TOTAL DISSOLVED GAS PRESSURE (TGP) MONITORING ON THE KOOTENAY RIVER AT CRESTON BRITISH COLUMBIA: 2002 DATA SUMMARY

- DATA REPORT -

Prepared for

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1.0 INTRODUCTION

At the request of the Ministry of Water, Land and Air Protection, a TGP study (known as TDG [Total Dissolved Gas] in the U.S.) was conducted on the Kootenay River, near Creston, BC, from 20 June to 15 July 2002. The purpose of this study was to determine TGP levels in the Canadian portion of the Kootenay River during spill from Libby Dam, located approximately 180 km upstream near Libby, Montana. This project was conducted concurrently with testing by the US Army Corp of Engineers to determine whether controlled spills from Libby Dam could be used to improve white sturgeon habitat (i.e., by increasing water velocity), while minimizing the risks of TGP produced during the spill event. Due to above average snow pack and precipitation within the Kootenay River basin in 2002, Libby Dam reservoir (Lake Koocanusa) quickly filled to maximum capacity and inflows exceeded maximum generation capacity of the Libby Dam power plant. This resulted in several days of involuntary spill during the monitoring period.

Previous studies have shown that spill from Libby Dam can produce moderate to high levels of TGP (e.g., 120%) that can potentially harm fish immediately downstream of the dam (USACE, 2002). The purpose of this study was to determine whether elevated TGP levels produced from spill at Libby Dam could be detected within the Canadian portion of the Kootenay River, prior to the river entering Kootenay Lake near Creston, B.C.

2.0 METHODOLOGY

2.1 Equipment and Calibration

The temporary TGP station consisted of a Hydrolab Minisonde provided by WLAP. This unit was a self-contained and fully submersible TGP monitor with data logging capabilities. Two portable TGP monitors, a TBO-F (Common Sensing Inc) and a TBO-DL (Point Four Ltd), were used to obtain spot measurements at the monitoring site and to verify the accuracy of readings obtained at the temporary station. These portable units consisted of a shore-based battery pack and datalogger connected to a submersible probe by a length of marine grade electrical cable. The following parameters were measured during the survey:

- Total dissolved gas pressure (mm Hg);
- Barometric pressure (mm Hg);
- Water temperature (ºC); and
- Partial pressure of dissolved oxygen (mm Hg).

Of the various parameters collected by the Minisonde (e.g., pH, conductivity, etc), only total dissolved gas pressure and water temperature were analyzed for the purpose of this study. Due to the manner of deployment of the Minisonde (i.e., the entire unit was submerged), barometric pressure could not be recorded with this type of monitor. To compensate for this limitation, a secondary TGP monitor and data logger was used to concurrently record barometric pressure.

Calibration and maintenance of all TGP monitors were performed prior to deployment, during the 3 July field servicing procedure, and upon removal of the station. Initial maintenance of the Minisonde required installation of new batteries to ensure that the unit would have sufficient power to operate for the full duration of the monitoring period. During calibration, a laptop and serial cable were connected to the unit to obtain a digital display of current parameter settings. Although the Minisonde was capable of measuring other parameters (e.g., conductivity, pH, etc.), only total gas pressure and water temperature were calibrated for this study. The dissolved oxygen sensor was not calibrated and dissolved oxygen data were not collected due to limited reliability of the sensor when deployed for an extended period of time (e.g., algal growth on the sensor). Deactivation of the circulator, in order to conserve battery power, would also likely have resulted in inaccurate dissolved oxygen readings. Once connected to the laptop, the Minisonde was held in a vertical position and the silastic membrane cartridge was removed in order to expose the pressure sensor to ambient atmospheric pressure. The resulting pressure reading was compared to a known local barometric pressure source. A two-point calibration was not required due to recent factory servicing of this unit. Once re-assembled, the silastic membrane was pressurized to ensure responsiveness. The temperature probe was calibrated in a water bath by use of an

accurate digital temperature reference. Prior to deployment, a final test run was conducted to ensure that the parameters measured by the Minisonde were recorded properly and could be downloaded. During the 3 July service of the Minisonde, replacement of the old membrane (typically performed every two weeks) was not possible due to the unavailability of a second membrane. Consequently, condensation build up within the original membrane over the duration of the study may have resulted in the recorded TGP levels being slightly lower than actual levels.

The portable meters were calibrated in a similar manner to the Minisonde calibration, by first adjusting their internal barometer to a known barometric pressure source. The silastic membrane was then removed from the probe and the probe pressure sensor adjusted to the current barometric pressure. Silastic membrane cartridges of both portable units were tested to ensure they were free of leaks and were responsive to changes in pressure. In the absence of the proper equipment to perform a two-point test on these older TGP monitors, both probes were deployed at a location with elevated TGP (i.e., the Brilliant Dam tailrace) to ensure that both monitors measured similar levels of TGP. The temperature sensor of each probe was calibrated in water and adjusted to match an accurate digital temperature sensor. For the purpose of recording accurate instantaneous dissolved oxygen measurements, the oxygen sensor of each portable unit was serviced and calibrated.

2.2 Site Identification and equipment deployment

With assistance from Brian Stushnoff (Area Manager, Creston Valley Wildlife Management Authority), an appropriate deployment site was identified on the east bank of the Kootenay River approximately 150 m downstream of the Highway 3 bridge. This site was chosen based on ease of accessibility and relative security compared to other locations with greater public access. Due to the likelihood of complete mixing over the large distance (i.e., 180 km) between the TGP station and Libby Dam, homogenous conditions between the left and right banks were assumed. The site consisted of a row of pilings used to support an old log landing that projected out from the east bank several metres into the mainstem of the Kootenay River. Water depth on the outside edge of pilings where the Minisonde was deployed was approximately 4 m.

Three-inch heavy-duty PVC pipe, 1.5 metres in length, was used to house and protect the Minisonde. A perforated T end-piece on the pipe allowed water to flow across the probe sensors while still conferring adequate protection. Once the probe was placed inside the PVC housing, an end cap to prevent easy removal of the probe was used to seal the end of the PVC pipe. A length of metal cable was used to attach the probe assembly on the outside edge of the pilings at a depth of approximately 3 m.

A second TGP meter was installed in the main office of the Creston Valley Wildlife Management Authority to record barometric pressure. Because of an elevation difference of 100 m between the office and the TGP station on the

Kootenay River, the difference in barometric pressure due to elevation was determined. This correction was later applied to the recorded barometric pressure data.

2.3 Data collection and processing

All TGP data from the temporary monitoring station was collected at a 10-minute interval. Prior to deployment, TGP measurements from the Minisonde and the two portable meters were obtained to ensure that readings from the Minisonde and portable meters were consistent. All logged data was downloaded from the Minisonde using a laptop computer. Once downloaded, the data file was briefly checked to ensure that the download process was successful. This same procedure was used during the download of barometric pressure data from the meter located in the Creston Valley Wildlife Management office. Once the data were downloaded successfully, auto-logging was re-initialized and the meters redeployed.

Data on the laptop was transferred to an office server where it was plotted and checked for errors using an Excel spreadsheet. For the purpose of this analysis, TGP and water temperature data were plotted in conjunction with total discharge (spill and generation combined) and generation discharge from Libby Dam to determine if spill from Libby Dam resulted in elevated TGP levels at the monitoring station.

3.0 RESULTS

All TGP data collected during the monitoring period is presented in Figure 3.1, where values range between a minimum of 762 mm Hg on 9 July and a maximum of 799 mm Hg on 3 July. Water temperatures recorded during this time show typical seasonal warming and ranged between a minimum of 9.8ºC at the start of the monitor session and a maximum of 15.4ºC near the end of the monitoring session. A cyclical pattern observed in the TGP data was likely the result of diel temperature change and photosynthetic activity. In the same figure, total discharge from Libby Dam ranged between a minimum of 506.9 m^3/s and a maximum of 1132.7 m^3/s. Maximum spill from Libby Dam was 441.8 m^3/s and this discharge level was maintained from 1 to 3 July. When converted to percent saturation, the majority of the data are below the 110% Canadian guideline and U.S. standard (USACE, 2002). Portable TGP readings taken over the duration of the study are presented in Table 3.1.

Table 3.1: Spot TGP measurements recorded during TGP monitoring survey in the Kootenay River, near Creston B.C., from 20 June to 16 July 2002.

Date/Time	Barometric Pressure (BP)	Temperature	Total Dissolved Gas Pressure (TGP)	Percent Saturation	Delta P (TGP-BP)	Partial Pressure of Oxygen
	(mm Hg)	(ºC)	(mm Hg)	(%)	(mm Hg)	(mm Hg)
20 June 16:34	716	10.5	775	108.2	59	N/A[a]
3 July 16:10	712	11.9	796	111.8	84	159
16 July 15:10	714	15.6	790	110.6	76	171

[a] Dissolved oxygen sensor was not functional.

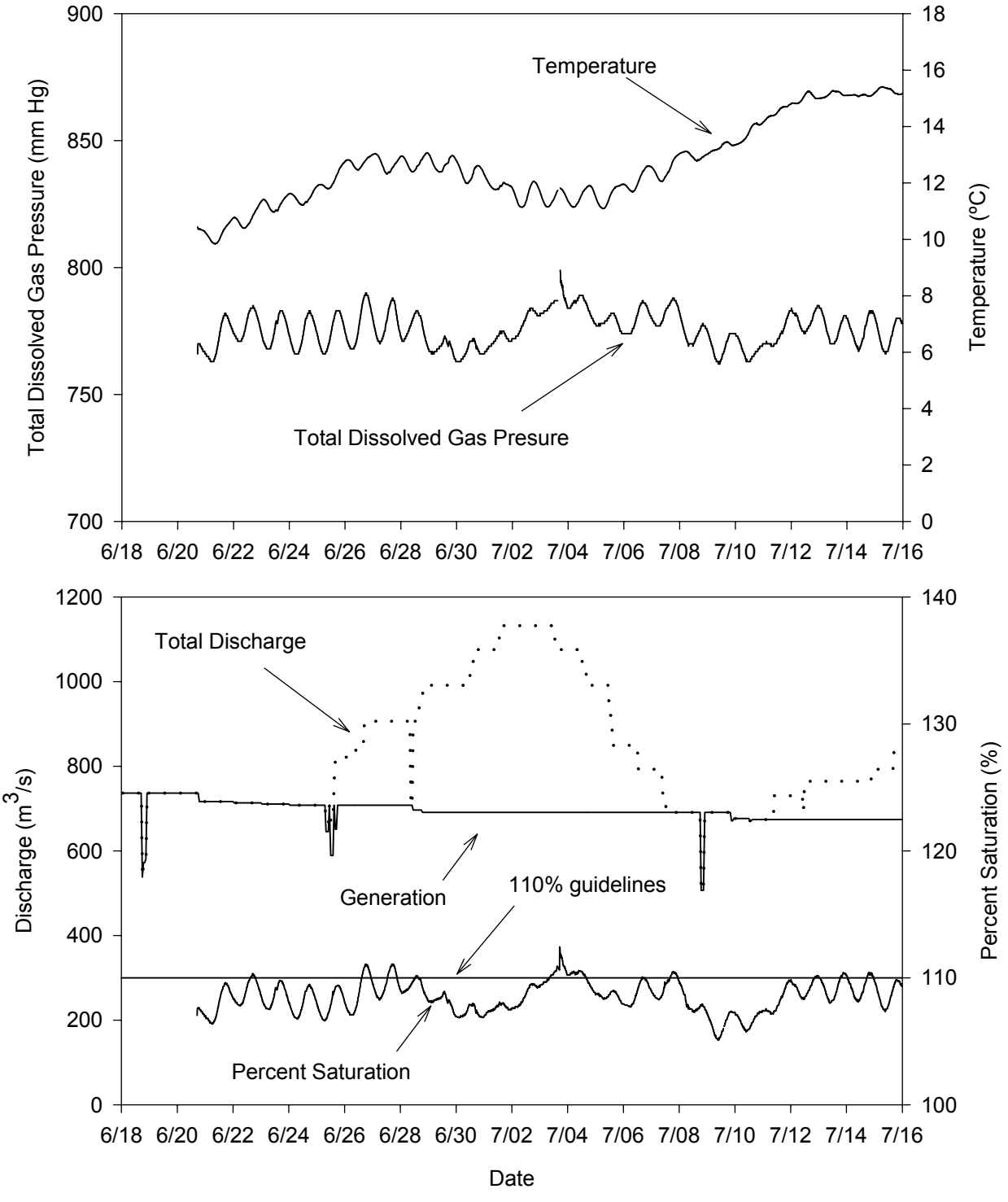

Figure 3.1 Upper graph represents TGP and water temperature data from the Canadian portion of the Kootenay River, near Creston B.C., from 20 June to 15 July 2002. The lower graph shows Libby Dam spill and generation in relation to percent saturation over the same time period.

4.0 DISCUSSION AND SUMMARY

Based on the relatively low levels of TGP observed during the survey, spill from Libby Dam appears to have minimal effect on TGP in the Canadian portion of the Kootenay River. All fluctuations in TGP were likely due to daytime heating of surface water that reduced the solubility of oxygen and nitrogen in water and resulted in an increase in TGP observed. During this study, daytime heating resulted in only minor TGP fluctuations of usually less than 20 mm Hg. The increase in TGP on 3 July, during which maximum TGP values were attained, occurred during the period of maximum spill at Libby Dam. During this time, however, the station was serviced to download stored data from the Minisonde and to calibrate the unit. The maximum TGP value of 799 mm Hg occurred immediately after servicing the unit. During the following hour, TGP levels gradually declined to approximately 780 mm Hg. This indicated that the increase in TGP was likely an artifact of the servicing and was not associated with spill at Libby Dam. Point TGP measurements recorded with the portable meters during the service period were slightly higher than the measurements recorded by the Minisonde. This indicated that the TGP values recorded by the Minisonde were slightly lower (approximately 10 mm Hg) than actual TGP levels. The reason for this difference was attributed to condensation in the silastic membrane. Even though this problem was recognized during the 3 July service, a spare silastic membrane to exchange with the original was not available.

In summary, the TGP data collected indicated that spill from Libby Dam did not increase TGP levels in the Canadian portion of the Kootenay River. All TGP values were either below or only slightly above the 110% U.S. TGP guidelines, and did not coincide with spills from Libby Dam. Elevated TGP levels produced by spill at Libby Dam are likely reduced as water flows over Kootenai Falls. Continued dissipation of any remaining dissolved gas occurs as the water flows north to Canada until equilibrium conditions are re-established.

5.0 LITERATURE CITED

U.S. Army Corps of Engineers, 2002 Libby dam spill test, Lincoln County, Montana, Draft Environmental Assessment, 2002. In Press.