



DEPARTMENT OF THE ARMY  
U.S. ARMY CORPS OF ENGINEERS  
201 NORTH THIRD AVENUE  
WALLA WALLA, WA 99362-1876

CENWW-EC-H

17 October 2016

MEMORANDUM FOR Chief, Hydrology Section, John Heitstuman

SUBJECT: Results of the Dworshak National Fish Hatchery Water Quality Study During Dworshak Dam Spill Test, Ahsahka, Idaho, April 2016

1. Introduction. In anticipation of generator unit number 3 outage from September 2016 to May 2017 at Dworshak Dam, an experimental spill test was conducted to collect data on the Dworshak National Fish Hatchery (NFH) river intake degassing system. In order to maintain its flood risk reduction mission, the U.S. Army Corps of Engineers (USACE) Walla Walla District (District) may have to exceed the maximum total dissolved gas (TDG) in the outage window. Since elevated TDG levels can cause deleterious gas bubble disease/trauma in fish, the purpose of the investigation was to identify and quantify the potential impacts to hatchery operations resulting from modified Dworshak operations during the unit outage. The state of Idaho water quality standard for TDG is to maintain below 110%. The first day test goal was to exceed the water quality TDG standard and operate at a ceiling of 115% gas saturation for a short duration. On day 2, a maximum of 120% TDG was reached by increasing releases and holding it at that level for at least 1 hour.

2. Methods.

a. A short-term exemption from the state of Idaho water quality TDG standard was obtained to perform the experimental spill test at Dworshak. The in-river target test spill was performed by the District, with monitoring in-hatchery by District and NFH personnel. On April 28, 2016 (Day 1), the in-river target goal was 115% TDG, and on April 29, 2016 (Day 2), the in-river target goal was 120% TDG. A permanent U.S. Geological Survey (USGS)/USACE TDG in-river gaging station near the water intake of the hatchery on the North Fork Clearwater River/Dworshak tailwater, Dworshak gage (USACE gage DWQI/USGS gage 13341000), was used as the primary in-river monitoring site for Dworshak operational adjustments. Dworshak powerhouse operators and District hydrology staff verbally communicated live Dworshak gage data readings during the spill experiment to coordinate proper operations to achieve in-river TDG test goals.

b. Several permanent USGS/USACE in-river gaging stations were used to monitor TDG, flow, and ambient air barometric pressure during the test. In addition to Dworshak gage, these stations included: Peck gage (USACE gage PEKI/USGS gage 13341050),

Lewiston gage (USACE gage LEWI/USGS gage 13343000), and the Orofino gage (USACE gage ORFI/USGS gage 13340000) (enclosure 1). Sondes (water quality sensors), were deployed on April 27, 2016, in a variety of locations within the hatchery and at two sites downstream, and were retrieved on April 30, 2016. Hatchery sites included: NFH Burrows Pond 50, Raceway B29, Degassing Chambers, and Collection Channel (enclosure 2). Two sondes were deployed at key locations downstream of the NFH: Nez Perce Tribal (NPT) Big Canyon Acclimation Facility holding tank and Nez Perce Tribal Hatchery (NPTH) at Cherry Lane water intake sub pump, at request of Nez Perce Tribe (enclosures 1 and 2).

c. Eight Hydrolab MS5 Mini Sondes were used to monitor water quality. Five of the sondes were outfitted with membrane diffusion method TDG sensors, thermometers (thermistors), luminescent dissolved oxygen, conductivity, and depth sensors. Three of the sondes were outfitted with only membrane diffusion method TDG sensors, thermistors, and depth sensors. Sondes were calibrated in the District water quality lab prior to deployment following standard operating procedures (Eaton et al. 1998, Hach 2006). After the sondes were retrieved from the field, a post-deployment calibration verification was performed on all sonde sensors.

### 3. Results.

a. Target TDG levels were obtained at Dworshak gage of 115% (114.9%) at 10.5 thousand cubic feet per second (kcfs) on Day 1 and 120% (119.9%) at 12 kcfs on Day 2 (enclosures 3 and 4). Operationally, on Day 1 at Dworshak, water was released through units 1 and 2 and over the spill crest, while on Day 2 water spill was switched from the spill crest to the regulating outlets. The 10.5 kcfs Dworshak release on Day 1 contributed to ~26% of the total flow of ~39.7 kcfs observed downstream of the confluence of the North and South Fork of the Clearwater River at the Peck gage on Day 1. This resulted in a reduction of in-river TDG from 114.9% TDG at Dworshak gage to 105.3% TDG at Peck gage (enclosure 4). The 12 kcfs Dworshak release on Day 2 contributed to ~31% of the total flow of ~38.5 kcfs observed downstream at the same gaging station. This resulted in reduction of in-river TDG from 119.9% at Dworshak gage to 106.9% at the Peck gage (enclosure 4).

b. On Day 1, the Dworshak gage TDG value of 114.9% resulted in the highest in-hatchery sonde site reading of 101.8% TDG (Burrows Pond 50) (enclosures 4 and 5). On Day 2 the 119.9% at Dworshak gage resulted in the highest hatchery site reading of 104.0% TDG (Burrows Pond 50). In-river TDG gage at Peck peaked at 105.3% on Day 1 and 106.9% on Day 2. TDG levels at NPT Big Canyon reached 101.9% on Day 1 and 102% on Day 2. TDG levels at NPTH Cherry Lane river water intake sub pump reached 104.2% on Day 1 and 105.6% on Day 2. Natural degassing occurred as expected, peaking downstream at Lewiston gage at 102.7% on Day 1 and 103.8 % on Day 2 (enclosure 4).

c. All sondes deployed for the test performed without malfunction and passed field side-by-side Quality Assurance checks and District lab calibration verifications (Bonneville Power Administration et al. 2015, USACE 2015).

#### 4. Discussion.

a. Degassing performance between the north and south sides of the river water intake degassing chamber was similar. The degassing towers performed exceptionally well during the test, reducing TDG by approximately 6-14%. The hatchery plumbing system did not appear to be contributing to TDG. With in-river TDG levels as high as 120%, the in-hatchery TDG levels can be as high as 104%, assuming similar performance as seen here.

b. The results of this test are highly influenced by a variety of environmental parameters. Water temperature, local air barometric pressure (local weather), and depth are known to influence dissolved gas solubility and saturation (Weitkamp & Katz 1980, Colt 1983). Dissolved gas was not measured in the main stem of the South Fork above the confluence so conditions occurring were not quantified, but they were likely near equilibrium (100% TDG) and may have aided in dilution of elevated TDG water from the North Fork. If closely monitored and managed, short-term Dworshak discharges resulting in elevated TDG, in conjunction with the repair activities, should not pose a threat to fish species in the NFH.

#### 5. References.

a. Bonneville Power Administration, U.S. Bureau of Reclamation, and U.S. Army Corps of Engineers. 2015. 2016 Water Management Plan, Appendix 4, Total Dissolved Gas Plan, <http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/>.

b. Colt, J.E. 1983. The computation and reporting of dissolved gas levels. *Water Research* 17: 841-849.

c. Eaton, A. D., Clesceri, L. S., Greenberg, A. E., Franson, M. A. H., American Public Health Association, American Water Works Association, & Water Environment Federation. 1998. *Standard methods for the examination of water and wastewater*. Washington, DC: American Public Health Association.

d. Hach Corporation. 2006. *Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobe: Users Manual, Third Edition*, Loveland, Colorado: Hach.

e. U.S. Army Corps of Engineers. 2016. *2015 Dissolved Gas and Temperature Report: Columbia Basin: Appendix J*. Portland, Oregon: USACE Northwestern Division.

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f. Weitkamp, D.E. and M. Katz. 1980. A review of dissolved gas supersaturation literature. Transactions of the American Fisheries Society. 109: 659–702.

Stephen C. Hall, PE  
Chief, Water Management

#### 5 Enclosures

Enclosure 1: Permanent USGS/USACE River Gaging Stations and Water Quality Sonde Deployment Sites Used During the TDG Spill Test

Enclosure 2: Dworshak National Fish Hatchery Water Quality Sonde Deployment Sites for TDG Spill Test

Enclosure 3: TDG (% Saturation) and Flow (Kcfs) Observed During Dworshak Dam Spill Test From April 27 to April 30, 2016

Enclosure 4. Maximum Total Dissolved Gas Levels Observed During Dworshak Dam Spill Test at Water Quality Monitoring Sites From Observed Target Levels of ~115%TDG and ~120%TDG

Enclosure 5. Total Dissolved Gas Measurements From Water Quality Sondes and River Gaging Stations at Dworshak NFH and the Clearwater River, ID, From April 27 to April 30, 2016

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**Permanent USGS/USACE River Gaging Stations and Water Quality Sonde Deployment Sites Used During the TDG Spill Test**

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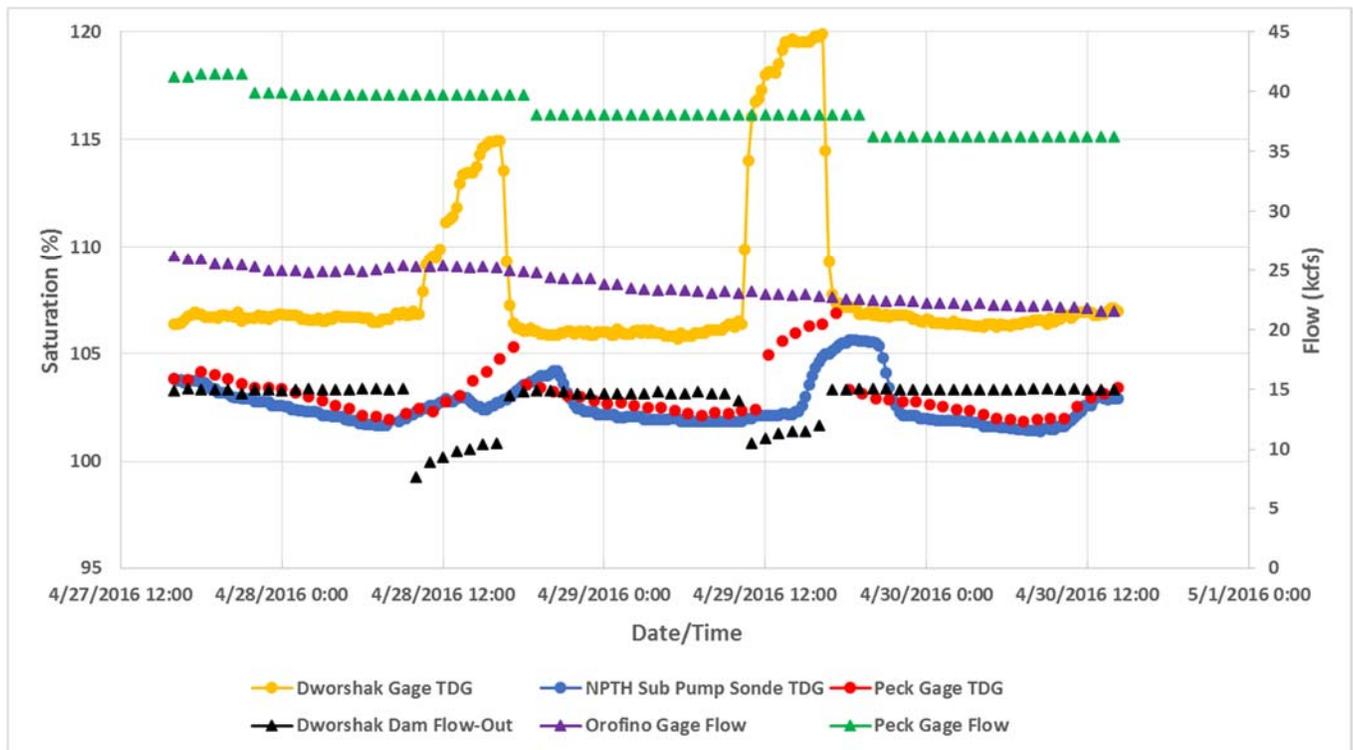
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**Dworshak National Fish Hatchery Water Quality Sonde  
Deployment Sites for TDG Spill Test**

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**TDG (% Saturation) and Flow (kcfs) Observed During Dworshak Dam Spill Test From April 27 to April 30, 2016**

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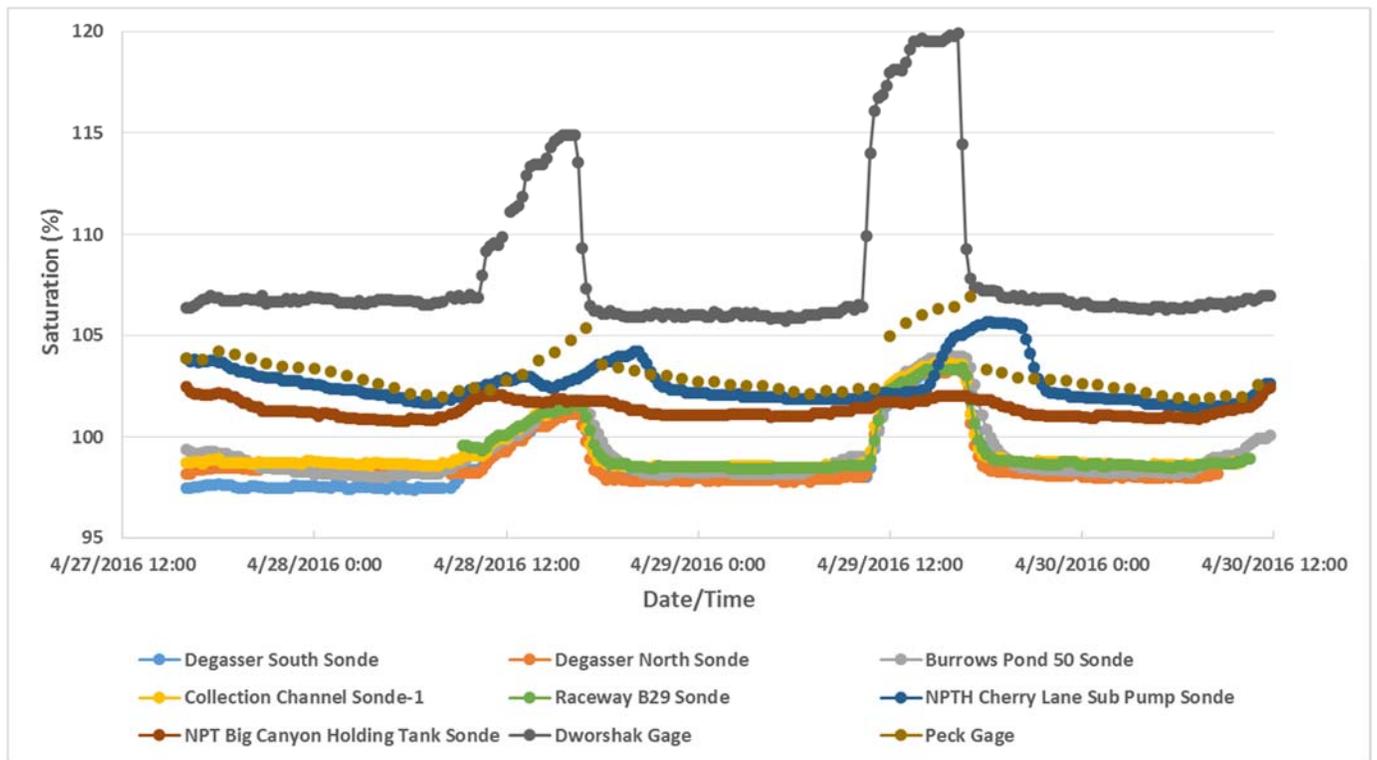
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<b>Water Quality Monitoring Site</b>	<b>Target Level Dworshak Gage 115% TDG on 4/28/16</b>	<b>Target Level Dworshak Gage 120% TDG on 4/29/16</b>
Degasser South	101.3	103.5
Degasser North	101.1	103.3
Raceway B-29	101.6	103.3
Collection Channel 1	101.6	103.6
Burrows Pond 50	101.8	104.0
Peck Gage	105.3	106.9
NPT Big Canyon	101.9	102.0
NPTH Cherry Lane	104.2	105.6
Lewiston Gage	102.7	103.8

**Maximum Total Dissolved Gas Levels Observed During Dworshak Dam Spill Test at Water Quality Monitoring Sites From Observed Target Levels of ~115%TDG and ~120%TDG**

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**Total Dissolved Gas Measurements From Water Quality Sondes and River Gaging Stations at Dworshak NFH and the Clearwater River, ID, From April 27 to April 30, 2016**