Winter Project Note:

2007 Lake L9323 Monitoring and Analysis

Introduction

As authorized by Fish Habitat Permit FH03-111-0380 (ADNR), CPAI withdraws water from Lake L9323 in the Colville River Basin. The objective of the winter 2007 Lake L9323 monitoring event was the collection of water quality and physical data in support of Alpine Operations. Water quality parameters were collected at six locations across Lake L9323, in addition to physical parameters of depth, ice thickness, freeboard, and water surface elevation (WSE). The basis for this project is to satisfy corrective actions outlined in the February 21, 2007 letter from ADNR regarding over withdrawal of water from Lake L9323.

Methods

The data collected as part of this investigation included water quality and hydrologic observations at Lake L9323. Six sample locations were investigated as represented in Figure 1.1. Two sample locations were selected in each of the three lake basins. Water quality was measured to depth in each of the sampling holes, yielding a profile of parameters from below the ice to the lake bottom at intervals of no greater than 1.5-feet.

Winter water quality parameters measured included dissolved oxygen (mg/L and %-saturation), conductivity, salinity, pH, and temperature. Specific conductance (referenced to 25^0C) was calculated from measured conductivity by Baker using standard methods and a standard conversion coefficient of 0.0191. Dissolved oxygen was measured using a Hach HQ40d LDO, standardized to atmospheric oxygen saturation. Conductivity, salinity, pH, and temperature were measured using a YSI 63 digital meter, standardized by TTT Environmental 24 hours prior to initial sampling. Conductivity calibration was checked on each day of sampling.

Water depth and ice thickness were recorded using a weighted rag tape and graduated rod,

respectively. Freeboard, distance from top of ice to water surface, was measured using a weighted rag tape. Water surface elevation was surveyed using standard level loop methods. Local control was used to establish elevation relative to British Petroleum Mean Sea Level (BPMSL).

Baker collected data from sample locations SL-1, SL-2 and SL-3 on the afternoon of February 27. The remaining three sample locations, SL-4, SL-5 and SL-6, were collected on the following afternoon (February 28). Baker was accompanied by LCMF, providing transportation and assistance. Water quality measurements were reviewed at the time of collection to identify potential anomalies associated with collection methods or equipment failure. Necessary steps were taken to minimize adverse effects of local environmental conditions on equipment used.

Luminescence measurement of dissolved oxygen (LDO) has recently been identified by the EPA (ATP Case No. N04-0013, 2006) as an acceptable method, meeting all necessary requirements of DO measurement, and recommends the method be used in future regulatory actions. Having used the Hach LDO for the past two years across a wide range of conditions on the North Slope, Baker has gained significant confidence in LDO technology. Repeatable results and side-by-side comparisons with previous membrane sensors suggest the Hach LDO provides consistent data of superior quality.

Results

Data collected on February 27 and 28 are presented in the attached tables. Water surface elevation collected during this event will be presented and compared with the breakup WSE in the final report. Environmental conditions were adverse, with an extreme ambient temperature near -35^0F and winds approaching 30 miles per hour.

Sample locations SL-1 and SL-2 were located in the west lake basin approximately 600-feet apart. The central basin held SL-3 and SL-4, which were positioned approximately 470-feet from each other. The east basin held the remaining two sample locations (SL-5 and SL-6) which were separated by 560-feet.

Physical Parameters

Across the entire lake ice thickness was relatively constant at approximately 4.7-feet. Freeboard also remained constant across the lake at 0.4-feet. Therefore the bottom of the ice was measured to be 4.3 feet below the water surface elevation which is considerable less than the assumed 7-foot ice thickness. Observed water depths ranged from 9.5 to 21.8-feet.

Dissolved Oxygen

Overall, similar general trends in concentration profiles were observed between the two sample locations in each of the three lake basins. Variation in values was apparent between locations in each basin, with maximum differences at equal depth being as great as 5.5 mg/L. In all but one case, dissolved oxygen (DO) concentrations approached 0.5 mg/L, reaching as low as 0.0 mg/L, at the bottom of the sampling profile.

The west lake basin, positioned east of the ice road and the location of water withdrawal, had significant variability of DO concentration in the upper strata between the two sampling locations (SL-1 and SL-2). A maximum concentration of 12.8 mg/L (5-feet) was observed at SL-2, while the maximum observed DO concentration at SL-1 was 8.0 mg/L (5-feet). At approximately 10-feet of depth DO concentrations converged to approximately 4.0 mg/L, following the same rapidly descending trend line to the lake bottom.

Values observed in the central basin were on average higher than those observed in the west basin (11.5 mg/L). The shallowest sample location (SL-4) reached a maximum depth of 9.5-feet with little drop in DO across the sample profile. This trend was similar to that observed at SL-3, with concentrations diving from 10.1 mg/L at 8.5-feet to 0.0 mg/L at 11.5-feet. Overall, dissolved oxygen varied by as much as 2.2 mg/L (5-feet).

Observed DO concentrations were of a stratified nature in the east basin, with zones of relatively constant concentration separated by thin layers of rapid change. Though the trend and depths of associated zones were similar between SL-5 and SL-6, values varied considerably, particularly in the lower reaches of the sampling profile. The east basin was the deepest sampled basin, with a maximum observed depth of 21.8-feet. Near surface concentrations averaged 9.8 mg/L varying by +/- 1.0 mg/L. Stable zones were identified around 9.5 to12.5-feet and 15.5-feet to near lake bottom. Within the shallowest zone SL-5

and SL-6 concentrations were approximately 5.3 and 2.9 mg/L, respectively. In the deeper zone these values dropped to 3.2 and 0.1 mg/L. In the last foot of sampling at SL-5 DO concentrations dropped to 0.2 mg/L.

Conductivity / Specific Conductance

Conductivity and specific conductance were relatively consistent across the three basins, with the top 90% of the water column averaging a specific conductance of 153 uS/cm. General relationships of specific conductance between basin-specific sampling locations emulated those seen in dissolved oxygen concentrations. In nearly every case, concentrations increased rapidly toward the bottom of the sampling profile, correlating with a decrease in dissolved oxygen (except SL-5). Maximum values of observed specific conductance were as high as 256 uS/cm near the lake bottom. Maximum values were seen in the east and west basins.

Salinity

Salinity was constant across all sampling locations and with respect to depth, with a value of 0.1 parts per thousand (ppt).

Temperature

Temperature profiles in the east and central lake basins were relatively linear, decreasing by approximately 0.25^0C/foot. Minimum temperatures were 0.5^0C at the shallowest sampling depth (5-feet), increasing to 1.8-2.3^0C at 12-feet. Temperatures in the east basin were less linear following the same general trend observed in specific conductance and dissolved oxygen profiles, having zones of relatively constant temperature. Values increased rapidly, by as much as 1.0^0C, to 8-feet followed by a small decrease of 0.7^0C over the last 12- feet. The maximum temperature observed at depth was 2.7^0C (21-feet).

pH

Observed pH generally decreased with depth in the water column, though the magnitude of this drop in pH was generally small. An average pH of 5.4 was observed at shallow depths with most values falling within the accuracy of the meter (+/- 0.2). Values were relatively similar between sample locations in each of the three basins, except in the east basin. Values of pH varied most significantly in the east basin throughout the water column, though values followed the same general trend. The greatest drop in pH within the water column and lowest pH observed occurred in the east basin.

Discussion

Bathymetry (Moulton) and observed ice thickness provides useful information by which collected data can be analyzed and related to one another. Basins and sample locations are distinctly separated by variations in lake morphometry and related shallows, producing "isolation depths" below which deeper waters are isolated from one another. The west lake basin is relatively smooth and consistent with respect to bathymetry. Conversely, the east basin has several deep holes, separated by shallower ridges. Given an observed ice thickness of roughly 5-feet and available bathymetry, it is likely that the west basin is hydraulically isolated from the central basin. Given the rate of ice formation at nearby lakes (L9313, L9312, and L9310) this isolation has likely occurred only recently.

Temperatures at each location generally follow the same initial trend, increasing linearly with depth. However, increased distance from the withdrawal location yields a trend toward stratification of the water column, potentially suggesting vertical mixing as a result of water withdrawal. Stratification of temperature relates closely with observed DO concentrations, particularly in the east basin. Though a lack of DO stratification would also suggest vertical mixing, the depth of DO stratification in the east basin doesn't occur until depths of greater than 10-feet; deeper than what is observed in the west and central basins. As such, a lack of DO stratification in the west and central basins can not be correlated to water withdrawal. Independent of maximum sample depth, DO concentrations decline to near zero: a direct result of respiration and decomposition at the benthic boundary layer (at or near the lake bottom).

Lateral mixing is not evident due to variations in DO between samples at shallow depths. This variability decreases further into the water column until concentrations converge at a depth equivalent to the apparent linkage depth. With increased light during the time of sampling and exposure of ice due to wind, photosynthetic activity in shallow waters could be a cause of lateral variability in observed DO. East basin DO stratification, though occurring at equivalent depths, varies significantly with respect to observed concentrations. Variations in DO concentration between sample locations in the west basin are likely due to variations

in the biological community, organic loading, and local morphometry of each location below the isolation depth.

As shown, specific conductance spiked near the lake bottom. Reduction in oxygen concentrations often is accompanied by lower oxidation-reduction potentials in the bottom waters, and the appearance of a number of soluble reduced compounds is not uncommon. The presence of such reduced compounds would also suggest a reduction in pH, which was observed in bottom waters.

Conclusions

Considering the volume of water withdrawn compared to the volume of water available, the methods used during this single investigation, and the reliability of the results of the sampling, there appears to be no significant reduction or negative impacts to the fish habitat at Lake L9323 due to the over withdrawal of 990,940 gallons.

ConocoPhillips Alaska, Inc.

DATE: 3/2/07	PROJECT:
DRAWN: MDM	FILE: L9323
CHECKED: MTA	SCALE: 1" = 1000'

Baker

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LAKE L9323

WATER QUALITY

SAMPLING LOCATIONS

FIGURE 1-1

(SHEET 1 OF 1)

Baker

Lake L9323 Water Quality -Winter 2007

West Lake Basin

Sample Date: February 27, 2007

Upstream Location Time	Water Depth (ft)	Ice Thickness (ft)	Free Board (ft)	Sample Depth (ft)	Temp (^{0}C)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	DO (mg/L)	DO (Percent Saturation)	Salinity (ppt)	pH
SL-01 N70°18'06" W151°00'31" 3:30 p.m.	12.2	4.6	0.4	5	0.5	81	156	8.0	55.62	0.1	5.55
				6	1.0	78	148	7.4	52.38	0.1	5.49
				7	1.3	79	147	6.9	48.84	0.1	5.47
				8	1.5	78	145	6.3	45.10	0.1	5.44
				9	1.6	78	144	5.1	36.56	0.1	5.44
				10	1.8	78	142	3.8	27.46	0.1	5.10
				11	1.9	80	146	0.3	2.10	0.1	4.76
				12	1.8	112	204	0.5	0.04	0.1	5.39

Sample Date: February 27, 2007

Upstream Location Time	Water Depth (ft)	Ice Thickness (ft)	Free Board (ft)	Sample Depth (ft)	Temp (^{0}C)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	DO (mg/L)	DO (Percent Saturation)	Salinity (ppt)	pH
SL-02 N70°18'00" W151°00'32" 4:00 p.m.	12.8	5	0.4	5	0.5	88	169	12.75	87.3	0.1	5.35
				6	0.9	85	161	12.6	87.1	0.1	5.33
				7	1.1	85	160	12.4	86.1	0.1	5.32
				8	1.3	85	158	10.5	74.0	0.1	5.35
				9	1.6	84	155	9.6	67.4	0.1	5.36
				10	1.7	83	153	3.7	26.4	0.1	5.31
				11	1.9	84	153	0.9	6.1	0.1	5.21
				12	2.3	143	257	0.8	5.6	0.1	5.00

Notes:

(1) All sample location coordinates referenced to NAD83 datum.

(2) Freeboard is the distance from the top of ice to the water surface.

(3) Sample depth is measured from the water surface.

(4) Salinity, conductivity, pH, and temperature were measured using a YSI-63 meter

(5) Specific conductance (referenced to 25^{0}C) was obtained using a standard conversion coefficient of 0.0191.

(6) Dissolved oxygen measurements were obtained using a Hach HQ40d LDO meter

Baker

Lake L9323 Water Quality - Winter 2007

Central Lake Basin

Sample Date: February 27, 2007

Upstream Location Time	Water Depth (ft)	Ice Thickness (ft)	Free Board (ft)	Sample Depth (ft)	Temp (^{0}C)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	DO (mg/L)	DO (Percent Saturation)	Salinity (ppt)	pH
SL-03 N70°17'55" W151°00'19" 5:00 p.m.	11.5	4.7	0.4	5.5	0.5	82	158	10.4	71.5	0.1	5.53
				7.0	1.1	79	148	10.2	71.2	0.1	5.48
				8.5	1.4	79	148	10.1	70.7	0.1	5.51
				10.0	1.8	84	155	7.0	49.0	0.1	5.38
				11.5	2.0	96	174	0.0	0.3	0.1	5.31

Sample Date: February 28, 2007

Upstream Location Time	Water Depth (ft)	Ice Thickness (ft)	Free Board (ft)	Sample Depth (ft)	Temp (^{0}C)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	DO (mg/L)	DO (Percent Saturation)	Salinity (ppt)	pH
SL-04 N70°17'55" W151°00'05" 1:50 p.m.	9.5	4.7	0.4	5.0	0.5	83	159	12.6	86.0	0.1	5.33
				6.0	1.1	81	153	12.1	83.2	0.1	5.26
				7.0	1.2	81	153	11.5	79.7	0.1	5.17
				8.0	1.2	81	152	11.5	80.7	0.1	5.00
				9.0	1.4	79	147	10.9	77.7	0.1	4.80

Notes:

(1) All sample location coordinates referenced to NAD83 datum.

(2) Freeboard is the distance from the top of ice to the water surface.

(3) Sample depth is measured from the water surface.

(4) Salinity, conductivity, pH, and temperature were measured using a YSI-63 meter

(5) Specific conductance (referenced to 25^{0}C) was obtained using a standard conversion coefficient of 0.0191.

(6) Dissolved oxygen measurements were obtained using a Hach HQ40d LDO meter

Baker

Lake L9323 Water Quality - Winter 2007

East Lake Basin

Sample Date: February 28, 2007

Upstream Location Time	Water Depth (ft)	Ice Thickness (ft)	Free Board (ft)	Sample Depth (ft)	Temp (^{0}C)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	DO (mg/L)	DO (Percent Saturation)	Salinity (ppt)	pH
SL-05 N70°17'51" W150°59'28" 2:15 p.m.	20	4.5	0.4	5.0	0.7	83	159	8.8	60.6	0.1	5.37
				6.5	1.3	82	153	7.4	51.7	0.1	5.25
				8.0	1.7	80	148	6.3	44.0	0.1	5.26
				9.5	1.7	80	147	5.8	40.8	0.1	5.22
				11.0	1.7	80	147	5.3	36.9	0.1	5.14
				12.5	1.8	82	149	4.9	34.6	0.1	4.60
				14.0	1.8	82	151	3.7	26.3	0.1	5.20
				15.5	1.9	82	150	3.3	22.9	0.1	4.98
				17.0	2.0	83	151	3.2	22.3	0.1	4.75
				18.5	2.2	83	150	3.0	21.3	0.1	4.40
				20.0	2.4	84	151	0.2	1.6	0.1	4.08

Sample Date: February 28, 2007

Upstream Location Time	Water Depth (ft)	Ice Thickness (ft)	Free Board (ft)	Sample Depth (ft)	Temp (^{0}C)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	DO (mg/L)	DO (Percent Saturation)	Salinity (ppt)	pH
SL-06 N70°17'46" W150°59'19" 4:00 p.m.	21.8	4.7	0.4	5.0	0.9	83	158	10.8	74.3	0.1	5.93
				6.5	1.3	83	155	10.1	7.0	0.1	6.00
				8.0	1.7	82	151	6.5	45.7	0.1	6.01
				9.5	2.0	80	145	3.4	23.9	0.1	6.00
				11.0	2.0	80	145	2.9	20.5	0.1	6.20
				12.5	2.1	79	144	2.6	18.1	0.1	6.29
				14.0	2.4	82	147	0.6	4.4	0.1	5.99
				15.5	2.5	82	146	0.2	1.7	0.1	5.92
				17.0	2.6	94	167	0.2	1.4	0.1	5.79
				18.5	2.7	102	181	0.1	0.5	0.1	5.47
				20.0	2.7	116	206	0.1	0.5	0.1	5.16
				21.0	2.7	132	235	0.1	0.5	0.1	4.90

Notes:

(1) All sample location coordinates referenced to NAD83 datum.

(2) Freeboard is the distance from the top of ice to the water surface.

(3) Sample depth is measured from the water surface.

(4) Salinity, conductivity, pH, and temperature were measured using a YSI-63 meter

(5) Specific conductance (referenced to 25^{0}C) was obtained using a standard conversion coefficient of 0.0191.

(6) Dissolved oxygen measurements were obtained using a Hach HQ40d meter