

Big Lake Water Quality Monitoring Program



**Big
Lake
Environment
Support
Society
2006**

Sponsored by a Grant from Alberta Ecotrust



Carried Out in Conjunction with the Alberta Lake Monitoring Society

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BLESS Water Quality Monitoring Program

Description

The BLESS water quality monitoring program involves in-field measurements of physical parameters (dissolved oxygen, temperature, pH, Total Dissolved Solids, salinity, and electrical conductance) and on-shore analyses of chemical parameters (ammonia, nitrite, nitrate, ortho-phosphate, total alkalinity, sulphate, silica and potassium). The physical parameters are measured with a hand-held LaMotte Tracer Pocketester Model 1766 and an Oakton Dissolved Oxygen meter. The chemical parameters are analysed with the LaMotte Smart2 Colorimeter system.

The Tracer Pocketester is an electronic instrument that uses an electrode to measure five different physical parameters (temperature, pH, TDS, salinity, and electrical conductance). An electrode is immersed into a sample. A small current or voltage is produced that is amplified electronically and translated into a digital readout for each parameter. Parameters are individually selected on the instrument by cycling the Mode button.



The Oakton meter measures dissolved oxygen in mg/L, ppm or % saturation along with water temperature in degrees Celsius or Fahrenheit. Up to 50 measurements may be stored in the metre's internal memory. The metre's probe uses a galvanic measuring element that enables measurements to be taken immediately when immersed in the sample and incorporates a replaceable membrane. Because the metre consumes oxygen when measuring, the probe must be moved continuously when taking readings.

The Smart2 electronic colorimeter provides a dedicated light source to help eliminate visual inconsistencies. The light source passes through a sample and is measured by a photodetector. The results are translated to a digital output in ppm, %T, or Absorbance. Different reagents are added to a water sample for each chemical parameter to be tested. See Appendix A for the Chemical Analysis methods used in the BLESS water quality monitoring program.



Purpose

The primary purpose of the BLESS water quality monitoring program is to obtain a current baseline of water quality data for comparison to changes that might occur in future. The intent is to capture changes shortly after they occur to aid in identifying potential threats to water quality and to report useful data regarding Big Lake water quality to government.

Sampling

Water samples were taken for the BLESS program once in July 2006, once in August, twice in September and once in February 2007. Six locations were sampled on each occasion in July, August and September: Atim Creek at Highway 44, the west basin of Big Lake, the east Basin Big Lake, the Sturgeon River at Meadowview Drive, Carrot Creek at Meadowview Drive and the

Sturgeon River at the outlet of Big Lake. Only one location, the west bay of Big Lake, was sampled in February. Physical parameters only were tested through the ice for the February sampling; chemical parameters were not tested. Data gathered is included at Appendix C to this report.

The Alberta Lake Management Society (ALMS) carried out a parallel water quality sampling program for Big Lake in 2006. Water samples for both programs were taken on Big Lake at the same time and in the same locations by BLESS volunteers and the person hired by ALMS. The ALMS program took composite water samples from both bays of Big Lake for subsequent laboratory analysis.

Locations sampled in 2006 are provided in the following table.

Site Name	Description	Latitude	Longitude
ALMS1	Big Lake, west bay, center	53.592208	-113.735215
ALMS1B	Big Lake, west bay, center	53.591875	-113.735399
ALMS2	Big Lake, west bay, off south shore	53.58478	-113.751383
ALMS2B	Big Lake, west bay, off south shore	53.584789	-113.751418
ALMS3	Big Lake, west bay, west shore, Atim Creek middle inlet	53.598291	-113.757624
ALMS3B	Big Lake, west bay, west shore, in Atim Creek southern inlet	53.594438	-113.758092
ALMS3BB	Big Lake, west bay, west shore, off Atim Creek southern inlet	53.594436	-113.758122
ALMS3C	Big Lake, west bay, west shore, off Atim Creek southern inlet	53.590683	-113.759745
ALMS4	Big Lake, west bay, centre of northern arm, off north shore	53.603594	-113.757172
ALMS4B	Big Lake, west bay, centre of northern arm, off north shore	53.603512	-113.757515
ALMS4C	Big Lake, west bay, in Atim Creek southern inlet	53.598112	-113.756206
ALMS4D	Big Lake, west bay, south of Atim Creek southern inlet	53.588691	-113.759526
ALMS5	Big Lake narrows, west end	53.592848	-113.698886
ALMS6	Big Lake narrows, east end	53.595815	-113.68377
ALMS7	Big Lake, east bay, just off southwest shore	53.597942	-113.69025
ALMS8	Big Lake, east bay, in the southern Sturgeon River inlet	53.604271	-113.684324
ALMS9B	Big Lake, east bay, off northwest shore	53.617375	-113.680833
ALMS10B	Big Lake, east bay, off north shore	53.618604	-113.672937
ALMS11B	Big Lake, east bay, off southeast shore	53.607115	-113.668718
ALMS12B	Big Lake, east bay, off east shore, south of BLESS platform	53.610196	-113.663392
BLESS AC	Atim Creek at Highway 44, east side of bridge	53.59723	-113.814173
BLESS SR	Sturgeon River at Meadowview Drive, south side of bridge	53.617464	-113.71539
BLESS CC	Carrot Creek at Meadowview Drive, south side of bridge	53.623772	-113.696457

BLESS SRO	Sturgeon River outlet from Big Lake at the BLESS Platform	53.614274	-113.659154
BLESS EB1	Big Lake, east bay	53.612514	-113.669034
BLESS WB1	Big Lake, west bay	53.601624	-113.750372
ALMS: Locations where water samples are taken for the 2006 Alberta Lake Management Society project for Big Lake. BLESS tests are also carried out at these locations in conjunction with ALMS testing.			

Physical Parameters Sampled

The BLESS program recorded readings for six physical parameters: Dissolved Oxygen, Temperature, Salinity, Conductivity, pH and Total Dissolved Solids. A description of each parameter follows.

Dissolved Oxygen (DO). The amount of oxygen dissolved in a given volume of water. Dissolved oxygen can be expressed in parts per million, percent saturation or milligrams per litre (mg/L) which is the unit used for BLESS water testing

Oxygen is produced during photosynthesis which is the process by which green plants convert carbon dioxide (CO₂) dissolved in water to sugars and oxygen using sunlight for energy. Photosynthesis therefore occurs only during daylight hours. Photosynthesis is an important source of oxygen in many lakes. Oxygen is consumed by plant decomposition (the breakdown of organic matter by bacteria or fungi). Decomposition occurs both day and night. Oxygen may also be added to a lake through aeration, commonly the mixing of water through wave action. Aeration through wind action may be more significant in shallow lakes such as Big Lake than in deeper lakes.

Water temperature affects DO readings; the higher the water temperature, the less oxygen it can hold. Oxygen is used by most aquatic organisms for respiration and, as such, is an important indicator of the health of a water body. Lakes with more than 5 mg/L are considered healthy. Most species of fish become distressed at oxygen levels of between 2-4 mg/L. Fish mortality normally occurs when oxygen levels are less than 2 mg/L.

Temperature. Most aquatic organisms are cold blooded, that is, unable to regulate their body temperature. Many organisms, including fish and insects, have preferred temperature ranges for survivability and optimum growth rates. Higher temperatures (within limits) generally equate to greater growth rates.

Temperature also affects water chemistry; warmer water holds less oxygen than cold water. High temperatures may cause water to reach an oxygen saturation point below the threshold for aquatic organisms and fish to survive.

Salinity. Salinity is a measure of the amount of mineral salts such as bicarbonate, sulfate, calcium, silica and sodium dissolved in water. The salinity of sea water is typically 35,000 parts per million. Fresh water has a salinity of less than 1000 ppm. Warm water is generally more saline than cooler water. Various fish species have a salinity tolerance in which they can exist. Northern pike, for example, can survive in water of up to 18,000 ppm salinity. An increase in salinity can decrease the diversity of vegetation in wetlands.

Wetlands such as Big Lake, thought to have areas of groundwater recharge and discharge, are influenced by the salinity of groundwater and the composition of the soils through which the

groundwater flows. Salinity may increase because of high evapotranspiration rates and low inflow rates that concentrate dissolved salts.

Conductivity. Conductivity is a measure of the ability of water to conduct an electrical current. It is related to the amount of dissolved ions in water, but it does not give an indication of which minerals are present. A higher conductivity indicates that more material, potentially contaminants, is dissolved in the water sample.

Conductivity in water can be influenced by factors such as road salts, fertilizers, and evaporation. Conductivity can be an indicator of human activity. A failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity.

Conductivity is measured in microsiemens per centimeter ($\mu\text{S}/\text{cm}$). Water temperature increases conductivity by from 2 to 3% per 1 degree Celsius.

Common conductivity values in $\mu\text{S}/\text{cm}$:

Absolute pure water - 0.055

Distilled water - 0.5

Mountain water - 1.0

Most drinking water sources - 500 to 800

Sea water - 56 mS/cm

Maximum for potable water - 1055

pH. pH is a measure of the concentration of hydrogen ions in water within a range of 0 and 14. A pH of 7 is neutral, less than 7 is acidic, greater than 7 is alkaline. pH determines the solubility of nutrients and heavy metals in water, metals are more soluble and therefore more toxic at lower pH levels. Big Lake is alkaline having a pH that approaches 11 at some locations during the summer.

Common pH values:

Battery acid - 0.3

Household lye - 13.6

Vinegar - 3

Ammonia - 11.4

Distilled water - 7

Total Dissolved Solids. Total Dissolved Solids (TDS) is a measure of the concentration of dissolved organic and inorganic chemicals in water. Dissolved solids are the remaining residue after suspended solids are filtered from water and water is evaporated.

Primary sources for TDS in receiving waters are agricultural runoff, leaching of soil contamination and point source water pollution discharge from industrial or sewage treatment plants. The most common constituents comprising TDS are calcium, phosphates, nitrates, sodium, potassium and chloride, which are found in nutrient runoff and pesticides and road salt often dissolved in urban stormwater runoff.

High TDS levels, especially due to dissolved salts, affect many forms of aquatic life. Salts act to dehydrate the skin of animals.

TDS values in lakes and streams are typically in the range of 50 to 250 mg/L. Drinking water is within the range of 25 to 500 mg/L TDS. Fresh distilled water has a conductivity range of 0.5 to 1.5 mg/L TDS.

Chemical Parameters Sampled

The BLESS water quality monitoring program tested for eight chemical parameters: ammonia, nitrate, nitrite, ortho phosphate, alkalinity, silica, sulphate and potassium. A description of each parameter and test procedures for the LaMotte Smart 2 Colorimeter and reagents are included at Appendix A.

Data Records

Data obtained for the BLESS water quality monitoring program was recorded in the field on paper record sheets that have been retained and the data has been transcribed to a spreadsheet for analysis.

Field Data Sheets for recording physical and chemical test results are included at Appendix B.

Problems Encountered

Several problems were experienced with the BLESS water quality testing program. Some equipment was back ordered and did not arrive until August. There are therefore some data gaps for 2006. The reagent for testing phosphate was unavailable until later in August consequently information on phosphates is missing from the August data set.

The Tracer Pocketester malfunctioned during the July testing as a result of being immersed too far into a water sample. Subsequent enquiries with the supplier revealed the metre is not waterproof. The supplier repaired the metre, however, some physical data is missing from the July data set.

The cord to the DO Metre was broken during installation. Subsequent investigation by the supplier revealed an improperly installed rubber protective covering on the cord as the cause. The supplier repaired the broken DO cord.

Data Analysis

Atim Creek

Atim Creek enters Big Lake from the west after passing north of Spruce Grove. It drains the agricultural lands around Stoney Plain, Spruce Grove and areas north towards Onoway.

The water in Atim Creek was generally of good quality with few exceptional analyses, except for dissolved phosphorus, which is quite high as would be expected from a creek the size of the Atim flowing through farm land. It is ten times the Alberta Water Quality Guidelines. The pH of the water dropped nearly 1 pH unit from July to September, although it is in the normal range for an aspen parkland stream. Dissolved oxygen was above the AWQG up to mid-August and then it started to drop until it was just below at the AWQG of 5.5 ppm.

Date of Sampling	Salinity (ppm)	Conductivity (μ S)	pH	TDS (mg/L)	DO (ppm)	Water Temp From DO Meter ($^{\circ}$ C)	Ammonia N (NH_3^+ -N) ppm	Nitrite (NO_2^{2-}) ppm	Nitrate (NO_3^-) ppm
15-Jul-06	383	745	8.65	527	7.42				
18-Aug-06	233	468	8.55	330	10.32	26.4	0.25	0.02	0
08-Sep-	272	541	7.97	373	6.3	18.7	0.4	0.066	0.044

06									
22-Sep-06	256	513	7.86	361	4.96	12.8	0.33	0.01	0.352

Date of Sampling	Dissolved Phosphorus ppm	Alkalinity ppm	Silica ppm	Sulphate ppm	Potassium ppm	Total Iron ppm
15-Jul-06						
18-Aug-06		159	11	41	1.1	
08-Sep-06	0.45	120	11	40	6.7	
22-Sep-06	0.31	175	12	62	3	0

COMMENTS ON PARAMETERS	AWQG (ppm)	CCME (ppm)	
Salinity			moderate levels, slightly variable
Conductivity			moderate levels, slightly variable track with salinity
pH	6.5 to 8.5	6.5 to 9	drops slightly throughout summer by 1 pH point, can be close to AWQGs
TDS			moderate levels, slightly variable track with salinity and conductivity
DO	5	5.5 to 6*	Highly variable, range of 5 ppm. Drops below AWQGs.
Water Temp			Generally high, due to shallow water
NUTRIENTS			
Ammonia	1.37 to 2.2 ***		modest concentration below AWQGs.
Nitrate		13**	low in keeping with ammonia
Nitrite	0.06		very low in keeping with ammonia and nitrate, occasional high conc (early Sept).
DP	0.05****		High concentrations, 10x the AWQGs.
Alkalinity	20		modest concentration
Cyanide	5		none
Iron		0.3	none
Silica			low
Sulphate			low
Potassium			variable
* CEQG Dissolved Oxygen guideline: for warm water biota: early life stages = 6 mg/L other life stages = 5.5 mg/L			
** This is for direct toxicity, not for issues around NO3 as a nutrient			
*** This depends a lot on the pH of the water, the more basic the less ammonia is tolerated.			
**** Total P, we analyzed only dissolved P.			

Big Lake West Bay

The exact locations of the samples varied somewhat, but all were near the center of the West Bay. Considering the shallow depth and wave action this shouldn't have mattered the water was well mixed.

The water quality of the west bay in summer is generally fairly good, although rather basic in pH tending up to above 10 in mid-summer and consistently over 9. The AWQGs and CCME Water Quality Guidelines recommend maximum pHs of 8.5 to 9. Dissolved oxygen was consistently high, no doubt due to shallow waters and well mixed conditions. The N cycle showed an unusual pattern with the slight buildup over time in nitrite, which is an intermediate step in the cycle from bacterial conversion of ammonia to nitrate, indicating that something in the second stage of the conversion is being upset. However, aquatic plants can use either form readily as a nutrient. Dissolved phosphorus is consistently above the AWQGs. Total iron was above the CWQGs in September.

Date of Sampling	Salinity (ppm)	Conductivity (μ S)	pH	TDS (mg/L)	DO (ppm)	Water Temp From DO Meter ($^{\circ}$ C)	Ammonia N (NH_3^+ -N) ppm	Nitrite (NO_2^{2-}) ppm	Nitrate (NO_3^-) ppm
21-Jul-06	322	647	10.35	452	11.7	24.8			
11-Aug-06	252	507	9.9	340	7.9	18.4			
11-Aug-06	Not tested						0.42	0.04	0.70
01-Sep-06	252	498	9.92	360	9.44	14.4	0.13	0.13	0.26
22-Sep-06	250	508	9.73	353	8.9	9.9	0.15	0.43	0

Date of Sampling	Dissolved Phosphorus ppm	Alkalinity ppm	Silica ppm	Sulphate ppm	Potassium ppm	Total Iron ppm
21-Jul-06						
11-Aug-06						
11-Aug-06		136	8	96	3.5	
01-Sep-06	0.18	65	12	114	3.9	
22-Sep-06	0.06	145	3	98	5.9	0.96

Big Lake East Bay

Similar to the West Bay, the East Bay has excessive pH values consistently above Alberta and Canadian Water Quality Guidelines. Dissolved oxygen is high through the fall no doubt due to shallow waters and good mixing from wind action. Dissolved phosphorus and total iron are both excessive in late summer. Nitrite is above the AWQG in mid-summer but it drops to very low levels in September.

Date of Sampling	Salinity ppm	Conductivity (μ S/cm)	pH	TDS (mg/L)	DO (ppm)	Water Temp From DO Meter ($^{\circ}$ C)	Ammonia N (NH_3^+ -N) ppm	Nitrite (NO_2^{2-}) ppm	Nitrate (NO_3^-) ppm
21-Jul-06					15.3	27.5			

11-Aug-06	Not tested						0.39	0.36	0.09
11-Aug-06	240	472	10.7	335	10.4	15.7			
01-Sep-06	250	501	10.15	343	13.85	17.4	0.28	0	0
22-Sep-06	256	510	9.44	360	9.67	9.9	0.1	0.05	0.57

Date of Sampling	Dissolved Phosphorus ppm	Alkalinity Ppm	Silica Ppm	Sulphate Ppm	Potassium ppm	Total Iron ppm
21-Jul-06						
11-Aug-06		145	1	89	6	
11-Aug-06						
01-Sep-06	0.09	102	5	84	5.4	
22-Sep-06	0.12	80	13	106	5.2	1.05

COMMENTS ON PARAMETERS	AWQG	CCME	Comments
Salinity			Modest, not variable
Conductivity			Modest, not variable
pH	6.5 to 8.5	6.5 to 9	Consistently excessive, drops slightly.
TDS			Modest, not variable
DO	5	5.5 to 6*	Consistently high
Water Temp			High due to shallow water
NUTRIENTS			
Ammonia	1.37 to 2.2 ***		Modest
Nitrate		13**	Fairly variable, tracks with nitrite
Nitrite	0.06		Fairly variable, tracks with nitrate
DP	0.05****		Excessive in late summer
Alkalinity	20		Modest
Cyanide	0.005		None
Iron		0.3	Excessive in late summer
Silica			Low but increases.
Sulphate			Low but increases.
Potassium			Modest

Sturgeon River at Meadowview Drive

The Sturgeon River drains the agricultural and acreage lands north of Big Lake towards Sandy Lake and Onoway. In general, pH is excessive in summer being at the upper limit of the AWQG values. Dissolved oxygen is good and increased throughout the summer, perhaps with reduced temperatures. Dissolved phosphorus can be very high with extreme variations from 1.76 to 0.06 ppm in a two week period. A high water storm event occurred just before the second sampling that may have diluted the phosphorus considerably. Total iron was excessive in late summer.

Date of Sampling	Salinity (ppm)	Conductivity ($\mu\text{S/cm}$)	pH	TDS (mg/L)	DO (ppm)	Water Temp From DO Meter ($^{\circ}\text{C}$)	Ammonia N ($\text{NH}_3^+\text{-N}$) ppm	Nitrite (NO_2^{2-}) ppm	Nitrate (NO_3^-) ppm
15-Jul-06	342	680	8.64	480	6.95				
18-Aug-06	285	574	9.03	401	6.8	22.5	0.24	0.02	0.44
08-Sep-06	305	610	9.12	429	9.83	18.4	0.23	0.007	0.09
22-Sep-06	303	611	8.81	429	11.36	12.7	0.26	0	0.09

Date of Sampling	Dissolved Phosphorus ppm	Alkalinity ppm	Silica ppm	Sulphate ppm	Potassium ppm	Total Iron ppm
15-Jul-06						
18-Aug-06		193	2	57	3.6	
08-Sep-06	1.76	129	2	81	8.5	
22-Sep-06	0.06	145	3	98	5.9	0.96

COMMENTS ON PARAMETERS	AWQG	CCME	Comments
Salinity			Modest, slightly variable
Conductivity			Modest, slightly variable
pH	6.5 to 8.5	6.5 to 9	High, occasionally over WQGs.
TDS			Modest, slightly variable
DO	5	5.5 to 6*	Moderate to high
Water Temp			High due to shallow water.
NUTRIENTS			
Ammonia	1.37 to 2.2 ***		Modest, consistent
Nitrate		13**	Modest, consistent
Nitrite	0.06		Low, consistent
DP	0.05****		Excessive in late summer.
Alkalinity	20		Modest, consistent
Cyanide	0.005		None in August.
Iron		0.3	Excessive in late summer.
Silica			Low, consistent
Sulphate			Low, consistent
Potassium			Low, but variable

Carrot Creek

Carrot Creek is a very small creek that drains agricultural lands just west and north of St. Albert. It passes right by a small gas plant west of St. Albert. The water quality is quite different in Carrot Creek from the Sturgeon River, being much more saline, with a higher electrical conductivity, and quite variable dissolved oxygen values that do not correspond to water temperatures. Ammonia is consistently present, but neither nitrite nor nitrate are present, possibly indicating a human source of ammonia to the creek. Sulphate and potassium are also considerably higher than in Sturgeon River. Dissolved phosphorus and total iron are both excessive.

Date of Sampling	Salinity (ppm)	Conductivity ($\mu\text{S}/\text{cm}$)	pH	TDS (mg/L)	DO (ppm)	Water Temp From DO Meter ($^{\circ}\text{C}$)	Ammonia N ($\text{NH}_3^{+}\text{-N}$) ppm	Nitrite (NO_2^{-}) ppm	Nitrate (NO_3^{-}) ppm
15-Jul-06	726	1456	9.48	1018	8.44				
18-Aug-06	572	1145	8.05	795	5.8	25.2	0.43	0	0
08-Sep-06	561	1131	8.87	791	12.3	20.8	0.44	0	0
22-Sep-06	447	885	8.45	620	10.32	14.1	0.27	0	0

Date of Sampling	Dissolved Phosphorus ppm	Alkalinity ppm	Silica ppm	Sulphate ppm	Potassium ppm	Total Iron ppm
15-Jul-06						
18-Aug-06		139	1	>100	>10	
08-Sep-06	1.94	135	1	132	14.6	
22-Sep-06	0.66	194	4	156	11.6	1.52

COMMENTS ON PARAMETERS	AWQG	CCME	Comments
Salinity			Moderately high, dropping throughout summer.
Conductivity			High, but drops in late summer, may be due to high water.
pH	6.5 to 8.5	6.5 to 9	High, occasionally above WQGs.
TDS			High, but drops in late summer, may be due to high water.
DO	5	5.5 to 6*	Highly variable, can drop close to WQG limit.
Water Temp			High due to shallow water.
NUTRIENTS			
Ammonia	1.37 to 2.2 ***		Modest, variable.
Nitrate		13**	None
Nitrite	0.06		None
DP	0.05****		Excessive, way above WQGs.
Alkalinity	20		Modest
Cyanide	0.005		
Iron		0.3	Excessive, way above WQGs.
Silica			Low
Sulphate			High. Could be more than what would naturally be expected in this area.
Potassium			High.

Sturgeon River at Big Lake Outlet

The Sturgeon River at the outlet from Big Lake is seriously degraded from the rest of the lake, it consistently has very low dissolved oxygen values approaching zero in August, but also being

quite variable. A massive algae bloom was noticed in this area and on the Sturgeon River in early summer, this may have had something to do with the low oxygen as the algae died and rotted in the late summer. Ammonia and dissolved phosphorus are both often excessive, being considerably above the AWQGs, sulphate was considerably higher than any other area of the lake, being consistent with anaerobic bacterial activity.

Date of Sampling	Salinity (ppm)	Conductivity (μ S)	pH	TDS (mg/L)	DO ppm	Water Temp From DO Meter ($^{\circ}$ C)	Potassium ppm	Ammonia N (NH_3^+ -N) ppm	Nitrite (NO_2^{2-}) ppm	Nitrate (NO_3^-) ppm
15-Jul-06	387	797	7.49	548	2.96					
19-Aug-06	328	657	7.57	455	0.34	19.1	5.5	0.35	0.09	0.18
09-Sep-06	323	667	7.45	464	2.36	14.3	8.5	3.22	0	0
22-Sep-06	318	633	8.06	455	7.2	10.1	10	0.34	0	0.75

Date of Sampling	Dissolved Phosphorus ppm	Alkalinity ppm	Silica ppm	Sulphate ppm	Total Iron ppm
15-Jul-06					
19-Aug-06		168	4	>100	
09-Sep-06	1.14	134	7	100	
22-Sep-06	0.48	170	5	116	0

COMMENTS ON PARAMETERS	AWQG	CCME	Comments
Salinity			Moderate, not variable
Conductivity			Moderate, not variable
pH	6.5 to 8.5	6.5 to 9	Moderate, not variable
TDS			Moderate, not variable
DO	5	5.5 to 6*	Extremely low until a high water event. Should be occasionally toxic to fish.
Water Temp			Moderately high, not as high as other basin.
NUTRIENTS			
Ammonia	1.37 to 2.2 ***		Occasionally excessive, should be toxic.
Nitrate		13**	Low, variable, does not track ammonia.
Nitrite	0.06		Low, variable, does not track ammonia.
DP	0.05****		Excessive. Should be occasionally toxic to fish.
Alkalinity	20		Moderate.
Cyanide	0.005		
Iron		0.3	None, Odd considering east bay has an excess.
Silica			Low.
Sulphate			High, similar to Carrot Creek (drains into this basin.)
Potassium			High.

Appendix A

Chemical Analyses – Methods

Taken from from the LaMotte SMART2Colorimeter REAGENT SYSTEMS TEST INSTRUCTIONS v.2.3 • 11.04

ALKALINITY–UDV

APPLICATION: Drinking and surface waters; swimming pool water.

RANGE: 0–200 ppm as CaCO₃

METHOD: The sample is added to a buffered indicator reagent. The color that develops, ranging from yellow to blue, will indicate the amount of alkalinity in the sample.

SAMPLE HANDLING & PRESERVATION: Samples should be analyzed as soon as possible after collection. Sample may be refrigerated for 24 hours.

INTERFERENCES: Quats and poly quats at high concentrations will interfere.

PROCEDURE

Use 10 mm square cell adapter

1. Press and hold **ON** button until colorimeter turns on.
2. Press ENTER to start.
3. Press ENTER to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 1 ALKALINTIY-UDV) from TESTING MENU.
5. Scroll to and select 1 ALKALINITY-UDV from menu.
6. Rinse a clean vial (0156) with sample water.
7. Use the syringe (1184) to add 3 mL of sample to the vial.
8. Insert the vial into chamber, close lid and select SCAN BLANK.
9. Remove vial from the colorimeter.
10. Use the syringe (1184) to add 3 mL of sample to an Alkalinity-UDV vial (4318).
11. Wait 2 minutes.
12. Invert vial 3 times to mix.

NOTE: If powder residue remains in the bottom of the vial after inverting, invert once more and tap bottom of vial sharply once or twice to dislodge powder. Mix.

13. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.

14. Press **OFF** button to turn the colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

AMMONIA-NITROGEN – HIGH RANGE NESSLERIZATION METHOD

Ammonia nitrogen is present in various concentrations in many surface and ground water supplies. Any sudden change in the concentration of ammonia nitrogen in a water supply is cause for suspicion. A product of microbiological activity, ammonia nitrogen is sometimes accepted as chemical evidence of pollution when encountered in natural waters.

Ammonia is rapidly oxidized in natural water systems by special bacterial groups that produce nitrite and nitrate. This oxidation requires that dissolved oxygen be available in the water. Ammonia is an additional source of nitrogen as a nutrient which may contribute to the expanded growth of undesirable algae and other forms of plant growth that overload the natural system and cause pollution.

APPLICATION: Drinking, surface, and saline waters; domestic and industrial wastes.

RANGE: 0.00–4.00 Ammonia Nitrogen

METHOD: Ammonia forms a colored complex with Nessler's Reagent in proportion to the amount of ammonia present in the sample. Rochelle salt is added to prevent precipitation of calcium or magnesium in undistilled samples.

SAMPLE HANDLING & PRESERVATION: Ammonia solutions tend to be unstable and should be analyzed immediately. Sample may be stored for 24 hours at 4°C or 28 days at –20°C.

INTERFERENCES: Sample turbidity and color may interfere. Turbidity may be removed by a filtration procedure. Color interference may be eliminated by blanking the instrument with a sample blank.

PROCEDURE

1. Press and hold **ON** button until colorimeter turns on.
2. Press ENTER to start.
3. Press ENTER to select TESTING MENU.
4. Scroll to and select ALL TESTS (or another sequence containing
- 5 Ammonia-N H) from TESTING MENU.
5. Scroll to and select 5 Ammonia-N H from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK. (See Note)
8. Remove tube from colorimeter. Add 8 drops of Ammonia Nitrogen Reagent #1 (V-4797). Cap and mix. Wait 1 minute.
9. Use the 1.0 mL pipet (0354) to add 1.0 mL of *Ammonia Nitrogen Reagent #2 (V-4798). Cap and mix. Allow 5 minutes for maximum color development.
10. At end of the 5 minute waiting period, immediately mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
11. Press **OFF** button to turn the colorimeter off or press the EXIT button exit to a previous menu or make another menu selection.

CALCULATIONS:

To express results as Unionized Ammonia (NH₃):

ppm Unionized Ammonia (NH₃) = ppm Ammonia-Nitrogen (NH₃-N) x 1.2

To express results as Ionized Ammonia (NH₄):

ppm Ionized Ammonia (NH₄+) = ppm Ammonia-Nitrogen (NH₃-N) x 1.3

To determine the percentages of Unionized and Ionized Ammonia-Nitrogen, consult the Appendix.

NITRATE-NITROGEN–LOW RANGE

CADMIUM REDUCTION METHOD

Nitrogen is essential for plant growth, but excessive amounts in water supplies can result in nutrient pollution. Nitrates, in conjunction with phosphate, stimulate the growth of algae creating water quality problems. Nitrogen compounds may enter water as nitrates or be converted to nitrates from agricultural fertilizers, sewage, industrial and packing house wastes, drainage from livestock feeding areas and manure. Nitrates in large amounts in drinking water can cause "blue baby syndrome" (methemoglobinemia) in infants in less than 6 months of age and other health problems.

U.S. Public Health Service Drinking Water Standards state that 10 ppm nitrate nitrogen should not be exceeded. To the sanitary and industrial engineer, concentrations of less than 1 ppm are acceptable.

APPLICATION: This method determines nitrate levels in drinking, surface, saline waters, domestic and industrial waters.

RANGE: 0.00–3.00 ppm Nitrate Nitrogen

METHOD: Powdered cadmium is used to reduce nitrate to nitrite. The nitrite that is originally present plus reduced nitrate is determined by diazotization of sulfanilamide and nitrite followed by coupling with N-(1 naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye which is measured colorimetrically.

SAMPLE HANDLING & PRESERVATION:

Analysis should be made as soon as possible. If analysis cannot be made within 24 hours, the sample should be preserved by refrigeration at 4°C. When samples must be stored for more than 24 hours, they can be preserved by adding 2 mL of concentrated sulfuric acid per liter of sample.

For best results, the analysis for nitrate should be determined at temperatures between 20°C and 25°C.

INTERFERENCES: Nitrite interferes at all levels. Use the following equation to compensate for nitrite interferences:

true Nitrate-N reading = Test result (ppm)–(Nitrite-N _ppm_ x 5.5)

Strong oxidizing and reducing substances interfere. Low results might be obtained for samples that contain high concentrations of iron and copper.

PROCEDURE

NOTE: Place Dispenser Cap (0692) on *Mixed Acid Reagent (V-6278). Save this cap for refill reagents.

1. Press and hold **ON** button until colorimeter turns on.
2. Press ENTER to start.
3. Press ENTER to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 64 Nitrate-N LR) from TESTING MENU.
5. Scroll to and select 64 Nitrate-N LR from menu.
6. Rinse a clean tube (0290) with sample water. Fill to 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter and pour off 5 mL into graduated cylinder or similar. Discard the remaining sample.
9. Pour the 5mL sample from a graduated cylinder or similar into the tube. Use the graduated cylinder or similar to measure 5 mL of *Mixed Acid Reagent (V-6278) and add to tube. Cap and mix. Wait 2 minutes before proceeding to Step 10.
10. Use the 0.1 g spoon (0699) to add two measures of *Nitrate Reducing Reagent (V-6279). Cap.
11. Hold tube by index finger and thumb and mix by inverting approximately 50-60 times a minute for four minutes. Wait 10 minutes for maximum color development.

NOTE: At end of waiting period an undissolved portion of Nitrate Reducing Reagent may remain in bottom of the tube without affecting results.

12. At the end of the 10 minute waiting period, mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.

13. Press **OFF** button to turn colorimeter off or press EXIT button to exit to a previous menu or make another menu selection.

To convert Nitrate Nitrogen (NO₃-N) results to ppm Nitrate (NO₃), multiply by 4.4.

NITRITE-NITROGEN-LOW RANGE DIAZOTIZATION METHOD

Nitrite represents an intermediate state in the nitrogen cycle, usually resulting from the bacterial decomposition of compounds containing organic nitrogen. Under aerobic conditions bacteria oxidize ammonia to nitrites; and under anaerobic conditions, bacteria reduce nitrates to nitrites. Nitrites are often used as preservatives when added to certain foods.

The nitrite concentration of drinking water rarely exceeds 0.1 ppm (mg/L).

APPLICATION: This method is applicable for the determination of nitrite in drinking, surface and saline waters; domestic and industrial wastes.

RANGE: 0.00–0.80 ppm Nitrite-Nitrogen

METHOD: The compound formed by diazotization of sulfanilamide and nitrite is coupled with N-(1-naphthyl)-ethylenediamine to produce a reddish-purple color, which is read colorimetrically.

SAMPLE HANDLING & PRESERVATION: Samples should be analyzed as soon as possible. They may be stored for 24 to 48 hours at 4°C.

INTERFERENCES: There are few known interfering substances at concentration less than 1000 times the nitrite-nitrogen concentration; however, the presence of strong oxidants or reductants may readily affect nitrite concentrations. High alkalinity (above 600 mg/L) will give low results due to a shift in pH.

PROCEDURE

NOTE: Place Dispenser Cap (0692) on *Mixed Acid Reagent (V-6278). Save this cap for refill reagents.

1. Press and hold **ON** button until colorimeter turns on.
2. Press ENTER to start.
3. Press ENTER to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 67 Nitrite-N LR) from TESTING MENU.
5. Scroll to and select 67 Nitrite-N LR from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter and pour off 5 mL into a graduated cylinder or similar. Discard the remaining sample.
9. Pour the 5 mL sample from the graduated cylinder into the colorimeter tube. Use graduated cylinder or similar to measure 5 mL of *Mixed Acid Reagent (V-6278) and add to tube. Cap and mix.
10. Use the 0.1 g spoon (0699) to add two measures of *Color Developing Reagent (V-6281). Cap and mix by gently inverting for 1 minute. Wait 5 minutes for maximum color development.
11. At the end of the 5 minute waiting period, mix, insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
12. Press **OFF** button to turn colorimeter off or press EXIT button to exit to a previous menu or make another menu selection.

NOTE: To convert nitrite-nitrogen (NO₂-N) results to ppm nitrite (NO₂), multiply results by 3.3.

PHOSPHATE–LOW RANGE ASCORBIC ACID REDUCTION METHOD

Phosphorus is an important nutrient for aquatic plants. The amount found in water is generally not more than 0.1 ppm unless the water has become polluted from waste water sources or excessive drainage from agricultural areas. When phosphorus is present in excess of the concentrations required for normal aquatic plant growth, a process called eutrophication takes place. This creates a favorable environment for the increase in algae and weeds. When algae cells die, oxygen is used in the decomposition and fish kills often result. Rapid decomposition of dense algae scums with associated organisms give rise to foul odors and hydrogen sulfide gas.

APPLICATION: Drinking, surface and saline waters; domestic and industrial wastes (Method based on reactions that are specific for orthophosphate).

RANGE: 0.00–3.00 ppm Orthophosphate

METHOD: Ammonium molybdate and antimony potassium tartrate react in a filtered acid medium with dilute solution of PO_4^{3-} to form an antimony-phosphomolybdate complex. This complex is reduced to an intense blue colored complex by ascorbic acid. The color is proportional to the amount of phosphate present. (Only orthophosphate forms a blue color in this test.)

Polyphosphates (and some organic phosphorus compounds) may be converted to the orthophosphate form by sulfuric acid digestion. Organic phosphorus compounds may be converted to the orthophosphate form by persulfate digestion.

SAMPLE HANDLING & PRESERVATION:

If benthic deposits are present in the area being sampled, great care should be taken not to include these deposits. If the analysis cannot be performed the same day of collection, the sample should be preserved by the addition of 2 mL of concentrated sulfuric acid or 40 mg mercuric chloride per liter and refrigerated at 4°C.

INTERFERENCES: **a.** No interference from copper, iron, or silicate at concentrations many times the concentration of sea water. However, high iron concentrations can cause precipitation and subsequent loss of phosphorus. **B.** Salt error for samples ranging from 5% to 20% salt content was found to be less than 1%. **C.** Mercuric chloride, HgCl_2 , when used as the preservative, interferes when the chloride levels are low (less than 50 mg/L). This interference is overcome by spiking samples with a minimum of 50 mg/L of sodium chloride.

PROCEDURE

1. Press and hold **ON** button until colorimeter turns on.
2. Press **ENTER** to start.
3. Press **ENTER** to select **TESTING MENU**.
4. Select **ALL TESTS** (or another sequence containing 78 Phosphate L) from **TESTING MENU**.
5. Scroll to and select 78 Phosphate L from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select **SCAN BLANK**.
8. Remove tube from colorimeter. Use 1.0 mL pipet (0354) to add 1.0 mL of *Phosphate Acid Reagent (V-6282). Cap and mix.
9. Use the 0.1 g spoon (0699) to add one measure of *Phosphate Reducing Reagent (V-6283). Cap and shake until powder dissolves. Wait 5 minutes for full color development. Solution will turn blue if phosphates are present.
10. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

POTASSIUM TETRAPHENYLBORON METHOD

Potassium, as the seventh most common element on the Earth, may be found in minor quantities in most water supplies. It seldom exceeds 10 ppm in drinking water and usually is less than 2 ppm. In some brine or runoff in agricultural areas the potassium concentration may reach 100 ppm.

APPLICATION: Drinking, surface, and saline water.

RANGE: 0.0–10.0 ppm Potassium

METHOD: Potassium reacts with sodium tetraphenylborate to form a colloidal white precipitate in quantities proportional to the potassium concentration.

SAMPLE HANDLING & PRESERVATION:

Store samples in polyethylene bottles, not in soft glass where leaching of potassium from the glass may occur. Samples may be acidified to pH 2 with nitric acid, but should be neutralized before analyzing.

INTERFERENCE: Calcium and magnesium interfere at very high concentrations. Check for stray light interference (see p. 17).

PROCEDURE

1. Press and hold **ON** button until colorimeter turns on.
2. Press ENTER to start.
3. Press ENTER to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 81 Potassium) from TESTING MENU.
5. Scroll to and select 81 Potassium from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter. Add 4 drops of *Sodium Hydroxide, 1.0N (4004WT). Cap and mix.
9. Use the 0.05 g spoon (0696) to add one measure of *Tetraphenylboron Powder (6364). Cap and shake vigorously until all of the powder has dissolved. Wait 5 minutes.
10. At end of 5 minute waiting period, mix tube again to suspend any settled precipitate. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
11. Press **OFF** button to turn colorimeter off or press EXIT button to exit to a previous menu or make another menu selection.

SILICA–HIGH RANGE SILICOMOLYBDATE METHOD

Silicon dioxide, SiO₂, commonly known as silica, occurs in all natural water. Silica may be present as suspended, insoluble particles in a colloidal or polymeric state. It may also be present in a reactive form as silicic acid or silicate ions. Silica is a major nutrient for diatoms. A silica cycle occurs in many bodies of water containing organisms, such as diatoms, that use silica in their skeletal structure. The silica removed from the water may be slowly returned to solution by the decomposition of the dead organisms. The major source of silica in natural water is from the decomposition of silicate minerals in the drainage basin from which the waters flow.

The presence of silica is particularly objectionable in water used for boiler feed water purposes, as it may cause the formation of a hard, dense scale which has unusually high resistance to heat transfer. Serious loss of turbine efficiency results from insoluble silica turbine blade deposits caused by vaporization of silica from boiler water.

APPLICATION: Boilers and cooling towers; domestic and industrial wastes.

RANGE: 0–75 ppm Silica

METHOD: Silica forms a complex with ammonium molybdate in an acidic solution to produce a yellow color in proportion to the amount of silica present. Phosphate also reacts with molybdate but the addition of oxalic acid eliminates the molybdophosphoric acid complex.

SAMPLE HANDLING & PRESERVATION: Silica samples may be preserved by refrigeration at 4°C in plastic containers up to one week without any change in silica concentration.

INTERFERENCES: Sulfides and large amounts of iron interfere. Color and turbidity may be removed by standardizing the instrument with the original water sample.

PROCEDURE

1. Press and hold **ON** button until colorimeter turns on.
2. Press ENTER to start.
3. Press ENTER to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 86 Silica Hi) from TESTING MENU.
5. Scroll to and select 86 Silica Hi from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter. Add 6 drops *Silica Reagent #1 (V-4466). Cap and invert to mix.
9. Add 12 drops of *Silica Reagent #2 (V-4467). Cap and mix. Wait 5 minutes.
10. At end of 5 minute waiting period, add 8 drops of *Silica Reagent #3 (V-4468). Cap and mix.
11. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
12. Press **OFF** button to turn colorimeter off or press EXIT button to exit to a previous menu or make another menu selection.

NOTE: To extend the range to 100 ppm, perform a 2:1 dilution of water sample, with silica-free water. Perform test and multiply result by 2.

SULFATE–HIGH RANGE

BARIUM CHLORIDE METHOD

The most common mineral forms of sulfur are iron sulfide, lead sulfide, zinc sulfide and as calcium sulfate and magnesium sulfate. In most fresh waters the sulfate ion is the second or third most abundant anion, being exceeded only by bicarbonate and, in some cases, silicate. Sulfur, in the form of sulfate, is considered an important nutrient element. Mineral springs are rich in sulfate and feed appreciable quantities of this compound to the watershed. Acid mine water drainage is a form of pollution which may contribute extremely large amounts of sulfate content to natural waters. Other sources of sulfate include waste material from pulp mills, steel mills, food processing operations and municipal wastes. Many bacteria obtain sulfur from sulfate for the synthesis of amino acids. In lakes and streams low in oxygen, this process of sulfate reduction causes the production of hydrogen sulfide, with its characteristic offensive odor. Calcium sulfate and magnesium sulfate contribute significantly to the hardness of water. Under natural conditions, the quantities ordinarily to be expected in lakes are between 3 and 30 parts per million.

APPLICATION: Drinking and surface waters, domestic and industrial wastes.

RANGE: 0–100 ppm Sulfate

METHOD: Sulfate ion is precipitated in an acid medium with barium chloride to form a barium sulfate suspension in proportion to the amount of sulfate present.

SAMPLE HANDLING & PRESERVATION:

Sulfate samples may be preserved by refrigeration at 4°C up to 7 days in glass or plastic containers without any change in concentration.

INTERFERENCE: Suspended matter and color interference may be removed by a filtration step. Silica in excess of 500 mg/L will interfere. Check for stray light interference (see page 17).

PROCEDURE

1. Press and hold **ON** button until colorimeter turns on.
2. Press ENTER to start.
3. Press ENTER to select TESTING MENU.
4. Select ALL TESTS (or another sequence containing 89 Sulfate-HR) from TESTING MENU.
5. Scroll to and select 89 Sulfate-HR from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select SCAN BLANK.
8. Remove tube from colorimeter. Use the 0.1 g spoon (0699) to add one measure of *Sulfate Reagent (V-6277). Cap and shake until powder dissolves. A white precipitate will develop if sulfates are present. Wait 5 minutes.
9. Mix tube again. Insert tube into chamber, close lid and select SCAN SAMPLE. Record result.
10. Press **OFF** button to turn colorimeter off or press EXIT button to exit to a previous menu or make another menu selection.

NOTE: If the sulfate concentration of the test sample is greater than 100 ppm, it is recommended that a dilution be made with deionized water and the results multiplied by the dilution factor. A white film is deposited on the inside of test tubes as a result of the sulfate test. Thoroughly clean and rinse test tubes after each test. For the most accurate results, samples and reactions should be at $25\pm 4^{\circ}\text{C}$.

Appendix B

BLESS Water Quality Monitoring Record Sheets

BLESS Water Quality Monitoring Record Sheet

Location Description	Coordinates (Latitude/Longitude)	Date	Salinity (ppm)	Conductivity (μ S)	pH	TDS (mg/L)	DO (ppm)	Water Temperature ($^{\circ}$ C)

BLESS Water Quality Monitoring Record Sheet (Chemical)

Location Description	Date	Ammonia	Nitrate	Nitrite	Dissolved Phosphorus	Alkalinity	Silica	Sulphate	Potassium	Water Temperature (°C)

Appendix C

Samples and readings taken with ALMS and later by BLESS volunteers from streams

Location	Date of Sampling	Physical-Chemical Parameters						Chemical Parameters (measured in ppm)								
		Salinity (ppm)	Conductivity ($\mu\text{S}/\text{cm}$)	pH	TDS (mg/L)	DO (ppm)	Water Temp ($^{\circ}\text{C}$)	NH_3	NO_3^-	NO_2^{2-}	Dissolved P	Alkalinity	Total Iron	Si	SO_3^-	K
Sturgeon River at Meadowview Dr	15-Jul-06	342	680	8.64	480	6.95	19.4									
Sturgeon River at Meadowview Dr (BLESS SR)	18-Aug-06	285	574	9.03	401	6.8	19	0.24	0.1	0.005		193		2	57	3.6
Sturgeon River at Meadowview Dr (BLESS SR)	08-Sep-06	305	610	9.12	429	9.83	18	0.23	0.02	0.002	1.76	129		2	81	8.5
Sturgeon River at Meadowview Dr (BLESS SR)	22-Sep-06	303	611	8.81	429	11.36	11.6	0.26	0.02	0	0.06	145	0.96	3	98	5.9

Location	Date of Sampling	Physical-Chemical Parameters						Chemical Parameters (measured in ppm)								
		Salinity (ppm)	Conductivity ($\mu\text{S}/\text{cm}$)	pH	TDS (mg/L)	DO (ppm)	Water Temp ($^{\circ}\text{C}$)	NH_3	NO_3^-	NO_2^{2-}	Dissolved P	Alkalinity	Total Iron	Si	SO_3^-	K
Carrot Creek at Meadowview Dr	15-Jul-06	726	1456	9.48	1018	8.44	18.6									
Carrot Creek at Meadowview Dr (BLESS CC)	18-Aug-06	572	1145	8.05	795	5.8	24	0.43	0	0		139		1	>100	>10
Carrot Creek at Meadowview Dr (BLESS CC)	08-Sep-06	561	1131	8.87	791	12.3	18.5	0.44	0	0	1.94	135		1	132	14.6
Carrot Creek at Meadowview Dr (BLESS CC)	22-Sep-06	447	885	8.45	620	10.32	11.8	0.27	0	0	0.66	194	1.52	4	156	11.6

Location	Date of Sampling	Physical-Chemical Parameters						Chemical Parameters (measured in ppm)								
		Salinity (ppm)	Conductivity (µS/cm)	pH	TDS (mg/L)	DO (ppm)	Water Temp (°C)	NH ₃	NO ₃ ⁻	NO ₂ ²⁻	Dissolved P	Alkalinity	Total Iron	Si	SO ₃ ⁻	K
Sturgeon River at Big Lake outlet	15-Jul-06	387	797	7.49	548	2.96	15.2									
Sturgeon River outlet at BLESS platform (BLESS SRO)	19-Aug-06	328	657	7.57	455	0.34	18.6	0.35	0.04	0.027		168		4	>100	5.5
Sturgeon River outlet at BLESS platform (BLESS SRO)	09-Sep-06	323	667	7.45	464	2.36	12.3	3.22	0	0	1.14	134		7	100	8.5
Sturgeon River outlet at BLESS platform (BLESS SRO)	22-Sep-06	318	633	8.06	455	7.2	9.7	0.34	0.17	0	0.48	170	0	5	116	10

Readings taken from around the lake with Alberta Lake Monitoring Society

	Date of Sampling	Physical-Chemical Parameters							Water Temp From DO Meter (°C)	Water Temp (°C)
		Salinity (ppm)	Conductivity (µS)	pH	TDS (mg/L)	DO (ppm)				
Sturgeon River at Big Lake outlet	15-Jul-06	387	797	7.49	548	2.96			15.2	
Carrot Creek at Meadowview Dr	15-Jul-06	726	1456	9.48	1018	8.44			18.6	
Sturgeon River at Meadowview Dr	15-Jul-06	342	680	8.64	480	6.95			19.4	
Shooting Club Canal near Big Lake	15-Jul-06	413	828	7.53	579	7.62			20.2	
Atim Creek at Hwy 44 Bridge	15-Jul-06	383	745	8.65	527	7.42			21.1	
Big Lake, west bay, center (ALMS 1B)	21-Jul-06	322	647	10.35	452	11.7		24.8	23.1	
Big Lake, west bay, off south shore (ALMS2B)	21-Jul-06	345	696	10.5	486	12.3		24.5	23.5	
Big Lake, west bay, west shore, off Atim Creek southern inlet (ALMS3BB)	21-Jul-06	390	785	10.56	548	11.9		24.4	23.4	
Big Lake, west bay, centre of northern arm, off north shore (ALMS4B)	21-Jul-06	310	628	10.6	474	14.97		24.7	23.9	

Big Lake, west bay, west shore, in Atim Creek southern inlet (ALMS3B)	21-Jul-06	meter became unserviceable	0.82	23.8
Big Lake narrows, west end (ALMS5)	21-Jul-06		15.83	27.2
Big Lake narrows, east end (ALMS6)	21-Jul-06		12.97	25.3
Big Lake, east bay, just off southwest shore (ALMS7)	21-Jul-06		16.32	26
Big Lake, east bay, in the southern Sturgeon River inlet (ALMS8)	21-Jul-06		7.7	25.8
Big Lake, east bay, off northwest shore (ALMS9B)	21-Jul-06		15.3	27.5
Big Lake, east bay, off north shore (ALMS10B)	21-Jul-06		13.36	25.6
Big Lake, east bay, off southeast shore (ALMS11B)	21-Jul-06		13.53	25.9
Big Lake, east bay, off east shore, south of BLESS platform (ALMS12B)	21-Jul-06		13.86	25.4

	Date of Sampling	Physical-Chemical Parameters						
		Salinity (ppm)	Conductivity (µS)	pH	TDS (mg/L)	DO (ppm)	Water Temp From DO Meter (°C)	Water Temp (°C)
Sturgeon River at Meadowview Dr (BLESS SR)	18-Aug-06	285	574	9.03	401	6.8	22.5	19
Sturgeon River outlet at BLESS platform (BLESS SRO)	19-Aug-06	328	657	7.57	455	0.34	19.1	18.6
Atim Creek at Hwy 44 Bridge (BLESS AC)	18-Aug-06	233	468	8.55	330	10.32	26.4	25
Carrot Creek at Meadowview Dr (BLESS CC)	18-Aug-06	572	1145	8.05	795	5.8	25.2	24
Big Lake East Bay (BLESS EB1)	11-Aug-06	Not tested						
Big Lake West Bay (BLESS WB1)	11-Aug-06	Not tested						
Big Lake, west bay, center (ALMS 1B)	11-Aug-06	252	507	9.9	340	7.9	18.4	19
Big Lake, west bay, off south shore (ALMS2B)	11-Aug-06	273	532	10	383	8.62	17.1	18.6
Big Lake, west bay, west shore, off Atim Creek southern inlet (ALMS3C)	11-Aug-06	284	566	10	391	7.06	16.7	17.9
Big Lake, west bay, centre of northern arm, off north shore (ALMS4B)	11-Aug-06	240	485	9.9	325	5.74	16.2	17.1
Big Lake, west bay, west shore, in Atim Creek southern inlet (ALMS4C)	11-Aug-06	290	598	8.1	413	1.99	16	16.1
Big Lake narrows, west end (ALMS5)	11-Aug-06	270	541	9.9	380	6.7	18	18.5
Big Lake narrows, east end (ALMS6)	11-Aug-06	263	529	10.1	373	8.35	16.4	17.3
Big Lake, east bay, just off southwest shore (ALMS7)	11-Aug-06	242	492	10.5	345	9.36	16.2	17.4

Big Lake, east bay, in the southern Sturgeon River inlet (ALMS8)	11-Aug-06	233	474	9	329	4.34	16.9	17.9
Big Lake, east bay, off northwest shore (ALMS9B)	11-Aug-06	240	472	10.7	335	10.4	15.7	17.1
Big Lake, east bay, off north shore (ALMS10B)	11-Aug-06	241	492	10.75	343	9.67	16.1	17.3
Big Lake, east bay, off southeast shore (ALMS11B)	11-Aug-06	245	480	11	333	10.3	16.3	17.6
Big Lake, east bay, off east shore, south of BLESS platform (ALMS12B)	11-Aug-06	257	517	10	359	8.82	16.3	17

	Date of Sampling	Physical-Chemical Parameters						
		Salinity (ppm)	Conductivity (μ S)	pH	TDS (mg/L)	DO (ppm)	Water Temp From DO Meter ($^{\circ}$ C)	Water Temp ($^{\circ}$ C)
Sturgeon River at Meadowview Dr (BLESS SR)	08-Sep-06	305	610	9.12	429	9.83	18.4	18
Sturgeon River outlet at BLESS platform (BLESS SRO)	09-Sep-06	323	667	7.45	464	2.36	14.3	12.3
Atim Creek at Hwy 44 Bridge (BLESS AC)	08-Sep-06	272	541	7.97	373	6.3	18.7	18.5
Carrot Creek at Meadowview Dr (BLESS CC)	08-Sep-06	561	1131	8.87	791	12.3	20.8	18.5
Big Lake East Bay (ALMS7)	01-Sep-06	250	501	10.15	343	13.85	17.4	17.8
Big Lake west bay, center (ALMS1)	01-Sep-06	252	498	9.92	360	9.44	14.4	13
Big Lake, west bay, center, off south shore (ALMS2)	01-Sep-06	275	553	9.04	403	6.99	12.9	13.4
Big Lake, west bay, west shore, off Atim Creek southern inlet (ALMS3C)	01-Sep-06	276	536	9.53	367	10.11	12.7	13.5
Big Lake, west bay, centre of northern arm, off north shore (ALMS4)	01-Sep-06	244	492	9.22	344	7.08	14.2	14.2
Big Lake, west bay, west shore, in Atim Creek southern inlet (ALMS4C)	01-Sep-06	305	637	7.93	429	6.87	13.5	13.9
Big Lake narrows, west end (ALMS5)	01-Sep-06	266	551	9.86	384	9.9	21.5	17
Big Lake narrows, east end (ALMS6)	01-Sep-06	271	536	9.58	380	9.45	18.4	17
Big Lake, east bay, in the southern Sturgeon River inlet (ALMS8)	01-Sep-06	232	475	9.16	330	5.55	18.3	18.7
Big Lake, east bay, off northwest shore (ALMS9B)	01-Sep-06	242	494	9.89	342	12.6	17.9	17.6
Big Lake, east bay, off north shore (ALMS10B)	01-Sep-06	245	490	9.97	342	12.4	17.1	17.6
Big Lake, east bay, off southeast shore (ALMS11B)	01-Sep-06	237	479	9.92	334	10.86	17.6	17.6
Big Lake, east bay, off east shore, south of BLESS platform (ALMS12B)	01-Sep-06	260	524	9.37	366	15.25	16.9	17.1

	Date of Sampling	Physical-Chemical Parameters						
		Salinity (ppm)	Conductivity (µS)	pH	TDS (mg/L)	DO (ppm)	Water Temp From DO Meter (°C)	Water Temp (°C)
Sturgeon River at Meadowview Dr (BLESS SR)	22-Sep-06	303	611	8.81	429	11.36	12.7	11.6
Sturgeon River outlet at BLESS platform (BLESS SRO)	22-Sep-06	318	633	8.06	455	7.2	10.1	9.7
Atim Creek at Hwy 44 Bridge (BLESS AC)	22-Sep-06	256	513	7.86	361	4.96	12.8	11
Carrot Creek at Meadowview Dr (BLESS CC)	22-Sep-06	447	885	8.45	620	10.32	14.1	11.8
Big Lake East Bay (ALMS7)	22-Sep-06	256	510	9.44	360	9.67	9.9	9.2
Big Lake west bay, center (ALMS1)	22-Sep-06	250	508	9.73	353	8.9	9.9	9.1
Big Lake, west bay, center, off south shore (ALMS2)	22-Sep-06	267	535	9.62	394	10.03	9.6	8.5
Big Lake, west bay, west shore, south of Atim Creek southern inlet (ALMS3D)	22-Sep-06	279	560	9.52	387	8.22	8.6	8.3
Big Lake, west bay, centre of northern arm, off north shore (ALMS4B)	22-Sep-06	236	525	8.25	330	6.13	8.6	8.3
Big Lake, west bay, west shore, in Atim Creek southern inlet (ALMS4C)	22-Sep-06	273	559	7.55	389	3.06	8.6	8.3
Big Lake narrows, west end (ALMS5)	22-Sep-06	254	514	10.12	362	9.48	11.1	9.6
Big Lake narrows, east end (ALMS6)	22-Sep-06	262	529	9.8	367	8.72	10.9	9.4
Big Lake, east bay, in the southern Sturgeon River inlet (ALMS8)	22-Sep-06	244	503	8.79	343	5.79	10.3	9.7
Big Lake, east bay, off northwest shore (ALMS9B)	22-Sep-06	260	525	9.18	378	9.32	11	9.9
Big Lake, east bay, off north shore (ALMS10B)	22-Sep-06	249	501	9.33	350	9.61	10.6	9.8
Big Lake, east bay, off southeast shore (ALMS11B)	22-Sep-06	255	514	9.31	361	8.53	11.6	9.8
Big Lake, east bay, off east shore, south of BLESS platform (ALMS12B)	22-Sep-06	246	499	9.24	345	9.62	10.1	9.5