission reserves the right to terminate or modify this order at any time.

Adaptive Management

Implementation of the TMDL for Lower Columbia River Total Dissolved Gas will continue. Oregon and Washington may request further studies to determine additional structural and operational gas abatement actions that can be feasibly implemented to reduce total dissolved gas.

Dated: _____ ON BEHALF OF THE COMMISSION

_____
Director

Historical Summary (1995–2014)
Contributed by the Fish Passage Center

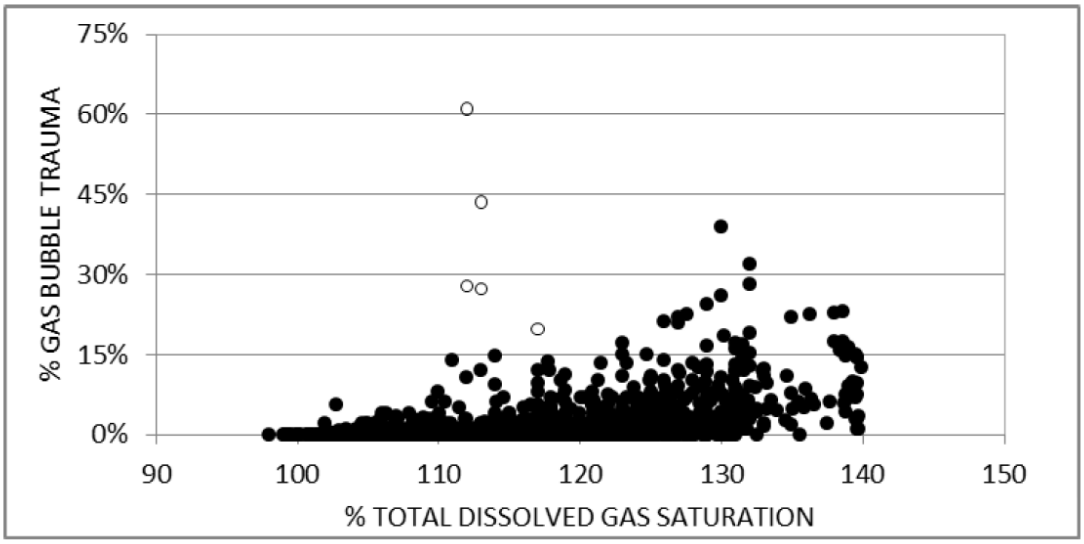
The goal of the juvenile salmonid gas bubble trauma monitoring program is to determine the relative extent that migrating juvenile salmonids have been exposed to harmful levels of total dissolved gas. The monitoring assesses the relative severity of exposure, and provides an "early warning" of potentially harmful levels of total dissolved gas. The determination is based upon the prevalence and severity of GBT-induced bubbles on the fish. The data are reported to the fisheries management entities, the water quality agencies of Washington and Oregon, and are available to other interested parties through Fish Passage Center weekly reports and daily postings to the Fish Passage Center web site during the season (www.fpc.org/smolt/gasbubbletrauma.html). The fisheries management entities review the data in-season to determine if modifications to spill are necessary based on the gas bubble trauma monitoring.

The Gas Bubble Trauma Monitoring Program has been implemented annually since 1995. There are twenty years of data available, and as a result of involuntary spill events, data for gas bubble trauma are available over a wide range of total dissolved gas concentrations. In fact, over this historic record, observations have occurred at tailwater TDG levels as high as 140 percent. This has allowed the assessment of the impacts of total dissolved gas on the salmonid population over a wide range of tailwater conditions.

Excluding Rock Island Dam samples, a total of 2,488 daily exams have occurred over the time period, with a total of 288,083 fish examined. The daily sample size criteria based on the monitoring protocol is 100 fish. In this analysis some flexibility was considered and all daily samples with greater than 75 fish were included. The monitoring program has consistently shown over the years that signs of gas bubble trauma are minimal when total dissolved gas is managed to the present dissolved gas standards associated with the implementation of the Federal Columbia River Power System Biological Opinion Spill program.

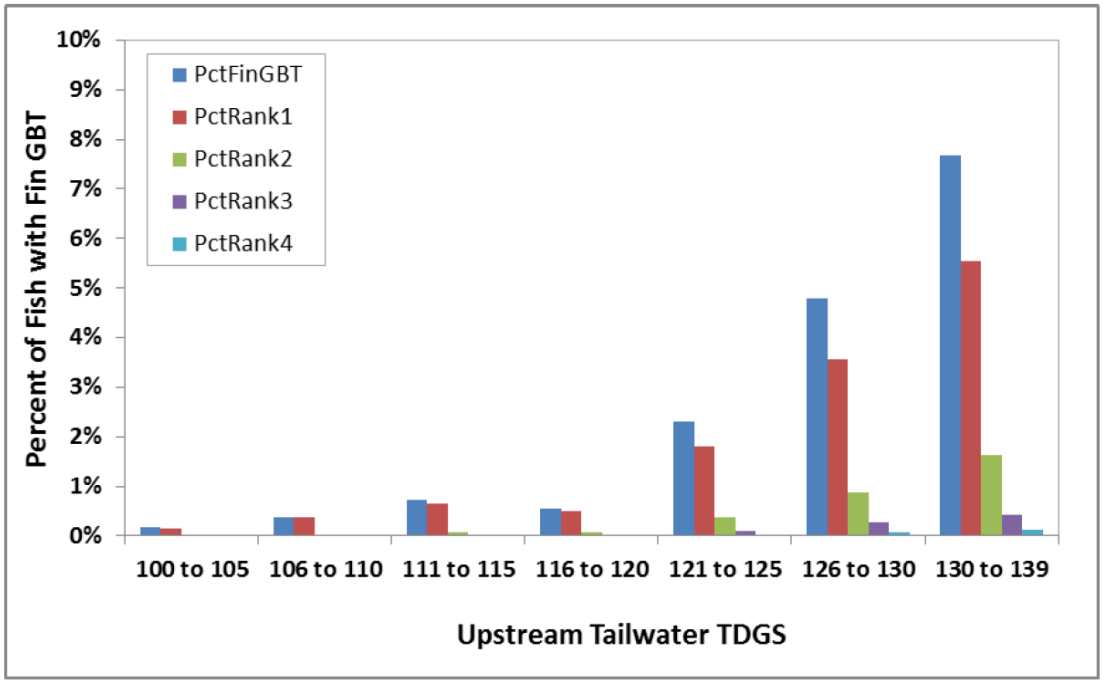
Over the 20 years of data collection, and with 2,488 samples, there have only been 34 instances when the 15 percent gas bubble trauma criterion was exceeded. Of those 34 instances, five can be attributed to late migrating steelhead smolts. Please see the open circles in Figure L-9. At the time these steelhead smolts were collected at Little Goose Dam approximately 98 percent of the juvenile steelhead migrating that year had already passed this project. These late-migrating fish were observed in the forebay of the dam on the surface, had prolonged migration times, and were likely residualizing (see www.fpc.org/documents/memos/136-07.pdf). These fish may be considered anomalous, and were likely present due to the very low flow conditions that occurred that year. The other 29 times the biological criteria were exceeded occurred when total dissolved gas was greater than 120 percent. Of these 29 exceedences, 26 (90 percent) were observed at total dissolved gas concentrations greater than 125 percent. Figure L-9 shows the summary of the 2,488 daily exams as a function of total dissolved gas.

Figure L-9
Percent gas bubble trauma observed as a function of total dissolved gas observed. Measured at the tailwater of the upstream project at the Snake River projects and at John Day Dam tailwater for the Columbia River samples. Open circles indicate observations for late-migrating steelhead observed in 2002 and 2007.



In the 20 years of monitoring, there have been several instances where gas bubble trauma data were collected during periods of uncontrolled spill that lead to higher levels of total dissolved gas. This allows fish collected to be sorted into groups that migrated under similar levels.

Figure L-10
Percent of all fish collected from 1995–2014 showing signs of gas bubble trauma at given total dissolved gas levels.



From Figure L-10 two things are apparent. The incidence of fish observed with signs of gas bubble trauma and the severity of those signs increases with increasing levels of total dissolved gas supersaturation. This is consistent with the research on which the monitoring program was developed. And, secondly, signs of gas bubble trauma are almost non-existent below 120 percent total dissolved gas, begin increasing slightly between 121 and 125 percent, and then increase in both incidence and severity above 125 percent total dissolved gas.

Discussion

Data collected over the past 20 years strongly suggest that the Biological Monitoring serves as an effective management tool providing "early warning" of potentially harmful levels of total dissolved gas. What we have learned from the historic data is that the "early warning" signs are not triggered at total dissolved gas levels less than 120 percent at the tailwater monitors. Most observations indicating potential harm occurred above total dissolved gas levels of 125 percent as measured at the tailwater monitors.