Willamette Action Teams for Ecosystem Restoration

Steering Team: July 14th Meeting

Big Cliff: Suggested Path for Discussion & Decisions

Notes added by D. Dishman (NMFS) on 7/14/17 are shown in blue text. Figures were also added from source documents.

The following is a proposed initial path forward for discussion and decision making about TDG at the Willamette's Big Cliff dam. The Steering Team will discuss this proposed path and refine as needed to achieve enhanced conditions for ESA listed fish downstream of the project:

1) Initiate the analysis below recommended by Bernadette (augmented by others):

> NOTE: TDG is measured at Niagara, OR, almost 3 miles downstream of the Big Cliff tailrace. It's about 2.7 mi from Big Cliff to Niagara, and an additional 1.3 mi to Minto, so almost ¾ of this reach is experiencing TDG levels ***higher*** than what is reported here.

- During what months is the project exceeding TDG standards?
  - 2015: September, October, December, January, February, March, May

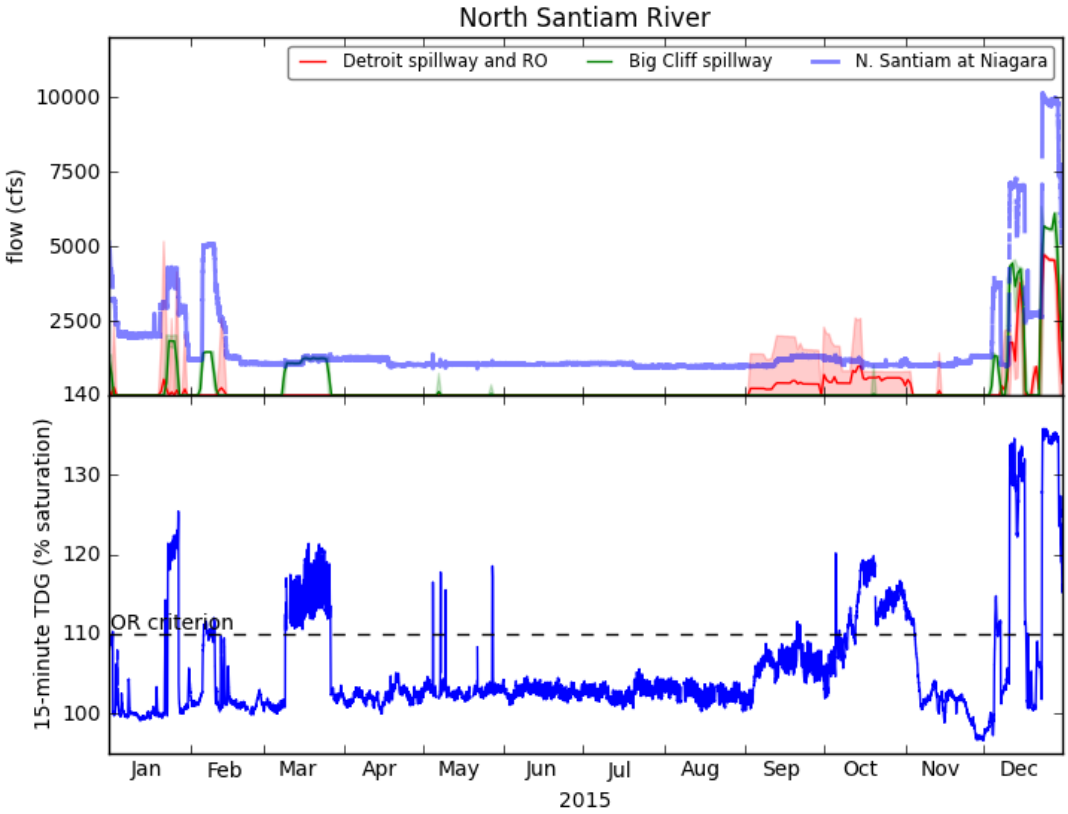


Figure from Willamette Basin Annual Water Quality Report for 2015 - Draft 90% Report (USACE 2016)

- 2016: October, November, December, January, March, April, May, June, July

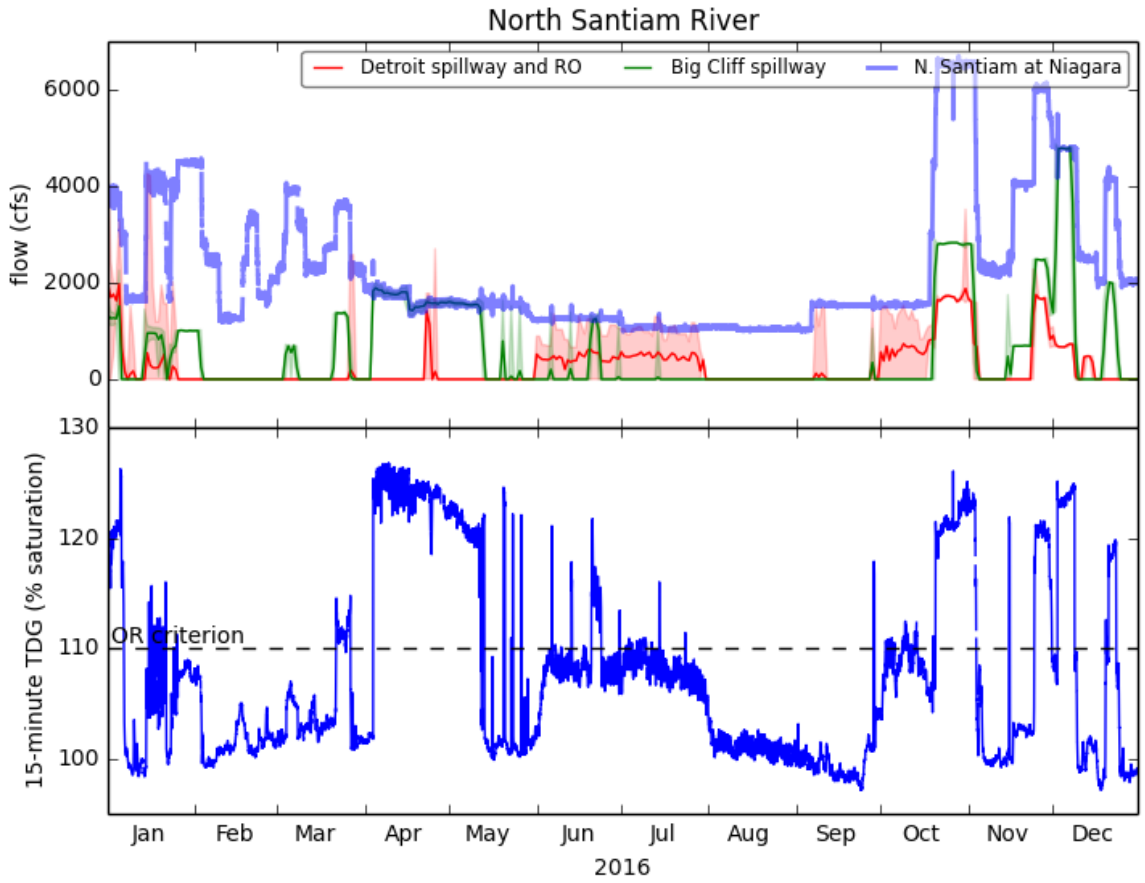


Figure from Willamette Basin Annual Water Quality Report for 2016 - Draft 90% Report (USACE 2017)

- 2017: January, February, March

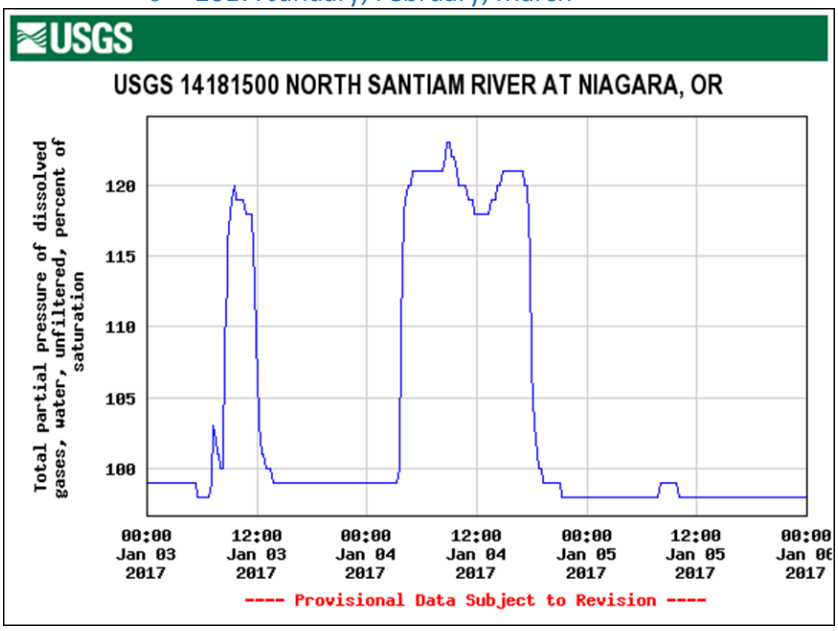


Figure from 17BCL04 "Turbine Unit Forced Outage"

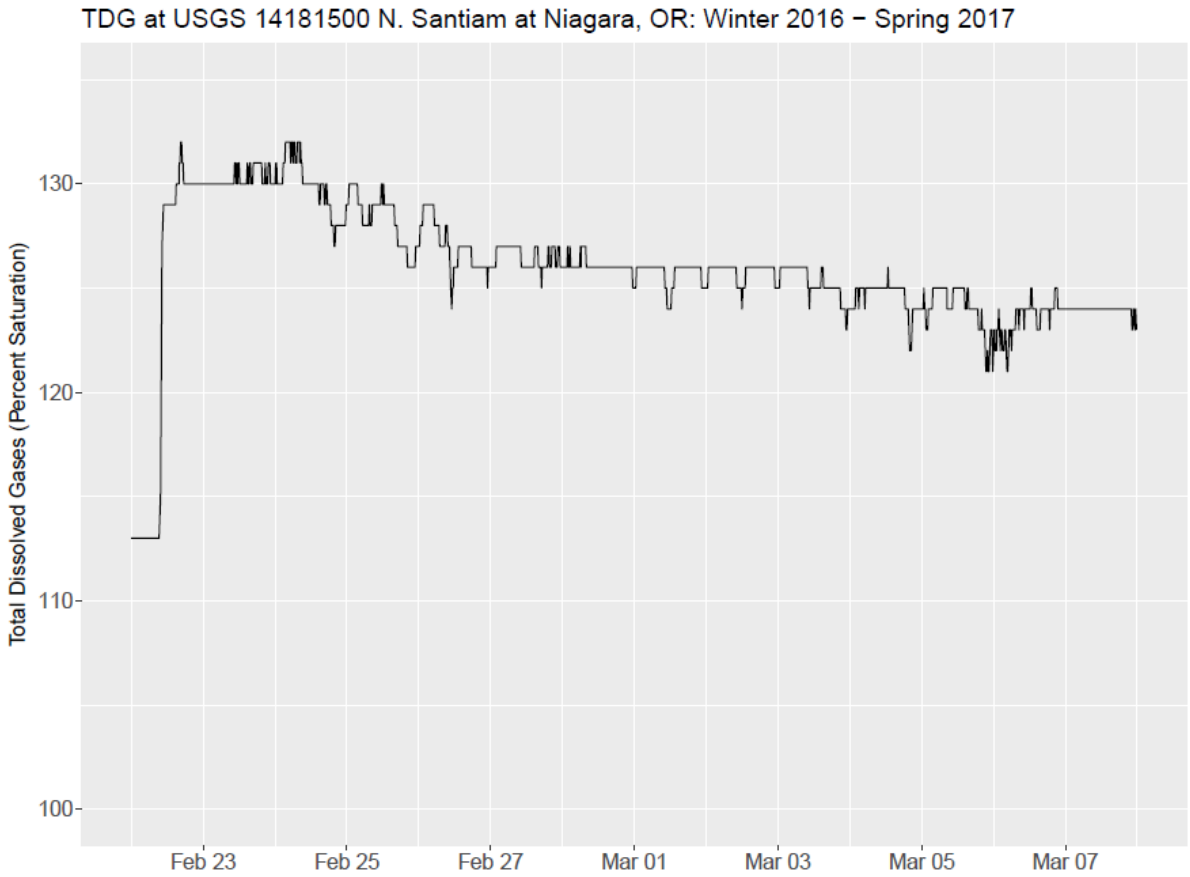


Figure from 17BCL04 "Turbine Unit Outage"

- What are the causes of those exceedances?
  - 2015 Annual Water Quality Report:
    "During the **October LRO temperature operations**, diel fluctuations in hourly TDG saturations exceeded the State of Oregon water quality standard, frequently ranging around 113%, and peaking at 119% over a five day period (October 15 – 20).
    The following TDG percent saturation peaks occurred during the Big Cliff spillway operations: five days in January the TDG peaked up to 125%; five days at beginning of February TDG peaked up to 112%; and over 15 days in March TDG peaked up to 121%, all well above the State of Oregon TDG standards. During these first three months of the year, TDG saturation ranged around 100% in-between the Big Cliff spillway operations. TDG saturation decreased by about 11% once the Big Cliff spillway operation was discontinued on March 26.
    In addition, there were several hours in **May** in which TDG was up near 118% as the Big Cliff spillway was briefly utilized due to **turbine outages for maintenance** (Figure 6-5).
    The highest TDG saturation spikes were evident in **December**, ranging from about 122% to 135% for several days due to Big Cliff spillway operations. The project was

discharging through the spillway **primarily due to increased outflows that exceeded turbine capacities**."

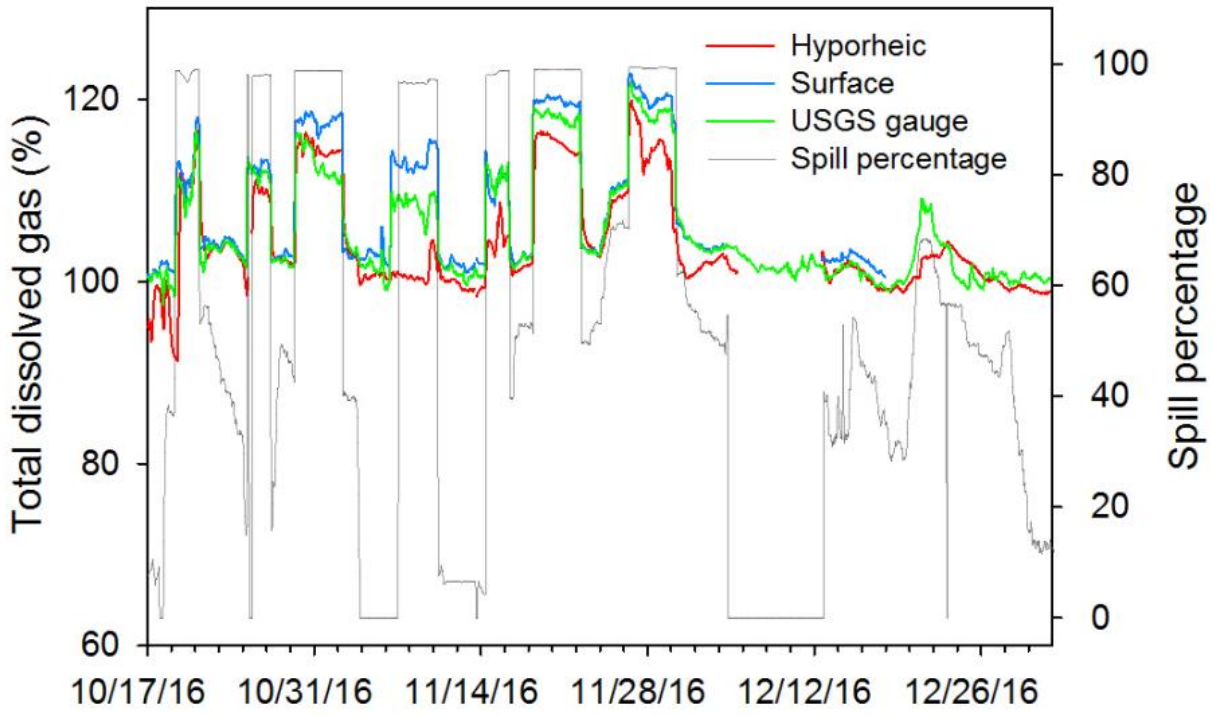
- 2016 Annual Water Quality Report:
  "During the temperature operations from **June through July**, diel fluctuations in hourly TDG saturations slightly exceeded the State of Oregon water quality standard at times. However, there were also five spikes during this period that exceeded the standard significantly with TDG saturation ranging from 116% to 121% during the Big Cliff spillway operations. These spikes occurred on June 6, 13, 20, 23, and July 14 (Figure 6-5). ***[No reason given]***
  The correlation between Big Cliff spillway operations and TDG saturation above the State standard of 110 percent is especially evident in early **January,** several weeks from **April through May, mid-October** to early **November**, late November, and a week in early **December** (Figure 6-5). During these periods the TDG saturation ranged from about 120% to 126% for several days. However, once the Big Cliff spillway discharge was discontinued, the TDG saturation decreased by about 20% at times (on May 13 for example). The Big Cliff spillway was **utilized primarily due to increased outflows that exceeded the turbine capacities and possibly due to some turbine outages for maintenance**."
  16BCL03 Turbine Unit Outage Due to Power Request – NOT MAINTENANCE
  17BCL01 Turbine Unit Outage: unplanned forced turbine unit outage at Big Cliff Dam that lasted for several days (December 2-8, 2016) which required emergency repairs and needed to be followed by a corrective action to restore normal function."

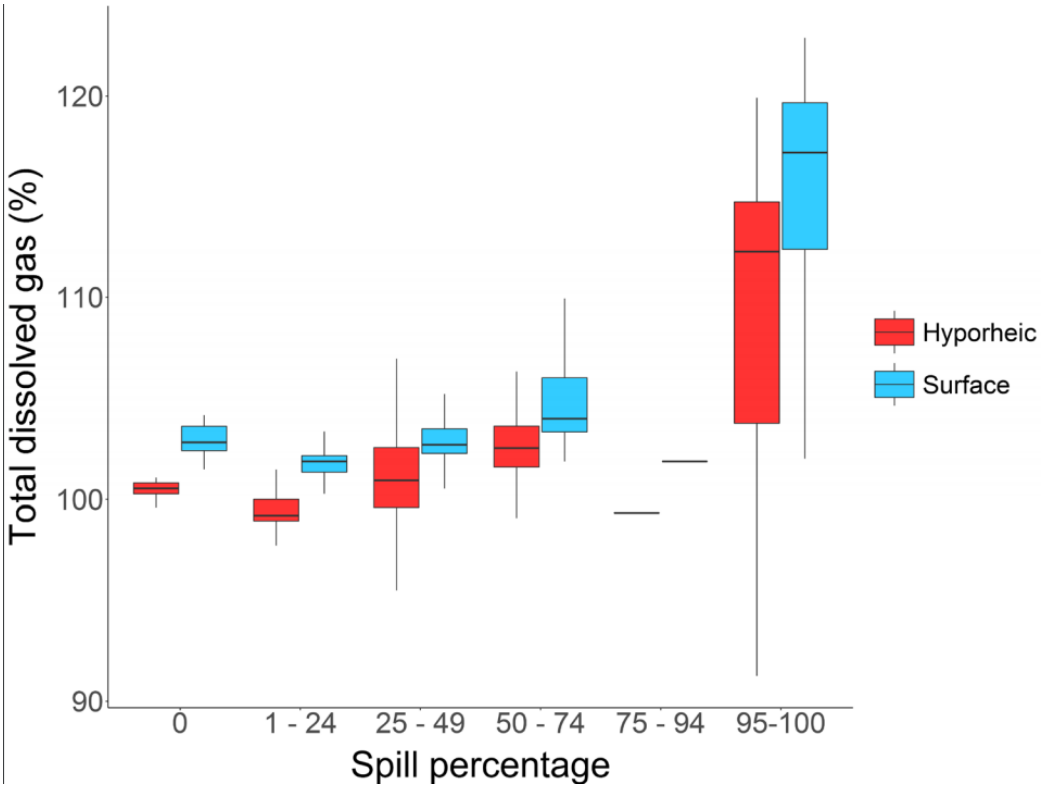
- 2017:
  17BCL02 Turbine Unit Forced Outage: This outage resulted from a fallen tree temporarily shorting a line, and was not immediately corrected because the emergency generator failed to startup automatically
  17BCL04 Turbine Unit Outage: An outage was scheduled February 22 for needed repairs, however, when bringing the system back online a head gate motor ground caused the head gate to fail to rise, and generation to be halted until the motor is repaired.

- How often is the project exceeding ODEQ's TDG standards?
  - This is the same as the 110% standard discussed above
- How often are these exceedances during flood control operations?
  - Specifically "*Except when streamflow exceeds the ten-year, seven-day average flood,* the concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection may not exceed 110 percent of saturation.*"* (Oregon Administrative Rules 340-041-0031); not the same as "flood control operations"
- What are the actual impacts of these high levels of TDG?
  - 2015 & 2016: "Levels of TDG observed between Big Cliff Dam and the Minto Fish Facility potentially negatively impacted salmonids during high discharge events, but the actual impact is unknown." – Water Quality Annual Reports
- What is the status of monitoring/gages below Big Cliff?
  - No longer reporting at USGS Niagara gage
    - If the Corps wants to provide their standard calculation tool, or a reference, we are happy to convert total partial pressure of gases in mm Hg to TDG %

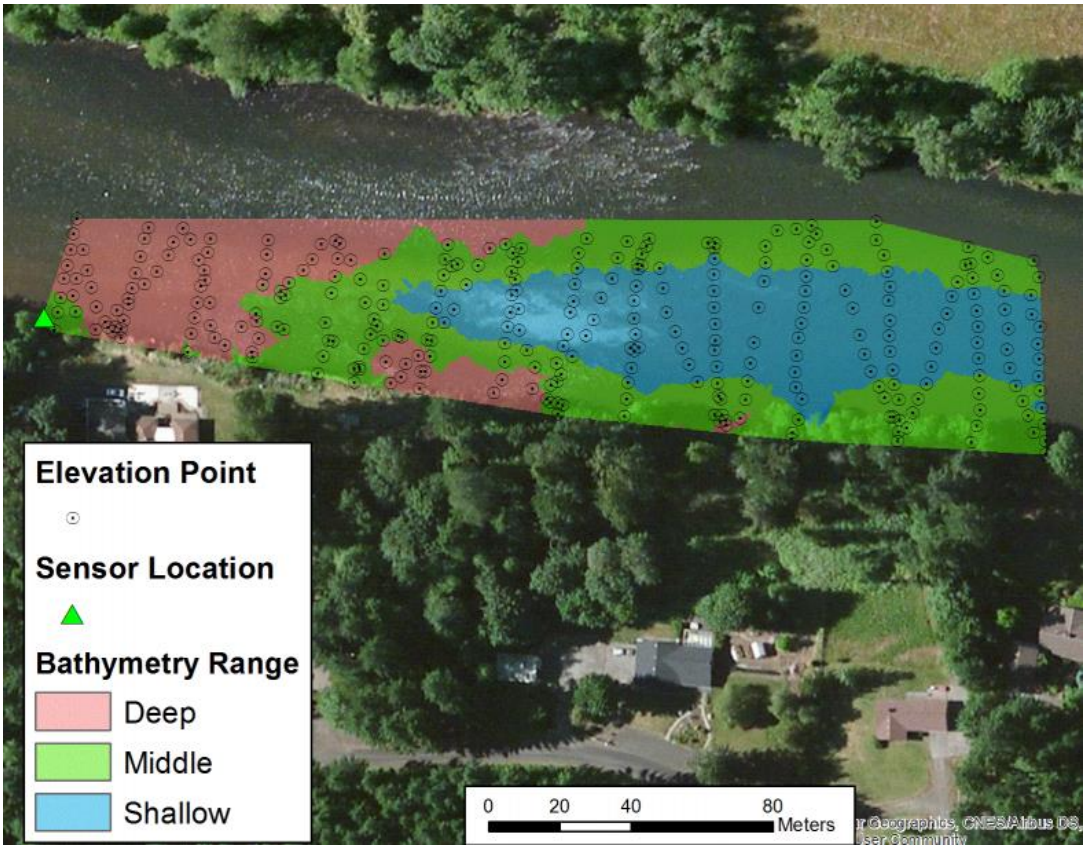
- A gage is being installed at Minto – hopefully it will be up and running within a week or so. How to get data reported publicly?
- What about right below the dam?

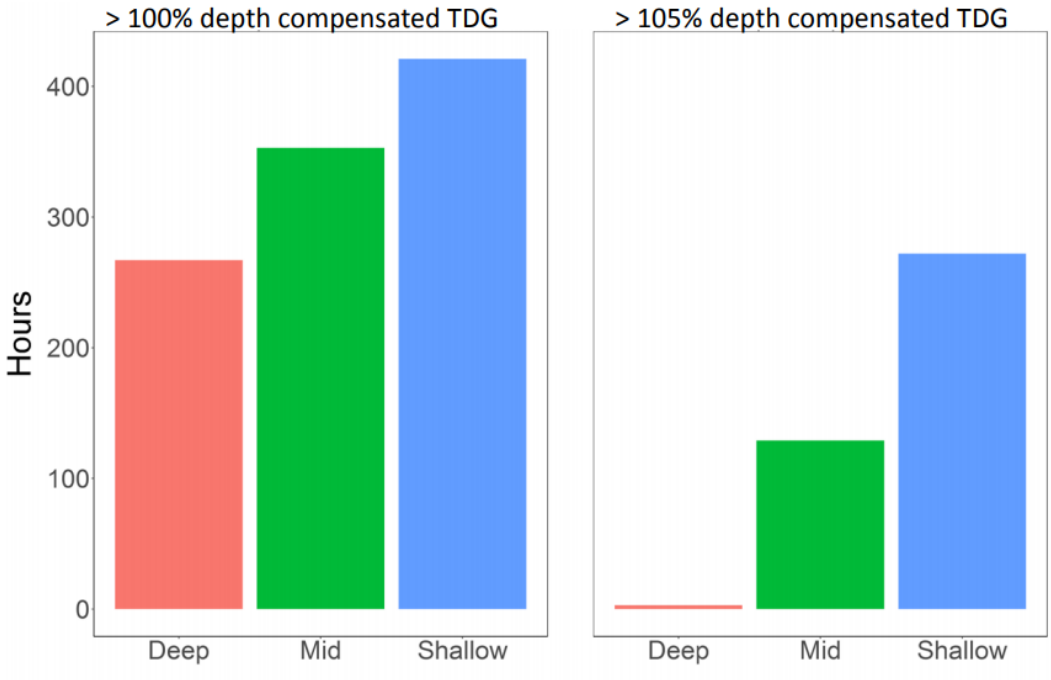
- What are the results of the study below Foster?





Figures from Arntzen et al 2017 Willamette Science Review presentation



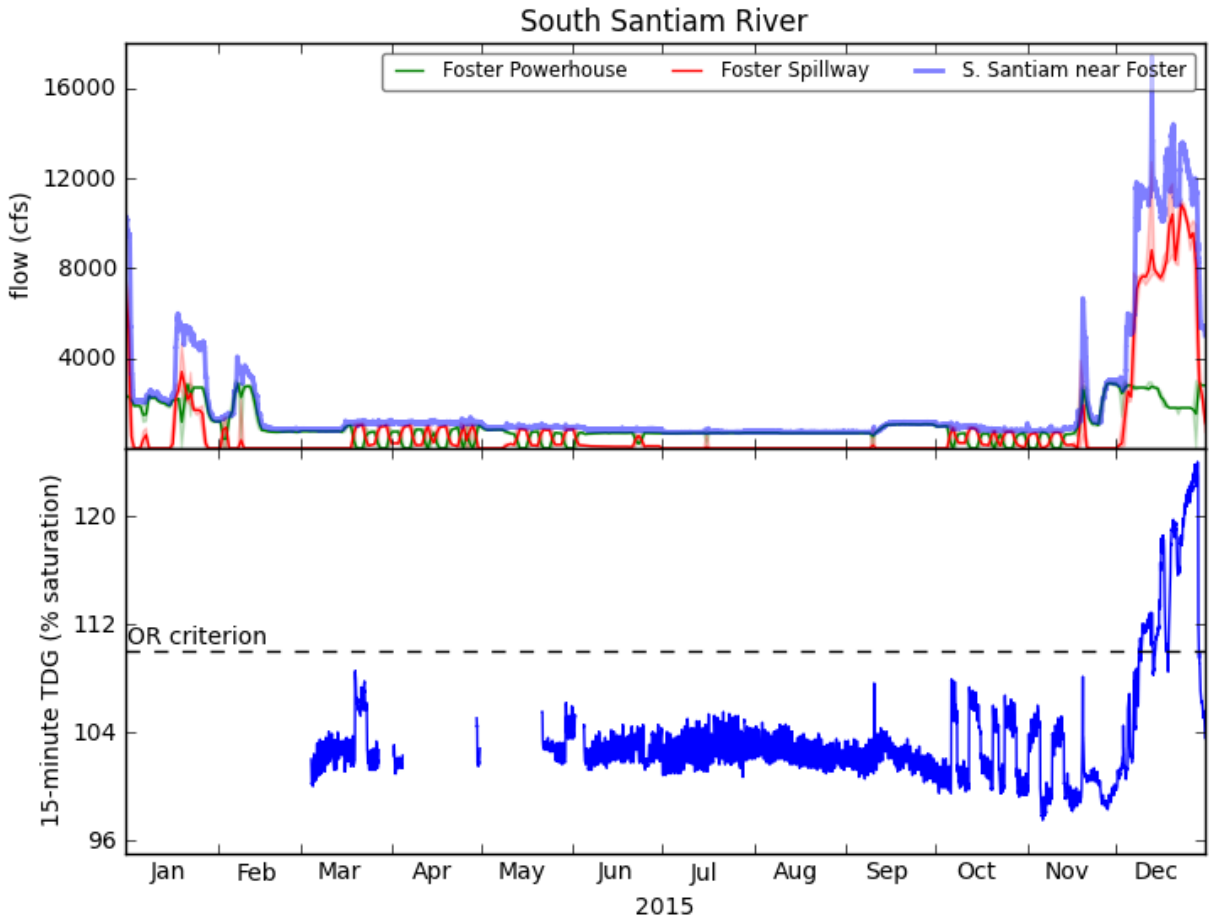


Figures from Arntzen et al 2017 Willamette Science Review presentation

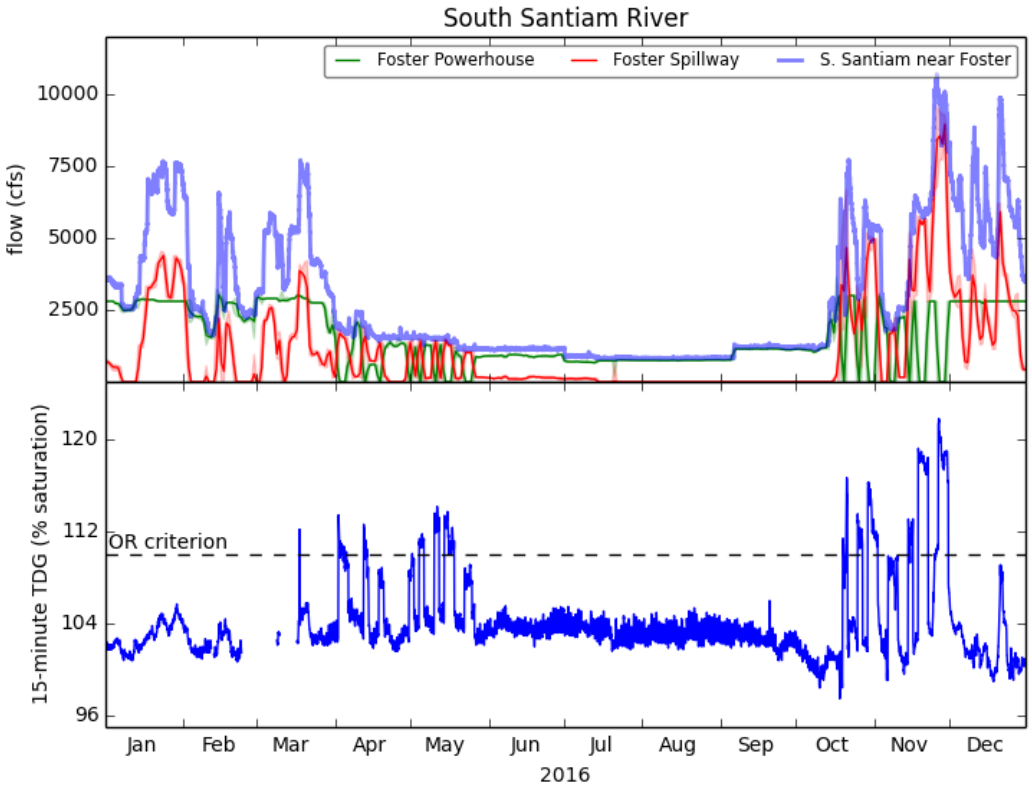
- Are there any other questions?
    - Any reason we can't refine the Detroit and Big Cliff powerhouse maintenance outage window now?

2) Review the S. Santiam TDG information as it pertains to the North Santiam, when available, and

- 2015 Annual Water Quality Report: "Throughout most of the year, up to December, TDG concentrations stayed well below the 110% criteria. The period of highest TDG percent saturation resulted from increased spillway flow throughout December. By the last week in December, the TDG concentrations were around 122% and reached a peak of 124% for a couple of hours on December 28. Utilization of the spillway was necessary since outflow exceeded the powerhouse capacity."



- 2016 Annual Water Quality Report: "Throughout most of the year, TDG concentrations stayed well below the 110% criteria and were around 104% throughout the summer months. The exceptions were in the spring and starting in mid-October through November when TDG concentrations were greater than the criteria. For example, TDG saturation peaked at 114 % during the spring. The period of the highest TDG saturation occurred from mid-October through November, with a peak of 121% during the last week of November. Utilization of the spillway was necessary since total outflow exceeded the powerhouse capacity."



3) Discuss the potential for a study in either FY17 or FY18 specific to TDG at depth below Big Cliff.

- What information would be needed from such a study?
  - 2016 Annual Water Quality Report: "An intensive TDG study was also conducted in the North Santiam in 2010 with measurements at Detroit tailrace, Big Cliff tailrace, Niagara, Minto and Mehama (USACE 2011). Excess TDG was found to dissipate to background levels within 10 miles downstream, at the Mehama site." The 2010 monitoring did not measure hyporheic TDG, and some members of the RME Team recommended a study for the N. Santiam similar to that done at S. Santiam for FY15 or FY16, but the Corps chose to first conduct the study on the S. Santiam.
  - Do we need more information? Who can summarize this or provide it to the group?

References:

Arntzen, E, R. Flaherty, A. Colotello, R. Harnish, J. Vavrinec, S. Zimmerman, J. Tagestad, and K. Stertz. 2017. Total dissolved gas levels below Foster Dam and implications for Chinook salmon and steelhead populations. 2017 Willamette Science Review Meeting, Corvallis, OR. February 8.

USACE. 2017. Willamette Basin Annual Water Quality Report for 2016 - Draft 90% Report. Portland District, Portland, OR.

USACE. 2016. Willamette Basin Annual Water Quality Report for 2015 - Draft 90% Report. Portland District, Portland, OR.

UPDATE for July 3rd Steering Team Discussion

Comments added to this section by D. Dishman 7/3/18

Figure from Willamette Basin Annual Water Quality Report for 2017 - Draft 90% Report (USACE 2018) showing TDG for 2017:

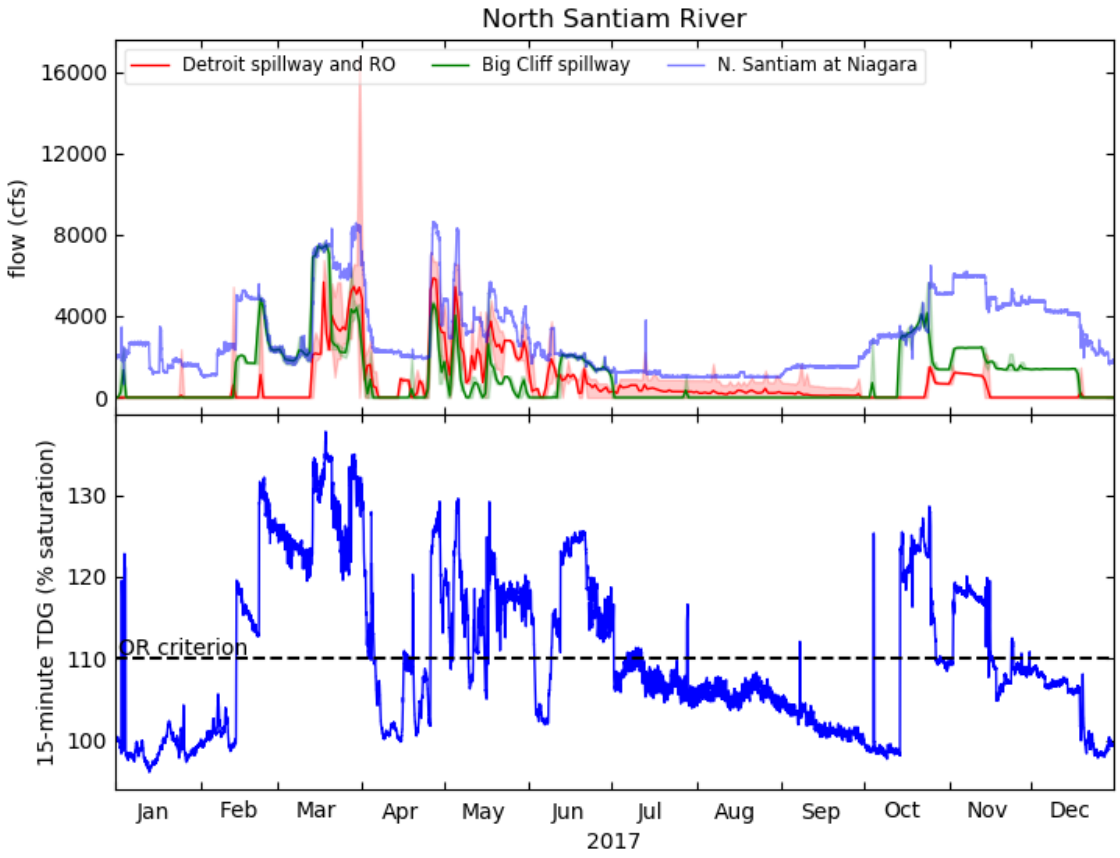


Figure 6-5. Detroit and Big Cliff Dam Operations and Subsequent Downstream Total Dissolved Gas Saturation (15-minute) Measured near Niagara, 2017. The shaded areas are minimum / maximum flow ranges.

From the 2017 Draft Water Quality Report (USACE 2018):

TDG saturations measured at the Niagara gaging station (BCLO) tracked fluctuations in Detroit and Big Cliff Dam operations; powerhouse, spillway and RO discharge (Figure 6-5). During the summer temperature operations from June through September, diel fluctuations in hourly TDG saturations were mostly below the State of Oregon water quality standard of 110 percent, with the main exception in June. The highest TDG saturation was in mid-June with TDG ranging from 118 – 125 % for two weeks when the Big Cliff spillway was also utilized due to a turbine outage. There were also a few weeks of significant spikes in TDG saturation during the fall temperature operations from mid-October through mid-November when the Big Cliff spillway was again being utilized due to total outflows exceeding the turbine capacity. The TDG saturation exceeded the State standard during this period while up to 128% in October and up to 120% in November for a total of about four weeks during the Big Cliff spillway operations:

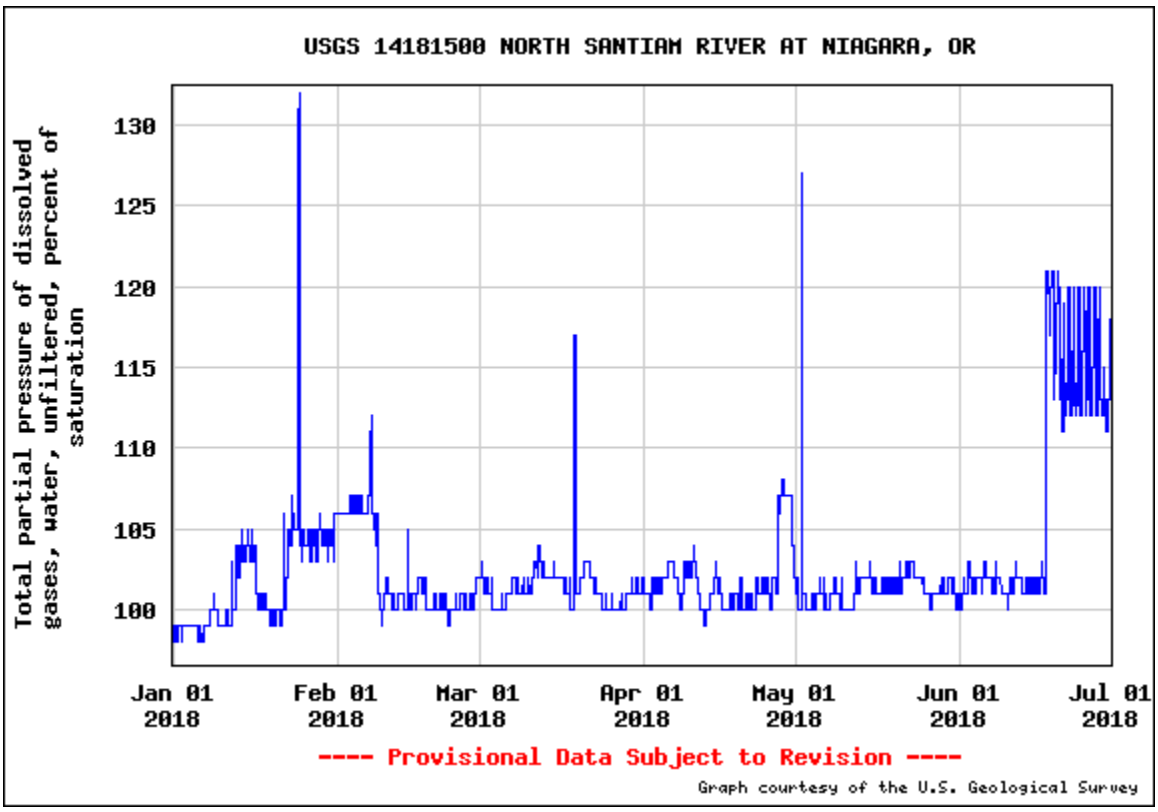
- Out of the 720 hours in June, 448 hours, or 62% of the time the Big Cliff unit was out for maintenance (an outage occurred). The specific dates that TDG spikes occurred were June 11 – 30, where June 12 – 21 TDG > 120%.
- Out of the 768 hours from October 15 – November 15, 247 hours, or 32% of the time the Big Cliff unit was out for maintenance (an outage occurred). The specific dates that TDG spikes occurred were from October 15 – 25.
- Out of these 768 hours, 520 hours, or 68% of the time the desired outflow was higher than the capacity of the Big Cliff unit which caused the TDG to spike (spill occurred while the turbine unit was running at full capacity). The specific dates these TDG spikes occurred were from October 25 – November 15.

The correlation between Big Cliff spillway operations and TDG saturation above the State standard of 110 percent is especially evident from mid-February through May (Figure 6-5). In addition, the TDG saturation was 130% or greater for just over two weeks between February through March. However, once the Big Cliff spillway discharge was discontinued, the TDG saturation decreased by about 20% at times; for example at the end of March and April, and again in mid-October. The Big Cliff spillway was utilized primarily due to turbine outages for maintenance and also for increased total outflows that exceeded turbine capacities:

- Out of the 267 hours from February 22 through March 31 when the TDG was 130% – 137%, 185 hours, or 69% of the time the Big Cliff unit was out for maintenance (an outage occurred).
- Out of these 267 hours, 82 hours, or 31% of the time the desired outflow was higher than the capacity of the Big Cliff unit which caused the TDG to spike
- During 2017, out of the 3922 hours where Big Cliff spilled:
    - 1445 hours, or 37%, were due to a unit outage
    - 2517 hours, or 64% were due to total outflow exceeding turbine capacity
    - 3387 hours, or 86%, had TDG higher than 110%
    - 2698 hours, or 68%, had TDG higher than 115%
    - 1620 hours, or 41%, had TDG higher than 120%

Overall, from July through mid-October, TDG saturation continued to decrease below the State standard, ranging between 100% – 110%; however TDG exceedances occurred most of the remainder of the year as total outflows were fairly high and turbine capacities were often exceeded. By comparison, the 2015 TDG levels were overall much lower throughout the year due mostly to a much dryer year with less total discharge and need to utilize the Big Cliff spillway.

USGS Data for TDG Saturation Below Big Cliff Dam in 2018 (so far):



From 2017 Annual Water Quality Report (USACE 2018), regarding studies of TDG dissipation conducted in 2010:

An intensive TDG study was also conducted in the North Santiam in 2010 with measurements taken at the sampling locations of the Detroit tailrace, Big Cliff tailrace, Niagara, Minto and Mehama (USACE 2011). Excess TDG saturation was found to dissipate significantly by the time that water reached Minto (about 6 miles downstream of Big Cliff Dam) and to background levels within 20 miles downstream, near the Mehama site (Figure 6-6). This degassing is primarily attributed to the natural rapids that stretch from Niagara to Minto. TDG saturation at the Big Cliff tailrace site was overall very similar compared to the Niagara site (which is located just upstream of the Niagara rapids); however, during TDG peaks the Big Cliff site was often up to 10 percent higher.

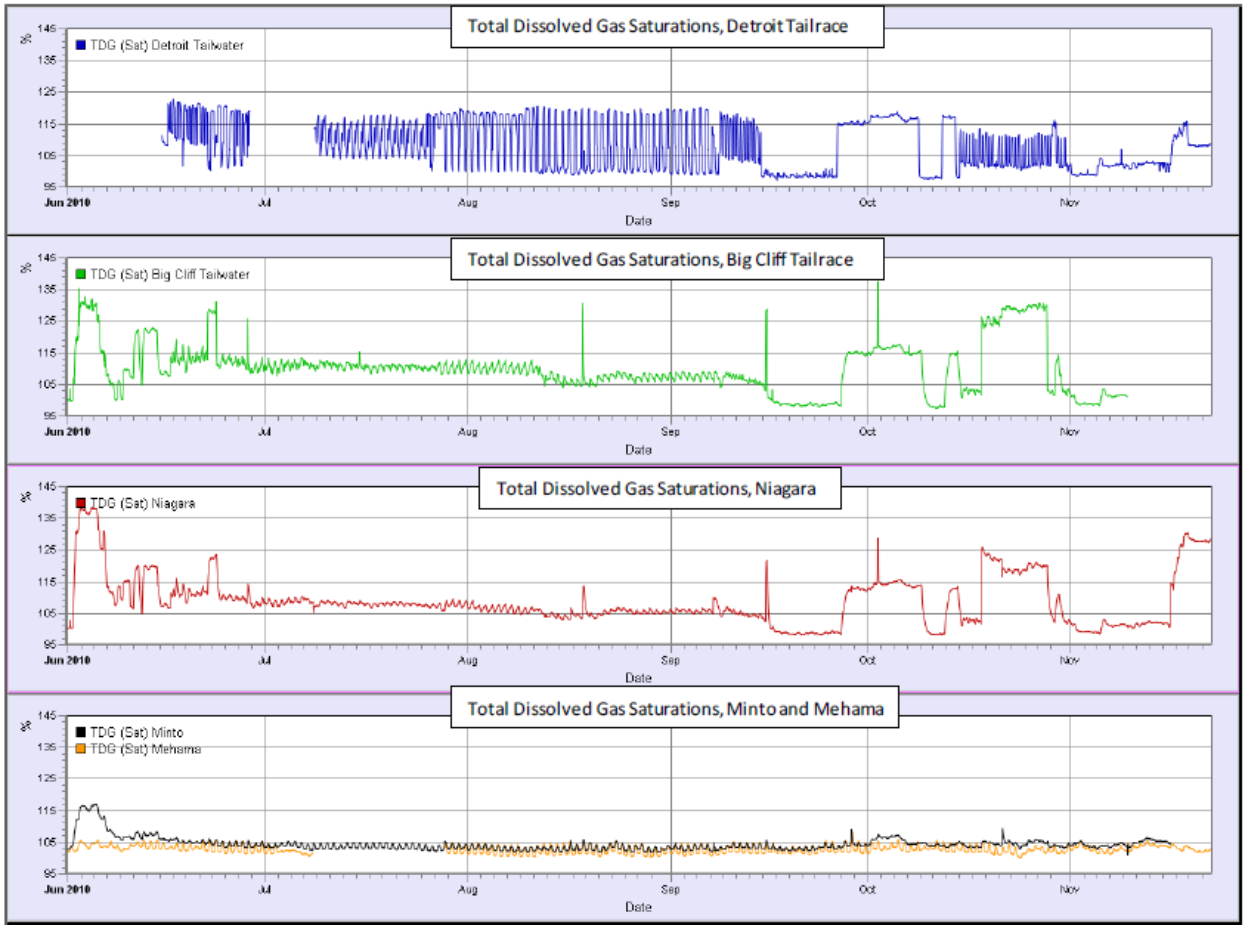


Figure 6-6. Total Dissolved Gas Saturation Measured in the Detroit and Big Cliff Tailraces and Near Niagara, Minto and Mehama on the North Santiam River, June through November, 2010. From the *Willamette Basin Annual Water Quality Report for Water Year 2010, pg. 25.*