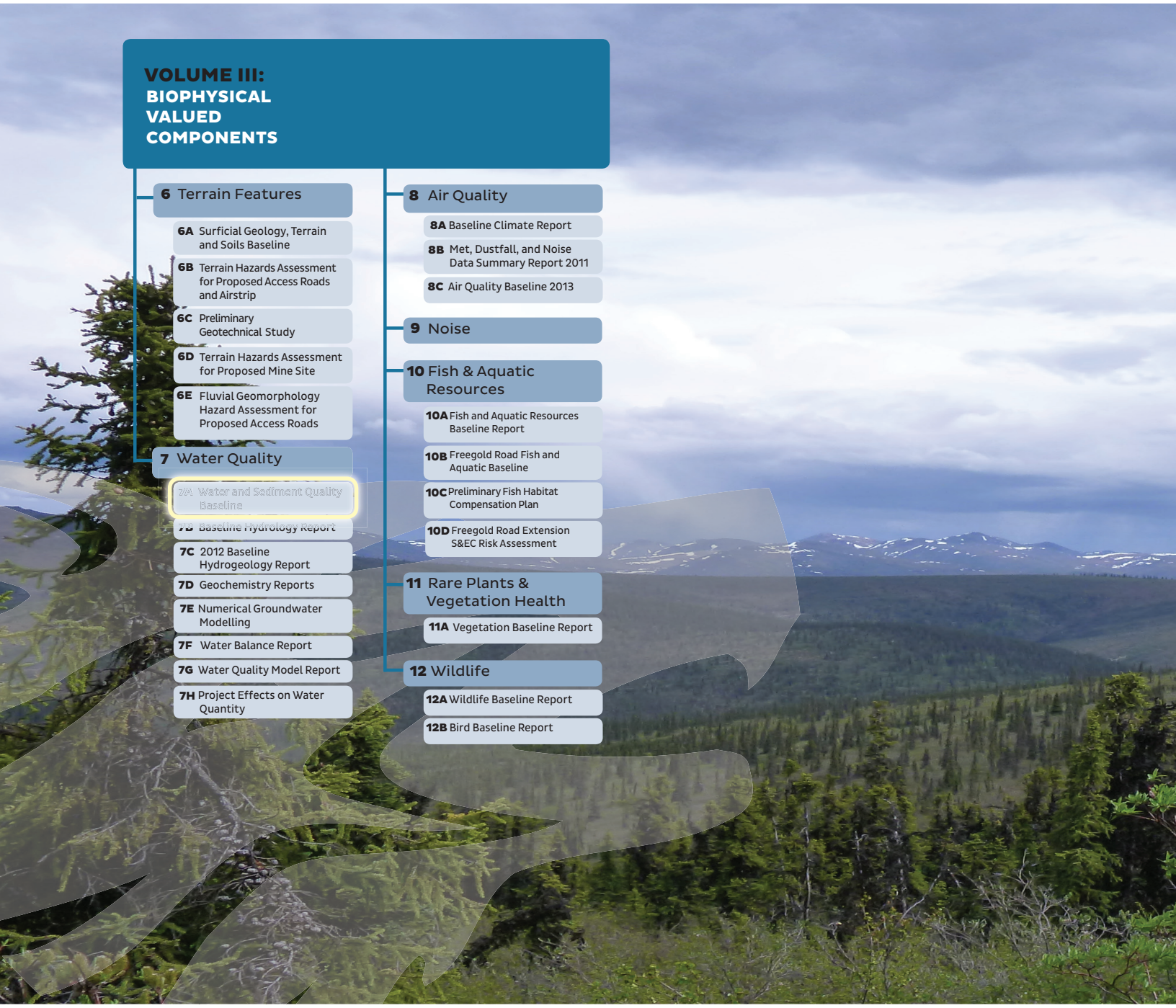
APPENDIX 7A: WATER AND SEDIMENT QUALITY BASELINE



PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Casino Project

Water and Sediment Quality Baseline

Prepared for

Casino Mining Corporation

October 15, 2013

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

*475 Howe Street, Suite 1030, Vancouver, BC V6C 2B3 **t** 604-629-9075*

October 15, 2013

Jesse Duke
Project Director
Casino Mining Corporation
2050-1111 West Georgia Street
Vancouver, BC V6E 4M3

Dear Mr. Duke:

Re: Casino Project

Palmer Environmental Consulting Group Inc. is pleased to submit the attached draft report describing the results of water and sediment quality baseline assessment conducted as part of the proposed Casino Mine Project's Project Proposal submission to the Yukon Environmental and Socio-Economic Assessment Board.

This report characterizes the pre-development conditions of the water and sediment quality in the proposed Casino Project area and provides a basis for an assessment of mine development effects. Owing to the proximity of watercourses to the Casino ore body, water and sediment quality in the Project area have naturally high levels of certain metals, including copper, aluminum, iron, lead, silver, cadmium and zinc.

Thank you for the opportunity to work with you on this project.

Yours truly,

Palmer Environmental Consulting Group Inc.

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Executive Summary

Casino Mining Corporation, formerly Western Copper Corporation, has 100% ownership of the Casino property. The Casino Project is a proposed porphyry copper-gold-molybdenum mine located at 611300E 6958000N in west-central Yukon, approximately 300 km northwest of the territorial capital of Whitehorse.

The Casino Project aquatic study area is defined by the boundaries of the two watersheds surrounding the ore body: the Britannia Creek watershed to the north and the Dip Creek watershed to the south. Water quality and sediment sampling studies were first conducted in 1993 to 1995 and then continued from 2008 to 2012 in the Casino Project area. Current baseline studies were based on sampling stations from the 1993-1995 studies. A total of 26 stations between 2008 and 2012 were chosen for water quality sampling. Stations were concentrated in the Casino Creek (a tributary to Dip Creek) and Britannia Creek watersheds as they have the potential to be directly affected by the Project. Himmelright (1994) indicated natural sources of acid rock drainage (ARD) exist near the mineral deposit and that the effects are seen most clearly in Proctor Gulch, a tributary that flows into upper Casino Creek. Elevated metal concentrations and high acidity from Proctor Gulch are major contributors to the chemistry in the surface waters of Casino Creek. Other sources of natural ARD include groundwater that flows directly into upper Canadian Creek (a tributary to Britannia Creek) and groundwater that discharges from a historical adit via a pipe to upper Meloy Creek and onward to Casino Creek.

Water samples were collected and analyzed for the full suite of physical parameters, anions, nutrients and total and dissolved metals. Minimum, mean, median and maximum concentrations were calculated for each parameter at all stations. Exceedances of the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of freshwater aquatic life were observed for a total of ten parameters (cadmium, copper, aluminum, iron, uranium, fluoride, zinc, lead, pH and silver) throughout the project area. The number of exceedances was highest for aluminum, cadmium, copper and iron. With the exception of uranium, exceedances were most numerous in the summer season (May to October), indicating a seasonal trend related to hydrological factors such as snow melt and stream flow.

Nutrient levels at all stations were below CCME guidelines, with approximately 20-70% of all ammonia, nitrite, nitrate, nitrate+nitrite-N, total phosphate and orthophosphate concentrations below analytical detection limits. Levels of many metals and anions were consistently low, with concentrations equal to or lower than analytical detection limits observed for 50% to 90% of the samples, including those for beryllium, boron, bismuth, bromide, chloride, mercury, tin, silver, titanium, thallium, vanadium and zirconium in all study areas.

The 2008-2012 water quality program confirmed the unique water chemistry of Proctor Gulch first reported by Himmelright (1994). Exceedances of CCME guidelines for pH, copper, aluminum and iron were found in 100% of the 16 samples from Proctor Gulch. Fluoride, cadmium, lead and zinc were also elevated in samples from Proctor Gulch. Additionally, water quality at this station exhibited highest values for acidity (and lowest pH), hardness, conductivity, total dissolved solids and turbidity, as well as lowest values for alkalinity.

Spatially, it was observed that copper, aluminum and iron concentrations were highest at Proctor Gulch (W12) and decreased with successive stations downstream at W8, W11 and W4. This indicates that

inflows from Casino Creek tributaries, Meloy Creek, Brynelson Creek and Austin Creek, effectively dilute the water so that average values are below CCME guidelines. Proctor Gulch consistently shows higher concentrations in the winter than in the summer for all the metals as groundwater is the major source of flow in the winter months.

A historical adit established to access a lead/zinc/silver deposit in the upper Meloy Creek watershed discharges groundwater in the spring and summer months (approximately May to August). This station (W43) was found to have the highest concentrations of cadmium, lead, silver and zinc of all the stations sampled. Of these four metals, only one cadmium sample (0.00004 mg/L in April 2011) exceeded guidelines in the lower reach of Casino Creek at W4, due to the small flow from the adit relative to Casino Creek,

Some effects from Proctor Gulch are observed in Dip Creek at station W5, just downstream of Casino Creek, particularly for copper, cadmium, lead and zinc, as background levels upstream in the Dip Creek watershed at stations W22, R2 and W9 have lower concentrations of these metals.

Although less pronounced, an overall similar spatial pattern for cadmium, zinc, copper, aluminum, iron and lead was observed for Canadian Creek and Britannia Creek. The uppermost station on Canadian Creek (W7) is situated in close proximity to the ore body and therefore likely receives baseflow with similar water quality to Proctor Gulch. This station exhibits the highest concentration of these metals in the Britannia Creek watershed, decreasing downstream to the Yukon River.

On the whole, hardness, conductivity and nitrogen based nutrients were higher in the winter months. Conversely, TSS, phosphorus based nutrients, organic matter and metal concentrations were higher in the summer months for all stations, indicating a seasonal trend most likely directly related to hydrological factors such as surface runoff and stream flow.

Sediment samples were collected from a total of 21 stations during sampling periods 1993-1995 and 2008-2012. Exceedances of CCME guidelines were identified for six metals: arsenic, cadmium, chromium, copper, lead and zinc.

Total metals in stream sediments tend to decrease with increasing distance from the headwaters of Casino Creek. Station R2 in a tributary to Dip Creek has one of the lowest sediment metals concentrations of all the stations in the Casino project Local Study Area (LSA). It appears to be representative of background conditions, as stations W16 (mid-Dip Creek downstream of Casino Creek), and W20 and W21 on the Klotassin River, show similarly low metals concentrations.

Spatial trends in stream sediment metal concentrations are less clear in the Britannia Creek watershed than in the Casino Creek watershed. Some trends are expected because of differences in the quantity and quality of groundwater discharge into low elevation areas versus high elevation areas. Downstream of Britannia Creek, the Yukon River shows concentrations of cadmium, chromium, mercury and zinc that were higher than in the Britannia Creek watershed, indicating elevated metal concentrations in the Yukon River that are unrelated to the effects of the ore body.

Acronyms and Abbreviations

ARD	Acid Rock Drainage
BC MOE	British Columbia Ministry of Environment
CCME	Canadian Council of Ministers of the Environment
CMC	Casino Mining Corporation
COV	Covariance
DL	Detection Limit
DOC	Dissolved Organic Carbon
GL	Guideline Values
GPS	Global Positioning System
HKP	Hallam Knight Piésold Ltd.
ICP	Inductively coupled plasma
/MS	Inductively coupled plasma mass spectrometry
ISO	International Standards Organization
ISQG	Interim Sediment Quality Guideline
LSA	Local Study Area
LT_{50}	Lethal Time for 50% of the test organisms
Max	Maximum
Min	Minimum
MMER	Metal Mining Effluent Regulations
µS	micro-Siemens
NA	Not applicable
ND	Not detectable/Below Detection Limit
NAN	Not a Number
NS	Not sampled
NTU	Nephelometric unit
PEL	Probable Effects Level
PQL	Practical Quantitation Limit
PYLET	Pacific and Yukon Laboratory for Environmental Testing
QA/QC	Quality Assurance/Quality Control
RDL	Reported Detection Limit
RPD	Relative Percent Difference
RSA	Regional Study Area
SD	Standard deviation
SE	Standard error
SSWQO	Site-Specific Water Quality Objectives
TDS	Total Dissolved Solids
TMF	Tailings Management Facility
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TSS	Total Suspended Solids
U.S. EPA	United States Environmental Protection Agency
YESAB	Yukon Environmental and Socio-Economic Assessment Board

Table of Contents

Letter
Executive Summary
Acknowledgements
Acronyms and Abbreviations

1 Introduction 1
1.1 Study Objectives 1

2 Study Area Boundaries 2

3 Methods 7
3.1 Historical References 7
3.2 Water Quality 7
3.2.1 Field Sampling Methods 7
3.2.2 Laboratory Methods 8
3.2.3 Quality Assurance/Quality Control 9
3.2.4 Data Analysis 11
3.3 Sediment Quality 12
3.3.1 Field Methods 12
3.3.2 Laboratory Methods 12
3.3.3 Quality Assurance and Quality Control 13
3.3.4 Data Analysis 14

4 Results 15
4.1 Water Quality 15
4.1.1 Seasonal Variability 19
4.2 Sediment Quality 34
4.2.1 Exceedances of CCME Sediment Quality Guidelines 34
4.2.2 Sources of Elevated Sediment Metal Concentrations 35
4.2.3 Routes of Metal Transfer to Stream Sediments 36

5 Conclusion 40

6 References 41

List of Figures

Figure 1. Current and Historic Water Quality Sampling Stations 3
Figure 2. Current and Historic Sediment Quality Sampling Stations 4
Figure 3. Winter and Summer average copper concentrations at W9, W3, R2, W6b, W20, Casino Project, 2008-2012 20
Figure 4. Total Number of Exceedances of CCME Guidelines, 2008-2012 23
Figure 5. Range of Values (Minimum, Median, Maximum) of Selected General Chemistry Parameters, Casino Project, 2008-2012 24
Figure 6. Range of Values (Minimum, Median, Maximum) of Selected Nutrients and Organic Matter Parameters, Casino Project, 2008-2012 26
Figure 7. Range of Values (Minimum, Median, Maximum) of Selected Anions, Casino Project, 2008-2012 27
Figure 8. Range of Values (Minimum, Median, Maximum) of Total Metals Parameters, Casino Project, 2008-2012 28
Figure 9. Median Concentrations of Total Metals, Dissolved Metals and TSS, 2008-2012 31
Figure 10. Range of Values (Mean and Standard Deviation) of Selected Total Metals Sediment Quality Parameters, Casino Project, 1993-1994 and 2008-2012 37

List of Tables

Table 1. Summary of Water Quality and Sediment Quality Sampling Stations, Casino Project 5
Table 2. Dates of Water and Sediment Quality Field Sampling Trips, Casino Project 6
Table 3. Water Quality Parameters and Detection Limits 8
Table 4. Sediment Quality Parameters and Detection Limits, Casino Project, 2008-2012 13
Table 5. Median Parameters Exceeding CCME Guidelines, Casino Project, 2008-2012 23
Table 6. Sediment Quality Parameters Exceeding CCME Guidelines 34

List of Appendices

Appendix A1. Casino Project: 2008 Environmental Studies Report (AECOM, 2009)
Appendix A2. Casino Project: 2009 Aquatic Studies Report (PECG, 2011a)
Appendix A3. Casino Project: 2010 Aquatic Studies Report (PECG, 2011b)
Appendix A4. Casino Project: 2011 Aquatic Studies Report (PECG, 2012)
Appendix A5. Casino Project: 2012 Aquatic Studies Report (PECG, 2013)
Appendix B1. Environment Canada Toxicity Testing: Final Analytical Results with QC data (2011)
Appendix B2. Surface Water Quality: Travel Blanks, Casino Project 2008-2012
Appendix B3. Surface Water Quality: Field Blanks, Casino Project 2008-2012
Appendix B4. Flagged Dissolved metals versus Total metals, Casino Project, 2008-2012
Appendix B5. Surface Water Quality Statistics: all stations all parameters, Casino Project, 2008-2012
Appendix B6. Surface Water Quality *In Situ* data, Casino Project, 2008-2012
Appendix C1. Sediment Quality Data, Casino Project, 1993-1995 & 2008-2012
Appendix C2. Sediment Quality Summary Statistics, Casino Project, 1993-1994 & 2008-2011

1 Introduction

The Casino Project is owned by Casino Mining Corporation (CMC). It is a proposed porphyry copper-gold-molybdenum mine located in west-central Yukon, at 611300E 6958000N, approximately 300 km northwest of the territorial capital of Whitehorse.=

Limited historical data are available on the aquatic environment of the Project area. Historical studies on the aquatic ecosystem of the Project property were first conducted from 1993 to 1995 (Hallam Knight Piésold, 1997). Recent studies of the aquatic ecosystem of the RSA, including water quality and sediment quality sampling, began in 2008. Sampling trips occurred in May, July, September and October of that year. These studies were continued in 2009, with monthly water quality sampling completed between May and December and sediment quality sampling completed in August. Monthly water quality sampling continued in 2010 and 2011, with some sediment sampling to address data gaps. The 2012 water quality program was scaled down to two sampling trips, March and May. Annual technical reports were developed for the aquatic field studies between 2008 and 2012 and can be found in Appendices A1 to A5.

This report comprises the results of the field studies from 1993-1995 and 2008-2012 for water quality and sediment quality in the Casino Project study areas.

1.1 Study Objectives

The purpose of these studies was to characterize the pre-development aquatic environment of the Project area in support of the project proposal to the Yukon Environmental and Socio-economic Assessment Board (YESAB).

Generally, the purpose was to obtain a good level of understanding of the ecology of the system. The specific objectives of the surface water and sediment quality sampling program were as follows:

- Compile a central database of baseline water quality and sediment quality data;
- Identify parameters that may be present at elevated levels, and use this information to propose site-specific water quality objectives, if needed;
- Provide the basis for assessing potential water quality effects, mitigation measures, monitoring and contingency planning as the mine planning proceeds; and
- Provide baseline data that can be used to support future monitoring programs.

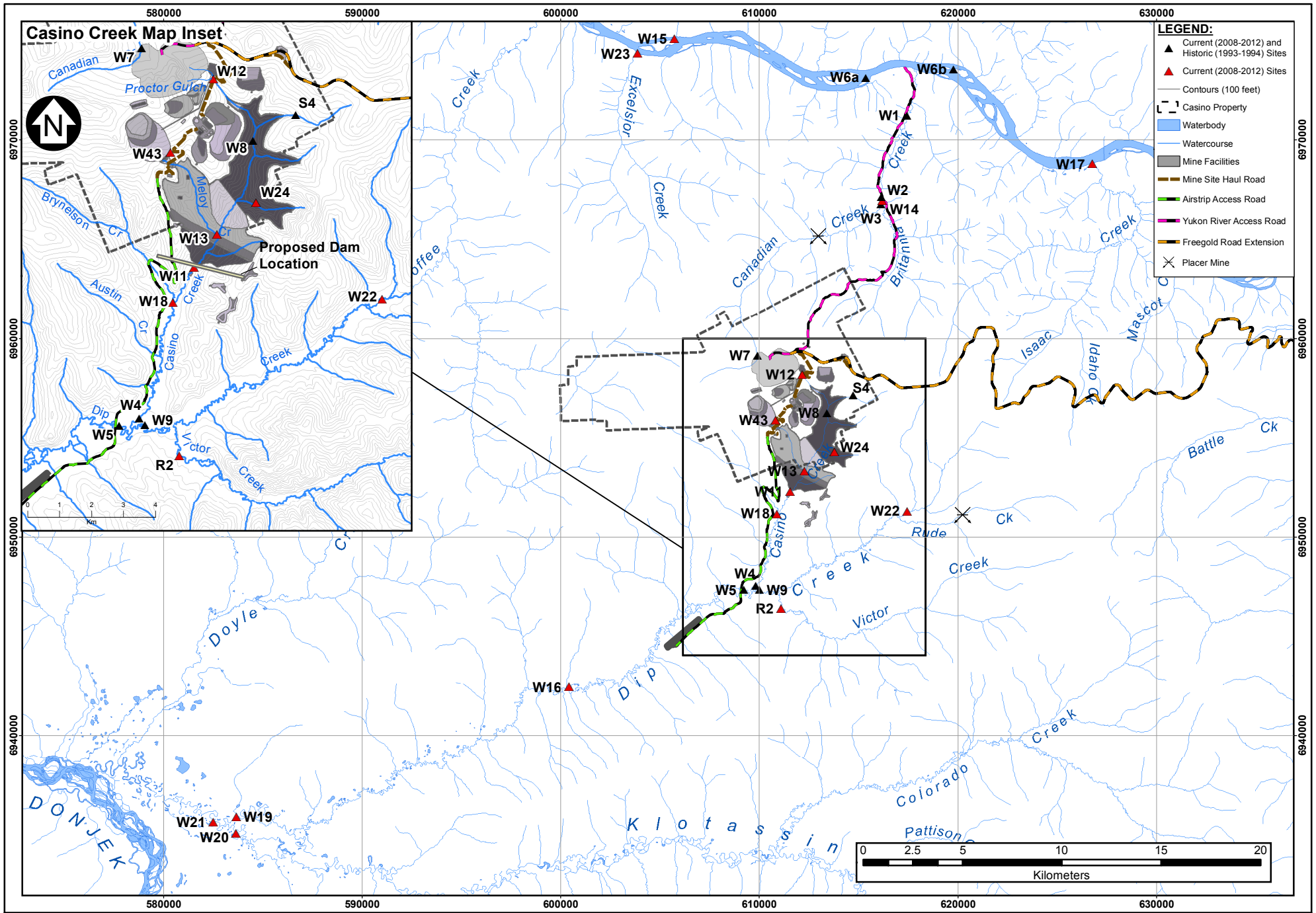
2 Study Area Boundaries

The study area for the water and sediment quality program encompasses two main watersheds surrounding the Project deposit: Dip Creek watershed to the south and Britannia Creek to the north. Most of the proposed mine infrastructure will be in the Casino Creek watershed, but some will be in the Britannia Creek watershed (e.g., the northern corner of the open pit). As such, Casino Creek is the main water body with potential Project effects, mostly associated with the proposed Tailings Management Facility (TMF) in the upper portion of the creek. Casino Creek discharges into Dip Creek, which then discharges to the Klotassin River, followed by the Donjek River, White River and finally to the Yukon River. In the Britannia Creek watershed, Canadian Creek is the main tributary that will have potential Project effects from the open pit development of the Project deposit. Canadian Creek flows into Britannia Creek, which then flows into the Yukon River.

The water and sediment quality study area also includes water bodies which are either indirectly affected (mid-to-far field effects) or are suitable for providing references sites by the Project activities:

- **Dip Creek Watershed**. The headwaters of Dip Creek are not expected to be affected by Project activities, but the reaches of Dip Creek downstream of its confluence with Casino Creek may be affected by a reduction in flows from Casino Creek caused by the impoundment of its headwaters. The effects of those flow reductions will decrease downstream from the confluence of Dip and Casino creeks.
- **Klotassin River Watershed**. Two far field stations (W20 and W21) were also established on the Klotassin River above and below the confluence with Dip Creek.
- **Isaac Creek Watershed**. This watershed, located to the east of the Britannia Creek Watershed, is not expected to be affected by Project activities. For that reason a reference water quality station – W17 – was located on Isaac Creek upstream of its confluence with the Yukon River.
- **Excelsior Creek Watershed**. This watershed, located west of the Britannia Creek Watershed, is also not expected to be affected by Project activities. A reference water quality station –W23 - was located on Excelsior Creek upstream of its confluence with the Yukon River.
- **Yukon River**. This river will be the receiving environment for flows from Britannia Creek. Therefore, water quality sampling stations were established along the Yukon River upstream (W6b – a reference station) and downstream (W6a and W15) of its confluence with Britannia Creek.

Figures 1 and 2 show the study area and Table 1 summarizes station names, locations, descriptions, rationale for selection (reference or exposed), and number of dates sampled for water quality and sediment quality. The number of samples for each station by date (by month and year) is summarized in Table 2.



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APP'D	-
REV	-
DATE	03Oct'13

NOTES:

1. BASE MAP: Digital Elevation Model and 1:250,000 and 1:50,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (www.geomaticsyukon.ca)
2. PROJECTION: NAD 1983 UTM Zone 7N
3. COORDINATE GRID: METRES
4. SCALE: 1:250,000

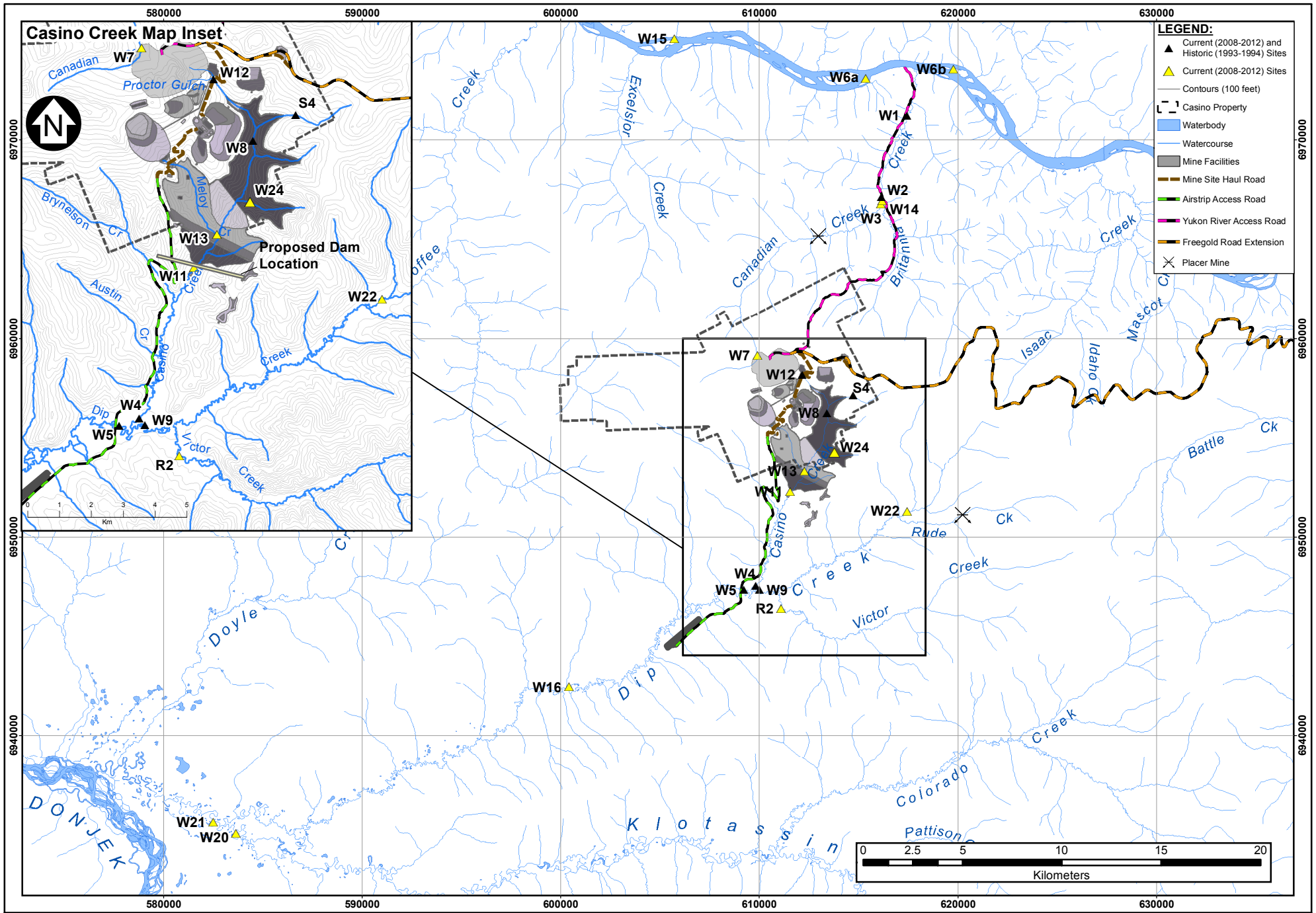
CASINO COPPER AND GOLD

CASINO PROJECT

Current and Historic Baseline Water Quality Sampling Stations

FIGURE 1

REF	REPORT 1
P/A	VA101-325/15



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NOTES:

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2. PROJECTION: NAD 1983 UTM Zone 7N
3. COORDINATE GRID: METRES
4. SCALE: 1:250,000

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CASINO PROJECT

Current and Historic Baseline Sediment Quality Sampling Stations

FIGURE 2

REF	REPORT 1
P/A	VA101-325/15

Table 1. Summary of Water Quality and Sediment Quality Sampling Stations, Casino Project

Sampling Station	Location	UTM Coordinates		Station Type	Rationale	Number of Samples	
		Northing	Easting			Water	Sediment
Casino Creek Watershed							
S4	Unnamed tributary, upper Casino Creek	6957240	613392	Exposure	Direct Project Influence	-	2
W12	Proctor Gulch, downstream of PG4	6958175	612163	Exposure	Direct Project Influence	16	3
W8	Upper Casino Creek, downstream of Proctor Gulch	6956,258	613398	Exposure	Direct Project Influence	13	3
W43	Historical adit, discharge into upper Meloy Creek watershed	6955906	610823	Source	Source of ARD	10	-
W13	Lower Meloy Creek	6953326	612275	Exposure	Direct Project Influence	12	1
W11	Proposed Dam Outflow	6952289	611557	Exposure	Direct Project Influence	25	1
W18	Lower Brynelson Creek	6951180	610893	Exposure	Direct Project Influence	22	-
W4	Mouth of Casino Creek	6947575	609833	Exposure	Direct Project Influence	24	2
W24	Unnamed emphemeral tributary, East side of Casino Creek	6954302	612888	Exposure	Direct Project Influence	1	1
Dip Creek							
W22	Upper Dip Creek, upstream of Placer Workings on Rude Creek Tributary	6951308	617447	Reference	Upstream of Project Influence	5	-
R2	Victor Creek, a tributary to Dip Creek	6946387	611102	Reference	Separate Basin	19	1
W9	Upstream of Casino Creek/Dip Creek confluence	6947352	610018	Reference	Upstream of Project Influence	17	3
W5	Downstream of Casino Creek/Dip Creek confluence	6947348	609219	Exposure	Downstream of Project Influence	22	3
W16	10 km downstream of Casino Creek/Dip Creek confluence	6942454	600423	Exposure	Downstream of Project Influence	22	1
W19	Lower Dip Creek, upstream of Klotassin River	6935916	583657	Exposure	Downstream of Project Influence	5	-
Klotassin River							
W20	Upstream of Dip Creek/Klotassin River confluence	6935082	583656	Reference	Upstream of Project Influence	19	1
W21	Downstream of Dip Creek/Klotassin River confluence	6935640	582490	Exposure	Downstream of Project Influence	17	2
Britannia Creek							
W7	Upper Canadian Creek, tributary to Britannia Creek	6959158	609913	Exposure	Direct Project Influence	18	1
W3	Canadian Creek, upstream of Canadian/Britannia creek confluence	6966789	616141	Exposure	Downstream of Project Influence	27	1
W14	Britannia Creek, upstream of Canadian/Britannia creek confluence	6966952	616205	Exposure	Upstream of Project Influence	22	1
W2	Britannia Creek, downstream of Canadian/Britannia creek confluence	6967156	616158	Exposure	Downstream of Project Influence	21	3
W1	Lower Britannia Creek	6971241	617439	Exposure	Downstream of Project Influence	21	3
Yukon River							
W17	Isaac Creek, tributary to Yukon River	6968802	626775	Reference	Separate Basin	9	-
W6b	Upstream of Britannia Creek/Yukon River confluence	6973576	619781	Reference	Upstream of Project Influence	25	1
W6a	Downstream of Britannia Creek/Yukon River confluence	6973129	615375	Exposure	Downstream of Project Influence	23	1
W15	Upstream of Excelsior Creek/Yukon River confluence	6975108	605721	Exposure	Downstream of Project Influence	21	1
W23	Excelsior Creek, tributary to Yukon River	6974354	603878	Reference	Separate Basin	2	-

Table 2. Dates of Water and Sediment Quality Field Sampling Trips, Casino Project

Sampling Site	Creek	Water																																													Sediment					
		1993					1994						1995		2008				2009							2010										2011								2012		1993	1994	2008	2009	2010	2011
		Jun	Jul	Aug	Sep	Oct	May	Jun	Jul	Aug	Oct	Dec	Jan	May	May	Jul	Sep	Oct	May	Jun	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Mar	Apr	May	Jun	Aug	Oct	Mar	May	Sep	Jul	Sep	Aug	Aug	Aug
Casino Creek Watershed																																																				
S4	Unnamed Tributary																																											✓				✓	
W12	Proctor Gulch														✓			✓		✓	✓	✓								✓	✓	✓	✓			✓	✓			✓	✓	✓	✓	S5		✓	✓		
W8	Casino	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓					✓									✓	✓	✓	✓			✓	✓			✓	✓	✓	✓	S3	S3	✓			
W43	Adit														✓	✓	✓	✓		✓	✓																	✓	✓	✓	✓							
W13	Meloy														✓	✓					✓	✓										✓	✓			✓	✓			✓	✓	✓	✓			✓			
W11	Casino														✓	✓		✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓			✓			
W18	Brynelson																	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓						
W4	Casino	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	S6		✓			
W24	Unnamed Tributary																																			✓	✓		✓	✓	✓								✓
Dip Creek Watershed																																																				
W22	Dip																																			✓	✓		✓	✓	✓	✓	✓						
R2	Victor																				✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓				✓		
W9	Dip	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	S8	S8	✓			
W5	Dip	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓				✓		✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	S7	S7	✓			
W16	Dip														✓	✓	✓		✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓								✓
W19	Dip																																			✓	✓		✓	✓	✓	✓	✓						
Klotassin River																																																				
W20	Klotassin																					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓					✓	
W21	Klotassin																					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓							✓	✓
Britannia Creek Watershed																																																				
W7	Canadian	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓		✓	✓	✓	✓						✓	✓	✓	✓	✓	✓		✓	✓			✓	✓					✓			
W3	Canadian	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓			✓			
W14	Britannia														✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓					✓			
W2	Britannia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓			✓	✓			S2	S2	✓			
W1	Britannia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓		✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓			S1	S1	✓			
Yukon River Watershed																																																				
W17	Isaac														✓	✓	✓				✓			✓												✓	✓		✓	✓	✓	✓	✓						
W6b	Yukon		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			✓	✓	✓	✓					✓	
W6a	Yukon		✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			✓	✓							✓	
W15	Yukon														✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			✓	✓								✓
W23	Excelsior																																			✓	✓		✓	✓	✓							

3 Methods

3.1 Historical References

Limited water quality and sediment quality data exist for the Casino Project study area. Environmental baseline studies were conducted between 1993 and 1995 by Hallam Knight Piésold Ltd. (HKP) (1997) for Pacific Sentinel Gold Corporation. These studies provide historical data on meteorology, hydrology, surface water quality, groundwater quality, stream sediment quality, periphyton, benthic invertebrates, fish, soils, terrestrial vegetation and wildlife. A separate study was completed in 1994 that focused specifically on the effect of natural ARD from Proctor Gulch on Casino Creek (Himmelright, 1994).

Although the HKP studies provide valuable historical information on the Casino Project area, the data were not combined with the 2008-2012 data for statistical data analyses and summaries. This decision was made for several reasons, including: (1) potentially varying field sampling methodologies used by historical (not well documented) and current programs, (2) varying analytical methods (i.e. sediment samples in 1993-1995 were not sieved prior to analysis, (3) detection limits for some water quality parameters that are equal to or exceed current CCME guidelines by up to 100 times, (4) a robust current dataset covering the years between 2008 and 2012, and (5) the potential for environmental variability over the past 10-20 years, which would hamper the assessment of any potential future changes. As historical information will still provide a long-term perspective of the aquatic study area, reference to this data are included where applicable throughout the baseline report

Water quality stations sampled in 1993-1995 include W1, W2, W3, W4, W5, W6a, W6b, W7, W8 and W9 and the specific locations are described in Table 1. Results were compared to Canadian Council of Ministers of the Environment (CCME) guidelines and although not specifically reported, the guidelines were likely from the originally published 1991 protocol for the derivation of water quality guidelines for the protection of aquatic life (CCME, 1991). Sediment quality stations sampled in 1993-1995 were named S1, S2, S3, S4, S5, S6, S7 and S8. Analyses of both water quality and sediment samples were carried out by ASL Ltd. in Burnaby, BC.

3.2 Water Quality

3.2.1 Field Sampling Methods

All surface water samples were grab samples, collected mid-stream approximately 20 cm under the surface with the bottle mouth facing upstream. In the winter months, a steel pole ice chipper or a gas powered auger was used to break through the ice layer to access the water. As water levels in the winter were substantially lower than in the summer, samples were collected at any depth below the surface of water whenever possible. Water quality samples for general chemical parameters were collected in two pre-cleaned 1 L plastic bottles supplied by Maxxam Analytics in Burnaby, BC. Samples for total metals were collected in 120 mL acid-washed plastic bottles supplied by the laboratory and preserved in the field

with laboratory-supplied nitric acid. Samples for dissolved metals were filtered in the field through 0.45-micron disposable filterware and preserved with laboratory-supplied nitric acid immediately after filtration. Samples for nutrients – ammonia, total Kjeldhal nitrogen (TKN), Total Organic Carbon (TOC), and dissolved orthophosphate – were collected in 120 mL bottles and preserved in the field with laboratory-supplied sulphuric acid. Total cyanide was collected in 120 mL bottles and preserved in the field with laboratory-supplied sodium hydroxide. Samples for Radium-226 were collected on August 29, 2011 at stations W8, W11, W43, W12 and W7 in pre-cleaned 1 L plastic bottles.

Field measurements of pH, temperature, dissolved oxygen and specific electrical conductivity were made at each station using an HI 9828 Hanna meter or a YSI Pro pH/conductivity/temperature meter. Results are available in Appendix B6.

All samples were kept cold and were not allowed to freeze. They were shipped via air cargo from Whitehorse to Maxxam Analytics in Burnaby, BC. Chain of Custody forms accompanied all samples.

Toxicity sampling was completed once, on July 13, 2011, at the historical adit (W43). On a site tour, Denis Lacroix, a Senior Environmental Officer of Environment Canada (EC), collected a sample from W43 and sent the filled containers to the Pacific and Yukon Laboratory for Environmental Testing (PYLET) in Vancouver, BC.

3.2.2 Laboratory Methods

Maxxam Analytics is accredited by the Canadian Association for Environmental Analytical Laboratories. Internal quality assurance/quality control programs are designed to comply with or exceed the data quality objectives of Industry, Canadian Regulators, United States Environmental Protection Agency (U.S. EPA) and the International Standards Organization (ISO). Every sample submission was subject to a full Quality Assurance analysis, which included matrix spikes, spiked blanks, method blanks and duplicates. These analyses provide a measure of their laboratories' analytical precision. The results of the quality analysis, which are not reported herein, met Maxxam's standards for QA/QC (QC limits of 80% - 120% for blanks/spikes and 20% for duplicate RPDs).

Table 3 shows the water quality variables that were measured and their Reported Detection Limits (RDL).

Table 3. Water Quality Parameters and Detection Limits

Parameter	Units	RDL	Parameter	Units	RDL
Physical			**Total and Dissolved Metals Continued**		
Conductivity	µS/cm	1	Boron	mg/L	0.05-0.3
pH	pH units	n/a	Cadmium	mg/L	0.000005-0.00003
Hardness	mg/L	0.5	Calcium	mg/L	0.05-0.3
Total Dissolved Solids (TDS)	mg/L	10	Chromium	mg/L	0.0001-0.0005
Total Suspended Solids (TSS)	mg/L	1	Cobalt	mg/L	0.000005-0.00003
Turbidity	NTU	0.1	Copper	mg/L	0.00005-0.0003
Anions			Iron	mg/L	0.001-0.005
Alkalinity	mg/L	0.5	Lead	mg/L	0.000005-0.00003
Acidity (pH 8.3)	mg/L	0.5	Lithium	mg/L	0.0005-0.003
Bromide	mg/L	0.01-0.05	Magnesium	mg/L	0.05-0.3

Parameter	Units	RDL	Parameter	Units	RDL
Chloride	mg/L	0.5	Manganese	mg/L	0.00005-0.0003
Fluoride	mg/L	0.01	Mercury	mg/L	0.00001-0.00005
Sulphate	mg/L	0.5	Molybdenum	mg/L	0.00005-0.0003
Cyanide (Total)	mg/L	0.0005	Nickel	mg/L	0.00002-0.0001
Cyanide (Weak Acid Dissociable)	mg/L	0.0005	Phosphorus	mg/L	0.002-0.01
Nutrients			Potassium	mg/L	0.05-0.3
Ammonia (as N)	mg/L	0.005	Selenium	mg/L	0.00004-0.0002
Nitrate (as N)	mg/L	0.002	Silicon	mg/L	0.1-0.5
Nitrite (as N)	mg/L	0.002	Silver	mg/L	0.000005-0.00003
Total Kjeldahl Nitrogen (TKN)	mg/L	0.02	Sodium	mg/L	0.05-0.3
Ortho-phosphate (as P)	mg/L	0.001	Strontium	mg/L	0.00005-0.0003
Total Phosphorus (as P)	mg/L	0.002	Thallium	mg/L	0.000002-0.00001
Total and Dissolved Metals			Tin	mg/L	0.0002-0.001
Aluminum	mg/L	0.0002-0.001	Titanium	mg/L	0.0005-0.003
Antimony	mg/L	0.00002-0.0001	Uranium	mg/L	0.000002-0.00001
Arsenic	mg/L	0.00002-0.0001	Vanadium	mg/L	0.0002-0.001
Barium	mg/L	0.00002-0.0001	Zinc	mg/L	0.0001-0.0005
Beryllium	mg/L	0.00001-0.00005	Zirconium	mg/L	0.0001-0.0005
Bismuth	mg/L	0.000005-0.00003	Radium-226	Bq/L	<0.001

The toxicity sample at station W43 was analyzed by PYLET of EC on September 7, 2011 using ICP (inductively coupled plasma) and ICP-MS (inductively coupled plasma mass spectrometry). A 48 hour LT_{50} (lethal time for 50% of the test organisms) bioassay was completed using sample water and the laboratory organism *Daphnia magna*. The results are documented as Appendix B1 of this report.

3.2.3 Quality Assurance/Quality Control

All field equipment was maintained in good working condition and measuring instruments were calibrated both in the field and in the office prior to travelling to the site. The HI 9828 Hanna Meter or YSI 556 was calibrated for pH prior to each field trip using prepared solutions with pH of 4, 7 and 10, and conductivity was checked prior to each field trip using the standard 1,413 µS/cm conductivity solution. In the field, the water quality meter was re-calibrated using the quick calibration option, which calibrates dissolved oxygen, pH and conductivity using a single point procedure. In addition, dissolved oxygen was re-calibrated at each station as required, when changes in temperature or atmospheric pressure were noted.

Water quality samples were collected by qualified aquatic biologists and were carried out by the same individual at each sampling station to ensure consistency. All water samples were collected using the industry standard sampling protocol: CCME's Protocols Manual for Water Quality Sampling in Canada (CCME 2011). Appropriate measures were taken by staff to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used bottles and preservative supplied by the analytical laboratory. All samples were collected with the mouth of the sampling bottle facing upstream. Care was taken to ensure that no upstream disturbances occurred as the result of walking on the creek bed prior to sampling.

Field and Travel Blanks

Blanks were collected to detect contamination in the field sampling process. Travel blanks were prepared by Maxxam and remained unopened throughout the duration of the field trip. Contamination was indicated

by parameters that exceeded detection limits by more than five times. Parameters that met these criteria include: nitrate (1), total kjeldahl nitrogen (1), total aluminum (5), total lead (3), total zinc (4), dissolved aluminum (2), dissolved lead (3) and dissolved zinc (3).

Although contamination from the container or preservative during transport and storage was possible, data from these dates did not show high numbers of outliers to indicate contamination. Raw data for travel blanks can be found in Appendix B2.

Field blanks were prepared at the sampling station by field crews using deionized water provided by Maxxam. Raw data for field blanks can be found in Appendix B3. As with the travel blanks, contamination was indicated by parameters that exceeded detection limits by more than five times. Parameters that met these criteria include: total dissolved solids (1), ammonia (3), sulphate (1), total nitrogen (1), total kjeldahl nitrogen (2), total aluminum (7), total barium (3), total cadmium (1), total copper (1), total lead (6), total manganese (1), total nickel (1), total phosphorous (2), total strontium (1), total tin (2), total uranium (6), total zinc (6), dissolved aluminum (7), dissolved barium (1), dissolved lead (2), dissolved manganese (1), dissolved uranium (3) and dissolved zinc (3).

Total and dissolved uranium concentrations were flagged as potential outliers at station W14 in Britannia Creek (0.097 and 0.095 mg/L, respectively) from the March 2011 sample set. As a result of the corresponding field blank hits, these values were treated as outliers and dropped from the dataset. All other field blank hits did not show corresponding outliers in the rest of the dataset.

Replicates

Replicate sampling was conducted randomly during each field visit and was collected either simultaneously or in close succession. Replicates provide a rough estimate of the overall precision associated with the field technique and laboratory analysis. Relative Percent Difference (RPD) calculations were used to assess analytical variability. Details on RPD analyses and results for each sampling year between 2008 and 2012 can be found in corresponding annual technical reports in Appendices A1-A5. As a summary, replicates were flagged if they deviated from the original sample by at least 25% and both values were at least five times the detection limit. Between 2008 and 2012, a total of 39 samples were replicated. An average of 7 out of the approximately 55 parameters analysed per replicate failed to meet the RPD criteria, which is around 14% of the parameters. Some parameters failed to meet the RPD criteria more often than others. Specifically, it was observed that ammonia, dissolved ortho phosphate, total lead, dissolved lead and dissolved zinc were parameters that exceeded the RPD criteria in 20-35% of the replicate samples, and turbidity and total kjeldahl nitrogen exceeded them in >35% of the replicate samples.

Dissolved versus Total Concentrations

Metals

Total metal concentrations include metals content both dissolved in the water and present as the particulates in the water. As such, total metal concentrations should always be greater than or equal to the dissolved metal concentrations. Levels of total and dissolved metals were compared to determine any contamination during sample filtration. Parameters were flagged as potential filtration contamination if the

dissolved concentrations exceeded the total concentrations by more than 25% and both concentrations were at least five times the detection limit. Data for flagged parameters can be found in Appendix B4.

Of the total number of measured metals, <1.5% per year showed any potential filtration contamination (135 out of 14,949 measurements). However, over 9% (41 out of 455) zinc measurements failed to meet the filter contamination criteria. Further analysis of the field blanks (Appendix B2) revealed that of the 19 zinc measurements, 3 dissolved zinc concentrations were greater than the total zinc concentrations and were five times the detection limit. Detection limits aside, an additional 5 dissolved zinc measurements were empirically greater than the total zinc measurement. This confirms that field filtering was a consistent source of zinc contamination and that the source is likely attributed to materials in the filter, and that field filtering could be contributing approximately 0.00089 mg/L of Zn to the reported dissolved zinc concentration in all field filtered dissolved zinc analyses. Other metals with higher dissolved concentrations than total concentrations (and five times the detection limit) include:

- aluminum in May 2008, July 2008, August 2009 and May 2012; and
- manganese in June 2009.

It appears that Maxxam has provided filtration apparatus or employ methods that may have led to possible contamination to water samples. Despite this, levels of the dissolved fractions of these metals are at minimum an order of magnitude lower than their respective CCME guidelines, if applicable, indicating this is an issue of analytical precision, not a toxicological one.

Organic Carbon
Total organic carbon (TOC) includes the particulate organic carbon fraction and the dissolved organic carbon fraction. Comparison of median TOC concentrations with DOC revealed that 11 out of the 25 (44%) stations exhibited higher DOC concentrations than TOC. Natural variability alone cannot explain this high percentage and further investigation into this revealed that filters provided by Maxxam were the cause of the DOC contamination (Tabitha Rudkin, personal communication, July 18, 2013). The filters provided by Maxxam between 2008 and 2013 were designed to be used for dissolved metals sampling only as it was known those filters were adding between 0.9 and 1.3 mg/L of dissolved organic carbon to the samples (Tabitha Rudkin, personal communication, July 18, 2013). A different filter should have been provided to field crews for DOC samples. Although this error by Maxxam did falsely contribute to higher DOC concentrations, the additional DOC was consistent enough that the overall spatial trend is still representative of true conditions.

3.2.4 Data Analysis

Outliers were defined as values that exceeded the mean concentrations by 3 standard deviations or were associated with a blank contamination, past recommended holding times or other analytical problems. A total of 20 outliers was dropped from statistical calculations but was kept in the raw data tables in Appendix A1 to A5. Parameters with values considered to be outliers include dissolved chloride, thiocyanate, weak acid dissociable cyanide, total mercury, dissolved sodium, nitrate, dissolved and total

lead, dissolved phosphorus, TDS, dissolved thallium, TKN, dissolved thallium and total and dissolved uranium.

The minimum, mean, median and maximum concentrations of all water quality parameters were calculated for each water quality station using Statistica version 8 (StatSoft Inc.,Tulsa OK, 2008), a statistical data analysis software, and are reported in Appendix B5. In some of the results discussion, the median, rather than the arithmetic mean, was assumed to be the best estimate of the central tendency of the data because many water quality variables are not normally distributed (Zar, 2009). To calculate statistics, all data for each station were pooled over the 2008-2012 sampling period, and values below detection limits were replaced with one-half the detection limit. Where replicate samples were collected, average values of each parameter were used in water quality analyses.

Concentrations of water quality parameters were compared to guidelines for the protection of freshwater aquatic life issued by the CCME (CCME, 2012), and parameters exceeding the guidelines were identified.

Results from the 2008-2012 field program were compared to the report descriptions of the 1993-1995 HKP program to substantiate results and provide a more thorough description of the baseline conditions.

3.3 Sediment Quality

3.3.1 Field Methods

HKP collected sediment quality samples from eight stream stations, labeled S1 to S8, first in September/November 1993 and then in July 1994 (Hallam Knight Piésold, 1997). Between one and six replicates at each station were collected. The finest grained sediments available were collected and sent to ASL Laboratories for analysis.

In September 2008, AECOM collected sediment quality samples from an additional twelve stations, and throughout 2009 and 2012 at least one sediment quality sample was collected from almost all water quality stations. Where feasible, sediment stations were located close to historical stations to facilitate the option of combining the data. Sediment samples were collected using laboratory supplied acid-washed glass sample jars as a scoop. Care was taken by the sampler to not disturb or stir up the area before obtaining the samples. Samples were collected from depositional areas of the stream, near the stream bank, at approximately 30-50 cm depth. Samples were collected from the top 4-6 cm layer and filled 120 mL sized jars. Effort was made to collect only the finest materials and that the area sampled had a surface layer that appeared to be intact and relatively flat.

3.3.2 Laboratory Methods

All sediment samples were analyzed for percent moisture, pH and total metal concentrations. Sediment grain size distribution can aid in understanding the nature of metals concentrations in sediment but was not analyzed as the original intent of the sampling design in 2008 was to maintain similarity with historical sampling as much as possible. Although the lack of grain size data does add some uncertainty, it does

not prevent the ability to make gross inferences about patterns. Field sampling effort focused on the collection of the finest grain size and would be expected to be somewhat similar among sampling stations. Metal concentrations were expressed as mg/kg dry weight (DW). From 1993 to 1995, HKP submitted samples to ASL Laboratories of Burnaby, BC but details on analytical methods were not provided in their report (Hallam Knight Piésold, 1997). Inquiries to present day ALS Laboratories revealed samples from HKP were not sieved prior to analysis (Lisa Ferenc, personal communication, July 26, 2013). HKP reported concentrations of 13 heavy metals, but not for every station or every sampling date. The metals were antimony, arsenic, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver and zinc. Samples collected in 2008-2012 were submitted to Maxxam, where they were dried at 55 ± 5°C, then sieved through a #10 mesh (2 mm) screen and digested using a nitric and hydrochloric acid mixture at 95°C for two hours. ICP-MS was used to analyze samples for metals content. The pH of the samples was measured using a combination pH electrode with an Ag/AgCl reference electrode. AECOM and PECG reported concentrations for a full suite of 30 metals at all stations and dates (Appendices A1-A5), including the same 13 metals as Hallam Knight Piésold (1997).

Table 4 shows the sediment quality variables that were measured and their detection limits.

Table 4. Sediment Quality Parameters and Detection Limits, Casino Project, 2008-2012

Parameter	Units	RDL	Parameter	Units	RDL
Physical					
Percent moisture		0.3	Manganese	mg/kg	0.2
pH	pH units	0.01	Mercury	mg/kg	0.05
Total Metals			Molybdenum	mg/kg	0.1
Aluminum	mg/kg	100	Nickel	mg/kg	0.8
Antimony	mg/kg	0.1	Phosphorus	mg/kg	10
Arsenic	mg/kg	0.2	Potassium	mg/kg	100
Barium	mg/kg	0.1	Selenium	mg/kg	0.5
Beryllium	mg/kg	0.1	Silver	mg/kg	0.05
Bismuth	mg/kg	0.1	Sodium	mg/kg	100
Cadmium	mg/kg	0.05	Strontium	mg/kg	0.1
Calcium	mg/kg	100	Thallium	mg/kg	0.05
Chromium	mg/kg	1	Tin	mg/kg	0.1
Cobalt	mg/kg	0.3	Titanium	mg/kg	1
Copper	mg/kg	0.5	Vanadium	mg/kg	2
Iron	mg/kg	100	Zinc	mg/kg	1
Lead	mg/kg	0.1	Zirconium	mg/kg	0.5
Magnesium	mg/kg	100			

Note: RDL = Reported Detection Limit from Maxxam Analytics.

3.3.3 Quality Assurance and Quality Control

Sediment quality samples were collected by a qualified aquatic biologist. Appropriate measures were taken to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used pre-cleaned sample bottles supplied by Maxxam. Care was taken to ensure the inner portion of the sample container and caps did not touch anything other than the sample itself. Sample containers were kept in the laboratory supplied cooler before and after collection of the sample. All

samples were kept cold at all times between sample collection and delivery to the laboratory. Chain of Custody forms accompanied all samples.

Replicate samples were collected in 2009, 2010 and 2011. Replicates were collected as multiple samples from the same general area to measure site heterogeneity. Details on replicate analysis methods and calculations can be found in Appendices A3-A5.

In 2009, several parameters exceeded the RPD of 50%, including aluminum, arsenic, barium, chromium, cobalt, copper, lead, magnesium, manganese, titanium, vanadium and zinc. In 2010, total bismuth was the only parameter that exceeded the RPD of 50%. In 2011, between 0 and 24 parameters (out of 32) exceeded the RPD, depending on the station location. These observations indicate heterogeneity of metal levels in the sediment is dependent on the specific site location. Between 2009 and 2011, replicates were sampled at stations W15, W16, W21, W24, R2, W12 and W6b. Stations W12, W15 and W24 had more than 35% of the parameters that exceeded the RPD. Heterogeneity at these stations appears to be higher than the other stations with replicate sampling. Replicates were sampled at W12 twice and W15 and W24 only once, so it cannot be determined whether the high heterogeneity is a consistent, recurring phenomenon.

3.3.4 Data Analysis

CCME (1999) established two types of guidelines: the Interim Sediment Quality Guidelines (ISQG) and the Probable Effects Level (PEL). ISQG are concentrations below which adverse biological effects are expected to occur rarely, and PEL are concentrations above which biological effects are expected to occur frequently.

Analyses in this baseline report uses data from the current 2008-2012 field program only. Raw data can be found in Appendix C1. Values below detection limits were replaced with one-half the detection limit. Mean, minimum, maximum and standard deviation were calculated in Statistica and summaries are shown in Appendix C2.

Results from the 2008-2012 field program were compared to the report descriptions of the 1993-1995 HKP program to substantiate results and provide a more thorough description of the baseline conditions.

4 Results

4.1 Water Quality

Raw data can be found in the appendices of the 2008-2012 annual reports in Appendix A1-A5 and summary statistics for water quality can be found in Appendix B5.

General Characteristics (Figure 5)

With the exception of Proctor Gulch (W12), neutral to basic conditions were observed in all study areas, with median pH between 6.81 and 8.09. All study areas except for Proctor Gulch and upper Canadian Creek (W7) exhibited a high buffering capacity, as indicated by average alkalinity between 38 mg/L and 96 mg/L and average hardness between 74 mg/L and 152 mg/L. Upper Canadian Creek (W7) is less buffered, as indicated by low alkalinity (<7.5 mg/L) and soft water (mean hardness <43 mg/L).

Water chemistry in Proctor Gulch is different from all other stations owing to its proximity to the mineralized zone on Patton Hill. It has been documented as a naturally occurring tributary that drains the south-eastern side of the mineralized zone of Patton Hill. According to a report prepared for Pacific Sentinel Gold Corporation on the effect of natural acid rock drainage on Casino Creek by Himmelright (1994), Proctor Gulch intermittently disappears underground where it is presumed to pass through the Casino Fault; when the water re-emerges, its chemistry changes from a pH of around 6.4 to pH 3.5 and increases in metal content. This natural ARD then enters Casino Creek. Although Proctor Gulch exhibited low alkalinity (below detection limits of 0.5 mg/L at W12), hardness at this station was highest among all the stations at 294 mg/L. The associated calcium concentrations were also highest, with an average of 87 mg/L compared with 13 mg/L to 38 mg/L in the rest of the study area. Median pH was the lowest of all the stations at pH 3.43.

Proctor Gulch also differed from the rest of the study stations by its high conductivity (810 µS/cm compared with a range of 111 to 289 µS/cm elsewhere), high TDS (590 mg/L compared with a range of 74 to 213 mg/L) and high turbidity (19 NTU compared with a range of 0.2 to 9.6 NTU). Although not as pronounced, upper Canadian Creek also differed from the rest of the study stations with the lowest conductivity (111 µS/cm) and lowest TDS (74 mg/L).

Nutrients and organic matter (Figure 6)

Nutrient (nitrogen and phosphorus compounds) concentrations at all stations were below CCME guidelines for the protection of aquatic life, with approximately 30 and 70% of all ammonia and nitrite concentrations, respectively, below analytical detection limits. The low levels are expected, given the geographic location and elevation of the study area. Average ammonia-N and nitrate+nitrite-N concentrations ranged from 0.009 to 0.061 mg/L and 0.01 to 0.38 mg/L, respectively. Nitrogen compounds tended to be lower in Yukon River (W6b, W6a and W15) compared with the rest of the study area. Nitrate in upper Canadian Creek (W7) was lowest (0.003 mg/L) of all the study stations (range of 0.03 to 0.4 mg/L elsewhere). Concentrations of total phosphate and ortho-phosphate ranged from 0.003

to 0.04 mg/L and 0.001 to 0.009 mg/L, respectively, with approximately 20-25% of concentrations below analytical detection limits. These concentrations indicate that the water bodies in the study area are oligotrophic and nutrient poor systems.

Similar results were reported by Hallam Knight Piésold (1997) where ammonia, nitrate and nitrite were frequently below CCME guidelines and/or detection limits and total phosphate and ortho-phosphate concentrations were within the same range as 2008-2012 data.

Organic matter concentrations (both dissolved organic carbon [DOC] and total organic carbon [TOC]) were lowest in the adit (W43) with an average of 1.5 mg/L and 1.3 mg/L, respectively, compared with the other study stations ranging from 2.6 to 12.4 mg/L and 2.7 to 12.7 mg/L, respectively.

Cyanide, Anions and Metals (Figure 7 and Figure 8)

Nearly 70% of all the cyanide (as Weak Acid Dissociable [WAD] and Thiocyanate) concentrations were at analytical detection limits (0.0005 mg/L). Of the remaining 30% of measured values, all but one (0.0038 mg/L CN-WAD at W12) was within 5 times the detection limit. Himmelright (1994) reported CCME guideline exceedances for cyanide in Casino Creek at W8 and Hallam Knight Piésold (1997) reported that levels of cyanogen-like compounds were above CCME guidelines (0.005 mg/L) in 42% (56/133) of all samples taken at all stations. These exceedances should be interpreted with caution as it was likely overstating the numbers of true exceedances. Up until the mid-90s, the analytical detection limit for cyanide was 0.005 mg/L. Around this time, ultra-low analytical methods were introduced and began to lower detection limits; for cyanide, new detection limits were lowered to 0.001 mg/L. Due to the higher uncertainty of analytical precision during this time period, concentrations that were above the CCME guidelines should also be greater than 10 times the detection limit. This criterion virtually eliminates all the cyanide exceedances in 1993-1995 as the data were all too close to the analytical detection limit to be considered valid.

Levels of many metals and anions were consistently low, with concentrations equal to or lower than analytical detection limits observed for more than 90% of the samples for boron, bismuth, bromide, mercury and tin in all the study areas. Metals and anions that were below the detection limit in at least 50% of the analyzed samples include beryllium, chloride, silver, titanium, thallium, vanadium and zirconium. Fluoride concentrations ranged from 0.03 to 0.41 mg/L and average concentrations exceeded CCME guidelines only at W12 (0.24 mg/L) and W20 (0.13 mg/L). High fluoride concentrations in freshwater environments are highly dependent on hydrogeological characteristics as fluoride-containing minerals can be leached by groundwater into surface water (CCME, 2002). This is likely the case for the high concentrations at W12. Hallam Knight Piésold (1997) also reported that fluoride concentrations exceeded guidelines in Proctor Gulch and upper Casino Creek.

Table 5 shows a summary of parameters with median values that exceeded CCME guidelines for protection of freshwater aquatic life. These included pH, fluoride and eight total metals: aluminum, cadmium, copper, iron, lead, silver, uranium, and zinc. Exceedances of aluminum, cadmium, copper and iron commonly occurred together. Exceedances for aluminum, cadmium and copper were the most frequent both in the number of sampling stations and in the proportion of samples, as shown in Figure 4.

Figure 8 shows the spatial distribution of concentrations of selected metals in the study area. These spatial distributions show the median concentrations of metals from upstream to downstream within the main watercourses of the Casino aquatic RSA. The error bars represent the minimum and maximum values and the red dashed line represents the (average) CCME guideline for the protection of aquatic life. The spatial distributions of copper, aluminum and iron concentrations demonstrate the highest concentrations are observed at Proctor Gulch (W12), where CCME guidelines were exceeded in 100% of the analyzed samples. Downstream of the confluence of Proctor Gulch, upper Casino station W8 shows the next highest concentration and continues to exceed CCME guidelines in 100% of analyzed samples for copper and aluminum, and 85% for iron. Concentrations of copper, aluminum and iron continue to decrease with successive stations downstream at W11 (100%, 67% and 54%) and W4 (75%, 38% and 17%).

Similarly, Himmelright (1994) reported that at the source, Proctor Gulch had very low pH (3.0-3.5) and concentrations that exceeded CCME (1991) aquatic life/drinking water guidelines for aluminum, copper, cadmium, iron, manganese and zinc. Samples from Casino Creek, downstream of Proctor Gulch at station W8, exceeded 1991 CCME guidelines for the same metals as Proctor Gulch. Water quality on Casino upstream of Proctor Gulch also showed relatively high concentrations of these metals although the pH was neutral (pH 7.22 in one sample). Effects from Proctor Gulch on Casino Creek were clearly seen at least 500 m downstream.

Historical and recent studies confirm that high metals and acidity in Casino Creek are attributable to the properties of Proctor Gulch. At the mouth of Casino Creek, before it flows into Dip Creek (W4), the water quality is good and inflows from Meloy, Brynelson and Austin Creeks further dilute the water from Proctor Gulch. As shown in Figure 8, Meloy (W13) and Brynelson (W18) creeks have low concentrations of these metals.

A historical adit from lead/zinc/silver exploration between 1965 and 1980 was partially sealed by CMC in 2008. What remains today is a pipe that discharges at surface in upper Meloy Creek watershed. This water (station W43) was included in the 2008-2012 baseline studies. Discharge occurs only during the spring and summer months and is frozen from October to April. At the point of discharge, it travels down the watershed for roughly two kilometres before joining Meloy Creek. Figure 8 shows that concentrations of cadmium, lead, silver and zinc are highest in the adit water, where CCME guidelines were exceeded by silver in 55% of the samples and in 100% of the samples for the other 3 metals. Of these four metals, only one cadmium sample (0.00004 mg/L in April 2011) exceeded guidelines in the lower reach of Casino Creek at W4, due to the small flow from the adit relative to Casino Creek.

Background levels (W22, R2 and W9) in Dip Creek have lower concentrations of these metals than lower Casino Creek and appear to be slightly elevated at the stations downstream of the confluence with Casino Creek (W5, W16 and W19). Metal concentrations then decrease downstream to the Klotassin River. The exceptions are iron and aluminum concentrations, which increase at downstream stations along Dip Creek. Iron concentrations are even above CCME guidelines in the Klotassin River. This is likely due to contribution of erodible soils to the TSS in Dip Creek, since median TSS increases from 3.5 to 15 mg/L at sampling stations further down the creek.

In Canadian and Britannia creeks, concentrations of cadmium and zinc, and to a lesser degree copper, aluminum, iron and lead, also show a similar trend to that observed in Casino Creek. The concentrations of these metals decrease downstream from the uppermost station on Canadian Creek (W7) to the Yukon River. Exceedances of CCME guidelines are 100% and 78% cadmium and copper in W7, 40% and 18% cadmium and copper in W3 and 38% copper in W2. Aluminum was elevated in upper Britannia creek station W14, with 36% of the samples exceeding CCME guidelines; 33% of the samples exceeded the guidelines at downstream station W22. Background metal concentrations in the Yukon River are lower than those in Canadian Creek.

Total Metals, Dissolved Metals and TSS (Figure 9)

Particle-associated metals tend to be found at higher concentrations when TSS levels are also elevated (Horowitz, 1991). Comparison of total metals with dissolved metals, paired with TSS, is shown in Figure 9 to determine whether exceedances in metals concentrations were due to turbid waters (i.e. caused by particulate bound metals) and whether or not this was also reflected by the dissolved metals data.

On a whole, the total and dissolved metal concentrations followed the same spatial trends as TSS. Stations with higher TSS had correspondingly higher metal concentrations as shown in Figure 9. Also, the fraction of the total metals concentration that was made up by dissolved metals was consistent throughout the stations for each metal. For cadmium, silver, uranium, copper, zinc, and chromium, the dissolved metals fraction was very close if not equal to the total metals concentration, indicating that most of the metals in the water bodies were in the dissolved phase. Conversely, the dissolved metals fraction for aluminum, iron and lead were noticeably lower than the total metals fraction. This is generally due to the complexing nature of these metals with suspended sediment which results in lower concentrations in the dissolved fraction. Factors such as low pH and low alkalinity can contribute to the mobilization of these metals into the dissolved phase (Butcher, 1988; Phippen *et al*., 2008; Nagpal, 1987), which can explain the high dissolved fractions at W12 (Proctor Gulch; median pH 3.43).

For cadmium, uranium, copper, aluminum, iron and chromium, the metals were mainly in the dissolved fraction for the tributaries to the Yukon River (W1-Britannia, W17-Sunshine and W23-Excelsior) but then switched to the particulate fraction in the Yukon River (W6b, W6a, W15). This is likely due to the Yukon River being a larger system with faster currents, which tends to stir up more particulate matter.

Another exception to the overall trends is seen for cadmium, silver, lead, zinc and somewhat in copper, at the historical adit (W43). The metals at this station were amongst the highest of all the stations, yet the TSS concentration was amongst the lowest. This indicates that TSS is not responsible for the high concentrations at this station and that it is likely attributable to the ARD from the historical lead/zinc/silver exploration activities.

Radium 226

Based on guidance from Environment Canada (Denis Lacroix, pers. Comm., 2011), analysis for Radium-226 was completed on one occasion. Radium-226 is a parameter required under Schedule 4 of the Metal Mining and Effluent Regulation (MMER). Analysis of this parameter at stations W8, W11, W43, W12 and

W7 shows non-detectable concentrations (<0.01 Bq/l) at all stations. The full analysis report can be found in Appendix A4.

Toxicity

In 2011, Denis Lacroix, a senior environmental officer at Environment Canada, collected water samples from the historical adit (station W43) and had them analyzed to evaluate the existing toxicity at the site. The original toxicity report can be found as Appendix B1 of this report. In summary, using a 48 hour LT_{50} Bioassay, it was found that after 3.5 hours of exposure to 100% sample concentration, there was 100% mortality for *Daphnia magna*. This confirms the toxicity of the natural ARD from the historical adit.

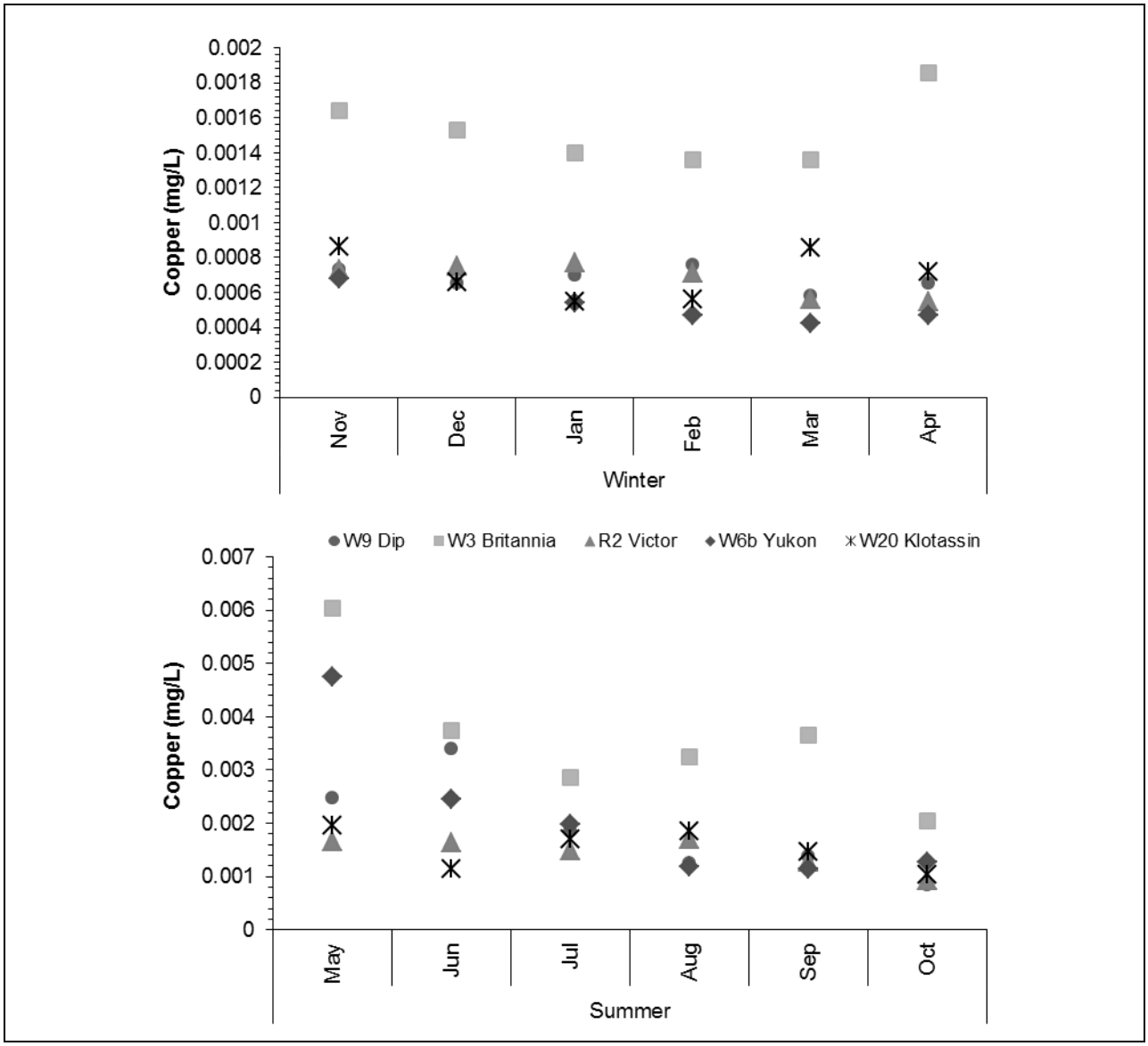
4.1.1 Seasonal Variability

Seasonal Sampling

Seasonality for the Casino project was separated into winter months (November to April) and summer months (May to October). As shown in Table 3, monthly visits to the Casino study area between August 2009 and October of 2010 were made in an effort to obtain consecutive monthly data for a minimum of 1 year. Of the 23 stations that were active during that time period, samples were obtained 15 out of 15 months only at stations W9 and W3. For the 2008-2012 period, a minimum of 1 sample per each calendar month was obtained for stations R2, W20, W21 and W15. Stations W2 and W6b are missing only 1 month each, January and December, respectively. Due to the dry conditions and subsequent lack of water at the sampling stations during January to April of 2010, all other stations have an incomplete full calendar monthly dataset. Seasonal sampling began in March of 2011, with the purpose of reducing intensive monthly sampling effort to a representative seasonal basis. In March of 2012, seasonal sampling was reduced from six months to two months and for a reduced number of stations. Of the 26 total stations from 2008-2012, sampling continued at 15 stations, which included 4 references (W22, R2, W6b, W17); 6 on Casino Creek (W12, W8, W13, W11, W18, W4); 3 on Dip Creek (W9, W5, W19); and 1 each on Klotassin River (W20) and Canadian Creek (W3).

A brief analysis was completed to determine whether the reduced seasonal sampling program was adequate to represent baseline conditions going forward. As a key parameter to monitor in the future, copper was selected as the representative parameter in this analysis. Figure 3 shows average copper concentrations on a monthly basis at 5 stations. Although the data count was insufficient for statistical comparison, this figure does show that copper concentrations in the winter months vary little and that a sample collected in March or April is likely representative of conditions during the winter period of November to April. Summer concentrations fluctuate more, especially in May for W3 and W6b, and in June for W9. This suggests that sampling in May does not provide an adequate summer measurement due to the processes of spring thaw from snow and ice melt. The month of July appears to be the most representative of average summer copper concentrations, so future baseline monitoring programs should take into consideration the variability of summer sampling between May and October.

Figure 3. Winter and Summer average copper concentrations at W9, W3, R2, W6b, W20, Casino Project, 2008-2012



Seasonal variations in water quality are also shown in Figures 4, 5, 6, 7 and 8 and Table 3. The raw data are presented in Appendices A1-A5.

Median pH values showed very little difference between summer and winter months. Hardness and conductivity values were generally similar, although concentrations were slightly higher in the winter. Hardness ranged from 52 to 482 mg/L in the winter to 41 to 257 mg/L in the summer, and conductivity ranged from 145 to 1325 mg/L in the winter to 122 to 800 mg/L in the summer.

Nitrogen based nutrients were higher in the winter months, which is likely caused by a decrease in population and activity of denitrifying bacteria due to colder temperatures. These bacteria are important

for degrading nitrogen compounds, which can otherwise build up in the winter months (Richardson *et al*. 2004). On the other hand, phosphorus based nutrients and organic matter tended to be higher in the summer months. This is likely due to warmer temperatures facilitating increased organic growth in the water and the subsequent release of phosphorus during biotic and abiotic processes (Kowalczewska-Madura and Goldyn, 2011).

Throughout the study area, organic carbon (DOC and TOC) levels were higher in the summer months than in the winter months. Clear differences were observed in Casino Creek where organic carbon levels were 2-3 times lower in the winter than in the summer (1.6 to 4.3 mg/L in the winter versus 4.7 to 9.4 mg/L in the summer for TOC and 1.8 to 4.9 mg/L in the winter versus 3.3 to 9.6 mg/L in the summer for DOC). Dip Creek also shows strong seasonal differences (2.0 to 5.6 mg/L in the winter versus 5.0 to 12.9 mg/L in the summer for TOC and 2.0 to 5.4 mg/L in the winter versus 6.0 to 12.3 mg/L in the summer for DOC). Organic carbon levels were lowest in upper Dip Creek and increased in a downstream trend.

As shown in Table 5, as well as in Figures 4 and 8, with a few exceptions metal concentrations were higher in the summer months for all stations, indicating a seasonal trend most likely directly related to hydrological factors such as surface runoff and stream flow. Higher flows typically correspond to higher metal concentrations as surface runoff can pick up or stir up soil and sediment, which in turn increases the loading of suspended solids that are bound with metals.

TSS levels along Casino Creek are highest at all stations in the summer (Figure 5) (range of 0.6 to 4.3 mg/L in the winter versus 8.6 to 18.4 mg/L in the summer) and increases downstream. The same trends are observed along Dip Creek, where winter and summer concentrations range from 0.5 to 1.5 mg/L and from 4.9 to 51.3 mg/L, respectively, and along Britannia Creek, where concentrations range from 0.9 to 3.6 mg/L in the winter to 5.1 to 15.1 mg/L in the summer. Correspondingly, concentrations of copper, aluminum, iron, cadmium, lead and zinc are also higher in the summer and also increase with increasing TSS downstream.

In contrast, Proctor Gulch (W12), Canadian Creek (W7) and Meloy Creek (W13) exhibited higher metal levels in the winter than in the summer, as shown in Figure 8. This is likely because groundwater is the major source of flow to Proctor Gulch and dilution from precipitation is reduced once the surface water in the creek freezes. The same explanation is likely applicable to Upper Canadian Creek, as its headwaters are very close to the ore body. Some of the groundwater contributing to the baseflow in the winter at W7 is likely to have travelled through the mineralized zone. For Meloy Creek, copper, uranium, cadmium, silver and zinc were higher in the winter months. These five metals are also high in the adit (W43) water, indicating the groundwater that discharges via the adit in the summer months continues to provide baseflow to Meloy Creek throughout the winter months.

Uranium is the one metal that is consistently higher in the winter than in the summer and even exceeds CCME guidelines (0.015 mg/L) in Proctor Gulch, upper Casino Creek, Meloy Creek, and Britannia Creek. Garrett (2007) observed that stream levels of uranium are highest amongst all streams in Canada (≥ 0.1 mg/L) in British Columbia and Yukon, and the rocks sampled are known to have high levels of uranium. Groundwater quality baseline monitoring confirms elevated uranium concentrations occur in the vicinity of Proctor Gulch, the ore body and the proposed TMF footprint. Surface water dilution likely masks the high uranium concentrations in the summer and therefore in the winter when groundwater becomes the main source, the high uranium concentrations are evident. Uranium concentrations do not follow the same trend as copper, aluminum and iron, which are metals that are clearly sourced from the ore body. Instead, uranium levels are comparable across both Casino and Britannia creek watersheds. Even upper Dip

Creek (W22) has one winter value (0.014 mg/L) that is just below the CCME guideline. The widespread elevated uranium concentrations likely relate to local bedrock lithology. Although CCME guidelines are exceeded for several stations, it is important to note that the British Columbia Water Quality Guidelines for uranium is 20 times higher (0.3 mg/L) and takes into account the naturally higher background levels in the BC-Yukon region.

Table 5. Median Parameters Exceeding CCME Guidelines, Casino Project, 2008-2012

Watershed	Creek/River	Station	Parameters exceeded		
			Summer	Winter	Year-round
Casino	Proctor Gulch	W12	Al, Cd, Cu, Fe, F, pH, Zn	Al, Cd, Cu, Fe, F, pH, U, Zn	Al, Cd, Cu, Fe, F, pH, Zn
	Casino	W8	Al, Cd, Cu, Fe	Al, Cd, Cu	Al, Cd, Cu, Fe
	Adit	W43	Ag, Cd, Cu, Pb, Zn	NS	Ag, Cd, Cu, Pb, Zn
	Meloy	W13	Cd, Pb	Cd, Cu, U	Cd
	Casino	W24	-	NS	-
	Casino	W11	Al, Cd, Cu, Fe	Cd, Cu, U	Al, Cd, Cu, Fe
	Casino	W4	Al, Cu	-	Cu
	Brynelson	W18	Al	-	-
Dip	Dip	W22*	-	-	-
	Victor	R2*	-	-	-
	Dip	W9*	Al	-	-
	Dip	W5	Al, Cu	-	Cu
	Dip	W16	Al, Cu, Fe	-	-
	Dip	W19	Al, Cd, Cu, Fe	Fe	Al, Cu, Fe
Klotassin	Klotassin	W20	F	Fe	Fe, F
	Klotassin	W21	Fe	Fe	Fe
Isaac	Isaac	W17*	Al	-	-
Britannia	Canadian	W7	Cd, Cu	Al, Cd, Cu, Fe	Cd, Cu
	Canadian	W3	Cu	U	-
	Britannia	W14	-	U	-
	Britannia	W2	Cu	U	-
	Britannia	W1	-	U	-
Yukon	Yukon	W6B*	Al, Cd, Fe	-	Al, Cd
	Yukon	W6A	Al, Cd	-	Cd
	Yukon	W15	Al, Cd	-	Cd
Excelsior	Excelsior	W23*	-	NS	-

Note: Dashes indicate no parameters exceeded CCME Guidelines. NS = Not sampled. = reference station. Summer = May to October; Winter = November to April.*

Figure 4. Total Number of Exceedances of CCME Guidelines, 2008-2012

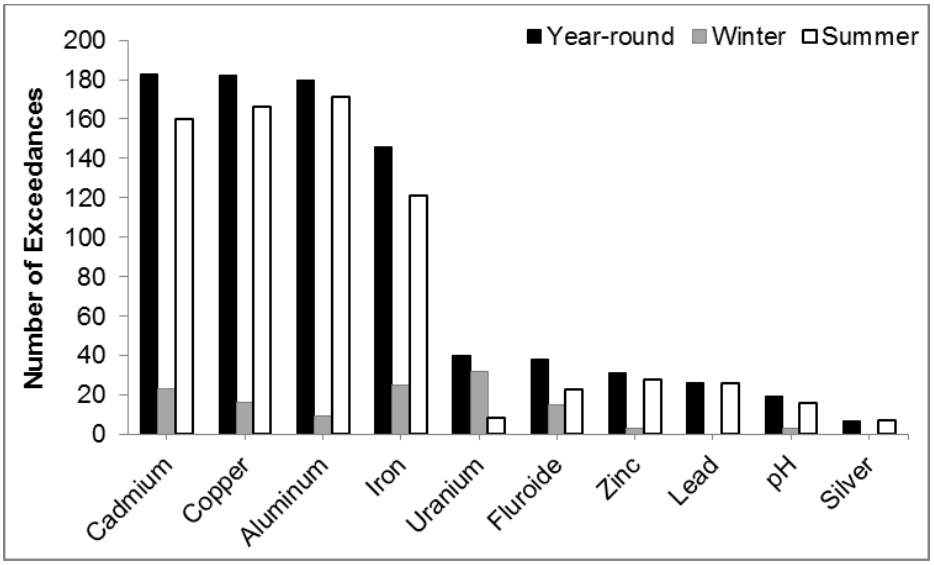


Figure 5. Range of Values (Minimum, Median, Maximum) of Selected General Chemistry Parameters, Casino Project, 2008-2012

(red dashed line is CCME Guideline, open circle is winter median and closed circle is summer median)

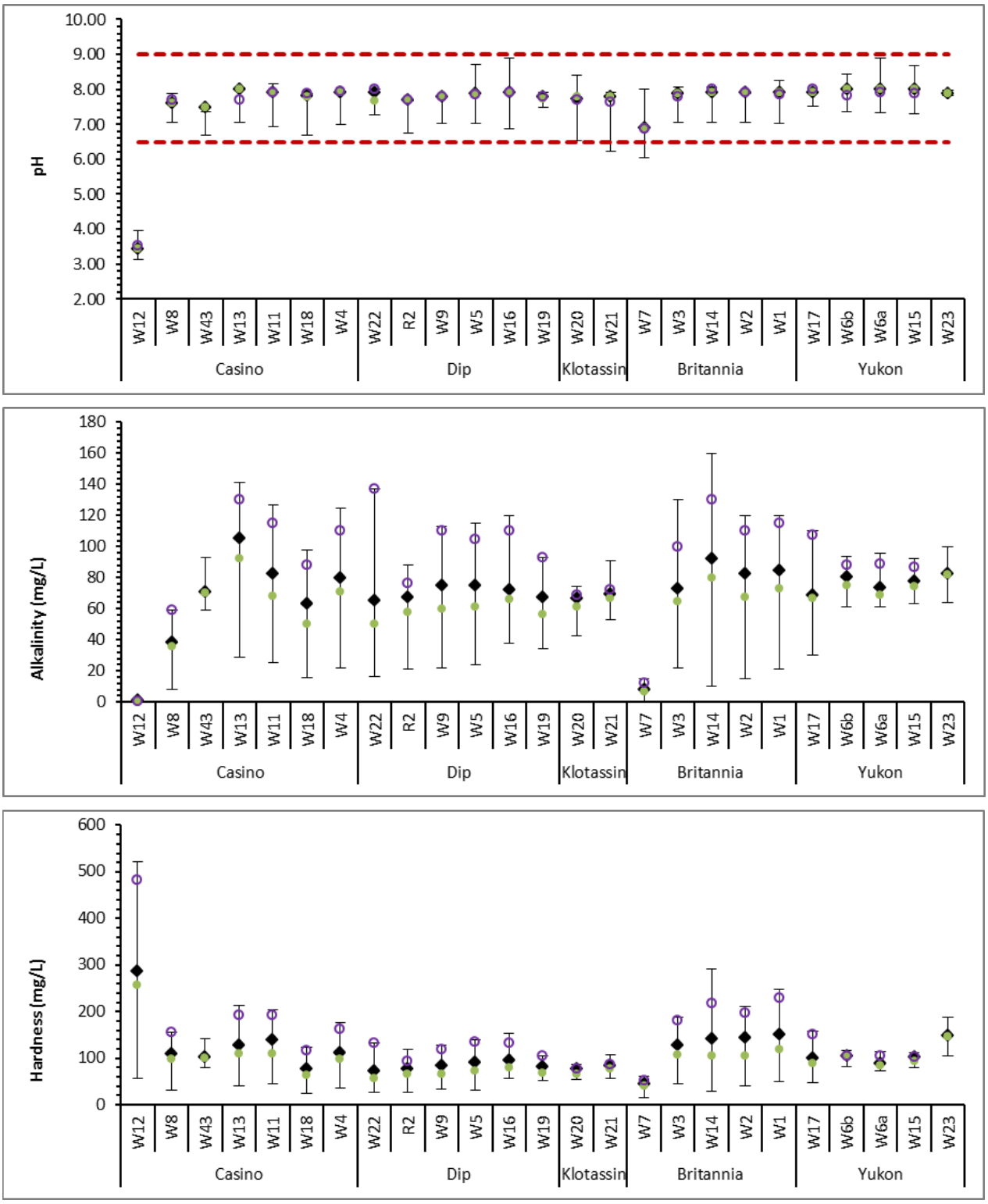
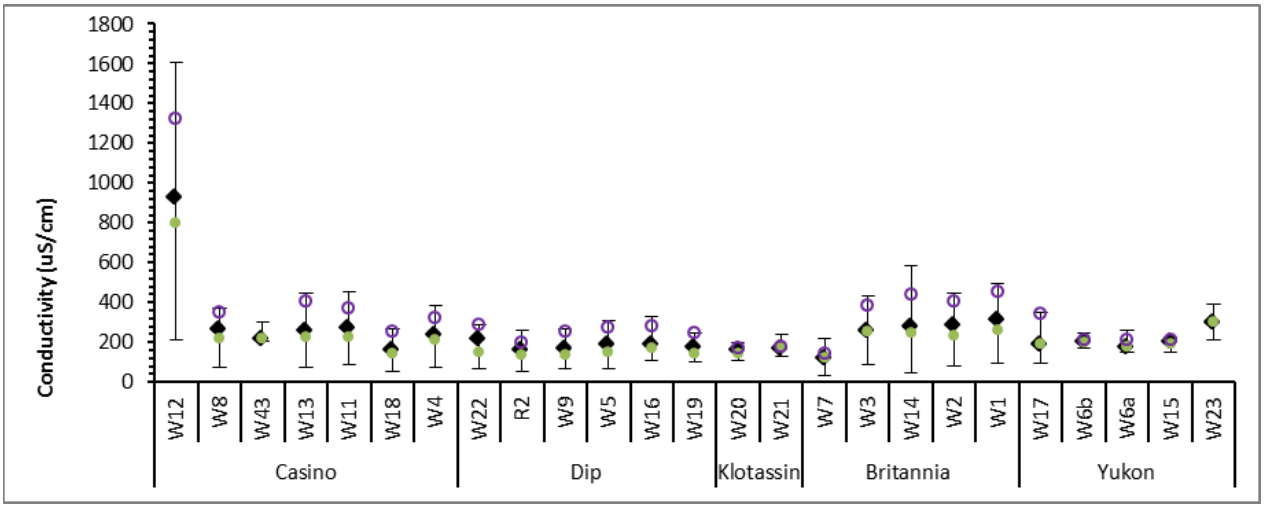


Figure 5. Continued: Range of Values (Minimum, Median, Maximum) of Selected General Chemistry Parameters, Casino Project, 2008-2012

(red dashed line is CCME Guideline, open circle is winter median and closed circle is summer median)



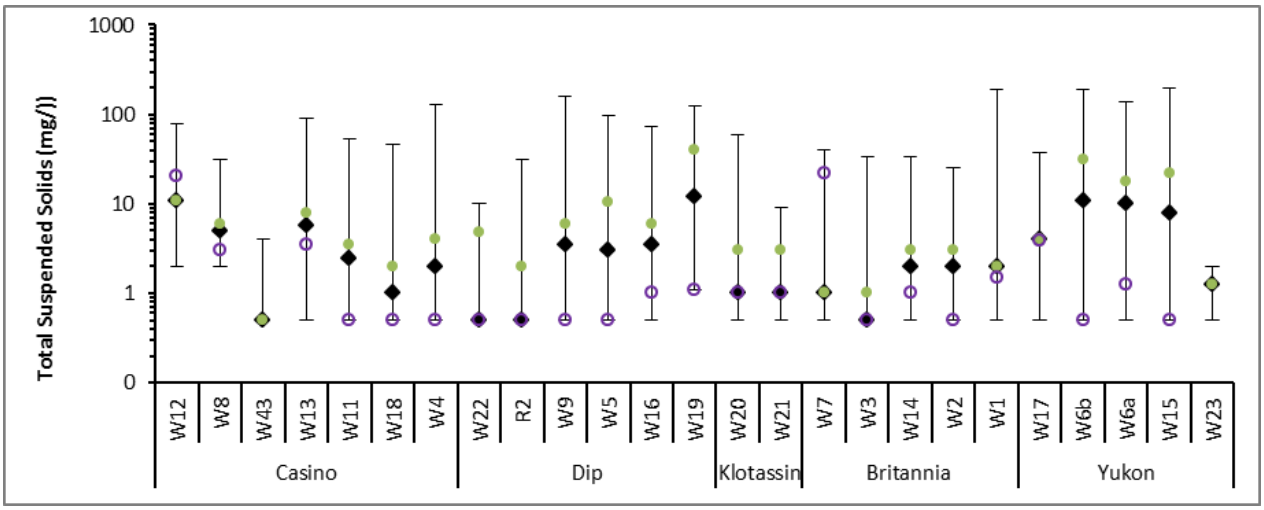
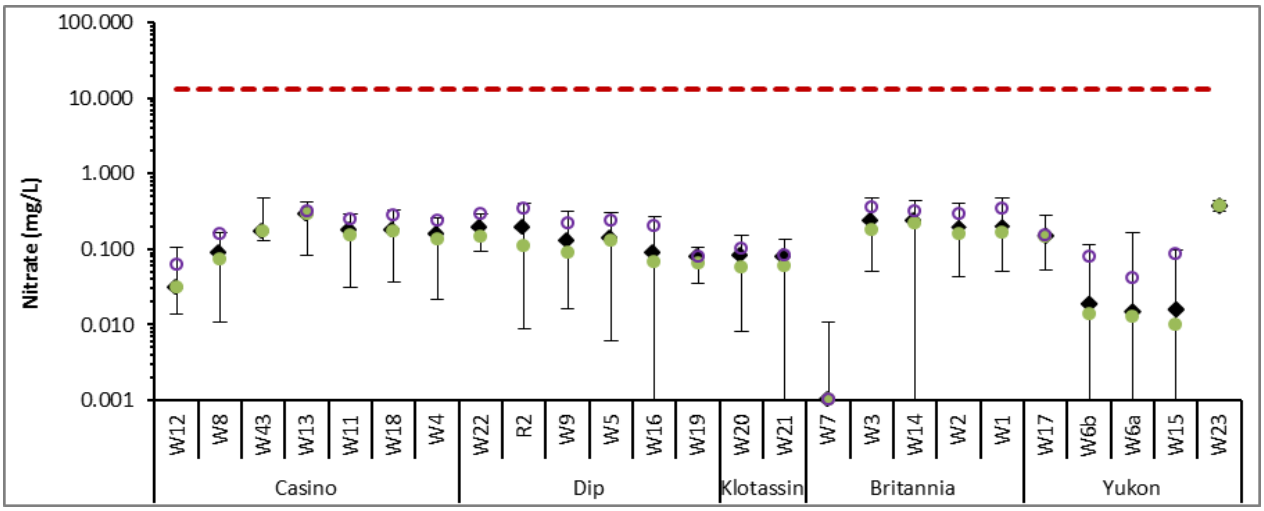


Figure 6. Range of Values (Minimum, Median, Maximum) of Selected Nutrients and Organic Matter Parameters, Casino Project, 2008-2012

(red dashed line is CCME Guideline, open circle is winter median and closed circle is summer median)



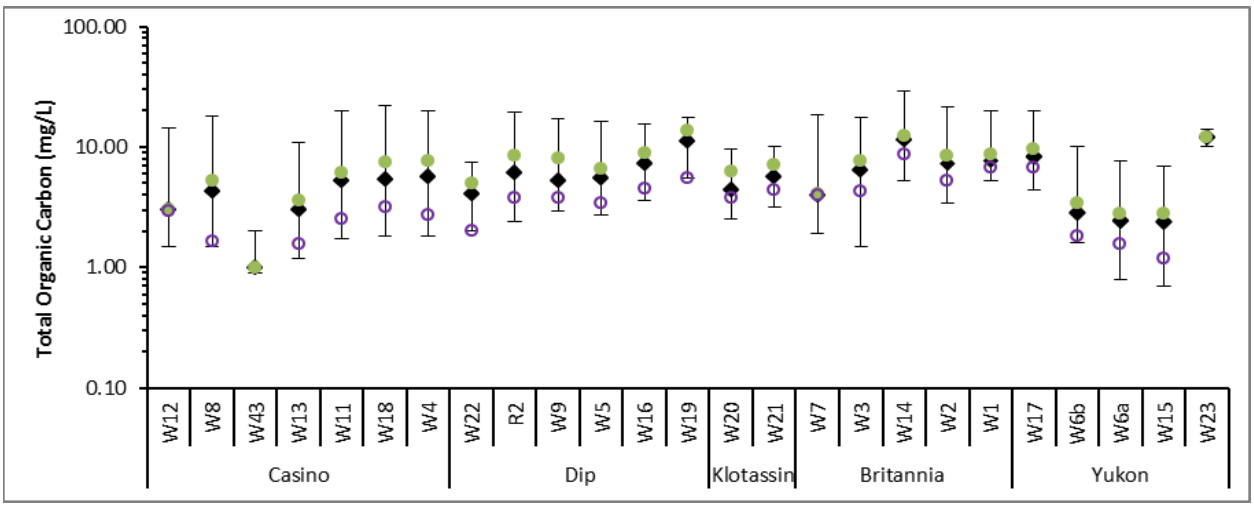


Figure 7. Range of Values (Minimum, Median, Maximum) of Selected Anions, Casino Project, 2008-2012

(red dashed line is CCME Guideline, open circle is winter median and closed circle is summer median)

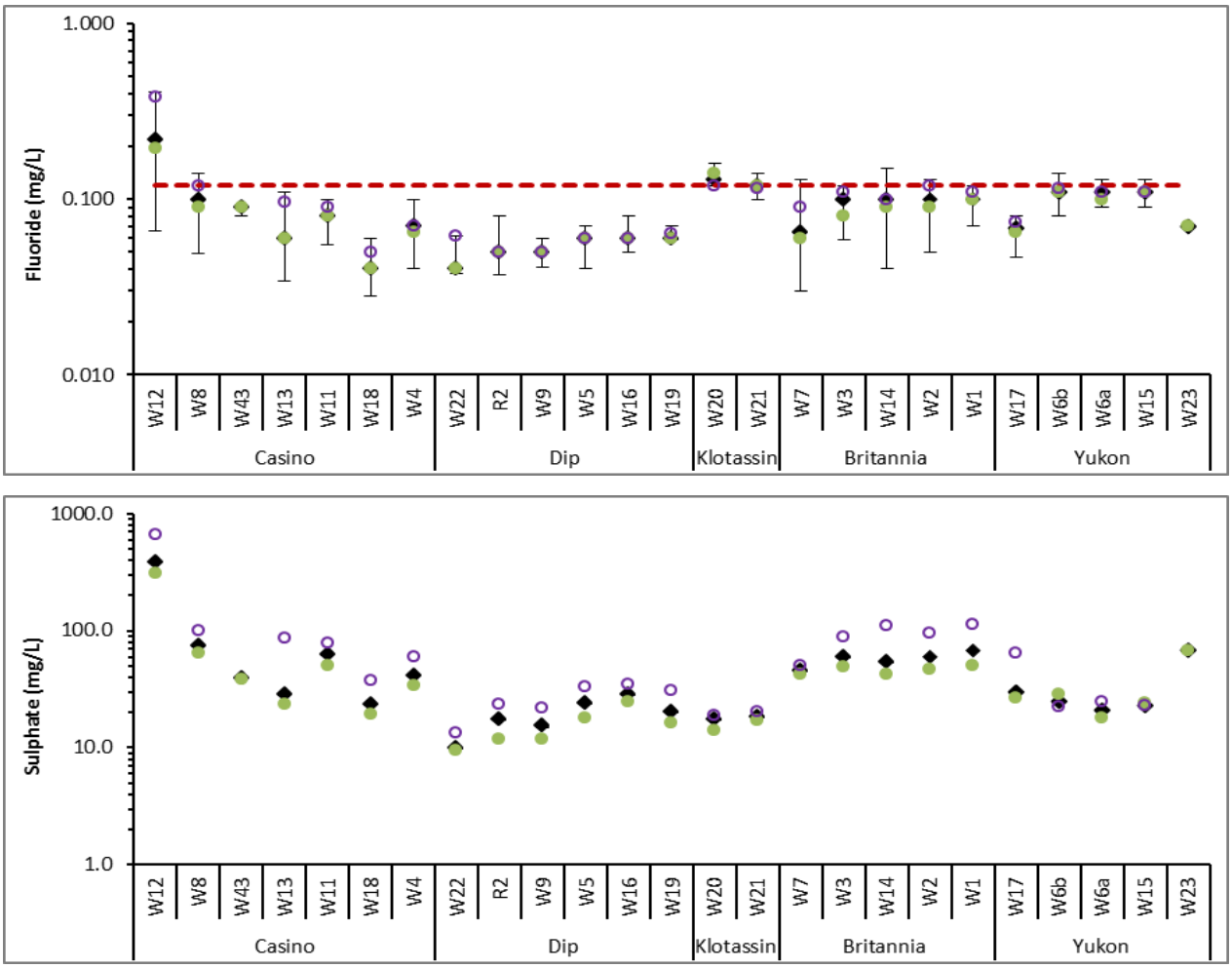


Figure 8. Range of Values (Minimum, Median, Maximum) of Total Metals Parameters, Casino Project, 2008-2012

(red dashed line is CCME Guideline, open circle is winter median and closed circle is summer median)

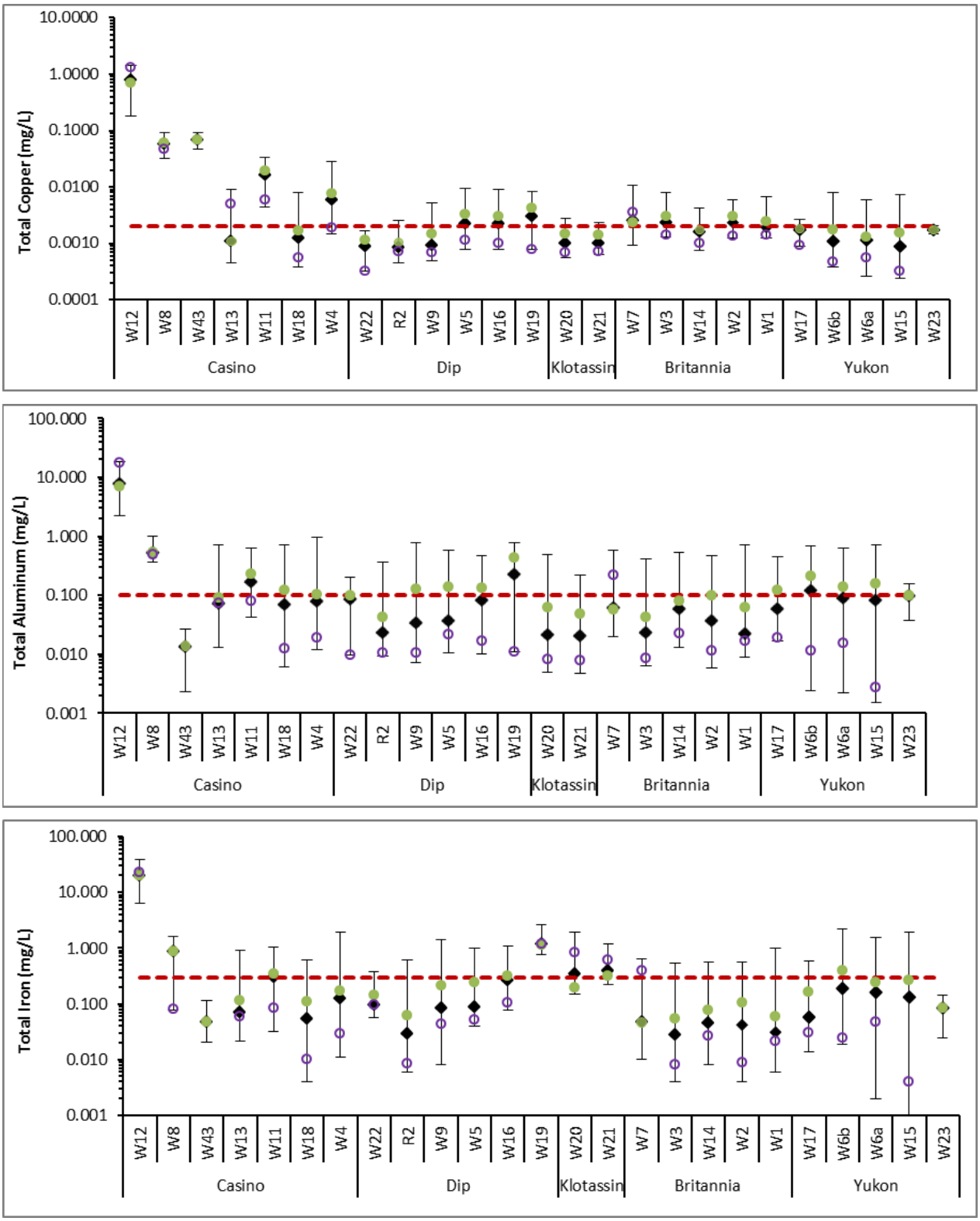
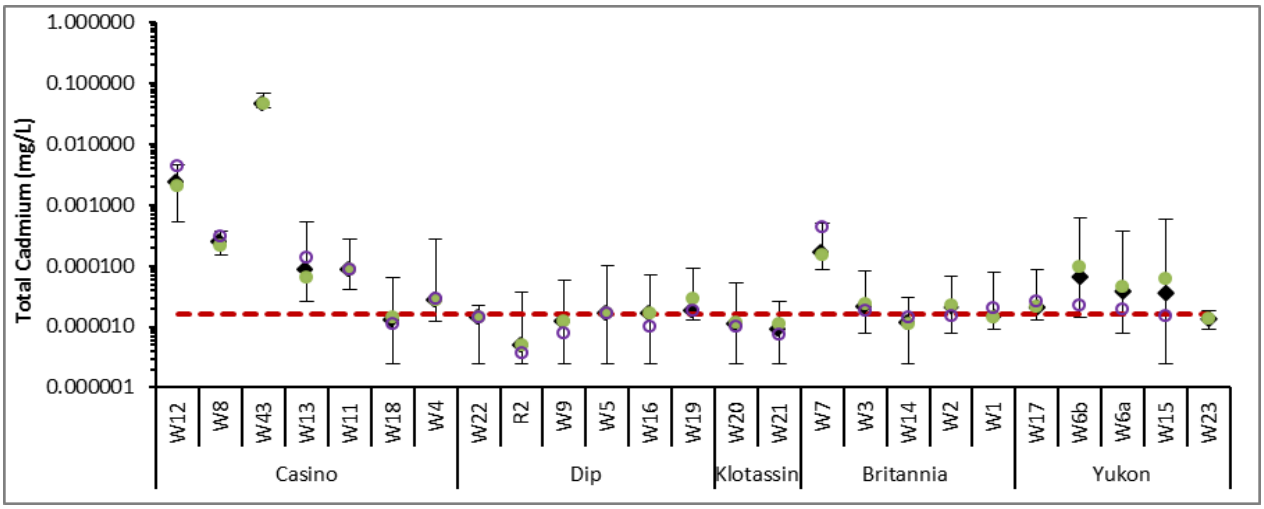
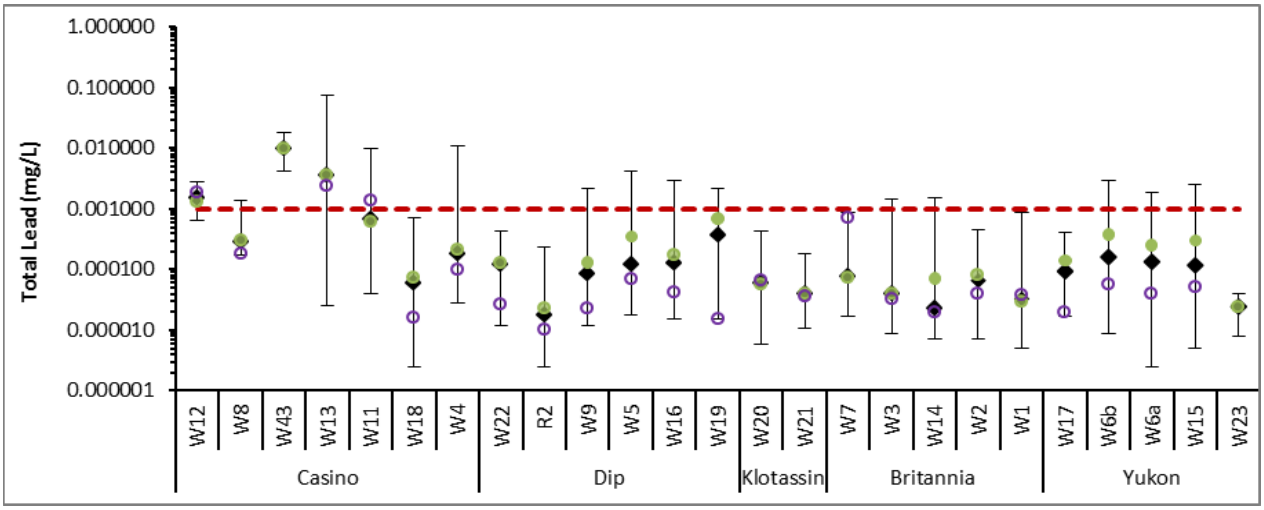


Figure 8. Continued: Range of Values (Minimum, Median, Maximum) of Total Metals Parameters, Casino Project, 2008-2012

(red dashed line is CCME Guideline, open circle is winter median and closed circle is summer median)





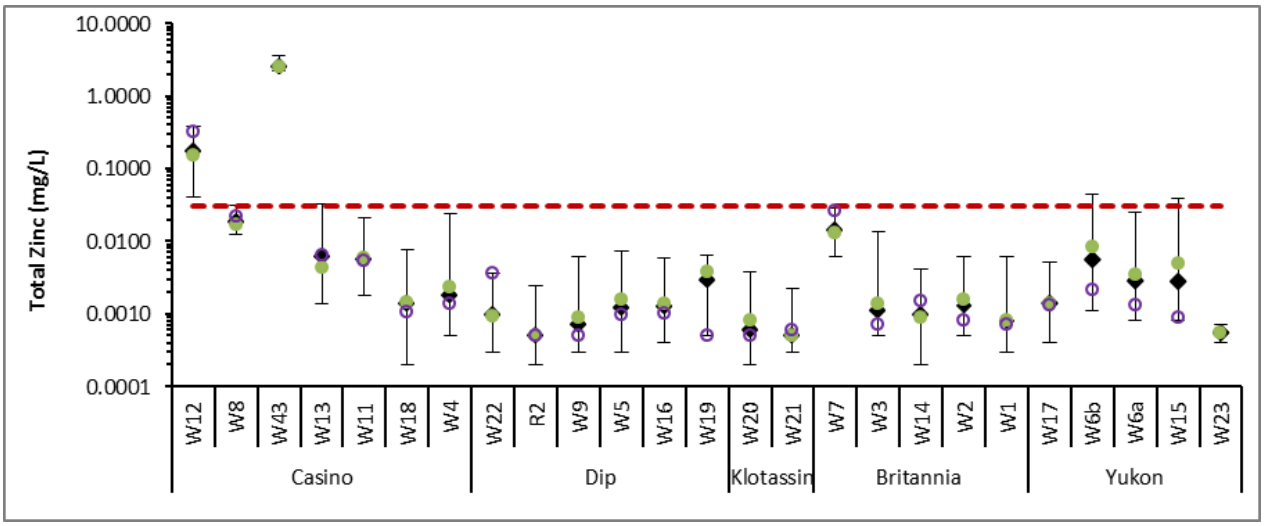
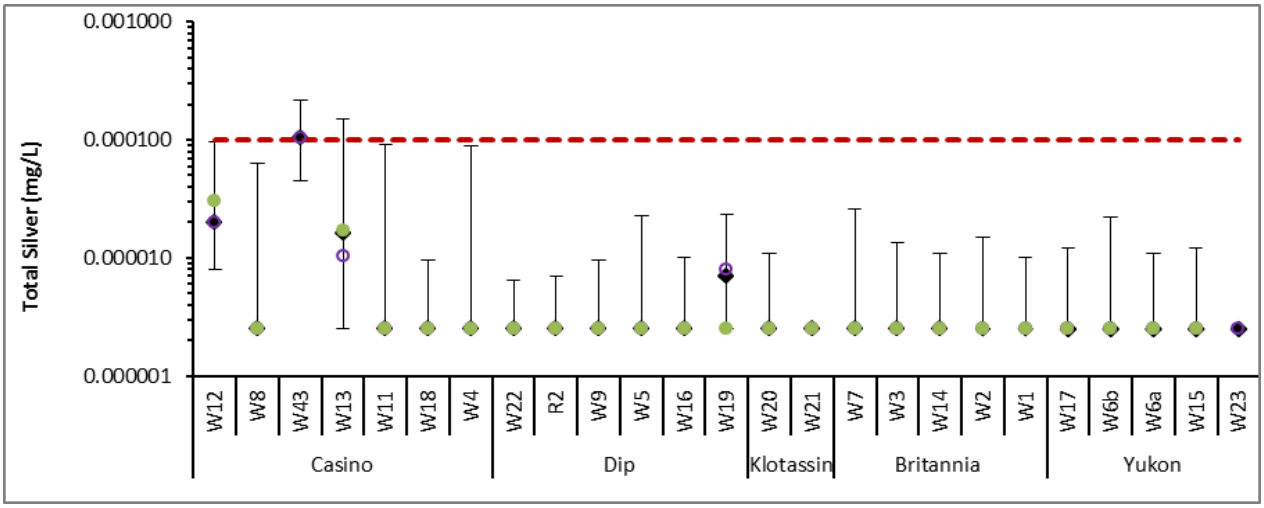


Figure 8. Continued: Range of Values (Minimum, Median, Maximum) of Total Metals Parameters, Casino Project, 2008-2012

(red dashed line is CCME Guideline, open circle is winter median and closed circle is summer median)



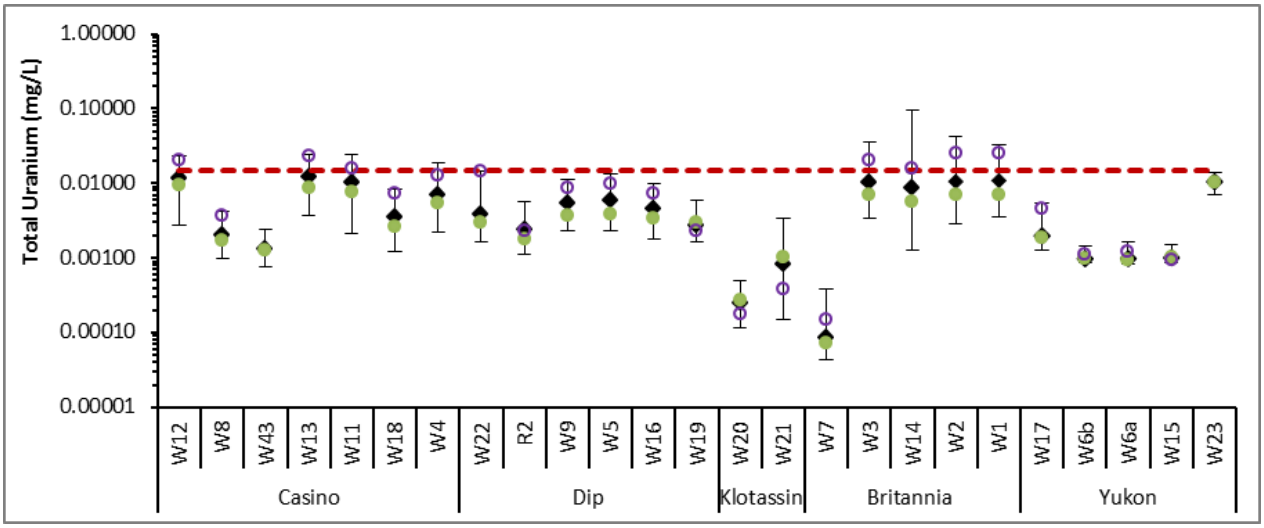
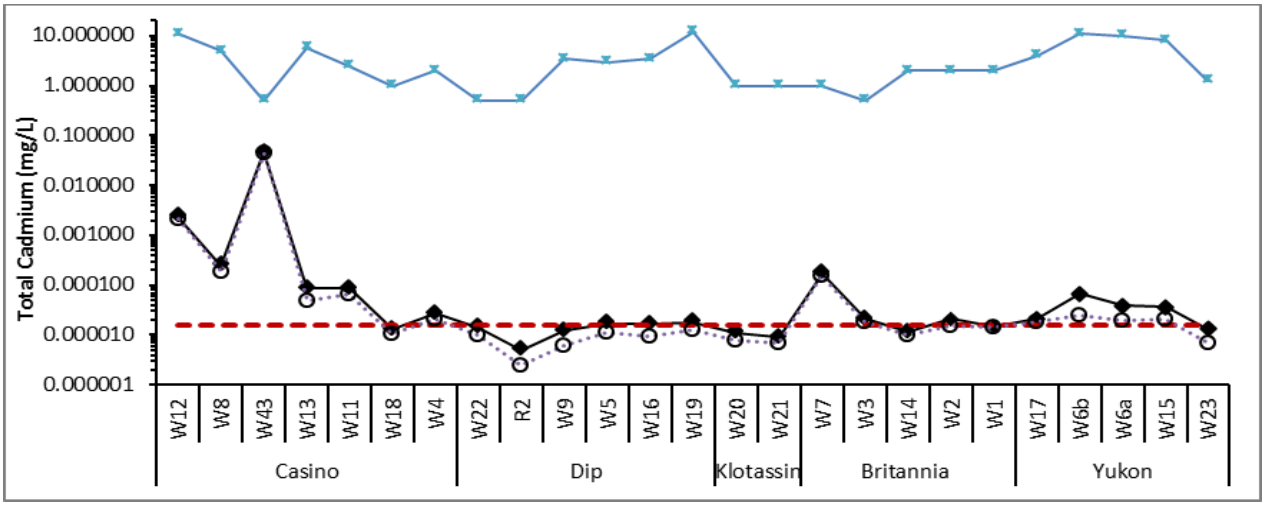
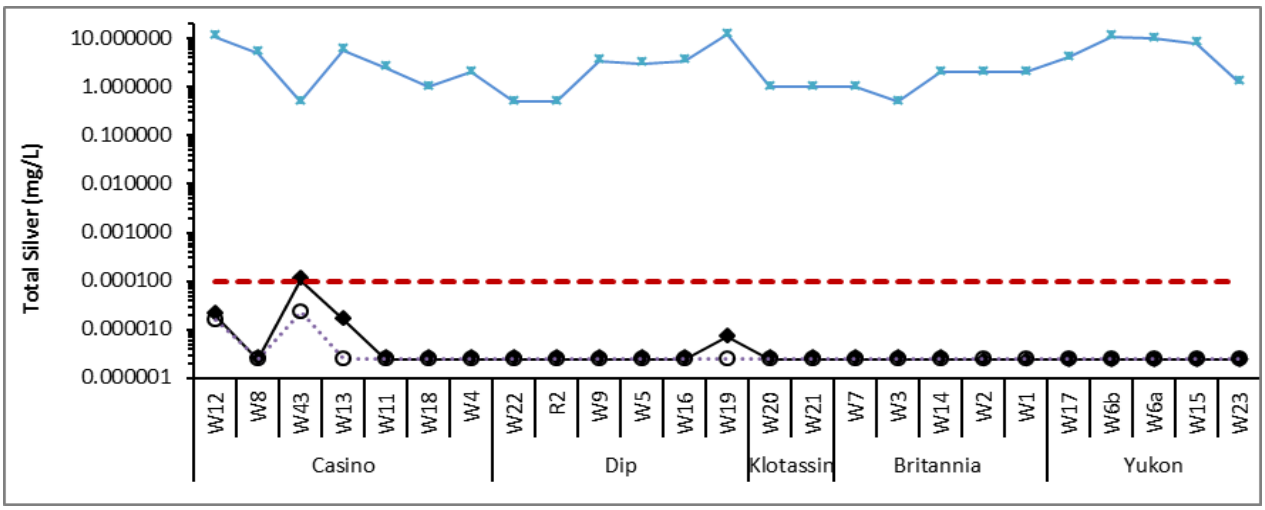


Figure 9. Median Concentrations of Total Metals, Dissolved Metals and TSS, 2008-2012

(red dashed line is CCME Guideline, blue line is TSS, black diamond is total metals, open circle is dissolved metals)





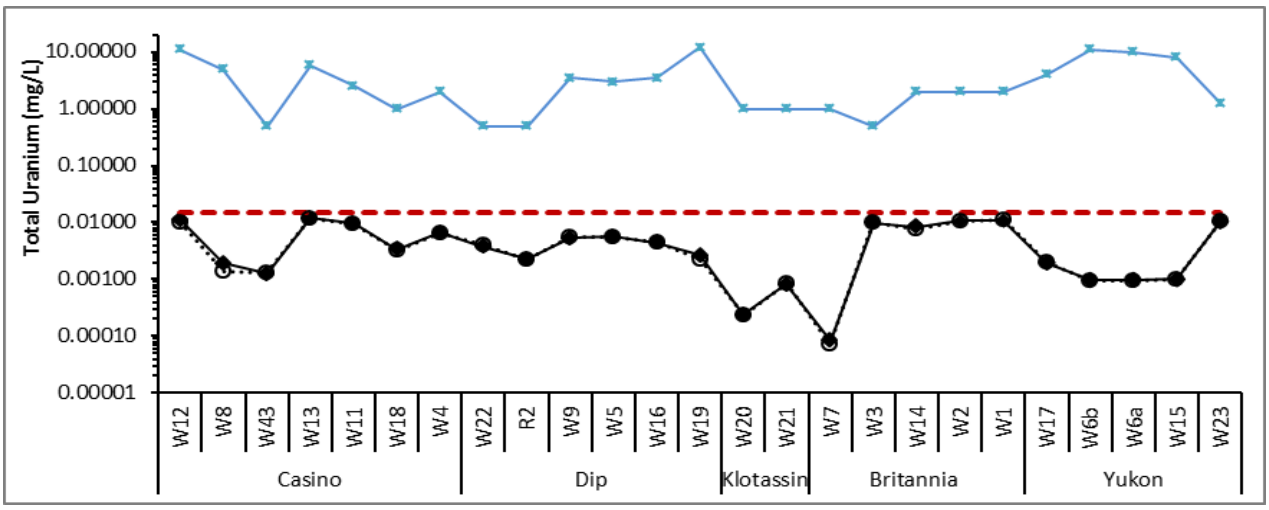


Figure 9. Continued: Median Concentrations of Total Metals, Dissolved Metals and TSS, 2008-2012

(red dashed line is CCME Guideline, blue line is TSS, black diamond is total metals, open circle is dissolved metals)

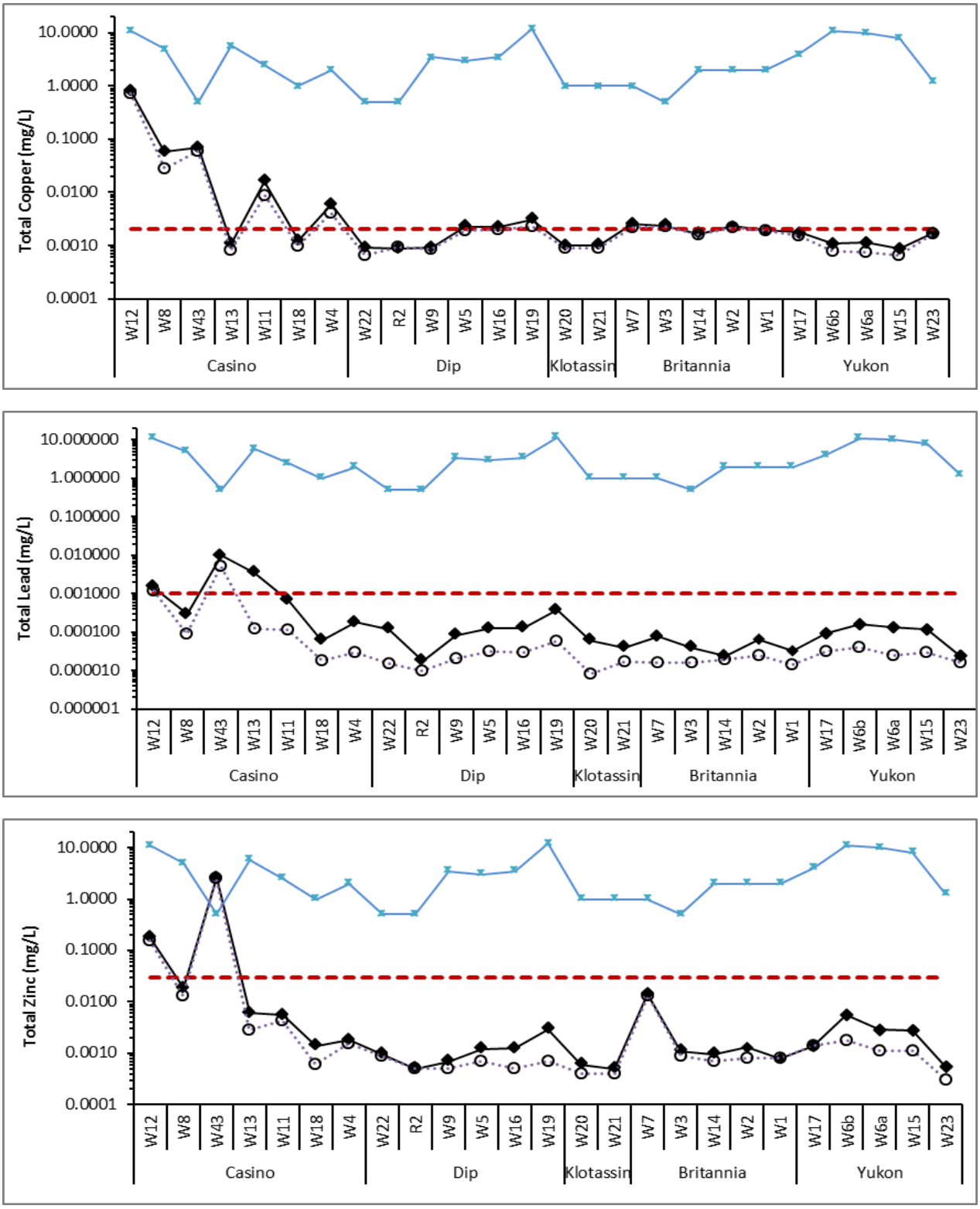
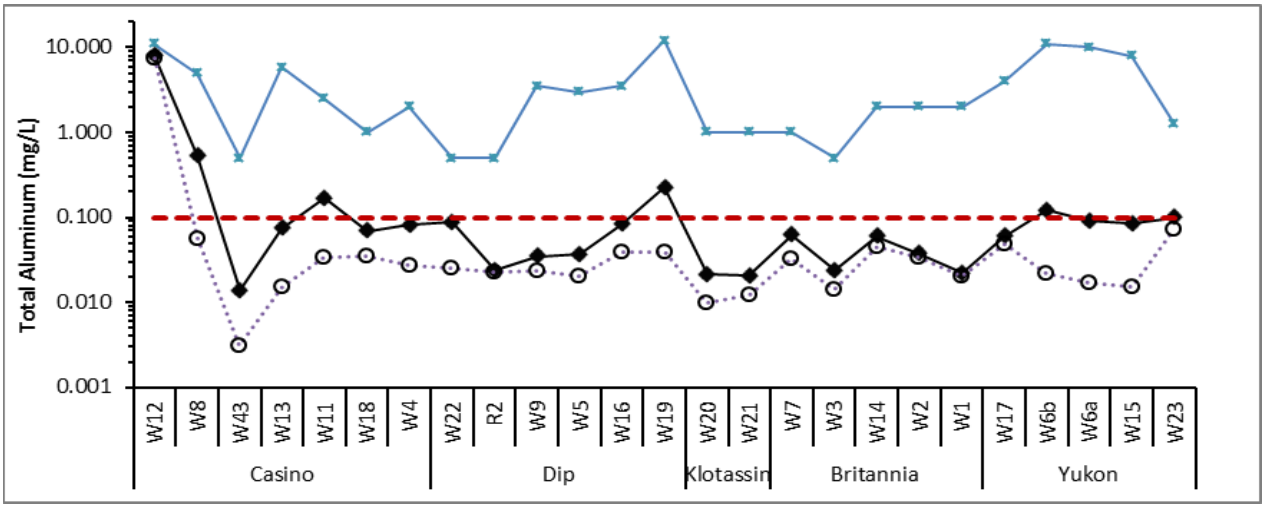
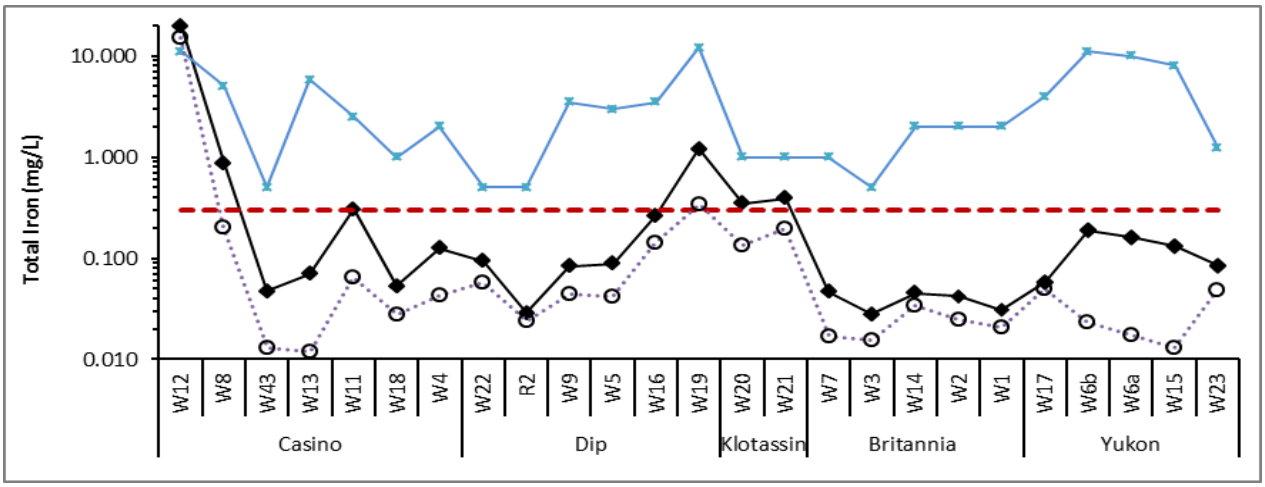


Figure 9. Continued: Median Concentrations of Total Metals, Dissolved Metals and TSS, 2008-2012

(red dashed line is CCME Guideline, blue line is TSS, black diamond is total metals, open circle is dissolved metals)





4.2 Sediment Quality

Raw data can be found in Appendix C1 and summary statistics for sediment quality can be found in Appendix C2.

4.2.1 Exceedances of CCME Sediment Quality Guidelines

Table 6 summarizes exceedances of CCME sediment guidelines. Of the seven metals with CCME sediment quality guidelines, exceedances were observed for six: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb) and zinc (Zn). There were no exceedances for mercury.

Table 6 shows arsenic exceedances occurred at every station for the ISQG. Clear spatial trends in exceedances were not evident for Yukon River or Klotassin River. In Britannia Creek, the greatest number of metal exceedances occurs in upper Canadian Creek at W7, which is similar to water quality trends. Spatial trends were evident in Casino Creek – the greatest number of metal exceedances occurs in upper Casino Creek, downstream of Proctor Gulch, and the incidence of exceedances decreases downstream along Casino Creek. The only exceedances observed in Dip Creek were for arsenic and cadmium and only for the ISQG; the PELs were never exceeded in Dip Creek.

Plots of mean sediment metal concentrations shown in Figure 10 revealed similar spatial distributions. For all metals, the highest concentrations were observed at stations in upper Casino Creek watershed. Concentrations declined downstream along Casino Creek with the lowest concentrations measured in Dip Creek. Concentrations of arsenic, cadmium, copper, lead, mercury, and zinc were lower in Britannia Creek watershed than in Casino Creek watershed, but concentrations of chromium were similar in both watersheds. Yukon watershed showed higher concentrations of cadmium, chromium, mercury and zinc than Dip Creek and Britannia Creek watersheds.

Table 6. Sediment Quality Parameters Exceeding CCME Guidelines

Watershed	Watercourse	Station	Interim Freshwater Sediment Quality Guideline (ISQG)	Probable Effects Level (PEL)
Casino Creek	Casino	S4	As, Cd, Cu	As
		S5/W12	As, Cu, Pb, Zn	As, Cu
		S3/W8	As, Cd, Cu, Pb, Zn	As, Cu
	Unnamed tributary	W24	As	As
	Meloy	W13	As, Cd, Pb, Zn	As, Pb
	Casino	W11	As, Cd, Cu, Pb, Zn	As, Pb
		S6/W4	As	-
Dip Creek	Dip	S8/W9*	As	-
		S7/W5	As, Cd	-
		W16	As	-
	Victor	R2*	As	-
Klotassin River	Klotassin	W20	As, Cr	-
		W21	As	-
Britannia Creek	Canadian	W7	As, Cd, Cu	-
		W3	As	As
	Britannia	W14	As	-
		S2/W2	As	As

Watershed	Watercourse	Station	Interim Freshwater Sediment Quality Guideline (ISQG)	Probable Effects Level (PEL)
		S1/W1	As	-
Yukon River	Yukon	W6B*	As, Cd, Zn	-
		W6A	As, Cd	-
		W15	As, Cd, Zn	-

Dashes indicate sample mean did not exceed CCME guidelines

4.2.2 Sources of Elevated Sediment Metal Concentrations

Sampling conducted between 2008 and 2011 revealed that throughout the study area, the highest concentrations of many of the metals analysed occurred in upper Casino Creek. These metals include antimony, arsenic, bismuth, cadmium, cobalt, copper, iron, lead, manganese, molybdenum, silver, thallium and zinc and those with CCME guidelines are depicted graphically in Figure 10.

Figure 10 shows that stations in upper Casino Creek had the highest mean sediment concentrations of arsenic (24.5 to 42.4 mg/kg DW) compared with the rest of the stations (6.0 to 18.5 mg/kg DW). The lowest pH (3.14) was at Proctor Gulch (W12).

The highest concentration of cadmium (1.80 mg/kg DW) was a single measurement at station W8 upper Casino Creek. The next two highest mean cadmium concentrations were measured at stations W11 and W13 (1.78 and 1.55 mg/kg DW, respectively), downstream of station W8.

The highest concentration of copper was measured at stations W8 and W12 (292 and 214 mg/kg DW, respectively) in upper Casino Creek. The next highest copper concentration was measured at next site downstream, W11 (191 mg/kg DW). After that, the next highest was in upper Canadian Creek at W7 (57 mg/kg DW). The rest of the sites had mean copper concentration between 6.3 and 33.4 mg/kg DW.

Lead and zinc had similar trends, where Meloy Creek (W13) had the highest concentrations (192 and 226 mg/kg DW, respectively), followed by W11 (111 and 192 mg/kg DW, respectively) in upper Casino Creek. The next highest concentration of lead was in W12 in Proctor Gulch and W8 in upper Casino Creek (62 and 43 mg/kg DW, respectively). Zinc concentrations in the Yukon River, downstream of Britannia Creek were similar (143 and 138 mg/kg DW, respectively) to W12 in Proctor Gulch (130 mg/kg DW).

The lowest concentrations of chromium, copper, lead and zinc were all measured at station R2 in a tributary to Dip Creek (4.0, 6.3, 3.3 and 32.5 mg/kg DW, respectively). Mercury concentrations were below detection limits (0.05 mg/kg DW) for all sites except for W12 on Proctor Gulch, W24 on the unnamed tributary to Casino Creek, W6a, W6b and W15 on Yukon River and S4 on the upper tributary to Casino Creek (0.034, 0.059, 0.060, 0.068, 0.085 and 0.09 mg/kg DW, respectively).

Although no CCME guideline exists for iron, the results from the 2008-2011 sampling period for iron shows a clear spatial trend with elevated concentrations in W12 (168,500 mg/kg DW) and decreasing downstream at stations W8, W11, W4 in Casino Creek , continuing through to W5, W9, W16 in Dip Creek (36,600, 34,900, 29,100, and 27,500, 25,600, 20,275 mg/kg DW, respectively).

Historical sediment sampling results from 1993-1995 yielded similar patterns of metal concentrations, with upper Casino Creek having highest concentrations of most of the metals including arsenic, antimony, cadmium, cobalt, copper, lead, molybdenum, selenium and zinc. Metals that were higher in lower Britannia Creek were chromium and nickel. Mercury was low in all samples and silver and tin were below detection limits.

In 1993, the copper concentration at S4 was reported as 1670 mg/kg and in 2010 it was 23.6 mg/kg DW. This measurement should be interpreted with caution because it was anomalously high compared to the rest of the copper concentrations. Laboratory handling in 1993 by ASL did not report any sieving of the sediment samples and is likely the explanation to the high discrepancy in these particular results.

These spatial trends indicate that the source of the elevated stream sediment concentrations in the study area is likely the mineralized zone on Patton Hill. For cadmium, copper and zinc, it also appears that a certain degree of deposition occurs at W8 below the Proctor Gulch confluence, and that this may be due to a precipitation of the metals in response to a pH shift in the water. Arsenic concentrations throughout the study area exceed the CCME ISQG and are reflective of natural sources from weathered rocks and soils. However, the elevated arsenic concentrations at most sites in upper Casino Creek and Canadian Creek exceed even the PEL guideline and are likely from the natural ARD in the groundwater near the ore body.

4.2.3 Routes of Metal Transfer to Stream Sediments

The primary route by which metals enter the surface streams is most likely Proctor Gulch, a small alpine stream that drains the south-eastern side of the mineralized zone. The stream is 1.5 km long, drops a vertical distance of 300 m for an average gradient of 20% and has an average flow of 0.006 m^3/s (Himmelright, 1994). Proctor Gulch intermittently flows underground where it passes through the Casino Fault geological formation. The material within the fault contains iron sulphides that are oxidized by water and air to form sulphuric acid. The acid then leaches metals out of the mineralized zone. The water in Proctor Gulch that re-emerges to the surface is acidic (e.g., a pH range of 3.2 to 3.9) and has elevated metal concentrations. This natural ARD then flows into Casino Creek.

The metals in water from Proctor Gulch exist in both the particulate and dissolved phases. As Proctor Gulch water passes down Casino Creek, some portion of the particles gets trapped in voids in the substrate. As the dissolved metals travel downstream and physical conditions change (i.e., pH rises to ~7.0 at S3/W8 and W11) some portion of the dissolved metal load precipitates and gets trapped in solid form in spaces in the substrate. As a result of these processes, metals are transferred from the water column to storage in the sediments, and total metal concentrations in the stream sediments of Casino Creek decrease downstream.

A second source of ARD comes from a pipe that drains an adit that was dug into the south-eastern side of Patton Hill several decades ago. The water from the pipe flows directly into the headwaters of Meloy Creek and then onwards into Casino Creek. As discussed in Section 4.1, the water quality at the end of the pipe is elevated cadmium, lead, silver and zinc. This water is primarily natural groundwater – the only

real effect of human intervention was to give it a direct route to the surface, although some limited sulphide oxidation may also be occurring, even though the adit is now covered and reclaimed.

Groundwater is likely the third source of elevated metals in stream sediments. Groundwater with elevated metal concentrations begins as meteoric water that falls on the surface of Patton Hill, passes through the mineralized zone, where it picks up metals, and then re-emerges in streams down-gradient of the mineralized zone. Groundwater contribution to stream sediment quality can be seen in the spatial gradient of arsenic, cadmium and copper in Figure 10. Concentrations of these metals are elevated in the stream sediments in Britannia Creek watershed, compared to stations in Dip Creek, even though there is no surface flow of natural ARD from Patton Hill into Canadian Creek or Britannia Creek. Groundwater is the likely source for those slightly elevated arsenic, cadmium and copper concentrations.

Figure 10. Range of Values (Mean and Standard Deviation) of Selected Total Metals Sediment Quality Parameters, Casino Project, 1993-1994 and 2008-2012

(dotted line is CCME ISQG guidline and dashed line is CCME PEL guideline)

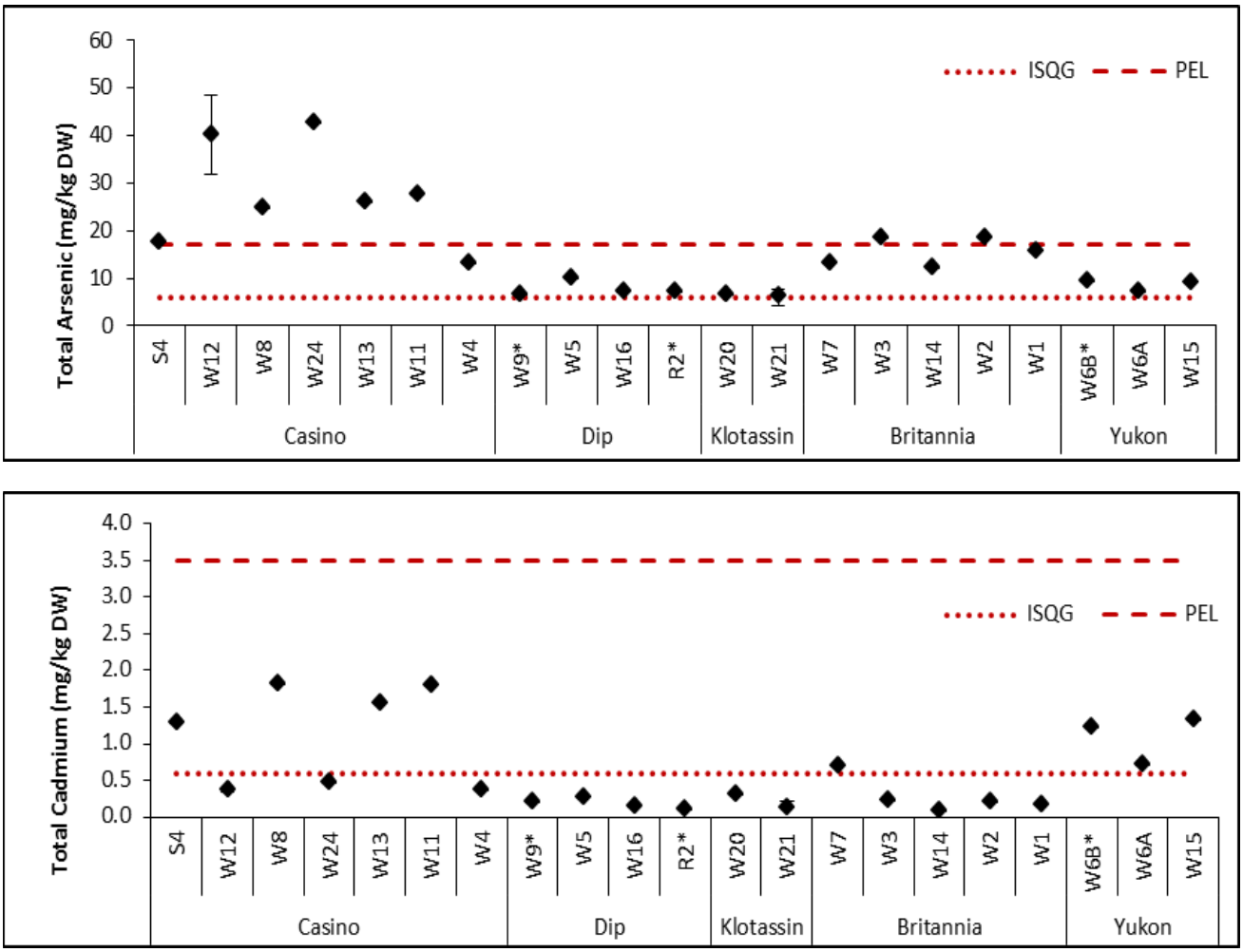


Figure 10. Continued: Range of Values (Mean and Standard Deviation) of Selected Total Metals Sediment Quality Parameters, Casino Project, 1993-1994 and 2008-2012

(dotted line is CCME ISQG guidline and dashed line is CCME PEL guideline)

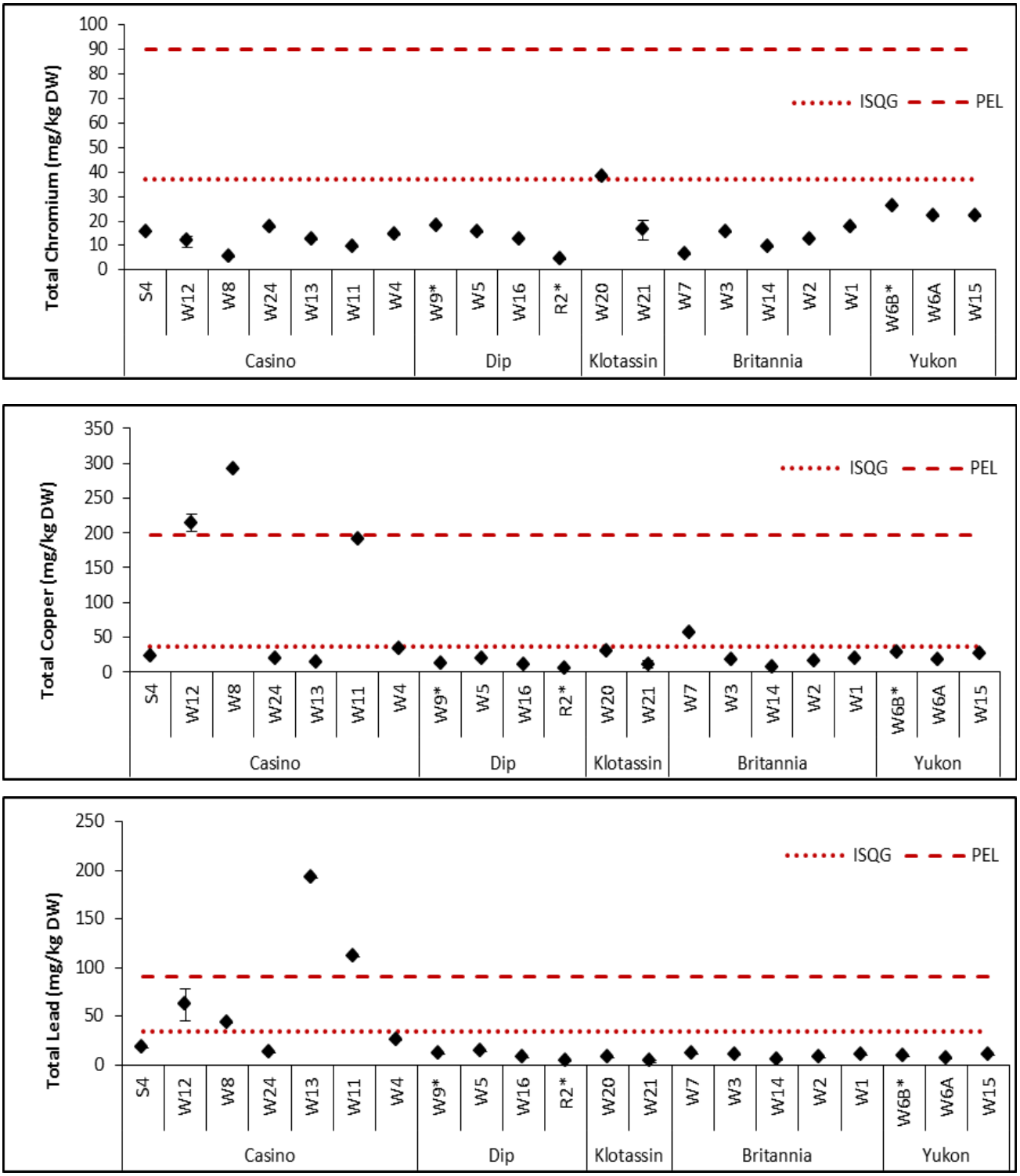
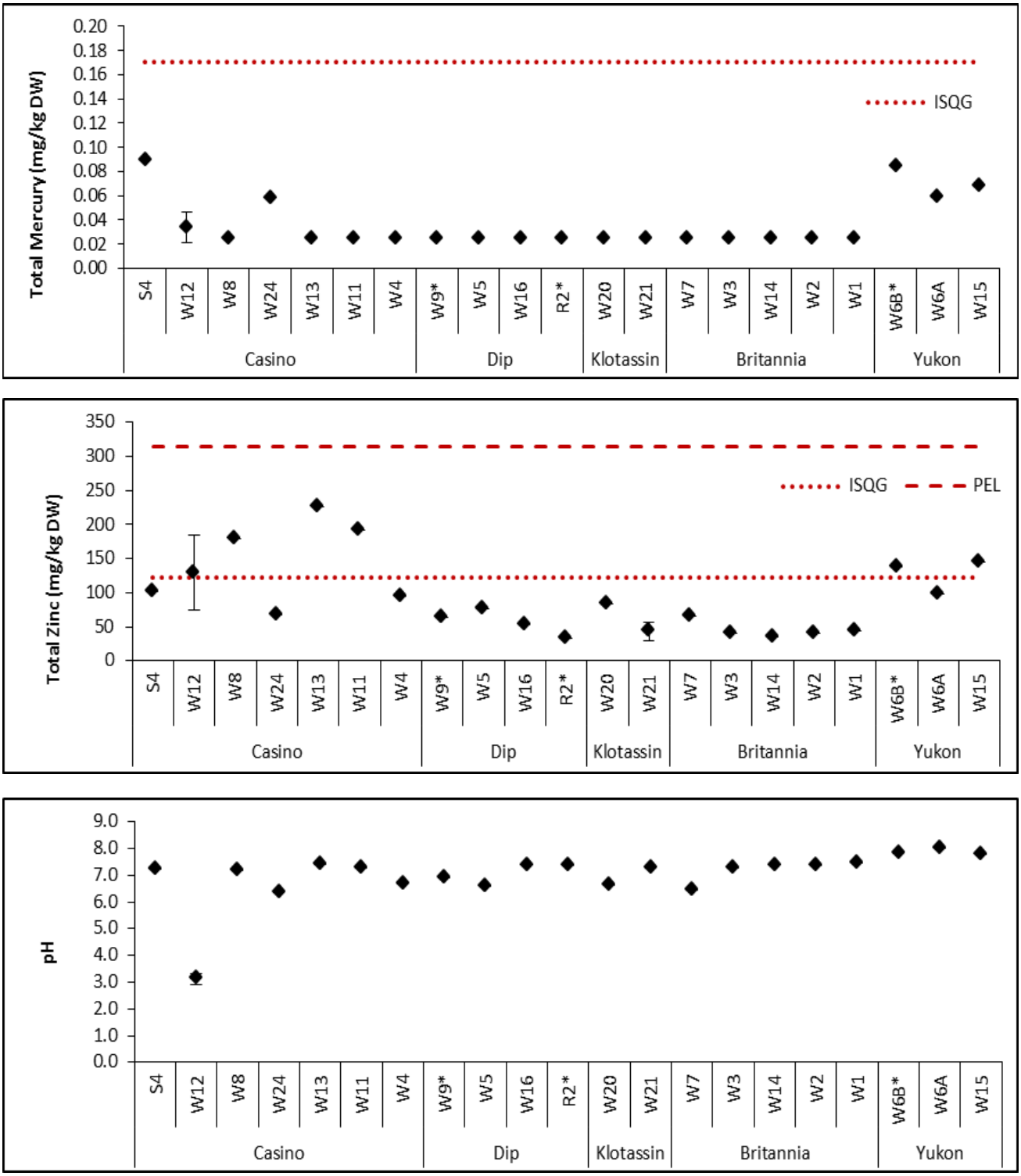


Figure 10. Continued: Range of Values (Mean and Standard Deviation) of Selected Total Metals Sediment Quality Parameters, Casino Project, 1993-1994 and 2008-2012

(dotted line is CCME ISQG guidline and dashed line is CCME PEL guideline)



5 Conclusion

The water quality and sediment quality baseline programs for the proposed Casino mine project was carried out by professional biologists in order to characterize the pre-development aquatic environment of the Project study area and with a main purpose of obtaining a good level of understanding of the water and sediment quality trends of the system. Results from historical studies (Hallam Knight Piesold, 1997; Himmelright, 1994) were used to develop current field studies (AECOM 2009; PECG 2011a/2011b/2012) and together describe the pre-development baseline water and sediment quality conditions of the Casino project area. The baseline will provide a benchmark for the assessment of potential effects of the Project on the aquatic environment as well as future monitoring programs.

The Project study area straddles two watersheds: Britannia Creek to the north and Dip Creek to the south. In the Dip Creek watershed, a natural source of acid rock drainage exists in the headwaters of Casino Creek. This source takes form as a small alpine tributary, Proctor Gulch, which flows through the mineralized zone of the ore body and as a result, has elevated concentrations of aluminum, cadmium, copper, iron, fluoride, zinc and acidity. Proctor Gulch flows into Casino Creek and the effects of the acid rock drainage are seen on both the water and sediment quality throughout the length of Casino Creek. In the Britannia Creek watershed, less pronounced effects of acid rock drainage can be seen in the upper tributary to Britannia Creek from groundwater contribution.

The baseline characterization includes the contribution of a historical adit, which is an anthropogenic, point source of acid rock drainage. The water from this adit flows to surface during the spring and summer months and discharges water with elevated cadmium, lead, silver and zinc concentrations to Casino Creek via Meloy Creek. The flow of this adit discharge is minor relative to Casino Creek and therefore effects of this acid rock drainage are not clearly detectable in lower Casino Creek. Some effects are seen in Meloy Creek, where elevated lead and silver are detectable in the water and elevated lead and zinc in the sediment.

Overall, the water and sediment quality of the Casino project aquatic environment are representative of expected conditions in areas surrounding a metallurgical ore body in a northern environment, where natural mineralization and hydrological factors play a role in characterizing the baseline conditions. The waterbodies in the study area are nutrient-poor and oligotrophic, which is expected given the high elevation and northern environment. Spatial trends in metal concentrations are heavily influenced by the ore body and temporal trends are governed by hydrological factors such as runoff and stream flow. As a whole, the results obtained from the two years of historical data and five years of current data have provided a consistent description of the baseline conditions and moving forward, the results will adequately provide a solid foundation for the consideration of potential effects of the development of the Casino mine.

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Appendix A

Technical Reports

- **A1. Casino Project: 2008 Environmental Studies Report (AECOM, 2009)**
- **A2. Casino Project: 2009 Aquatic Studies Report (PECG, 2011a)**
- **A3. Casino Project: 2010 Aquatic Studies Report (PECG, 2011b)**
- **A4. Casino Project: 2011 Aquatic Studies Report (PECG, 2012)**
- **A5. Casino Project: 2012 Aquatic Studies Report (PECG, 2013)**

AECOM

Western Copper Corporation

Casino Project: 2008 Environmental Studies Report

draft for discussion

Prepared by:

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Project Number:

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Date:

March 2009

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March 25, 2009 Project Number: 80049 107402

Paul West-Sells
Executive Vice President, Corporate Development
Western Copper Corporation
2050-1111 West Georgia Street
Vancouver, BC V6E 4M3

draft for discussion

Dear Dr. West-Sells:

Re: Casino Project: 2008 Environmental Studies Report

AECOM is pleased to submit the attached report describing the studies conducted in 2008 on the atmospheric, aquatic and terrestrial environments of the Casino Project area. If there are any questions or comments on this report, then please contact the undersigned. Thank you for the opportunity to work with you on this project.

Sincerely,
AECOM Canada Ltd.

Rick Palmer, B.Sc., R.P.Bio.
Senior Aquatic Biologist
Rick.Palmer@aecom.com

RP:gc

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Revision #	Revised By	Date	Issue / Revision Description

Executive Summary

This report describes the studies conducted in 2008 on the atmospheric, aquatic and terrestrial environments of the Casino Project area. The Casino Project is a proposed porphyry copper-gold-molybdenum mine located at latitude 62° 44'N and longitude 138° 50'W in west-central Yukon, 300 km northwest of the territorial capital of Whitehorse.

On October 3, 2008, the Casino meteorological station was installed on Patton Hill at an elevation of 1,203 m above sea level. The station consists of a 10 m-high, free-standing tower equipped with instrumentation, datalogger, and logger enclosure. It records wind speed and direction, rainfall, air temperature, barometric pressure, relative humidity and snow depth and stores the records in a datalogger powered by a battery charged with a solar panel. The datalogger is equipped with a satellite modem for remotely accessing the data.

Surveys of the aquatic environment were made on May 9, May 20-24, July 7-11, September 9-13 and October 9-11. The objectives were to measure stream flows, to sample water quality, stream sediment quality, periphyton communities, benthic invertebrate communities and fish communities, and to describe fish habitat.

In May 2008, dataloggers were installed at six hydrometric stations to measure water surface elevation (from which stream flows were calculated) and water temperature. A seventh station was added in October. Those data were downloaded on subsequent trips in July, September and October. Stations were winterized in October. In general, manual measurements of discharge and stage were conducted at medium to high flows. Analysis showed fair to strong correlations of discharge and stage. Reconstruction of the hydrographs showed two large peaks of discharge at all stations that were assumed to be initiated by a regional precipitation event. Historic discharge data for 1993 and 1994 were compared to the 2008 flow data at three sites.

A total of 19 sites were chosen for water quality sampling. Water samples were collected from each site in May, July and September and analyzed for the full suite of physical parameters, anions, nutrients and total and dissolved metals. Exceedances of the Canadian Council of Ministers of the Environment (CCME) guidelines for protection of freshwater aquatic life were observed for nine parameters. The number of exceedances was highest for cadmium, copper and aluminum and least for cyanide. Exceedances were most numerous in May, similar between July and September and least numerous in October, indicating a seasonal trend most likely directly related to hydrological factors such as snow melt and stream flow.

Principal components analysis was used to identify the major spatial and temporal trends in water quality. The first component, WQ1, was positively correlated with 16 dissolved and total metals and negatively correlated with total and dissolved molybdenum, and was the geochemical signal of drainage from the adit of the lower camp into the upper reach of Casino Creek.

The second component, WQ2, was positively correlated with ten dissolved and total metals, sulphate, nitrite and ammonia and negatively correlated with pH, alkalinity, barium and nitrate. This “iron-pH” component

reflects the geochemical signature of the surficial geology of Proctor Gulch, the upper Casino Creek and Britannia Creek.

The third component, WQ3, was positively correlated with hardness, conductivity, Total Dissolved Solids (TDS), and 13 total and dissolved metals. These parameters typically reflect the influence of groundwater flows.

The fourth component, WQ4, was positively correlated with 12 dissolved and total metals, Total Suspended Solids (TSS) and Total Kjeldahl Nitrogen (TKN) and negatively correlated with dissolved and total silicon. The scores for this “vanadium-silicon” component were lowest for sites in Casino Creek and in upper Britannia Creek, and highest for sites in Dip Creek, Britannia Creek, Sunshine Creek and the Yukon River. Therefore, WQ4 represents a geochemical signal found at all sites except those in Casino Creek and upper Britannia Creek.

The fifth component, WQ5, was positively correlated with dissolved and total selenium and nickel and turbidity. The scores for this “selenium-nickel-turbidity” component were highest for sites in the Yukon River, hence WQ5 represents a geochemical signal associated with the Yukon River.

Sediment samples were collected from a sub-set of 12 stream sites in September and pH and total metal concentrations were measured. Exceedances of CCME sediment guidelines were identified for five total metals: arsenic, cadmium, copper, lead and zinc. All of those metals except arsenic were also observed to exceed CCME water quality guidelines at some stations on some dates. A PCA of sediment quality variables extracted three components that accounted for 87.7% of the explained variance. SQ1 was highly positively correlated with manganese, cadmium, cobalt, zinc, lead and antimony; SQ2 was highly positively correlated with vanadium, titanium, aluminum, tin, phosphorus, sodium and barium; and SQ3 was highly positively correlated with bismuth, silver and arsenic and highly negatively correlated with pH.

Five samples each of periphyton and benthic invertebrate communities were collected from seven stream sites in September. There were highly significant differences in mean periphyton density among sites with sites P8, P7 and P4 in Casino Creek having significantly higher mean density than other sites. There were no significant differences among sites in the Shannon-Weiner diversity index, but there were highly significant differences among sites in species richness because of higher richness for sites P8, P7 and P4 than for other sites.

Over 95% of the benthic organisms at each site belonged to eight taxa: the insect Orders of Diptera, Plecoptera, Ephemeroptera, Trichoptera, Prostigmata and Collembola plus the worms of Class Oligochaeta and Phylum Nematoda. There were statistically significant differences in mean density and diversity among sites.

Fish communities at 12 stream sites were sampled in July and September with minnow traps, electrofishers and angling. In addition, an aerial survey of Britannia and Canadian creeks was conducted on September 11 to search for Pacific salmon spawners (none were observed).

A total of 40 fish from two species – Arctic grayling (*Thymallus arcticus*) and slimy sculpin (*Cottus cognatus*) – were captured. Apart from one Arctic grayling caught by angling, all were captured by electrofishing. Only Arctic grayling were found in the Britannia Creek Watershed, but both Arctic grayling and slimy sculpin were found in Casino Creek and Dip Creek watersheds. Slimy sculpin made up the majority of the catch (81 to 86%) in those two watersheds, respectively.

Arctic grayling were absent from the study area in September, most likely due to late-summer outmigration in search of overwintering habitat. In contrast, the mean catch-per-unit-effort (CPUE) of slimy sculpin for Casino and Dip Creeks was not significantly different between July and September, indicating that slimy sculpin either did not outmigrate from Casino Creek until after mid-September.

Arctic grayling ranged in length from 173 to 300 mm and in age from two to siz years, indicating the presence of juvenile and adults but not young-of-the-year. Slimy sculpin ranged in length from 29 to 294 mm, indicating the presence of juveniles and adults.

Nine slimy sculpin were collected from Casino and Dip creeks in July and September and subjected to whole-body tissue metals analysis.

Reconnaissance surveys of the terrestrial environment were conducted on July 7-11 and September 8-11, 2008. The objectives were to provide sufficient preliminary information on soils and vegetation to plan a future air photograph interpretation study of vegetation communities, and to document wildlife presence and use of the various plant communities and habitats.

Aerial surveys of vegetation communities and wildlife were conducted in a helicopter that flew slowly at low altitudes. Aerial surveys were followed by ground surveys conducted on foot or with all terrain vehicles. Soil pits were dug, samples of vegetation were collected and animal sighting and signs (claw marks, paw prints, antlers, scat, etc.) were photographed and their GPS co-ordinates recorded.

The surveys showed that the study area is characterized by smooth, rolling topography with moderate to deeply incised valleys. Wildlife habitat consists of a variety of plant communities ranging from sparsely vegetated bare rock, large expanses of heath tundra, wet sedge meadows with tall riparian shrubland and treed slopes dominated by spruce, aspen, birch and willows. Open stands of black spruce and white spruce occur in valleys and lower slopes, with black spruce on wetter sites and white spruce on better drained sites. Willow, shrub birch, Labrador tea, mosses and lichens are principal understory species.

Fifteen species of mammals and ten species of birds were observed or heard during the surveys. Moose were observed along the Yukon River and along Casino and Dip creeks. The area being considered for the proposed Casino Project appears to be a preferred moose wintering area. Caribou were seen and caribou sign (e.g., pellets, shed antlers, trails, etc.) was found on ridge tops. Numerous wolf tracks and scats were observed along Dip Creek, suggesting the presence of a den site. Grizzly bears and black bears were observed and well-developed small mammal trails were observed in some spruce habitat.

Potential summer and winter range, lambing areas and escape terrain for sheep are limited within the survey area. No thinhorn sheep were observed along the Yukon River bank directly across from Britannia Creek.

Acknowledgements

The studies described in this report were carried out by the following AECOM staff:

- Project Management:
  - Rick Palmer, B.Sc., Senior Aquatic Biologist
- Hydrology:
  - Chad Davey, B.A., M.Sc., Environmental Scientist
  - Rolf Aslund, P.Eng., Senior Water Resources Engineer
- Surface Water Quality and Sediment Quality:
  - Kai Woloshyn, B.Sc., Environmental Scientist
  - May Quach, M.Env.Sci., CEPIT, Aquatic Ecologist
- Fish and Fish Habitat:
  - Jennifer Sarchuk, B.Sc., Biologist
  - Genevieve Martin, B.Sc., Environmental Biologist
  - Eric Cleveland, Fish. Wild. Tech., Environmental Technician
- Soils and Vegetation:
  - Sean Bennett, B.Sc., R.P.F., Terrestrial Ecologist
  - Kevin Lloyd, M.Sc., Senior Ecologist
- Wildlife and Wildlife Habitat:
  - Paul Fraser, B.Sc., P.Bio., Senior Wildlife Biologist
  - Laurence Turney, B.Sc., R.P.Bio., Senior Wildlife Ecologist

Climate and air quality was the responsibility of the following RWDI staff: Geoff Doerksen, M.Sc., Project Manager, and Kathy Preston.

Acronyms and Abbreviations

ANOVA	Analysis of variance
asl	above sea level
BC MELP	British Columbia Ministry of Environment, Lands and Parks
BC MOE	British Columbia Ministry of Environment
BC MOF	British Columbia Ministry of Forests
BC MWLAP	British Columbia Ministry of Water, Land and Air Protection
CABIN	Canadian Aquatic Biomonitoring Network
CCME	Canadian Council of Ministers of the Environment
CEAA	Canadian Environmental Assessment Agency
CO	Confined
CPUE	Catch-per-Unit-Effort
DFO	Fisheries and Oceans Canada
DOC	Dissolved Organic Carbon
EEM	Environmental Effects Monitoring
EN	Entrenched
EPT	Ephemeroptera-Plecoptera-Trichoptera
FC	Frequently confined
FES	Fraser Environmental Services Ltd.
FISS	Fisheries Information Summary System
GIF	Ground inspection plots
GPS	Global Positioning System
H’	Shannon-Weiner diversity index
HKP	Hallam Knight Piésold Ltd.
ICP	Inductively Coupled Argon Plasma Spectroscopy
ISQG	Interim Sediment Quality Guideline
K	Growth coefficient (von Bertalanffy parameter)
kPa	kilo Pascals
L_∞	Asymptotic length (von Bertalanffy parameter)
LSA	Local Study Area
LWD	Large Woody Debris
MMER	Metal Mining Effluent Regulations
µS	micro-Siemens
NA	Not applicable
NAN	Not a Number
NS	Not sampled
NTU	Nephelometric unit
NWRI	National Water Research Institute
OC	Occasionally confined
P	Probability of making a Type I error
PCA	Principal Component Analysis

Acronyms and Abbreviations (cont'd)

PEL	Probable Effects Level
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
r^2	coefficient of determination
RDL	Reported Detection Limit
RPD	Relative Percent Difference
RSA	Regional Study Area
S	Taxonomic richness
SE	Standard error
t_0	age at which length is zero (von Bertalanffy parameter)
TDS	Total Dissolved Solids
TEM	Terrestrial Ecosystem Mapping
TIA	Tailings Impoundment Area
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TSS	Total Suspended Solids
UC	Unconfined
U.S. EPA	United States Environmental Protection Agency

Table of Contents

page

Statement of Qualifications and Limitations
Letter of Transmittal
Distribution List
Executive Summary 1
Acknowledgments iv
Acronyms and Abbreviations v

1. Introduction 1
1.1 Overview 1
1.2 Project History 1
1.3 Historical Sources of Environmental Data 4
1.4 Study Areas 4
1.4.1 General 4
1.4.2 Atmospheric Environment 5
1.4.3 Aquatic Environment 5
1.4.4 Terrestrial Environment 8
1.5 Study Objectives 8

2. Methods 12
2.1 Atmospheric Environment 12
2.1.1 Location and Setup of Meteorological Station 12
2.1.2 Quality Assurance/Quality Control (QA/QC) 12
2.2 Aquatic Environment 14
2.2.1 Dates and Locations of Sampling and Surveying 14
2.2.1.1 General 14
2.2.1.2 Hydrology 15
2.2.1.3 Water Quality 17
2.2.1.4 Sediment Quality 18
2.2.1.5 Periphyton and Benthic Invertebrates 18
2.2.1.6 Fish Communities 19
2.2.1.7 Fish Habitat 21
2.2.2 Sample Collection 22
2.2.2.1 Hydrology 22
2.2.2.2 Water Quality 22
2.2.2.3 Sediment Quality 24
2.2.2.4 Periphyton 24
2.2.2.5 Benthic Invertebrates 25
2.2.2.6 Fish Community 25
2.2.2.7 Fish Tissue Metals Concentrations 26
2.2.2.8 Fish Habitat 27
2.2.3 QA/QC 28

2.2.3.1 Water Quality ... 28
2.2.3.2 Sediment Quality ... 30
2.2.3.3 Periphyton and Benthos ... 30
2.2.3.4 Fish and Fish Habitat ... 31
2.2.4 Data Analysis ... 31
2.2.4.1 Hydrology ... 31
2.2.4.2 Water Quality ... 32
2.2.4.3 Sediment Quality ... 32
2.2.4.4 Periphyton and Benthos ... 33
2.2.4.5 Fish and Fish Habitat ... 33
2.3 Terrestrial Environment ... 34
3. Results and Discussion ... 35
3.1 Atmospheric Environment ... 35
3.2 Aquatic Environment ... 35
3.2.1 Hydrology ... 35
3.2.1.1 Stage-Discharge Rating Curves ... 35
3.2.1.2 Hydrographs ... 40
3.2.1.3 Historic Flow Data ... 47
3.2.2 Water Quality ... 47
3.2.2.1 Statistical Summary ... 47
3.2.2.2 Exceedances of Water Quality Guidelines ... 53
3.2.2.3 Principal Component Analysis ... 54
3.2.3 Sediment Quality ... 66
3.2.3.1 Exceedances of Sediment Quality Guidelines ... 66
3.2.3.2 Principal Component Analysis ... 66
3.2.4 Periphyton ... 69
3.2.5 Benthic Invertebrates ... 72
3.2.6 Fish Community ... 75
3.2.6.1 Catch, Effort and CPUE ... 75
3.2.6.2 Size, Age and Growth ... 79
3.2.6.3 Tissue Metals Concentrations ... 84
3.2.6.4 Salmon Spawning Survey ... 86
3.2.7 Fish Habitat ... 86
3.2.7.1 General ... 86
3.2.7.2 Britannia Creek Watershed ... 86
3.2.7.3 Casino Creek Watershed ... 91
3.2.7.4 Dip Creek ... 95
3.3 Terrestrial Environment ... 97
3.3.1 Soils and Vegetation ... 97
3.3.2 Wildlife Observations ... 100
3.3.2.1 General ... 100
3.3.2.2 July 7 to 11 Survey ... 101
3.3.2.3 September 8 to 11 Survey ... 101
4. References ... 102

List of Figures

Figure 1. Aquatic Regional Study Area in Relation to the Yukon River 2
Figure 2. Proposed Casino Mine Site Layout 3
Figure 3. Atmospheric Local Study Area 6
Figure 4. Aquatic Regional Study Area with Sampling Sites 7
Figure 5. Terrestrial LSA with Wildlife Observations and Vegetation Plots 9
Figure 6a. Terrestrial LSA, Access Road and Areas of Interest for Thinhorn Sheep and Raptors 10
Figure 7. Stage-Discharge Rating Curve for Site W1, Britannia Creek, Casino Project, 2008 36
Figure 8. Stage-Discharge Rating Curve for Site W3, Canadian Creek, Casino Project, 2008 37
Figure 9. Stage-Discharge Rating Curve for Site W4, Casino Creek, Casino Project, 2008 38
Figure 10. Stage-Discharge Rating Curve for Site W9, Dip Creek, Casino Project, 2008 38
Figure 11. Stage-Discharge Rating Curve for Site W11, Casino Creek, Casino Project, 2008 39
Figure 12. Stage-Discharge Rating Curve for Site W14, Britannia Creek, Casino Project, 2008 40
Figure 13. Hydrograph for Station W1, Britannia Creek, Casino Project, 2008 41
Figure 14. Hydrograph for Station W3, Canadian Creek, Casino Project, 2008 42
Figure 15. Hydrograph for Station W4, Casino Creek, Casino Project, 2008 43
Figure 16. Hydrograph for Station W9, Dip Creek, Casino Project, 2008 44
Figure 17. Hydrograph for Station W11, Casino Creek, Casino Project, 2008 45
Figure 18. Hydrograph for Station W14, Britannia Creek, Casino Project, 2008 46
Figure 19. Hydrograph for Station W1, Britannia Creek, Casino Project, 1993-1994 48
Figure 20. Hydrograph for Station W3, Canadian Creek, Casino Project, 1993-1994 49
Figure 21. Hydrograph for Station W4, Casino Creek, Casino Project, 1993-1994 50
Figure 22. Water Quality Exceedances of CCME Guidelines, Casino Project, 2008 54
Figure 23. Plot of Mean WQ1 Scores on Sampling Site, Casino Project, 2008 57
Figure 24. Plot of WQ1 Scores on Sampling Date, Yukon River and Sunshine Creek, Casino Project, 2008 58
Figure 25. Plot of WQ1 Scores on Sampling Date, Britannia Creek Watershed, Casino Project, 2008 59
Figure 26. Plot of WQ1 Scores on Sampling Date, Casino Creek Watershed, Casino Project, 2008 59
Figure 27. Plot of WQ1 Scores on Sampling Date, Dip Creek Watershed, Casino Project, 2008 60
Figure 28. Plot of Mean WQ2 Scores on Sampling Site, Casino Project, 2008 60
Figure 29. Plot of WQ2 Scores on Sampling Date, Yukon River and Sunshine Creek, Casino Project, 2008 61
Figure 30. Plot of WQ2 Scores on Sampling Date, Britannia Creek Watershed, Casino Project, 2008 62
Figure 31. Plot of WQ2 Scores on Sampling Date, Casino Creek Watershed, Casino Project, 2008 62
Figure 32. Plot of WQ2 Scores on Sampling Date, Dip Creek Watershed, Casino Project, 2008 63
Figure 33. Plot of Mean WQ3 Scores on Sampling Site, Casino Project, 2008 64

Figure 34. Plot of Mean WQ4 Scores on Sampling Site, Casino Project, 2008 65
Figure 35. Plot of Mean WQ5 Scores on Sampling Site, Casino Project, 2008 65
Figure 36. Plot of SQ1 Scores on Sampling Site 67
Figure 37. Plot of SQ2 Scores on Sampling Site 68
Figure 38. Plot of SQ3 Scores on Sampling Site 68
Figure 39. Mean Density of Periphyton by Site, Casino Project, 2008 69
Figure 40. Mean Taxonomic Richness of Periphyton Communities, Casino Project, 2008 71
Figure 41. Mean Shannon-Wiener Diversity Index of Periphyton Communities, Casino Project, 2008 72
Figure 42. Mean Density of Benthic Invertebrates by Site, Casino Project, 2008 73
Figure 43. Mean Taxonomic Richness of Benthic Invertebrate Communities, Casino Project, 2008 74
Figure 44. Mean Total EPT of Benthic Invertebrate Communities, Casino Project, 2008 75
Figure 45. Mean Shannon-Weiner Index of Diversity of Benthic Invertebrate Communities, Casino Project, 2008 75
Figure 46. Electrofishing CPUE, Arctic Grayling, Casino Project, 2008 78
Figure 47. Electrofishing CPUE, Slimy Sculpin, Casino Project, 2008 78
Figure 48. Length Frequencies of Arctic Grayling and Slimy Sculpin, Casino Project, 2008 80
Figure 49. Weight-length Regressions for Arctic Grayling and Slimy Sculpin, Casino Project, 2008 81
Figure 50. Age Frequency Distribution, Arctic Grayling, Casino Project, 2008 82
Figure 51. Length-Age Plot, Arctic Grayling, Casino Project, 2008 82
Figure 52. Length-Age Relationship, Arctic Grayling, Britannia Watershed, 1993-1994 and 2008 83
Figure 53. Length-Age Relationship, Arctic Grayling, Casino Watershed, 1993-1994 and 2008 83
Figure 54. Plot of PC2 Scores on PC1 Scores for Slimy Sculpin Tissue Metal Samples 86

List of Tables

Table 1. Sampling Trips, Aquatic Environment, Casino Project, 2008 14
Table 2. Summary of Hydrometric Stations and Datalogger Installation Dates, Casino Project, 2008 15
Table 3. Summary of Water Quality Sampling Sites, Casino Project, 2008 17
Table 4. Summary of Benthos and Periphyton Sampling Sites and Dates, Casino Project, 2008 19
Table 5. Summary of Fish and Fish Habitat Sampling Sites and Dates, Casino Project, 2008 20
Table 6. Co-ordinates of Electrofishing Upstream and Downstream, Minnow Trapping and Angling, Casino Project, 2008 21
Table 7. Locations of Fish Habitat Surveys, September 11-12, 2008 22
Table 8. Water Quality Parameters and Detection Limits 23
Table 9. Sediment Quality Parameters and Detection Limits 24
Table 10. Fish Tissue Metals and Detection Limits 27
Table 11. RPD Analysis of Replicate Water Quality Samples, Casino Project, 2008 29

Table 12. Summary of Manual Discharges and 'z' for Hydrometric Stations 36
Table 13. Water Quality Summary Statistics, Casino Creek Watershed, 2008 51
Table 14. Water Quality Summary Statistics, Britannia Creek Watershed, 2008 52
Table 15. Water Quality Parameters Exceeding CCME Guidelines, Casino Project, 2008 53
Table 16. Correlations of Water Quality Parameters with Principal Components 55
Table 17. Sediment Quality Parameters Exceeding CCME Guidelines, Casino Project, 2008 66
Table 18. Correlations of Sediment Quality Variables with Principal Components 67
Table 19. Percentage Composition of Periphyton Communities, Casino Project, 2008 70
Table 20. Percentage Composition of Benthic Invertebrate Communities, Casino Project, 2008 73
Table 21. Fish Catch, Casino Project, 2008 77
Table 22. Fish Species in the Aquatics Local Study Area, Casino Project, 1993 to 2008 79
Table 23. Mean Size and Age of Fish, Casino Project, 2008 80
Table 24. Mean Whole-Body Metal Concentrations, Slimy Sculpin, Casino Project, 2008 84
Table 25. Correlations of Principal Components with Slimy Sculpin Tissue Metal Concentrations 85
Table 26. Common and Scientific Names of Wildlife Observed at the Casino Project Area, 2008 100

List of Photos

Photo 1. Casino meteorological monitoring station equipped with (A) sonic ranger, (B) relative humidity and temperature probe, (C) solar panel, (D) datalogger enclosure, (E) satellite antenna and (F) rain gauge 13
Photo 2. Lower Reach of Britannia Creek Looking Upstream, September 11, 2008 87
Photo 3. Upper Reach of Britannia Creek Looking Upstream, September 11, 2008 88
Photo 4. Canadian Creek Above the Confluence with Britannia Creek (Site F03) Looking Upstream, July 8, 2008 88
Photo 5. Lower Reach of Canadian Creek Looking Upstream, September 11, 2008 89
Photo 6. Lower Reach of Canadian Creek (F04) Looking Downstream, July 8, 2008 90
Photo 7. Reach 2 of Canadian Creek (Cascade Pools) Looking Upstream, September 11, 2008 90
Photo 8. Upper Reach (number 3) of Canadian Creek Looking Upstream, September 11, 2008 91
Photo 9. Upper Reach (number 2) of Casino Creek Looking Upstream, September 12, 2008 92
Photo 10. Lower Reach (number 1) of Casino Creek Looking Downstream, September 12, 2008 92
Photo 11. Reach 1 of Meloy Creek Looking Upstream, September 12, 2008 93
Photo 12. Upper Reach of Brynelsen Creek Looking Upstream, September 12, 2008 94
Photo 13. Lower Reach of Brynelsen Creek Looking Upstream, September 12, 2008 94
Photo 14. Upper Reach of Austin Creek Looking Upstream, September 12, 2008 95
Photo 15. Lower Reach of Austin Creek Looking Upstream, September 12, 2008 96
Photo 16. Reach of Dip Creek Enclosing Site F14 Looking Downstream, September 12, 2008 96
Photo 17. Alpine Habitat, Casino Project, 2008 97
Photo 18. Felsenmeer Habitat (Exposed Broken Rock), Casino Project, 2008 98

Photo 19. Aspen Forest Habitat, Casino Project, 2008 98
Photo 20. Floodplain Habitat, Casino Project, 2008 99
Photo 21. Island Habitat, Yukon River, Casino Project, 2008 99
Photo 22. Mixedwood Forest Habitat, Casino Project, 2008 100

Appendices

A. Atmospheric Environment
- A1. Casino Mine – Methodology Report for Installation of Meteorological Station

B. Aquatic Environment
- B1. Stream Stage-Discharge Data, Casino Project, 2008
- B2. Surface Water Quality Data, Casino Project, May 2008
- B3. Surface Water Quality Data, Casino Project, July 2008
- B4. Surface Water Quality Data, Casino Project, September 2008
- B5. Surface Water Quality Data, Casino Project, October 2008
- B6. Surface Water Quality Replicate Data, Casino Project, 2008
- B7. Sediment Quality Data, Casino Project, September 2008
- B8. Periphyton Taxonomy, Casino Project, September 2008
- B9. Benthic Invertebrate Taxonomy, Casino Project, September 2008
- B10. FISS Reports for Watersheds of the Aquatic Regional Study Area of the Casino Project
- B11. Minnow Trapping Catch, Effort and CPUE, Casino Project, 2008
- B12. Electrofishing Effort, Catch and CPUE, Casino Project, 2008
- B13. Angling Catch, Casino Project, 2008
- B14. Fish Biological Characteristics, Casino Project, 2008
- B15. Fish Tissue Metal Concentrations, Casino Project, 2008
- B16. Fish Habitat Data, Casino Project, July 2008
- B17. Fish Habitat Data, Casino Project, September 2008

C. Terrestrial Environment
- C1. Ecosystem Classification Data, Casino Project, July 2008
- C2. Ecosystem Classification Data, Casino Project, September 2008
- C3. Wildlife Survey Data, Casino Project, 2008

1. Introduction

1.1 Overview

This report describes the studies conducted in 2008 on the atmospheric, aquatic and terrestrial environments of the Casino Project area. Studies on hydrogeology (AECOM in preparation) and geochemistry (Lorax 2009) are reported separately. The purpose of these studies was to characterize the pre-development environment in support of the permitting process for the Casino Project.

The Casino Project is a proposed porphyry copper-gold-molybdenum mine located at latitude 62°44'N and longitude 138°50'W in west-central Yukon, 300 km northwest of the territorial capital of Whitehorse. Figure 1 shows the location of the Casino Project, surrounded by the aquatic Regional Study Area (RSA), in relation to the Yukon River – to which all of the streams in the Casino Project area eventually discharge.

In August 2008, a pre-feasibility study of the Casino Project was completed (M3 Engineering 2008). It envisioned a conventional truck-shovel, open pit mine. Waste rock will be stored in three waste rock dumps located south and east of the open pit (Figure 2). Tailings, process water, treated sewage effluent, leachate from the waste rock dumps and surface runoff from the mine site will be stored in a Tailings Impoundment Area (TIA) located in the headwaters of Casino Creek south of the waste rock dumps. The TIA is intended to be a zero discharge operation, hence makeup water will be pumped to the TIA through a pipeline from a site on the Yukon River approximately 17 km to the north. A 187 km-long unpaved access road (see Figures 6a and 6b) will be built from the Alaskan Highway at a point about 48 km northwest of Burwash Landing out to the mine site. It will be used to bring in equipment, supplies and fuel and to truck out metal concentrate.

1.2 Project History

The first known recording of a lode mineral claim in the area was in 1917. Discovery of silverlead veins in the 1930's led to further exploration that eventually led to the discovery in 1969 of the large copper and molybdenum porphyry deposit on Patton Hill. Over the next 23 years, various parties including Brameda Resources, Quintana Minerals, Teck Corporation and Archer, Cathro and Associates Ltd. acquired the property and did more drilling. In 1992, Pacific Sentinel Gold Corp. acquired the property and ran a major drilling program from 1992 to 1995. In addition, they performed a considerable amount of metallurgical, geotechnical and environmental work and completed a scoping study in 1995. Soon thereafter, First Trimark Resources and CRS Copper Resources obtained the property. In 2004, the two firms combined to form Lumina Copper Corporation and in November 2006 Western Copper Corporation acquired Lumina Copper Corporation and the Casino property.

Figure 1. Aquatic Regional Study Area in Relation to the Yukon River

(Y:\Projects\2008\80049 - Casino Aquatics\Report on 2008 Environmental Studies\Figures)

Figure 2. Proposed Casino Mine Site Layout

(Y:\Projects\2008\80049 - Casino Aquatics\Report on 2008 Environmental Studies\Figures)

1.3 Historical Sources of Environmental Data

In 1997, Hallam Knight Piésold Ltd. (HKP) completed a data report for Pacific Sentinel Gold Corp. summarizing the results of environmental baseline studies conducted from 1993 to 1995 (Hallam Knight Piésold 1997). The report provided data on meteorology, hydrology, surface water quality, groundwater quality, stream sediment quality, periphyton, benthic invertebrates, fish, soils, terrestrial vegetation and wildlife. Some of that data was compared to that collected in 2008 in this report.

Apart from Hallam Knight Piésold (1997), there are limited data available on the aquatic environment of the Casino area. Fisheries and Oceans Canada (DFO) has conducted surveys of fish and fish habitat in watersheds in the area, including the reaches of the Yukon River adjacent to the Casino property and the lower reaches of Dip Creek and the Klotassin, Donjek and White rivers. These were conducted for the purposes of managing Pacific salmon fisheries in the Yukon River, and for classifying fish habitat in support of the Yukon Placer Authorization (Government of Canada 2000). The results of these surveys are reported in DFO's Fisheries Information Summary System (FISS) (Appendix B10). The sources of the information listed in the FISS reports are Hallam Knight Piésold (1997) and memoranda, letters, personal communications and other relevant information held in the files of DFO's Whitehorse office.

Fish and Wildlife Branch of Yukon Department of Environment has conducted surveys of wildlife in the Casino study area and along its proposed access routes. Some of that data has been published, e.g., Farnell *et al.* (1991), but most of the baseline information on the relative abundance, seasonal distribution, movement and habitat use of wildlife in the Project area has yet to be collated and published. Some Traditional Knowledge of the Project area is available. For example, the current management plan for the Klaza Caribou Herd was derived in part from Traditional Knowledge of behaviour and habitat use provided by the Little Salmon/Carmacks First Nation (Yukon Environment 2004).

1.4 Study Areas

1.4.1 General

Two types of study area were defined for each of the three environmental components: a Local Study Area (LSA) and a Regional Study Area (RSA). The Canadian Environmental Assessment Agency (CEAA) defines a LSA as:

> "The area within which local effects are assessed (i.e., within close proximity to the action where direct effects are anticipated)" (CEAA 2008)

The boundaries of LSAs are defined by topographic features such as watershed boundaries (for aquatics) and slope breaks (for vegetation and wildlife). The LSA is of a size that lends itself to sampling and mapping at high intensity. CEAA (2008) defines a RSA as:

> "The area within which cumulative effects are assessed (i.e., extending a distance from the project footprint in which both direct and indirect effects are anticipated to occur)."

In practice, the RSA encompasses the LSA plus a larger surrounding area that is of sufficient size to evaluate the potential severity of Project-specific effects in combination with other past, present and reasonably foreseeable effects. The RSA may also include reference sampling sites that will be used as controls to assess Project-related effects on the LSA during the operational and post-closure phases of the Project. The RSA is defined by ecological boundaries and it is of a size that lends itself to sampling and mapping at lower intensities than an LSA.

1.4.2 Atmospheric Environment

The atmospheric LSA was based on the assumption that the atmospheric conditions measured at the meteorological station at the mine site are representative of conditions up to 20 km away (Geoff Doerksen, RWDI, personal communication) (Figure 3). The atmospheric RSA has not yet been defined.

1.4.3 Aquatic Environment

The LSA for the aquatic environment was defined by the boundaries of the two watersheds surrounding the Casino deposit: the Britannia Creek Watershed to the north and the Casino Creek Watershed to the south (Figure 4). Most of the proposed mine infrastructure will be in the Casino Creek Watershed, but some (e.g., the northern corner of the open pit) will be in the Britannia Creek Watershed. The northern part of the LSA is drained by Britannia Creek and one of its tributaries, Canadian Creek. Britannia Creek flows into the Yukon River. The northern edge of the LSA includes a 2 km-long reach of the Yukon River. The southern part of the property is drained by Casino Creek which flows south to Dip Creek and thence to the Yukon River via the Klotassin, Donjek and White rivers. The southern edge of the LSA includes a 2 km-long reach of Dip Creek.

The aquatics RSA was defined as the LSA plus four adjacent areas:

- ***Dip Creek Watershed***. The headwaters of Dip Creek are not expected to be affected by Project activities, but the reaches of Dip Creek downstream of the confluence of Dip and Casino creeks will be affected by reduction in flows from Casino Creek caused by the impoundment of its headwaters. The effects of those flow reductions will decrease with downstream distance from the confluence of Dip and Casino creeks. One water quality site (W16) was placed approximately 11 km downstream of the confluence to monitor far-field effects.
- **Sunshine Creek Watershed**. This watershed, located to the east of the Britannia Creek Watershed, is not expected to be affected by Project activities. For that reason a reference water quality station – site W17 – was located on Sunshine Creek upstream of its confluence with the Yukon River.
- ***Excelsior Creek Watershed***. This watershed, located to the west of Britannia Creek Watershed, is also not expected to be affected by Project activities. It was originally intended to be the site of a reference water quality site, but that site (W17) was eventually moved to Sunshine Creek for logistical reasons. This watershed may serve as a location for a reference site in the future.

Figure 3. Atmospheric Local Study Area

(Y:\Projects\2008\80049 - Casino Aquatics\Report on 2008 Environmental Studies\Figures)

Figure 4. Aquatic Regional Study Area with Sampling Sites

(Y:\Projects\2008\80049 - Casino Aquatics\Report on 2008 Environmental Studies\Figures)

- ***Yukon River***. This river will be the receiving environment for flows from Britannia Creek. Therefore, water quality sampling stations were placed upstream (W6b – a reference site) and downstream (W6a and W15) of the confluence of Britannia Creek and the Yukon River.

1.4.4 Terrestrial Environment

The terrestrial LSA was defined by the boundaries of the Casino Creek, Britannia Creek and Dip Creek watersheds (Figure 5). It is larger than the aquatics LSA but smaller than the aquatics RSA. The terrestrial RSA has not yet been defined. Figures 6a and 6b show the terrestrial LSA in relation to the proposed road route and the Wildlife Key Areas that have been identified by the Fish and Wildlife Branch of the Yukon Department of Environment.

1.5 Study Objectives

The overall objective of the 2008 environmental studies was to characterize the pre-development atmospheric, aquatic and terrestrial environments of the Casino Project area. The sampling strategy was to use, as much as was possible, the same sampling sites or areas that were monitored by Hallam Knight Piésold Ltd. from 1993 to 1995. This will develop further a multi-year database that will allow assessment of natural inter-annual variability.

The specific objective for the atmospheric studies was to install an automated meteorological station on Patton Hill that was capable of being remotely downloaded and that will record meteorological data continuously from the date of installation to the present. These measurements will provide the necessary observations for air quality modelling.

The specific objectives for the aquatic studies were the following:

- Install hydrometric stations on streams in the LSA that will continuously record stream flows and water temperatures.
- Develop stage-discharge curves for each hydrometric station from manual measurements of stream flow and staff gauge height collected over the open-water season.
- Sample stream water quality at sites in the LSA and RSA throughout the open-water season.
- Sample stream sediment quality at sites in the LSA once in 2008.
- Measure the density and taxonomic composition of the mid-summer periphyton communities in the LSA. Periphyton is the term given to the algal community that grows attached to stream substrates. It is the principal source of primary production for stream ecosystems and, because it is fixed to the substrate, it is useful for assessing mine effects on the aquatic environment.
- Measure the density and taxonomic composition of the stream benthic invertebrate communities in the LSA. Benthic invertebrates are a major source of prey for fish and, because they are attached to the substrate, are useful for assessing mine effects on the aquatic environment. Benthic invertebrates are a required component of the Environmental Effects Monitoring (EEM) guidelines of the Metal Mining Effluent Regulations (MMER) (Environment Canada 2002).

Figure 5. Terrestrial LSA with Wildlife Observations and Vegetation Plots

(Y:\Projects\2008\80049 - Casino Aquatics\Report on 2008 Environmental Studies\Figures)

Figure 6a. Terrestrial LSA, Access Road and Areas of Interest for Thinhorn Sheep and Raptors

(Y:\Projects\2008\80049 - Casino Aquatics\Report on 2008 Environmental Studies\Figures)

Figure 6b. Terrestrial LSA, Access Road and Wildlife Areas of Interest for Moose and Woodland Cariboo

(Y:\Projects\2008\80049 - Casino Aquatics\Report on 2008 Environmental Studies\Figures)

- Identify the fish species present in the LSA, describe their spatial distributions and measure their relative abundance and biological characteristics. Fish are the principal predators of stream communities and are a required component of the EEM guidelines of the MMER.
- Measure the whole-body tissue metal concentrations of slimy sculpin (*Cottus cognatus*) from each of the two watersheds in the LSA. Slimy sculpin were chosen because they are a resident species, hence their tissue metal concentrations will reflect local background metal concentrations in water. Tissue metal concentrations are a required component of the EEM guidelines of the MMER.
- Measure the key physical characteristics of stream fish habitat in the LSA.

The specific objectives of the terrestrial ecosystem studies were to collect sufficient preliminary information on soils and vegetation to plan a future air photograph interpretation study of the vegetation communities of the terrestrial LSA and RSA, and to document wildlife presence and use of the various plant communities and habitats.

2. Methods

2.1 Atmospheric Environment

2.1.1 Location and Setup of Meteorological Station

The geomorphology of the Casino Project area – a ridge from which watersheds descend to the north and south – meant that the atmospheric characteristics of the study area could be adequately monitored with a single meteorological station installed near the top of the ridge. The Casino meteorological station was installed on Patton Hill on October 3, 2008, and has been recording data continuously since that day. The station is located at 62°43’27.837”N and 138°49’0.562”W (UTM co-ordinates of 611,609E and 6,956,775N) at an elevation of 1,203 m above sea level (asl) (Figure 3). Appendix A1 shows the letter report from RWDI Air Inc. that describes the station and its installation.

The station consists of a 10 m-high, free-standing tower equipped with instrumentation, datalogger, and logger enclosure (Photo 1). The station is sited in a transition zone between tree line and alpine with an unobstructed fetch of at least 100 m in all directions. The site is sparsely covered in low brush and trees that are approximately 10 m tall. The station has instrumentation capable of measuring wind speed and direction, rainfall, air temperature, barometric pressure, relative humidity and snow depth. Observations are recorded and stored by a datalogger, which is powered by a battery charged with a solar panel at the station. The datalogger is equipped with a satellite modem for remotely accessing the data.

2.1.2 Quality Assurance/Quality Control (QA/QC)

Because the meteorological station was installed late in 2008, too few data have been collected from that station to be presented and analyzed in this report. However, the data that are being collected will be processed according to the following QA/QC protocols.

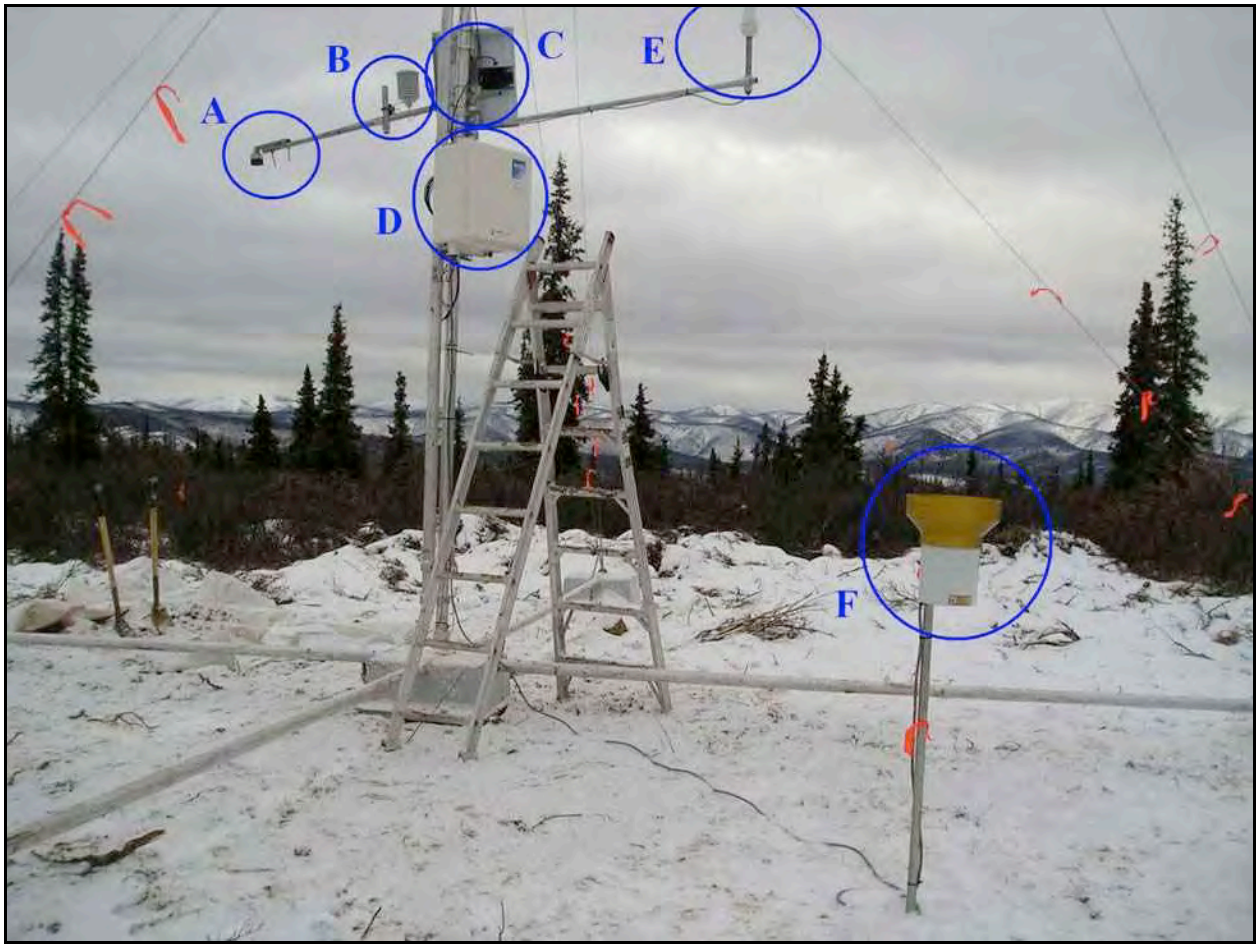

Photo 1. Casino meteorological monitoring station equipped with (A) sonic ranger, (B) relative humidity and temperature probe, (C) solar panel, (D) datalogger enclosure, (E) satellite antenna and (F) rain gauge

Three types of missing data are typically found in the datalogger of the meteorological station. The first is a missing timestamp or record for a particular averaging period. This occurs when the time series skips over a record or series of records entirely. Timestamps of missing periods are manually added to the final dataset. Values for each parameter are given a “Not a Number” (NAN) value for these periods. If missing periods persist or occur regularly, then appropriate action (e.g., send a field technician to the station) will be taken to investigate and resolve the issue.

The second type of missing data is a value for one or more parameters reported as NAN. This flag is typically given to invalid or erroneous data and is excluded in any analysis of data. If one or more parameters persistently shows NAN, then appropriate action (e.g., send a field technician to the station) will be taken to investigate and resolve the issue.

The third type of missing data is a value for one or more parameters that is reported as “0”. This may or may not be an erroneous value, depending on the parameter in question. It is not acceptable under any circumstances for barometric pressure, relative humidity and battery voltage. Values that are reported as zero for those variables will be replaced with NAN and are noted and documented in the final dataset.

Data are checked to see if they are within acceptable upper and lower limits by examining the range of values for each parameter. These limits does not reflect the instrument’s operational range, but they give the physical bounds in which the measurement makes sense. Any values outside the following limits will be considered to be erroneous and will be replaced with NAN:

- Wind speed (0 to 110 km/h);
- Wind direction (0 to 360°);
- Standard deviation of wind direction (0 to 100°);
- Air temperature (-50°C to 35°C);
- Barometric pressure (90 to 110 kPa);
- Relative humidity (0.1% to 100%);
- Rainfall (daily) (0 to 60 mm); and
- Battery voltage (10 to 15 Volts).

2.2 Aquatic Environment

2.2.1 Dates and Locations of Sampling and Surveying

2.2.1.1 General

The study design for the 2008 aquatics work was similar to the sampling design used in the 1993-1995 study by Hallam Knight Piésold. With a few exceptions, the same sampling locations were used and similar sampling techniques were employed. Five sampling trips were made from May to October (Table 1). For each trip, a fixed-wing aircraft was chartered from Alkan Air to fly from Whitehorse to the Casino property. While on the property, aquatic scientists travelled to sampling sites by helicopter (chartered from Capitol Helicopters), by all-terrain vehicles or by foot, depending on weather and trail conditions.

Table 1. Sampling Trips, Aquatic Environment, Casino Project, 2008

Date	Reconnaissance	Hydrology	Water Quality	Sediment Quality	Periphyton and Benthos	Fish and Fish Habitat
May 9	X	-	-	-	-	-
May 20-24	-	X	X	-	-	-
Jul 7-11	-	X	X	-	-	X
Sep 9-13	-	X	X	X	X	X
Oct 9-11	-	X	X	-	-	-

Dashes indicate no data were collected.

2.2.1.2 Hydrology

A total of seven hydrometric stations were installed in 2008. From May 21 to 23, dataloggers (Model 3001 Levelogger Gold, Solinst Corporation) were installed at six hydrometric stations: W1, W3, W4, W9, W11 and W14 (Table 2). This instrument uses a pressure transducer to measure water surface elevation and a thermometer to measure water temperature every hour. Pressure and temperature data were stored in the datalogger and were downloaded on subsequent trips in July, September and October. A barologger was installed at the airstrip to collect barometric air pressure (for barometric compensation for the hydrometric station loggers) and air temperature. On October 9, a seventh hydrometric station was added (H18) on Casino Creek.

Table 2. Summary of Hydrometric Stations and Datalogger Installation Dates, Casino Project, 2008

Watershed	Creek	Site	GPS Co-ordinates*			Dates	
			Easting	Northing		Installation	Winterization
Airstrip	-	-	612,244	6,957,050		May 22	-
Britannia Creek	Britannia	W1	617,439	6,971,241		May 22	Oct 10
	Canadian	W3**	616,141	6,966,789		May 23	Oct 11
	Britannia	W14	616,205	6,966,952		May 23	Oct 10
Casino Creek	Casino	W11	611,557	6,952,289		May 22	Oct 9
	Casino	H18	610,860	6,951,451		Oct 9	Oct 9
	Casino	W4	609,833	6,947,575		May 22	Oct 10
Dip Creek	Dip	W9**	610,018	6,947,352		May 22	Oct 10

**UTM Zone 7N, NAD 83.*

***reference site.*

Dashes indicate no data were available.

During the May field visit, the dataloggers were surveyed using a standard survey rod and level. The water level, the streambed, and the height of the datalogger in the water were determined at each logger station in relation to benchmarks (i.e., large spikes) installed on the creek bank. This allowed for water level measurements to be calculated relative to a fixed land-based benchmark.

Three of the six hydrometric stations were located in the Britannia Creek Watershed:

- W1 on the lower reaches of Britannia Creek;
- W3 on Canadian Creek upstream of the confluence of Canadian and Britannia creeks; and
- W14 on Britannia Creek upstream of its confluence with Canadian Creek.

Two stations were located in the Casino Creek Watershed:

- W11 installed in the upper reach of Casino Creek outside of the southern edge of the proposed TIA; and
- W4 installed on Casino Creek upstream of its confluence with Dip Creek.

One station was located in the Dip Creek Watershed – W9 on Dip Creek upstream of its confluence with Casino Creek.

On October 9, a seventh hydrometric station, H18, was installed in Casino Creek downstream of its confluence with Brynelsen Creek. This station was added to quantify the contribution of flow from Brynelsen Creek.

Two of the seven stations – W3 and W9 – are reference stations, which means they will not be affected by Project activities.

From October 9 to 11, the six dataloggers were winterized by covering each instrument in a latex balloon filled with glycol to prevent damage to the sensors when the surrounding water freezes during winter. Each datalogger was then installed inside a heavy duty, 10 cm-diameters plastic pipe that was partially buried in the stream substrate. Holes were drilled in the pipe to provide hydraulic connection between the stream and the datalogger. Pipes were secured to the stream bank with steel rods anchored by 2 m-long pieces of rebar. All dataloggers were attached with direct read cables for efficient data downloading.

Instantaneous stream flows were also measured manually at additional sites (e.g., W7, W8, W12, W13, W16 and W16 in May). Those sites are summarized in Section 2.2.1.3.

2.2.1.3 Water Quality

A total of 19 sites were chosen for water quality sampling of which six were the hydrometric stations installed in May 2008 (Table 3). Five sites were in the Britannia Creek Watershed:

- hydrometric stations W1, W3 and W14;
- W2 on Britannia Creek just downstream of the confluence of Canadian and Britannia creeks; and
- W7 located on upper Canadian Creek.

Table 3. Summary of Water Quality Sampling Sites, Casino Project, 2008

Watershed	Creek/River	Site	GPS Co-ordinates	
			Easting	Northing
Britannia Creek	Britannia	W2	616,158	6,967,156
	Canadian	W7	609,913	6,959,158
Casino Creek	Casino	W12	612,163	6,958,175
	Casino	W8	613,398	6,956,258
	Meloy	W43	610,823	6,955,906
	Meloy	W13	612,275	6,953,326
	Brynelsen	W18	610,893	6,951,180
Dip Creek	Dip	W9*	610,018	6,947,352
	Dip	W5	609,219	6,947,348
	Dip	W16	600,423	6,942,454
Sunshine Creek	Sunshine	W17*	626,775	6,968,802
Yukon River	Yukon	W6a	615,375	6,973,129
	Yukon	W6b*	619,781	6,973,576
	Yukon	W15	605,721	6,975,108

Dashes indicate no data were available.

Water quality sampling was also conducted at the six hydrometric stations listed in Table 2.

**reference site.*

Five sites were in the Casino Creek Watershed:

- hydrometric stations W11 and W4;
- W12 in Proctor Gulch, the uppermost reach of Casino Creek;
- W8 in the upper reach of Casino Creek upstream of the confluence of Meloy Creek;
- W43 on the adit discharge pipe of the lower camp (which discharges into upper Meloy Creek);
- W13 on Meloy Creek upstream of its confluence with Casino Creek; and
- W18 on Brynelsen Creek upstream of its confluence with Casino Creek.

Three sites were in the Dip Creek Watershed:

- hydrometric station W9;
- W5 on Dip Creek downstream of its confluence with Casino Creek; and
- W16 on Dip Creek 11 km west of site W5 – a far-field site.

One site – W17 – was on Sunshine Creek upstream of its confluence with the Yukon River.

Three sites were located on the Yukon River:

- W6a downstream from the outflow of Britannia Creek;
- W6b upstream of the outflow of Britannia Creek; and
- W15 upstream of the outflow of Excelsior Creek.

Of these 19 sites, three – W9, W17 and W6b – are reference sites, 15 sites are potentially affected by future mine activities, and one – W43 – has already been disturbed.

2.2.1.4 Sediment Quality

A total of 12 stream sites were sampled for sediment quality between September 9 and 10:

- five sites in the Britannia Creek Watershed (W1, W2, W3, W7 and W14);
- five sites in the Casino Creek Watershed (W4, W11, W12, W8 and W13); and
- two sites in the Dip Creek Watershed (W9 and W5).

Only W9 is a reference site. The co-ordinates of the sites are shown in Tables 2 and 3.

2.2.1.5 Periphyton and Benthic Invertebrates

Periphyton and benthic invertebrates were sampled from September 10 to 13. The two communities were sampled at that date because they were expected to have reached their maximum density and diversity after a summer of growth. Four sites were sampled in the Britannia Creek Watershed (Figure 4 and Table 4):

- B1/P1 (where “B” refers to benthos and “P” to periphyton) in lower Britannia Creek upstream of its confluence with the Yukon River;

- B2/P2 in Britannia Creek downstream of the confluence of Canadian and Britannia creeks;
- B3/P3 in Canadian Creek upstream of the confluence of Canadian and Britannia creeks; and
- B8/P8 at the head of Canadian Creek in an area that is proposed to become part of the open pit of the Casino Mine.

Table 4. Summary of Benthos and Periphyton Sampling Sites and Dates, Casino Project, 2008

Watershed	Creek	Site	GPS Co-ordinates		Date
			Easting	Northing	
Britannia Creek	Britannia	B1/P1	617,661	6,973,246	Sep 11
	Britannia	B2/P2	616,163	6,967,197	Sep 10
	Canadian	B3/P3	616,043	6,966,702	Sep 10
	Canadian	B8/P8	609,807	6,958,838	Sep 12
Casino Creek	Casino	B7/P7	613,396	6,956,247	Sep 10
	Casino	B4/P4	610,115	6,947,946	Sep 10
Dip Creek	Dip	B5/P5	609.363	6,947,024	Sep 10

Two sites were sampled in the Casino Creek Watershed – site B4/P4 located upstream of the confluence of Dip and Casino creeks, and site B7/P7 located at the head of Casino Creek in an area that is proposed to be covered by the Casino TIA.

One site were sampled in the Dip Creek Watershed – B5/P5 on Dip Creek, downstream of the confluence of Casino and Dip creeks.

None of these seven sites are reference sites – all are potentially affected by future mine activities.

2.2.1.6 Fish Communities

Fish communities were sampled from July 8 to 11 and from September 10 to 13. Sampling in late May was planned but was cancelled after reconnaissance on May 9 showed that most streams were too turbid to allow visual counts of Arctic grayling spawners or to allow electrofishing.

Four sites were sampled for fish in the Britannia Creek Watershed (Figure 4 and Tables 5 and 6):

- F01 (where “F” refers to fish) on lower Britannia Creek upstream of site B1/P1;
- F03 on lower Britannia Creek below the confluence of Canadian and Britannia creeks;
- F04 on Canadian creek approximately mid-way between sites F03 and F05; and
- F05 on upper Canadian Creek.

Sites F02 and F06 were Hallam Knight Piésold sites that were not sampled in 2008.

Seven sites were sampled for fish in the Casino Creek Watershed:

- F07 on upper Casino Creek downstream of the confluence of an unnamed tributary;
- F08 on upper Casino Creek approximately 2 km downstream of site F07 at the confluence of another unnamed tributary;
- F09 on Meloy Creek, a tributary of Casino Creek;
- F10 and F11 on Brynelsen Creek, another tributary to Casino Creek;
- F12 on Austin Creek upstream of its confluence with Casino Creek; and
- F13 on lower Casino Creek upstream of its confluence with Dip Creek.

One fish sampling site was located in the Dip Creek Watershed – site F14 on Dip Creek downstream of its confluence with Casino Creek.

There were no reference sites for fish in 2008 – all sites may potentially be affected by future mine activities. In particular, sites F07, F08 and F09 are located in an area of Casino Creek that is proposed to be covered by the TIA.

Table 5. Summary of Fish and Fish Habitat Sampling Sites and Dates, Casino Project, 2008

Watershed	Creek	Site	Electrofishing	Minnow Trapping	Angling	Fish Habitat Assessment
Britannia Creek	Britannia	F01	Jul 10	Jul 11	-	-
	Canadian	F03	Jul 8	-	-	Jul 8
	Canadian	F04	Jul 8	-	-	Jul 8
	Canadian	F05	Jul 9	Jul 11	-	-
Casino Creek	Casino	F07	Jul 9	Jul 11	-	Jul 9
	Casino	F08	Jul 9, Sep 12	Jul 11, Sep 12	Jul 11	Jul 9
	Meloy	F09	Jul 9	Jul 11	-	-
	Brynelsen	F10	Jul 9	-	-	-
	Brynelsen	F11	Jul 10, Sep 12	Sep 12	-	-
	Austin	F12	Jul 10	-	-	-
	Casino	F13	Jul 10	-	-	-
Dip Creek	Dip	F14	Sep 12	Jul 11, Sep 12	Jul 11	-

Dashes indicate no sampling at that site and date.

Stations F02 and F06 were not sampled in 2008.

Table 6. Co-ordinates of Electrofishing Upstream and Downstream, Minnow Trapping and Angling, Casino Project, 2008

Method	Site	GPS Co-ordinates	
		Easting	Northing
Electrofishing	F03-us	615,977	6,966,612
	F03-ds	616,015	6,966,696
	F04-us	610,252	6,963,764
	F04-ds	610,392	6,963,879
	F07-us	613,466	6,956,473
	F07-ds	613,449	6,956,383
	F08-us	613,044	6,954,528
	F08-ds	613,032	6,954,443
	F09-us	611,670	6,954,231
	F09-ds	611,689	6,954,068
	F10-us	609,353	6,953,502
	F10-ds	609,456	6,953,369
	F05-us	609,631	6,960,021
	F05-ds	609,518	6,960,215
	F11-us	610,122	6,952,279
	F11-ds	610,346	6,952,105
	F12-us	610,087	6,949,723
	F12-ds	610,190	6,949,589
	F13-us	610,260	6,948,372
	F13-ds	610,245	6,948,318
	F14-ds	609,367	6,947,025
	F01-us	617,439	6,971,280
	F01-ds	617,561	6,971,369
Minnow Trapping	F14	609,480	6,950,644
	F09	611,689	6,954,068
	F08	613,044	6,954,528
	F07	613,449	6,956,383
	F05	609,631	6,960,021
	F01	617,561	6,971,369
Angling	F14	609,480	6,947,025
	F08	613,044	6,954,528

us = upstream and ds = downstream.

In addition to direct sampling of fish communities, an aerial survey of Britannia and Canadian creeks was conducted on September 11 to search for Pacific salmon spawners. The survey was followed by foot surveys of selected stream reaches to ground-truth the aerial observations.

2.2.1.7 Fish Habitat

In July, sections of stream 75 to 200 m length centred over fish sampling sites were surveyed (Table 5): two in Britannia Creek Watershed (F07 and F08) and two in Casino Creek Watershed (F03 and F04).

In September, the focus shifted to surveying representative sections of stream reaches. The reaches and reach breaks were similar to those used by Hallam Knight Piésold (1997) (Figure 4). Table 7 shows the reach numbers for each stream and the GPS co-ordinates of the centre of the representative section that was surveyed.

Table 7. Locations of Fish Habitat Surveys, September 11-12, 2008

Site	Reach	Co-ordinates		Date
		Easting	Northing	
Lower Reach of Britannia Creek	1	617,126	6,970,199	11-Sep
Upper Reach of Britannia Creek	2	616,279	6,966,540	11-Sep
Lover Reach of Canadian Creek	1	615,314	6,966,030	11-Sep
Placer Mine on Canadian Creek	2	614,725	6,965,616	11-Sep
Cascade pools on Canadian Creek	2	609,160	6,960,684	11-Sep
Near Tank Farm on Canadian Creek	4	609,776	6,958,820	11-Sep
Upper Reach of Canadian Creek	3	609,622	6,958,679	11-Sep
At site F14 on Dip Creek	1	609,367	6,947,025	12-Sep
Meloy Creek	1	611,661	6,954,143	12-Sep
Upper Reach of Casino Creek	2	613,087	6,954,573	12-Sep
Lower Reach of Casino Creek	1	610,515	6,950,136	12-Sep
Lower Reach of Brynelsen Creek	1	610,209	6,952,288	12-Sep
Upper Reach of Brynelsen Creek	2	609,448	6,953,393	12-Sep
Lower Reach of Austin Creek	1	610,157	6,949,620	12-Sep
Upper Reach of Austin Creek	2	608,816	6,951,236	12-Sep

2.2.2 Sample Collection

2.2.2.1 Hydrology

In accordance with conventional stream gauging protocols for propeller-type meters, all hydrometric stations were established in straight channels, free from obstructions. Each site was selected to ensure representative hydraulic conditions.

Manual stream velocities were measured with a Marsh-McBirney Flo-mate 2000. The stream discharge (Q, m^3/s) was calculated following the United States Geological Survey mid-section method. The width of the stream was 'discretized' into 'panels', the number of which depending on the total width of the stream and the variation in stream velocity across the section. A stream velocity measurement was taken in the middle of each panel. In most instances, the number of panels was such that only between 5% and 10% of the flow passes though each panel. Stream velocity measurements were collected at 60% of the total depth at each measurement point in the cross-section. At points with depths greater than 50 cm, two velocity measurements were taken: one at 20% of the total depth; and, the other at 80% of the total depth. Flow was calculated at both points and the average of the two flows were used as the contribution of flow from that panel. Flows were summed over all the panels to obtain the total stream flow on that date.

Water stage (h, cm) was measured in two ways: measuring the height of the water at the logger installation, and measuring the depth of water at the thalweg – the deepest, fastest section of water in the cross-section.

2.2.2.2 Water Quality

All surface water samples were grab samples, collected in mid-stream approximately 20 cm under the surface with the bottle mouths facing upstream. Water quality samples were collected for general chemical parameters in pre-cleaned 500 mL plastic bottles supplied by the analytical laboratory. Samples for total metals were collected in 250 mL acid-washed plastic bottles supplied by the laboratory and preserved in the

field with laboratory-supplied nitric acid. Samples for dissolved metals were vacuum filtered in the field through 0.45-micron disposable filterware and preserved with laboratory-supplied nitric acid immediately after filtration. Samples for nutrients – ammonia, total Kjeldhal nitrogen (TKN) and dissolved orthophosphate – were collected in 250 mL bottles and preserved in the field with laboratory-supplied sulphuric acid. Total cyanide was collected in 1 L bottles containing laboratory-supplied sodium hydroxide as a preservative. Total Organic Carbon (TOC) was collected in 125 mL glass-amber bottles and preserved with laboratory-supplied hydrochloric acid. Dissolved Organic Carbon (TOC) was collected in 125 mL glass-amber bottles and preserved with laboratory-supplied hydrochloric acid immediately after filtration.

All samples were kept cold and were not allowed to freeze. They were shipped via air cargo from Whitehorse to Maxxam Analytics in Vancouver, BC. Maxxam Analytics is accredited by the Canadian Association for Environmental Analytical Laboratories. Chain of Custody forms accompanied all samples. Table 8 shows the water quality variables that were measured and their Reported Detection Limits (RDL).

Table 8. Water Quality Parameters and Detection Limits

Parameter	Units	RDL	Parameter	Units	RDL
Physical			Cadmium	mg/L	0.000005
Conductivity	µS/cm	1	Calcium	mg/L	0.05
pH	pH units	0.1	Chromium	mg/L	0.0001
Hardness	mg/L $CaCO_3$	0.5	Cobalt	mg/L	0.000005
Total Dissolved Solids (TDS)	mg/L	1	Copper	mg/L	0.00005
Total Suspended Solids (TSS)	mg/L	1	Iron	mg/L	0.001
Turbidity	NTU	0.1	Lead	mg/L	0.000005
Anions			Lithium	mg/L	0.0005
Alkalinity	mg/L $CaCO_3$	0.5	Magnesium	mg/L	0.05
Chloride	mg/L	0.5	Manganese	mg/L	0.00005
Sulphate	mg/L	0.5	Mercury	mg/L	0.00001
Cyanide (Total)	mg/L	0.0005	Molybdenum	mg/L	0.00005
Cyanide (Weak Acid Dissociable)	mg/L	0.0005	Nickel	mg/L	0.00002
Nutrients			Phosphorus	mg/L	0.002
Ammonia (as N)	mg/L	0.005	Potassium	mg/L	0.05
Nitrate (as N)	mg/L	0.005	Selenium	mg/L	0.00004
Nitrite (as N)	mg/L	0.002	Silicon	mg/L	0.1
Total Kjeldahl Nitrogen	mg/L	0.02	Silver	mg/L	0.000005
Ortho-phosphate (as P)	mg/L	0.001	Sodium	mg/L	0.05
Total and Dissolved Metals			Strontium	mg/L	0.00005
Aluminum	mg/L	0.0002	Thallium	mg/L	0.000002
Antimony	mg/L	0.00002	Tin	mg/L	0.00001
Arsenic	mg/L	0.00002	Titanium	mg/L	0.0005
Barium	mg/L	0.00002	Uranium	mg/L	0.000002
Beryllium	mg/L	0.00001	Vanadium	mg/L	0.0002
Bismuth	mg/L	0.000005	Zinc	mg/L	0.0001
Boron	mg/L	0.005	Zirconium	mg/L	0.0001

RDL = Reported Detection Limit from Maxxam Analytics.

µS = micro-Siemens, and NTU = nephelometric units.

Field measurements of pH, temperature and specific electrical conductivity were made at each site using a YSI Pro pH/conductivity/temperature meter.

2.2.2.3 Sediment Quality

One sample of stream bottom sediment was collected in September 2008 from each of the 12 sites listed in Section 2.2.1.4. The sediment was collected using established protocols from depositional areas of the stream. Where possible, sediment samples were collected by using the jar provided by the analytical lab as a scoop. Appropriate measures were taken to reduce potential for sample contamination. For example, field staff wore disposable nitrile gloves when sampling. All samples were kept cold at all times between sample collection and delivery to the laboratory. Chain of Custody forms accompanied all samples. Table 9 shows the sediment quality variables that were measured and their detection limits.

Table 9. Sediment Quality Parameters and Detection Limits

Parameter	Units	RDL	Parameter	Units	RDL
Physical					
Percent moisture	%	0.3	Manganese	mg/kg	0.2
pH	pH units	0.01	Mercury	mg/kg	0.05
Total Metals			Molybdenum	mg/kg	0.1
Aluminum	mg/kg	100	Nickel	mg/kg	0.8
Antimony	mg/kg	0.1	Phosphorus	mg/kg	10
Arsenic	mg/kg	0.2	Potassium	mg/kg	100
Barium	mg/kg	0.1	Selenium	mg/kg	0.5
Beryllium	mg/kg	0.1	Silver	mg/kg	0.05
Bismuth	mg/kg	0.1	Sodium	mg/kg	100
Cadmium	mg/kg	0.05	Strontium	mg/kg	0.1
Calcium	mg/kg	100	Thallium	mg/kg	0.05
Chromium	mg/kg	1	Tin	mg/kg	0.1
Cobalt	mg/kg	0.3	Titanium	mg/kg	1
Copper	mg/kg	0.5	Vanadium	mg/kg	2
Iron	mg/kg	100	Zinc	mg/kg	1
Lead	mg/kg	0.1	Zirconium	mg/kg	0.5
Magnesium	mg/kg	100			

RDL = Reported Detection Limit from Maxxam Analytics.

All units are mg/kg dry weight unless otherwise noted.

2.2.2.4 Periphyton

Five samples of periphyton were collected from each of the seven sampling sites from September 10 to 11, for a total of 35 samples. Each sample was collected from one rock selected from the stream bed. Each rock was scraped with a scalpel and the scrapings were washed into a sterile 500 mL plastic bottle jar with a squeeze bottle containing stream water. Each sample was preserved by adding Lugol's iodine solution.

All samples were stored in coolers and kept cool until they could be shipped to Fraser Environmental Services Ltd. (FES) of Surrey, BC, for analysis of taxonomic composition. Chain of Custody forms accompanied all samples.

Periphyton density (cells/cm^2) was calculated for each sample by dividing the total number of cells estimated for a sample by the surface area that was scraped for each sample. Sub-sampling was required to estimate numbers of cells (FES 1994). Sample surface area was estimated by tracing the outlines of each rock on a sheet of wax paper. Back in the office, the wax paper outlines were scanned to JPG file format at high resolution. The images were then rasterized and imported into AutoCAD where new vector boundaries were created based on the outside edge of the wax paper for each sample. This process ensured minimal margin of error and allowed for quick calculation once the scans were complete.

2.2.2.5 Benthic Invertebrates

Five samples of benthic invertebrates were collected from each of the seven sampling sites from September 10 to 11, for a total of 35 samples. Samples of benthic invertebrates were taken from areas of riffle habitat with similar stream depths and velocities. The Surber sampler has a surface area of 0.093 m^2 and mesh size of 250 µm. It was placed facing into the stream current with the hinged frame resting on the streambed. Substrate within the area defined by the frame was disturbed by hand for approximately 5 minutes to dislodge benthic organisms, which were swept into the net by the stream current. The organisms caught in the net were then washed into a sample bottle and preserved with 85% ethanol. This was repeated four more times at nearby areas to obtain five replicate samples at each site.

Samples of benthos were shipped to Cordillera Consulting in Summerland, BC, for taxonomic identification to the lowest practical taxonomic level, which was to the Order level for most aquatic insects, to the Class level for oligochaetes and to the Phylum level for nematodes. Chain of Custody forms accompanied all samples. All organisms in each sample were counted and identified – no sub-sampling was required.

Total density of benthic invertebrates collected by a Surber sampler was calculated by dividing the total number of organisms counted from a sample by the sampling area of the Surber sampler.

2.2.2.6 Fish Community

Three gears were used to sample fish: minnow traps, backpack electrofishers and angling. Three minnow traps were installed at each of five sites in July and two traps were installed at each of three sites in September for a total of 21 minnow trap installations. Minnow traps are made of galvanized steal wire and are conical in shape with a length of 42 cm, a width of 23 cm and a mesh size of 0.6 cm. Minnow traps were placed at each site in deep pools or among large woody debris or in slow-moving eddies. They were anchored to large woody debris or rocks and rocks were placed within the traps to weight them down. They were marked with red or yellow fluorescent flagging tape. Each trap was baited with canned salmon placed in a small perforated bag. Traps were soaked for 24 hours.

A mixture of one-pass and three-pass electrofishing was conducted. Three-pass electrofishing was conducted wherever flows were low enough that blocking nets could be installed in streams, but flows were

high enough at many sites to wash blocking nets out. For those sites, only one-pass electrofishing with no blocking nets were used.

For three-pass electrofishing, blocking nets were installed at the upstream and downstream ends of a stream section 75 m in length. Then, a two-person crew walked the stream section in an upstream direction repeatedly sweeping the stream from bank to bank with the wand of the electrofishing unit. Fish that were temporarily stunned by the electric field were scooped up with a dipnet and stored in a water-filled live bucket. After a pass was complete, the crew processed the captured fish on the stream bank. After waiting one half hour, another pass was conducted. After three passes, the blocking nets were removed and all processed fish were released live back into the stream except for those sculpin that were retained for tissue metals analysis.

Between passes, captured fish were identified to species and counted. Then, fork length was measured to the nearest 1 mm with a measuring board (total length was measured for slimy sculpin), and wet weight was measured to the nearest 0.1 g with a balance. Scales were collected from Arctic grayling for age analysis. The collection site was always on the side of the fish mid-way between the lateral line and the dorsal fin. Arctic grayling scales were sent to North Shore Environmental Services Ltd. In Thunder Bay, ON, where the scales were mounted on micro-fiches and the annuli were counted. A Chain of Custody form accompanied the samples.

Angling was conducted at two sites in July using standard angling gear. Angling effort (i.e., time spent angling) was not recorded. Fish were not processed for biological characteristics and no aging structures were collected.

2.2.2.7 Fish Tissue Metals Concentrations

A sub-set of slimy sculpin captured by electrofishing in July and September were collected for analysis of whole-body tissue metals concentrations. Each fish was placed in a labelled plastic bag and frozen immediately. The samples were sent to CANTEST analytical laboratories in Vancouver, BC. Chain of Custody forms accompanied all samples. At CANTEST, samples were digested using a nitric acid-hydrogen peroxide procedure based on U.S. EPA method 200.3. The concentrations of 32 metals were measured using Inductively Coupled Argon Plasma Spectroscopy (ICP) or ICP Mass Spectroscopy (Table 10). The concentrations of mercury were measured using Cold Vapour Atomic Absorption Spectrophotometry or Cold Vapour Atomic Fluorescence Spectrophotometry.

Table 10. Fish Tissue Metals and Detection Limits

Metal	RDL	Metal	RDL
Aluminum	0.5	Nickel	0.1
Antimony	0.1	Phosphorus	0.5
Arsenic	0.1	Potassium	1
Barium	0.1	Selenium	0.2
Beryllium	0.02	Silicon	10
Boron	2	Silver	0.01
Cadmium	0.02	Sodium	1
Calcium	1	Strontium	0.05
Chromium	0.1	Tellurium	0.1
Cobalt	0.1	Thallium	0.02
Copper	0.1	Tin	0.1
Iron	5	Titanium	0.3
Lead	0.1	Uranium	0.04
Magnesium	0.5	Vanadium	0.5
Manganese	0.1	Zinc	0.5
Mercury	0.01	Zirconium	3
Molybdenum	0.1		

All units are µg/g wet weight.

RDL = Reported Detection Limit.

2.2.2.8 Fish Habitat

Fish habitat was characterized following a modified version of the methods described in the *Fish Habitat Assessment Procedures* guide for the British Columbia government (Johnston and Slaney 1994). Stream length and stream width (i.e., wetted and bankfull width) was measured with surveyor's measuring tape. Gradient was measured with a clinometer. Stream depth was measured with a meter stick. Stream stage was assessed as low, medium or high visually by comparison between stream surface height and bankfull height. Habitat was visually assessed into the following five types:

- ***Pools*** have zero gradient, slow-moving water and a concave bottom;
- ***Runs*** (also called glides) are sections of non-turbulent, fast-flowing water;
- ***Riffles*** are areas of turbulent, fast-flowing water with gravel or cobble substrates and with obvious surface turbulence;
- ***Cascades*** are steep, stepped "riffles" of bedrock or emergent cobble or boulders in channels with gradients greater than about 4%;
- ***Other*** includes wetland complexes that lack an identifiable primary channel, sloughs, lakes, areas of sub-surface flow or areas where the channel cannot be observed (e.g., under large log jams).

Stream substrate was assessed visually into the following classes:

- fines (or silt);
- small gravel (2-16 mm particle diameter);
- large gravel (16-54 mm);
- small cobble (64-128 mm);
- large cobble (128-256 mm);

- boulder (>256 mm) or
- bedrock.

The percent of the stream surface that provided fish with cover was described using the following classes:

- deep pool;
- large woody debris (LWD);
- boulder;
- cutbank;
- instream vegetation; and
- overhanging vegetation.

The percentage of the overhead forest canopy that was closed was estimated visually.

The percentages of a stream section that belonged to each habitat type had to add to 100%, as did the percentages of the substrate of a stream section that belonged to each size class and the percent of the canopy that was closed. However, the percentages of cover provided by the various classes did not have to add up to 100%.

Stream confinement was assessed as:

- unconfined (UC) – the stream bank is not touching the valley wall;
- occasionally confined (OC) – the stream bank is occasionally confined by the valley wall or terraces;
- frequently confined (FC) – the stream bank is frequently confined by the valley wall or terraces;
- confined (CO) – the stream bank is in continuous or repeated contact at the outside of meander bends;
- entrenched (EN) – the stream bank is in continuous contact with the valley walls or terraces due to downcutting; and
- not applicable (NA) – no valley walls exist (e.g., alluvial fans).

The stream section was classified as braided or non-braided and the percent of the stream surface area made up of gravel bars was recorded.

Finally, a suite of water quality variables were measured with field instruments (e.g., YSI model 556): pH, water temperature, TDS, conductivity and dissolved oxygen concentration.

2.2.3 QA/QC

2.2.3.1 Water Quality

All field equipment were maintained in good working condition and measuring instruments were calibrated frequently. For example, the pH meter was calibrated prior to each field trip using prepared solutions with pHs of 4 and 7, and the conductivity meter was checked prior to each field trip using the standard 1,413 µS/cm conductivity solution.

Water quality samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency. All water samples were collected using industry standard sampling protocols. Appropriate measures were taken to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used bottles and preservative supplied by the analytical laboratory. All samples were collected with the mouth of the sampling bottle facing upstream. Care was taken to ensure that no upstream disturbances occurred as the result of walking within the creek bed prior to sampling.

Ten percent of the number of water quality samples were replicated, hence a total of five replicate samples were collected: two in May, two in July and one in September. Replicate sample locations were chosen randomly. Appendix B6 shows the results of analysis of replicate samples. Relative Percent Difference (RPD) was used to assess analytical variability. RPD was defined as:

$$\%RPD = \frac{2(X_1 - X_2)}{(X_1 + X_2)} * 100$$

where X_1 = the concentration of a parameter in the first sample and X_2 = the concentration of the same parameter in the second sample (i.e., the replicate). An RPD less than 25% is considered an acceptable difference, and an RPD greater than 25% warrants further examination to ensure that the result was not due to sampling error or analytical error. RPD is only relevant when both values are greater than the Practical Quantitation Limit (PQL), which was defined for this project as three times the detection limit. The PQL is considered the lowest concentration that can be accurately measured, as opposed to just detected.

As shown in Appendix B6 and Table 11, between one and seven of the 89 parameters that were measured from each sample had RPDs greater than 25% and met PQL restrictions. This was equivalent to between 1% and 8% of all parameters, which is considered to be an acceptable level of variability.

Table 11. RPD Analysis of Replicate Water Quality Samples, Casino Project, 2008

Month	Replicate	Number of Parameters with RPD>25%	Percent of Parameters with RPD>25%
May	1	7	8
May	2	3	3
July	3	1	1
July	4	3	3
September	5	2	2

A total of 89 parameters were measured from each sample.

The sites, dates and parameters for which RPD was greater than 25% were as follows:

- W1, May, turbidity, sulphate, total iron, total lead, total phosphorus, total titanium and total vanadium;
- W5, May, TSS, turbidity and dissolved thorium;

- W1, July, chloride;
- W43, July, TKN, dissolved aluminum and dissolved silver; and
- W43, September, TKN and dissolved nickel.

Sites W1, W5 and W43 should be targeted in future QA/QC monitoring to investigate further these results.

The results of the field and travel blanks are shown in Appendices B2 to B5. All values were below detection limits, indicating no contamination of samples.

Maxxam Analytics, which conducted the analyses of water and sediment samples, is a certified member of the Canadian Association of Environmental Analytical Laboratories. Maxxam split several samples into duplicates and analyzed each one separately to provide a measure of their laboratories analytical precision. Duplicates were chosen randomly by Maxxam. The results, which are not reported here, met Maxxam's standards for QA/QC.

2.2.3.2 Sediment Quality

Sediment quality samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency. All sediment samples were collected using industry standard sampling protocols. Appropriate measures were taken to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used sample bottles supplied by the analytical laboratory.

No replicate sediment quality samples were collected.

2.2.3.3 Periphyton and Benthos

Periphyton and benthic invertebrates samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency.

Fraser Environmental Services Ltd. (FES) has over ten years experience in analysis of periphyton from streams and rivers of western Canada. FES has the following standard QA/QC procedures (FES 1994):

- all microscopes are calibrated on a regular basis;
- consistent sample concentration and sub-sampling techniques are employed for identifications;
- taxonomic identifications are verified by comparison with reference collections, including an in-house reference collection;
- difficult, typical or dominant specimens are sent to external experts for confirmation. Part of this process includes compiling a list of experts for different groups of organisms. Verified specimens are incorporated into FES' reference collection; and
- all FES personnel actively participate in a taxonomists' working group.

Cordillera Consulting has over ten years experience in taxonomic analysis of benthic invertebrates from streams, rivers and lakes of western Canada. The following QA/QC procedures are followed by Cordillera Consulting (http://www.cordilleraconsulting.com):

- sorting efficiency – 10% of the whole sample number was resorted with an expectation of >90% efficiency in the sorting process.
- taxonomic efficiency – 10% of the identified sample vials were sent to another taxonomist. The two results were compared with simple statistics and the taxonomists discussed how best to correct their differences and make appropriate changes to the results.
- taxonomic precision – an externally verified reference collection is maintained by Cordillera Consulting. Any new specimens are sent away to experts of that taxon and the collection is reviewed every five years.

2.2.3.4 Fish and Fish Habitat

All fish and fish habitat field data were recorded on paper field notes and then transferred to electronic spreadsheets in the office. The spreadsheets were compared with the field notes to identify and correct transcription errors. A variety of other measures were taken to further ensure the validity of the data. For example, fish weights were plotted on fish lengths for each species separately to identify outliers that may have been due to errors in recording or transcription. Outliers were then corrected, if possible, or excluded from the analyzed dataset.

Blanks and duplicates were run by CANTEST for each of the two batches of slimy sculpin tissue that were analyzed for metals concentration. Appendix B15 shows those data. In both cases the blanks were below detection limits, indicating no contamination of equipment. RPDs were calculated for each metal from the duplicate samples. In all cases, the RPDs were below the 20% limit specified by the *British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment, Biological Material and Discrete Ambient Air Samples* (BC MOE 2007).

2.2.4 Data Analysis

2.2.4.1 Hydrology

In order to reconstruct a discharge hydrograph for each hydrometric station, a relationship between manual measurements of discharge and water stage (referred herein as a rating curve) was developed. A power function is used to predict discharge from water stage:

$$Q = a(h - z)^b$$

where Q is discharge (m^3/s), h is stage (m), z is gauge height at “zero flow” (m), and a and b are constants. An estimate of z was obtained by plotting log(Q) versus log (h) – z was the y-intercept when log(Q) = 0. Then, the power function was converted to a linear regression equation by taking logarithms:

$$\log(Q) = \log a + b \log(h - z)$$

and regression analysis was used to estimate values for a and b for each hydrometric site.

To reconstruct a hydrograph at each site, the continuous stage readings recorded by the datalogger were converted to hourly flows using the fitted stage-discharge relationship for each site. Daily mean discharges were calculated from the hourly discharges.

2.2.4.2 Water Quality

The minimum, median and maximum concentrations of selected water quality parameters were calculated for each site sampled in 2008. The median, rather than the arithmetic mean, was assumed to be the best estimate of the central tendency of the data because many water quality variables tend not to be normally distributed. To calculate statistics, all data for each site were pooled over the May-October sampling period and values below detection limits were replaced with one-half the detection limit.

Concentrations of water quality parameters were compared to guidelines for the protection of freshwater aquatic life issued by the Canadian Council of the Ministers of the Environment (CCME) (CCME 2008), and exceedances of the guidelines were identified.

Principal components analysis (PCA) of water quality was used to reduce the redundancy within the dataset and identify underlying trends. The first step in PCA of water quality was to remove all variables for which 90% of the records were below detection limits. For the remaining variables, all values below detection limits were replaced with one-half the detection limit. Concentrations of total and dissolved metals were transformed with natural logarithms to normalize the frequency distributions. The varimax option was used to rotate components in order to maximize the contrast between components and improve comprehension of the results.

2.2.4.3 Sediment Quality

The minimum, median and maximum concentrations of each sediment quality parameter were not calculated because only one sample was taken for each site sampled in September 2008.

The 2008 sediment quality data was compared to the CCME (2008) sediment guidelines for the protection of freshwater aquatic life. There are two classes of guidelines: the Probable Effects Level (PEL), which defines the level above which adverse effects are expected to occur frequently; and the Interim Sediment Quality Guideline (ISQG), which is lower than the PEL and which defines the concentration below which minimal effects on the aquatic environment are expected.

PCA of sediment quality was calculated in the same way as PCA of water quality. All metals for which 90% of the records were below detection limits were removed. For the remaining metals, all values below detection limits were replaced with one-half the detection limit. Metal concentrations were transformed with natural logarithms to normalize the frequency distributions, and the varimax option was used to rotate components.

2.2.4.4 Periphyton and Benthos

One-way Analysis of Variance (ANOVA) was used to compare mean densities of periphyton and of benthic invertebrates between sites. ANOVA assesses the statistical significance of differences using F-ratios. Significance was assessed as none ($P>0.05$), low ($0.01<P<0.05$), medium ($0.001<P<0.01$) and high ($P<0.001$), where P is the probability of making a Type I error (i.e., rejecting a true null hypothesis). Densities were ln-transformed to normalize the frequency distributions and to satisfy the assumption of equal variances – two prerequisites of parametric statistics.

The taxonomic composition of periphyton and benthos communities were assessed using tabular means after pooling replicates for each site.

Two indices of taxonomic diversity were calculated for each sample of periphyton and three indices were calculated for each sample of benthic invertebrates using the protocols recommended by the Canadian Aquatic Biomonitoring Network (CABIN), which is supported by the National Water Research Institute (NWRI) of Environment Canada (NWRI 2008):

- taxonomic richness (S), calculated as the total number of families in a sample, regardless of their relative abundances;
- EPT abundance (EPT), defined as the total number of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) in a sample. These three orders of aquatic insects are typically most sensitive to habitat disturbance. EPT was not calculated for periphyton; and
- Shannon-Weiner diversity index (H'), calculated as $-\Sigma(p_i \ln(p_i))$, where $p_i = n_i/N$, n_i = the total number of individuals in the ith species, N = the total number of organisms in the sample, and H' was calculated by summing over all species (i.e., over S).

For the purposes of calculating S and H', those taxa that could not be identified to the family or species level (e.g., unidentified flagella for periphyton and Phylum Nematoda for benthos) were treated as if they were a family or a species. The periphyton data reported by Fraser Environmental Services included less than signs (<) for some species or genus, indicating that the species or genus were present in the sample but not in sufficient numbers to allow density to be calculated. Those data were used to calculate periphyton richness, but they were not used to calculate densities and Shannon-Wiener diversity indices.

2.2.4.5 Fish and Fish Habitat

The standard error (SE) was the index of dispersion for all arithmetic means shown in this report, and n was the sample size.

Total catch-per-unit-effort (CPUE) of minnow traps was not calculated because the traps caught no fish. Electrofishing CPUE was defined as the number of fish captured per 100 seconds of electrofishing effort. Angling CPUE was not calculated because fishing effort (i.e., angling time) was not recorded.

One-way ANOVA was used to compare mean fish CPUE between seasons and sites and mean fish length and weight between watersheds.

Weight-length regressions for fish were calculated as ln(W) = a + bln(L), where W = weight (g) and L = fork length (mm), a = the intercept of the regression and b = the slope of the regression. Both weight and length were ln-transformed to normalize their frequency distributions and produce homogenous variances. The coefficient of determination (i.e., r^2) for all regressions were adjusted for the number of degrees of freedom.

The length-age relationship for Arctic grayling was estimated by fitting a von Bertalanffy growth model with non-linear regression. The model is $L = L_\infty(1 - \exp(-K(t - t_0)))$ where L = length (mm), t = age (year), L_∞ = length (mm) at infinite age (also known as asymptotic length), K = growth coefficient ($year^{-1}$) and t_0 = the age (year) at which L = 0 mm. The advantage to using a von Bertalanffy model is that it predicts non-zero lengths for 0-age fish.

Analysis of slimy sculpin tissue metal concentrations was similar to that of water quality and sediment quality: remove all metals for which 90% of the records were below detection limits, replace all values below detection limits with one-half the detection limit, and use PCA to identify underlying trends. Metal concentrations were transformed with natural logarithms to normalize the frequency distributions, and the varimax option was used to rotate components.

2.3 Terrestrial Environment

Two terrestrial reconnaissance surveys were conducted in 2008: one from July 7 to 11 and a second from September 8 to 11. Aerial surveys of the terrestrial LSA were conducted in a helicopter at low altitudes (mean height of 150 m above ground level) and low speeds (40 to 55 knots). Two observers scanned the ground with binoculars and recorded observations on vegetation communities and wildlife in field notes and on a map of the LSA. Photographs of vegetation communities were taken.

Aerial surveys were followed by ground-based surveys conducted by foot or with ATVs. A total of 33 sites – 17 in July and 16 in September – were surveyed (Figure 5). At each site, wildlife habitat was classified (e.g., aspen forest, riparian, alpine subalpine, etc.), surficial geology was classified (e.g., collivial, fluvial, bedrock, etc.), and general features of the habitat were described (e.g., slope, aspect, drainage, etc.). Soil pits were dug to a minimum 40 cm (where possible) or to the C layer. Samples of vegetation were collected and animal sighting and signs (claw marks, paw prints, antlers, scat, etc.) were photographed and their GPS co-ordinates recorded with a Garmin 76 handheld GPS with accuracy of between 5 and 10 m.

The vegetation sampling strategy was guided by the *Standards for Terrestrial Ecosystem Mapping (TEM) in British Columbia* (RIC 1998). This system provides an established and uniform means of describing vegetation, soils and terrain characteristics based on air photo interpretation and field data collection programs. Sampling of vegetation used a combination of ground inspection plots (GIF) and visual checks, using Ecosystem Field Forms adapted from methodology outlined in the *Field Manual for Describing Terrestrial Ecosystems* (BC MELP and MOF 1998). Ground inspections used FS212 (adapted) field forms to record site, soil and vegetation information. Notes describing the plot, in context and variability within the polygon, were recorded. Photographs were taken at each plot.

Visual checks involved recording brief point or area characteristics made from the air (helicopter) or ground, and were used to note the basic ecosystem unit, vegetation, and other key features. The primary function of visual plots was to aid in the delineation of polygon and to confirm the placement of polygon boundaries during the photo interpretation and mapping phases proposed for 2009.

Vegetation nomenclature followed that of the *Flora of the Yukon Territory* Second Edition (Cody 2000). A detailed rare plant survey of the Project area was not within the scope of this assessment. Instead, attempts were made to identify potentially rare, sensitive and/or endangered vegetation or vegetation communities within the study area. In general, alpine/sub-alpine and riparian communities across the LSA were expected to possess the greatest potential of harbouring rare plants or sensitive plant communities because they are sensitive to disturbance and may take above mean lengths of time to recover from disturbance. Riparian areas also provide high wildlife habitat value.

The terrestrial data collected in 2008 were reconnaissance-level only and hence were not subjected to extensive analysis. They primary purpose was to provide sufficient data to effectively plan more comprehensive surveys in the future.

3. Results and Discussion

3.1 Atmospheric Environment

There were too few meteorological data to be analyzed in this report because the Casino meteorological station has only been operating since October 3, 2008. Air temperatures recorded by the barologger at the Casino airstrip are shown in Section 3.2.1.2 below.

3.2 Aquatic Environment

3.2.1 Hydrology

3.2.1.1 Stage-Discharge Rating Curves

Appendix B1 shows the stage-discharge data for the six hydrometric stations. Table 12 summarizes the manual discharge measurements and shows the estimates of the gauge height at zero flow (z) for each of the hydrometric stations.

Table 12. Summary of Manual Discharges and 'z' for Hydrometric Stations

Creek	Site	May (m^3/s)	July (m^3/s)	September (m^3/s)	October (m^3/s)	Gauge at Zero Flow (z, m)
Britannia	W1	2.539	0.840	2.136	0.403	0.06
Canadian	W3	1.621	0.332	1.568	0.375	0.26
Casino	W4	1.499	0.495	2.118	0.809	0.18
Dip	W9	3.988	3.613	3.252	1.105	0.29
Casino	W11	0.865	0.136	0.707	0.401	0.06
Britannia	W14	0.864	0.290	0.398	0.145	0.03

Figures 7 through 12 show the stage-discharge rating curves for sites W1, W3, W4, W9, W11 and W14 respectively. The regression statistics shown in each figure – sample size (n), coefficient of determination (r^2) and the probability that the slope is equal to zero (P) – are the results of the log-linear regression analysis. In each case, the regression provided an apparently fair to strong fit to the data. However, two of the regressions – those for W9 and W11 – were not significant (P>0.05) due to the small sample size.

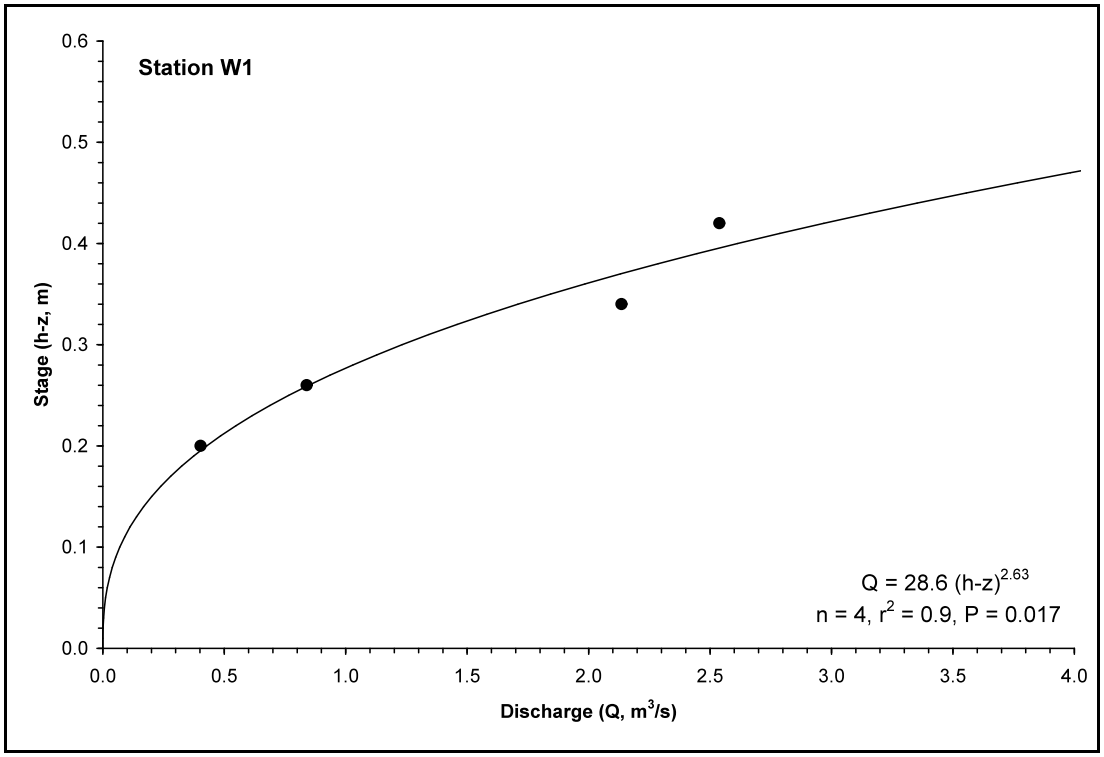

Figure 7. Stage-Discharge Rating Curve for Site W1, Britannia Creek, Casino Project, 2008

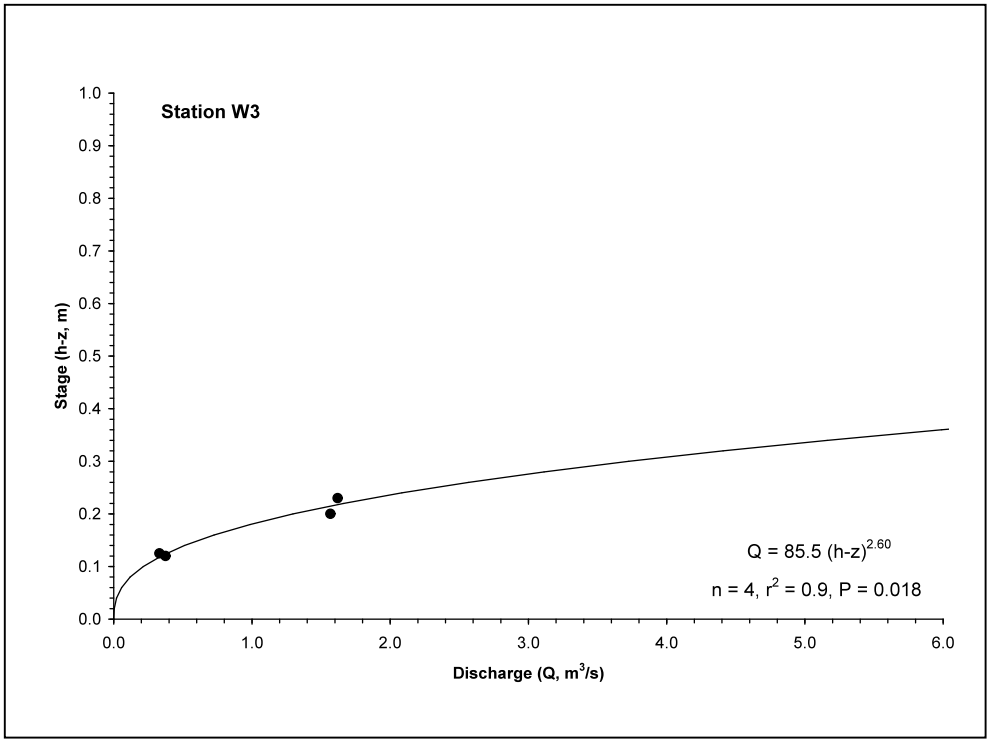

Figure 8. Stage-Discharge Rating Curve for Site W3, Canadian Creek, Casino Project, 2008

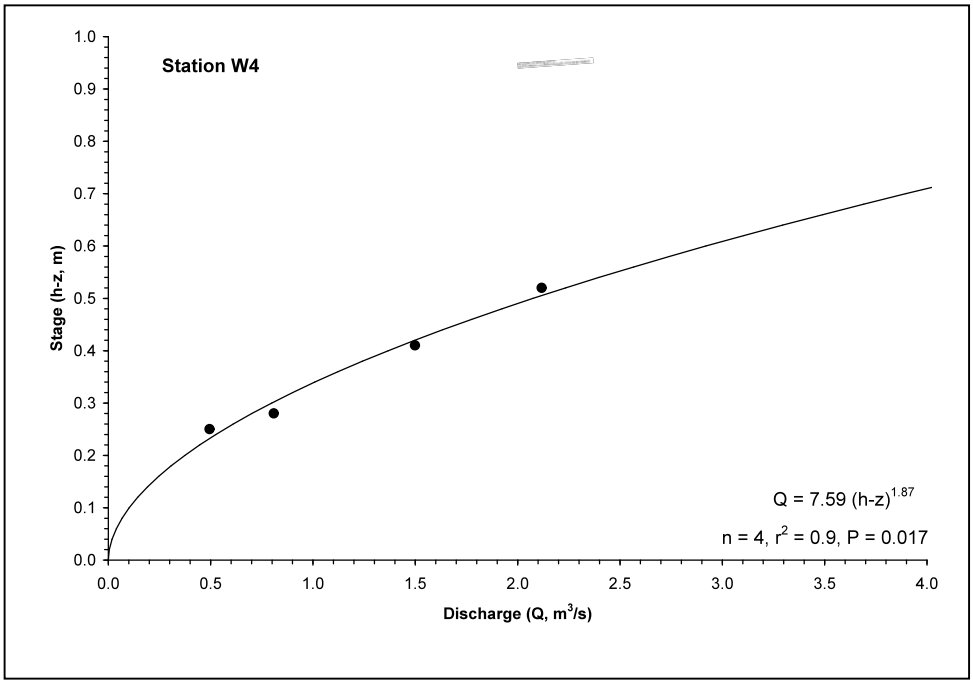

Figure 9. Stage-Discharge Rating Curve for Site W4, Casino Creek, Casino Project, 2008

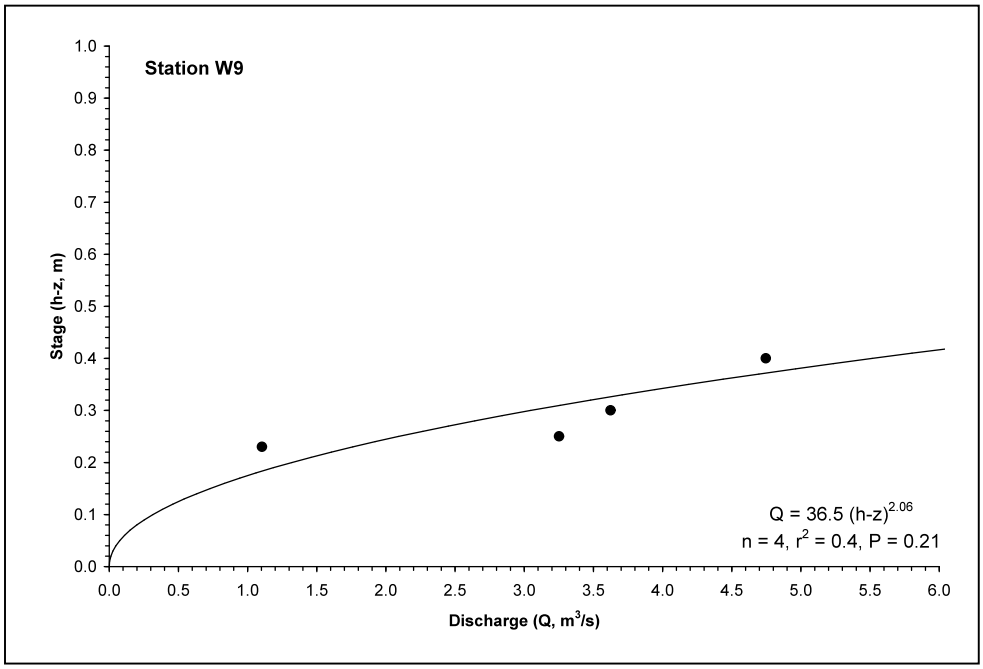

Figure 10. Stage-Discharge Rating Curve for Site W9, Dip Creek, Casino Project, 2008

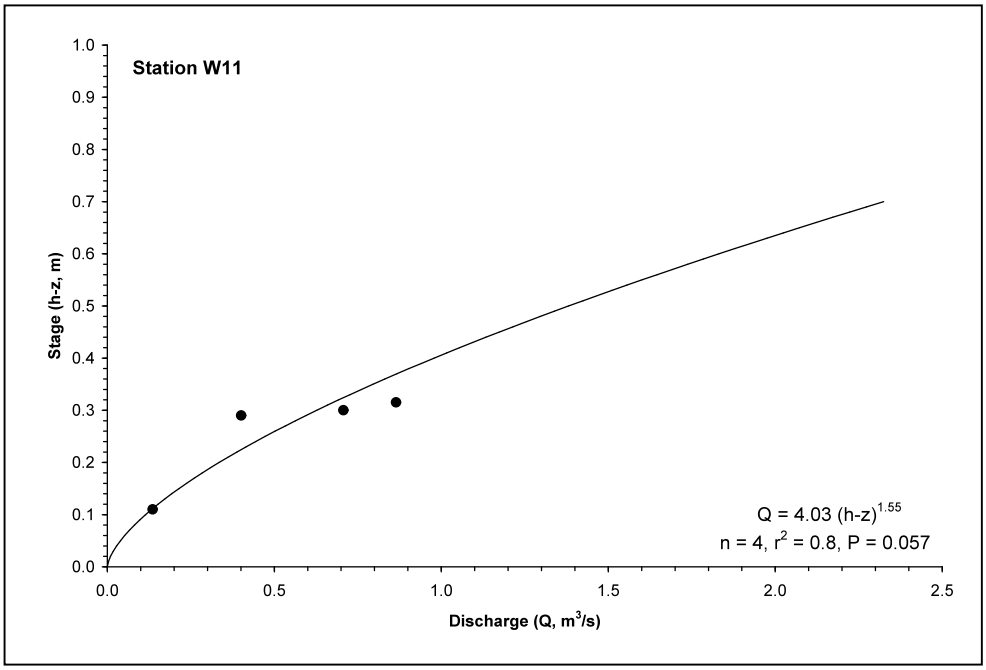

Figure 11. Stage-Discharge Rating Curve for Site W11, Casino Creek, Casino Project, 2008

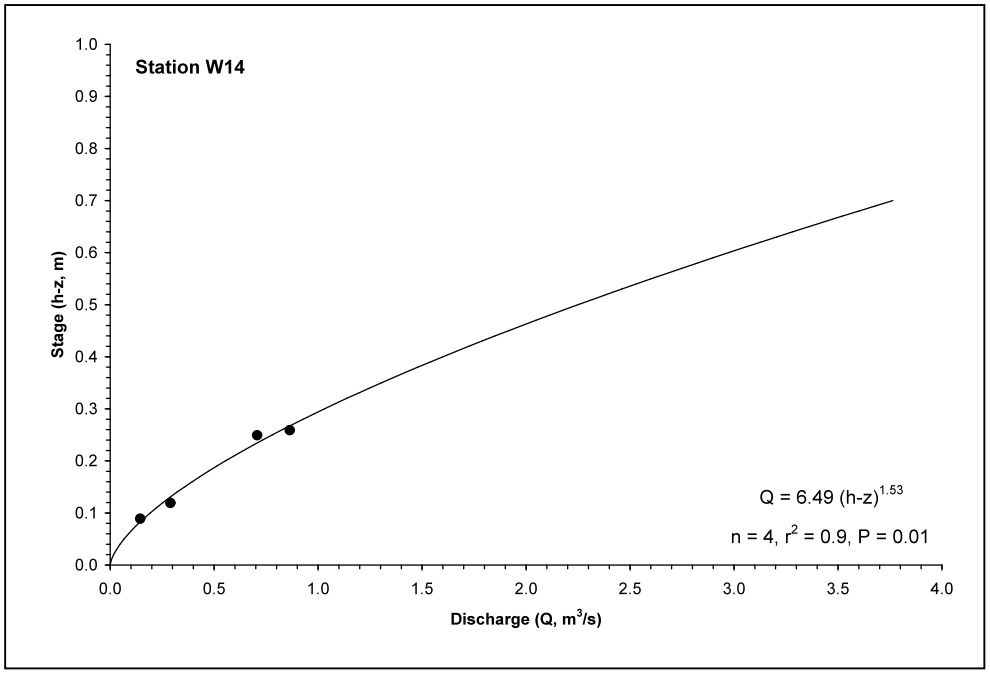

Figure 12. Stage-Discharge Rating Curve for Site W14, Britannia Creek, Casino Project, 2008

In general, the manual measurements during each field visit were conducted during medium to high flow events. Consequently, the reconstruction of discharge at lower flows is less reliable. Future field visits should attempt to capture, if possible, lower flows in efforts to produce more representative stage-discharge rating curves.

3.2.1.2 Hydrographs

Figures 13 to 18 show the hydrographs for stations W1, W3, W4, W9, W11 and W14, respectively. Discharge is shown as a solid blue line, water temperature as the dashed green line and air temperature as the dotted orange line. Due to a logger malfunction at station W4 (Figure 15), data was not collected between May 22 and July 9, 2008.

In the absence of meteorological data, it is difficult to ascertain the source (snow melt, precipitation, permafrost melting, etc.) of specific peaks in discharge for each station. However, The following observations can be made with a moderate degree of confidence, based on the temporal patterns of stream temperature and air temperature, in conjunction with the temporal pattern of specific discharge peaks:

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Figure 13. Hydrograph for Station W1, Britannia Creek, Casino Project, 2008

(Y:\Projects\2008\80049 - Casino Aquatics\Hydrology\80048_DTAB_CS_Casino Hydrographs_09mar10_CED_Ver4[W1-Figure 13].xls)

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Figure 14. Hydrograph for Station W3, Canadian Creek, Casino Project, 2008

(Y:\Projects\2008\80049 - Casino Aquatics\Hydrology\80048_DTAB_CS_Casino Hydrographs_09mar10_CED_Ver4[W3-Figure 14].xls)

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Figure 15. Hydrograph for Station W4, Casino Creek, Casino Project, 2008

(Y:\Projects\2008\80049 - Casino Aquatics\Hydrology\80048_DTAB_CS_Casino Hydrographs_09mar10_CED_Ver4[W4-Figure 15].xls)

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Figure 16. Hydrograph for Station W9, Dip Creek, Casino Project, 2008

(Y:\Projects\2008\80049 - Casino Aquatics\Hydrology\80048_DTAB_CS_Casino Hydrographs_09mar10_CED_Ver4[W9-Figure 16].xls)

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Figure 17. Hydrograph for Station W11, Casino Creek, Casino Project, 2008

(Y:\Projects\2008\80049 - Casino Aquatics\Hydrology\80048_DTAB_CS_Casino Hydrographs_09mar10_CED_Ver4[W11-Figure 17].xls)

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Figure 18. Hydrograph for Station W14, Britannia Creek, Casino Project, 2008

(Y:\Projects\2008\80049 - Casino Aquatics\Hydrology\80048_DTAB_CS_Casino Hydrographs_09mar10_CED_Ver4[W14-Figure 18].xls)

- The peak discharge of freshet, and associated 'falling limb', was only captured at sites along Britannia and Canadian creek (W1 and W3 - Figures 13 and 14).
- A large, regional precipitation event appeared to have occurred, as was evident from a decrease in stream and air temperatures, around July 20, causing a large peak in discharge on July 20 and 21 at all stations.
- A very large, regional precipitation event appeared to have occurred, as was evident from a decrease in stream and air temperatures, around August 25, causing the largest peak in discharge on August 26 for all stations. This peak discharge was large enough to overflow stream banks, as was noted by the presence of overflow channels, newly deposited silt on floodplains and newly deposited debris on floodplain during the September field visit.
- The fluctuating pattern of discharge along Casino Creek (sites W4 and W11 – Figures 15 and 17) and Dip Creek (site W9 – Figure 16) are similar, although unique when comparing these creeks to Canadian Creek (site W3 – Figure 14) and Britannia Creek (sites W1 and W14 – Figures 13 and 18).
- Britannia and Canadian creeks appear to be more "flashy" than Casino and Dip creeks. That is, they appear more responsive to assumed smaller scale precipitation events. However, meteorological data are needed to confirm this conclusion because it is possible that fluctuations in air temperature could be causing melt of permafrost, creating a similar pattern in discharge peaks.
- On several occasions it appears that there no stream flow in Canadian Creek (site W3 – Figure 14), although it is assumed that there was discharge during these times. Additional low flow manual measurements are needed to improve the rating curve at this station.

3.2.1.3 Historic Flow Data

Figures 19 to 21 show the historic flow data calculated from the HKP data that were collected in 1993 and 1994 for hydrometric sites W1, W3 and W4, respectively. When compared to the flow data that was collected in 2008, the following observations can be made:

- peak flow events at site W1 for the HKP data (Figure 19) are similar in magnitude and character (i.e., flashy response) to the peaks observed in 2008 (Figure 13);
- peak flow events at site W3 for the HKP data (Figure 20) are much lower than peak flows observed in 2008 (Figure 14). Both sets of flow data appear to have a flashy response to precipitation events; and
- peak flow events at site W4 for the HKP data (Figure 21) are similar in magnitude and characteristics to the peaks observed in 2008 (Figure 15).

It is important to note that a detailed comparative analyses between the HKP and AECOM flow data are limited due to the relatively small sample size of the manual measurements used to construct the rating curves for the 2008.

3.2.2 Water Quality

3.2.2.1 Statistical Summary

Appendices B2 to B5 show the surface water quality data for the months of May, July, September and October 2008, and Tables 13 and 14 show the minimum, median and maximum values for selected water quality parameters for sites in Casino Creek and Britannia Creek, respectively.

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Figure 19. Hydrograph for Station W1, Britannia Creek, Casino Project, 1993-1994

(Y:\Projects\2008\80049 - Casino Aquatics\Hydrology\80048_DTAB_Knight_Piesold stage data 93-94_09Mar13_CED_v1[H1-W1-Figure 19].xls)

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Figure 20. Hydrograph for Station W3, Canadian Creek, Casino Project, 1993-1994

(Y:\Projects\2008\80049 - Casino Aquatics\Hydrology\80048_DTAB_Knight_Piesold stage data 93-94_09Mar13_CED_v1[H3 (W3)-Figure 20].xls)

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Figure 21. Hydrograph for Station W4, Casino Creek, Casino Project, 1993-1994

(Y:\Projects\2008\80049 - Casino Aquatics\Hydrology\80048_DTAB_Knight_Piesold stage data 93-94_09Mar13_CED_v1[H4 (W4)-Figure 21].xls)

Table 13. Water Quality Summary Statistics, Casino Creek Watershed, 2008

(Y:\Projects\2008\80049 - Casino Aquatics\Report on 2008 Environmental Studies\Tables\WQ Statistics Casino 2008[Casino_sum_stats].xls)

Table 14. Water Quality Summary Statistics, Britannia Creek Watershed, 2008

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3.2.2.2 Exceedances of Water Quality Guidelines

Table 15 shows that CCME guidelines for protection of freshwater aquatic life were exceeded for pH, total cyanide (CN) and eight total metals: aluminum (Al), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), silver (Ag) and zinc (Zn). Exceedances of at least one parameter were found at all sites except W18, but that station was only sampled in October. The number of exceedances was highest for cadmium, copper and aluminum and least for cyanide (Figure 22). Exceedances of cadmium, copper and aluminum often occurred together at the same stations. Exceedances were most numerous in May (n = 84), similar between July (n = 46) and September (n = 50), and least numerous in October (n = 24), indicating a seasonal trend related to hydrological factors such as snow melt and stream flow.

Table 15. Water Quality Parameters Exceeding CCME Guidelines, Casino Project, 2008

Site	May	July	September	October
W7	pH, Al, Cd, Cu, Fe	Cd, Cu	Al, Cd, Cu	Cd
W3	Al, Cd, Cu, Fe	-	Al, Cd, Cu	Cu
W14	Al, Cd, Cu, Fe	Al	Al, Cd, Cu, Fe	-
W2	Al, Cd, Cu, Fe	Al, Cd, Fe	Al, Cd, Cu	NS
W1	Al, Cd, Cr, Cu, Fe	-	Cu	-
W6b	Al, Cd, Cr, Cu, Fe, Pb, Zn	Al, Cd, Fe	Al, Cd	Al, Cd, Fe
W6a	Al, Cd, Cr, Cu, Fe	Al, Cd, Fe	Cd	Al, Cd
W15	Al, Cd, Cr, Cu, Fe, Pb, Zn	Al, Cd, Fe	Al, Cd	NS
W17	Al, Cd	Al, Cd	Cd	NS
W43	Cd, Cu, Pb, Zn	Cd, Cu, Pb, Zn	Cd, Cu, Pb, Ag, Zn	Cd, Cu, Pb, Ag, Zn
W12	pH, Al, Cd, Cu, Pb, Fe, Zn	pH, Al, Cd, Cu, Fe, Zn	pH, Al, Cd, Cu, Fe, Zn	pH, CN, Al, Cd, Cu, Fe, Zn
W8	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	NS
W13	Al, Cd, Cu, Pb	Cd	Cd	NS
W11	Al, Cd, Cu, Fe	Cd, Cu	Al, Cd, Cu	Cd, Cu
W18	NS	NS	NS	-
W4	Al, Cd, Cu, Fe	Cu	Al, Cd, Cu	Cd, Cu
W9	Al, Cd, Cu, Fe, Pb	Al, Cu, Fe	Al	-
W5	Al, Cd, Cu, Fe, Pb	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	Cu
W16	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	NS

Dashes indicate no parameters exceeded CCME guidelines. NS = Not sampled.

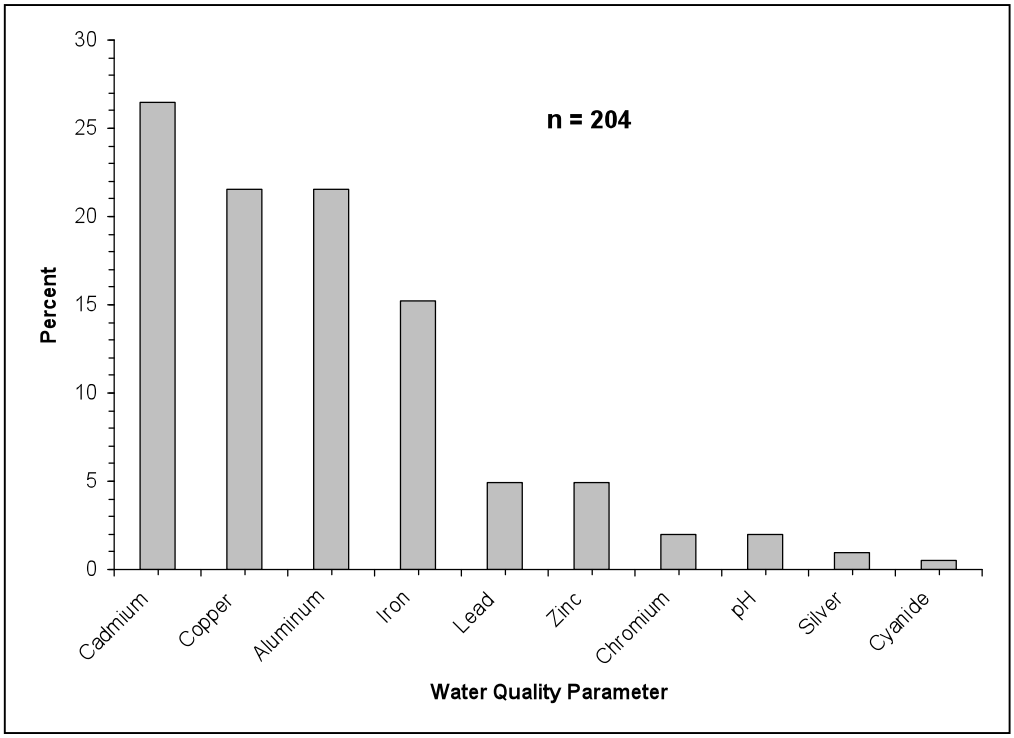


Figure 22. Water Quality Exceedances of CCME Guidelines, Casino Project, 2008

3.2.2.3 Principal Component Analysis

Data

Field measurements of pH and conductivity were excluded from the dataset because the laboratory measurements of pH and conductivity were assumed to be more accurate. Acidity and TOC were excluded because they were measured in less than 10% of the records. Six variables were excluded (total boron, total tin, dissolved bismuth, dissolved boron, dissolved mercury and dissolved tin) because 90% or more of the records were below detection limits. For the remaining 79 variables, a total of 822 records (or 14% of the dataset) were replaced: 732 records of metal concentrations below detection limits were replaced by one-half the detection limit, 60 absent records of DOC for May, July and September were replaced by the mean for October and 30 absent records of dissolved metals for station W3 on September 10 were replaced with the geometric means of dissolved metals that were calculated from records for May, July and October. All metals were ln-transformed to normalize their distributions.

Components and Their Correlations

Eleven components were extracted from the data matrix, but the first five components accounted for 70.5% of the explained variance and a scree plot (not shown here) indicated that the remaining six factors were of little significance (Table 16).

Table 16. Correlations of Water Quality Parameters with Principal Components

Parameter	WQ1	WQ2	WQ3	WQ4	WQ5
Percent explained variance	19.2	16.6	15.4	11.9	7.4
Cumulative explained variance	19.2	35.8	51.2	63.1	70.5
Total Cadmium	0.95	-0.03	0.03	-0.15	0.16
Total Zinc	0.95	0.00	-0.01	-0.12	0.15
Dissolved Cadmium	0.94	-0.04	0.02	-0.27	0.05
Dissolved Zinc	0.93	-0.03	0.01	-0.10	0.00
Total Silver	0.91	0.01	-0.06	0.05	0.05
Dissolved Silver	0.87	0.16	0.17	-0.16	-0.11
Dissolved Lead	0.86	0.07	0.03	0.06	-0.10
Total Lead	0.84	0.01	-0.07	0.37	0.05
Dissolved Manganese	0.83	0.33	0.12	-0.02	-0.17
Total Thallium	0.79	0.36	0.18	0.20	0.28
Total Manganese	0.78	0.32	0.11	0.21	0.14
Dissolved Copper	0.76	0.50	0.20	-0.21	-0.13
Dissolved Thallium	0.74	0.24	0.38	-0.18	0.21
Total Copper	0.74	0.51	0.23	-0.15	-0.02
Total Antimony	0.69	-0.52	0.37	-0.02	-0.12
Dissolved Antimony	0.65	-0.53	0.36	-0.04	-0.15
Total Molybdenum	-0.91	-0.09	0.09	0.13	0.19
Dissolved Molybdenum	-0.90	-0.08	0.02	0.19	0.22
Dissolved Iron	0.09	0.93	0.06	0.26	0.04
Dissolved Aluminum	-0.09	0.91	0.00	0.23	0.08
Dissolved Beryllium	0.24	0.85	-0.02	0.17	0.02
Total Aluminum	-0.09	0.81	-0.01	0.36	0.28
Total Beryllium	0.16	0.78	-0.01	0.38	0.33
Total Iron	0.16	0.75	0.07	0.38	0.31
Dissolved Cobalt	0.55	0.75	0.15	-0.08	-0.08
Total Cobalt	0.45	0.71	0.12	0.19	0.30
Dissolved Chromium	-0.11	0.64	-0.03	0.59	-0.01
Sulfate	0.22	0.57	0.56	-0.25	0.18
Nitrite	0.02	0.45	-0.17	0.08	-0.06
Ammonia	0.08	0.43	0.24	-0.10	0.32
Total Mercury	0.15	0.39	-0.27	0.09	-0.10
pH	-0.40	-0.78	-0.08	0.15	-0.11
Alkalinity	-0.18	-0.75	0.51	-0.04	0.02
Dissolved Barium	-0.13	-0.67	0.12	0.00	-0.22
Total Barium	-0.10	-0.63	-0.01	0.36	0.13
Nitrate	0.20	-0.46	0.43	-0.15	-0.51
Total Magnesium	-0.01	-0.11	0.95	-0.08	0.16
Dissolved Calcium	0.14	0.04	0.88	-0.28	0.23
Total Calcium	0.13	0.03	0.88	-0.28	0.24
Total Strontium	0.18	-0.27	0.85	-0.21	-0.09
Dissolved Strontium	0.20	-0.26	0.85	-0.22	-0.12
Hardness	0.15	0.30	0.82	-0.23	0.24
Total Uranium	-0.18	0.14	0.81	0.13	-0.36
Dissolved Uranium	-0.21	0.07	0.73	0.12	-0.39
Total Potassium	0.30	-0.01	0.72	0.04	0.06
Dissolved Potassium	0.31	0.02	0.71	0.03	0.04
Conductivity	0.20	0.45	0.71	-0.27	0.20
Total Sodium	-0.06	-0.07	0.68	-0.36	-0.24
Dissolved Magnesium	-0.05	-0.20	0.64	-0.03	0.05
TDS	0.16	0.42	0.64	-0.24	0.22
Dissolved Lithium	0.35	0.04	0.41	-0.03	0.22
Total Lithium	0.30	0.02	0.37	0.00	0.26

Parameter	WQ1	WQ2	WQ3	WQ4	WQ5
Total Vanadium	-0.24	0.07	-0.34	0.83	0.20
Total Titanium	-0.30	0.15	-0.34	0.79	0.14
Total Chromium	-0.16	0.45	-0.10	0.78	0.28
Total Phosphorus	-0.01	0.20	-0.33	0.76	0.37
Total Zirconium	-0.30	0.27	-0.17	0.74	-0.20
Total Arsenic	0.15	-0.35	0.10	0.72	0.16
Dissolved Vanadium	-0.20	0.14	-0.19	0.66	-0.07
Dissolved Titanium	0.03	0.46	-0.32	0.65	-0.03
Dissolved Phosphorous	0.09	0.50	-0.37	0.62	-0.03
Dissolved Zirconium	-0.27	0.41	-0.01	0.62	-0.36
TSS	0.06	0.02	-0.14	0.60	0.45
Dissolved Arsenic	-0.19	-0.29	0.24	0.47	-0.03
TKN	-0.15	0.41	-0.26	0.43	-0.18
Dissolved Silicon	0.12	0.00	0.36	-0.46	-0.21
Total Silicon	0.11	-0.01	0.38	-0.49	-0.17
Total Selenium	-0.21	0.09	0.20	0.00	0.87
Dissolved Selenium	-0.27	0.12	0.17	0.11	0.86
Total Nickel	0.18	0.48	-0.02	0.37	0.74
Turbidity	0.13	0.19	0.02	0.29	0.67
Dissolved Nickel	0.25	0.49	-0.08	0.24	0.64
Total Cyanide	-0.04	0.20	0.18	0.09	-0.05
Cyanide WAD	0.03	0.26	0.06	0.16	-0.06
Dissolved Sodium	0.02	0.11	0.53	-0.21	-0.05
Ortho-Phosphorus	0.06	-0.22	0.02	-0.27	0.28
Chloride	0.03	-0.10	0.15	0.04	-0.07
Total Bismuth	0.13	0.22	-0.43	0.41	0.22
DOC	-0.24	-0.01	0.18	0.11	-0.12

The first component, WQ1, was positively correlated with 16 dissolved and total metals, including cadmium, zinc, silver, lead, manganese, thallium, copper and antimony, and negatively correlated with total and dissolved molybdenum. This was called the “heavy metals” component because it reflects the magnitudes of the concentrations of heavy metals. The first component extracted from a water quality data set is almost always a “size” or “magnitude” component.

The second component, WQ2, was positively correlated with ten dissolved and total metals, including iron, aluminum, beryllium, cobalt, chromium and mercury, one anion – sulphate – and two nutrients – nitrite and ammonia – and negatively correlated with pH, alkalinity, barium and nitrate. This was called the “iron-pH” component because it reflects a pH- and alkalinity-related difference in metal concentrations among sites and dates.

The third component, WQ3, was positively correlated with hardness, conductivity, TDS, and 13 total and dissolved metals, including magnesium, calcium, strontium, uranium, potassium, sodium and lithium. The metals are all those associated with TDS, which typically reflects the influence of groundwater flows. Therefore, WQ3 was called the “TDS” component.

The fourth component, WQ4, was positively correlated with 12 dissolved and total metals, including vanadium, titanium chromium, phosphorus, zirconium and arsenic, TSS and TKN and negatively correlated with dissolved and total silicon. It was called the “vanadium-silicon” component.

The fifth component, WQ5, was positively correlated with dissolved and total selenium and nickel and turbidity. It was called the “selenium-nickel-turbidity” component.

Seven parameters – total cyanide, cyanide WAD, dissolved sodium, ortho-phosphorus, chloride, total bismuth and DOC – were not significantly correlated with any of the first six components.

Spatial and Temporal Variation in WQ1 Scores

The highest mean WQ1 score was observed at site W43, the discharge pipe of the adit of the lower camp, which discharges into upper Meloy Creek of the Casino Creek Watershed (Figure 23). The second highest mean WQ1 score was observed for site W12 in Proctor Gulch, the uppermost reach of Casino Creek, and the third highest mean score was at site W8 in the upper reach of Casino Creek upstream of the confluence of Meloy Creek. The lowest mean WQ1 score was for site W18 in Brynelsen Creek. Mean WQ1 scores for the other 15 sites fell within a narrow range. These findings indicate that WQ1 represents the geochemical signal of drainage from the adit of the lower camp, and that adit drainage flows downstream through all of the water quality sampling sites of Casino Creek except for Brynelsen Creek.

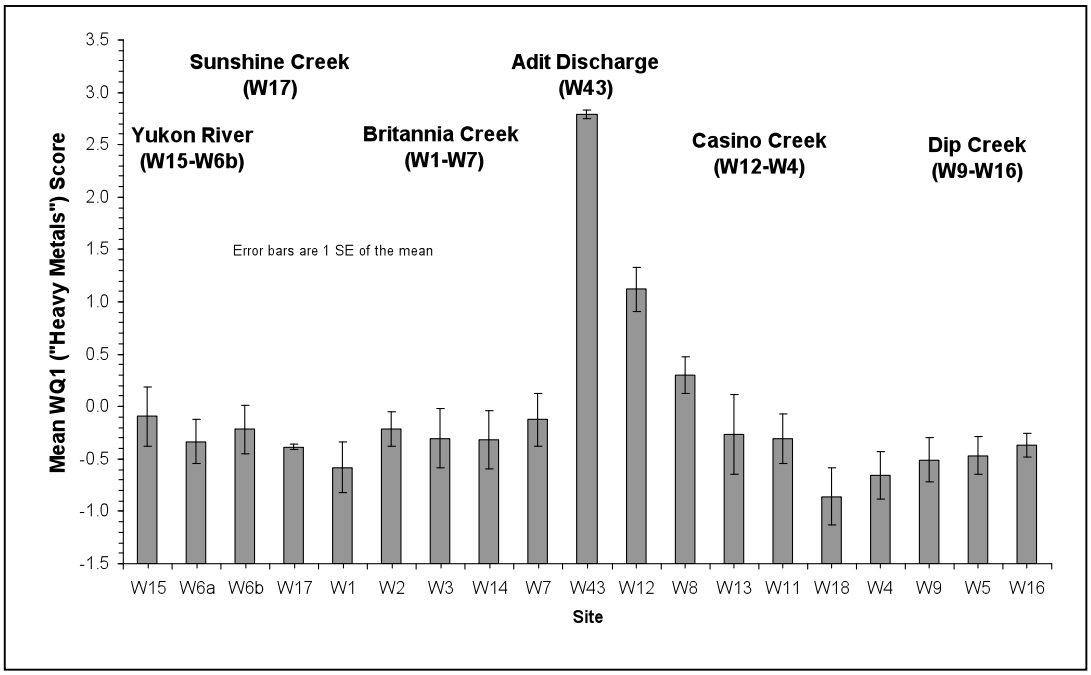


Figure 23. Plot of Mean WQ1 Scores on Sampling Site, Casino Project, 2008

WQ1 scores were highest in May and decreased continuously over the open-water season at all three Yukon River sites (Figure 24). The WQ1 scores for site W17 in Sunshine Creek did not show a seasonal trend. WQ1 scores for the five sites in the Britannia Creek Watershed showed a strong seasonal trend with the highest scores in May and September and the lowest in July and October (Figure 25). WQ1 scores in the Casino Creek Watershed showed the downstream gradient. WQ1 scores for site W43 did not show a seasonal trend, but WQ1 scores for the other five sites showed a bimodal seasonal pattern similar to that

observed in the Britannia Creek Watershed (Figure 26). WQ1 scores for the three sites along Dip Creek showed a strong decreasing seasonal trend with less of a bimodal pattern. (Figure 27). The seasonal trends, particularly the bimodal pattern observed in Britannia and Casino creeks, indicate that WQ1 scores vary directly with stream flow.

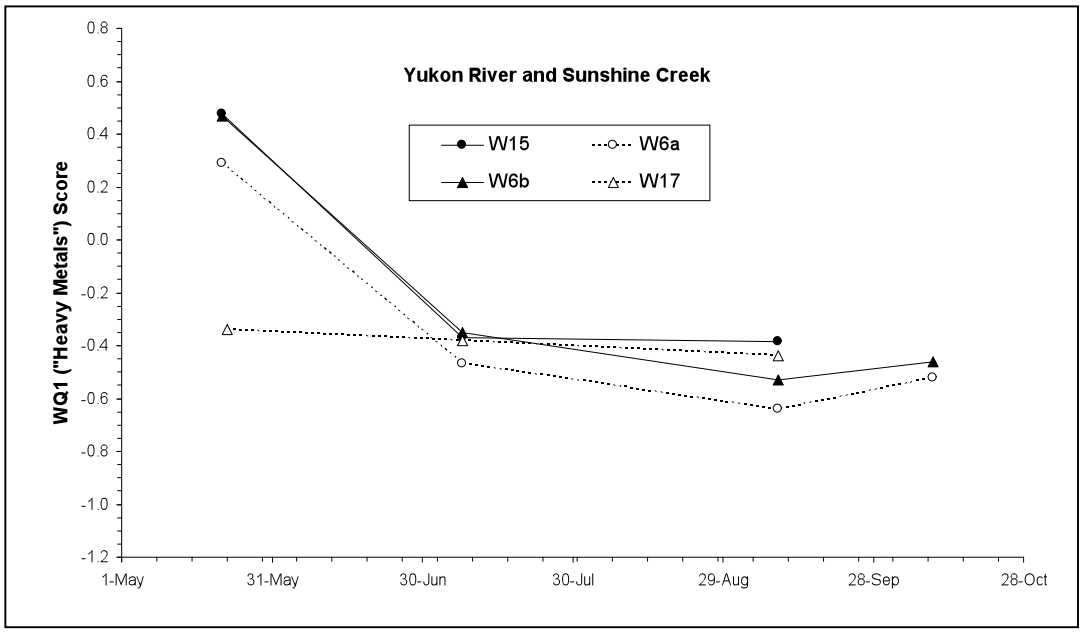
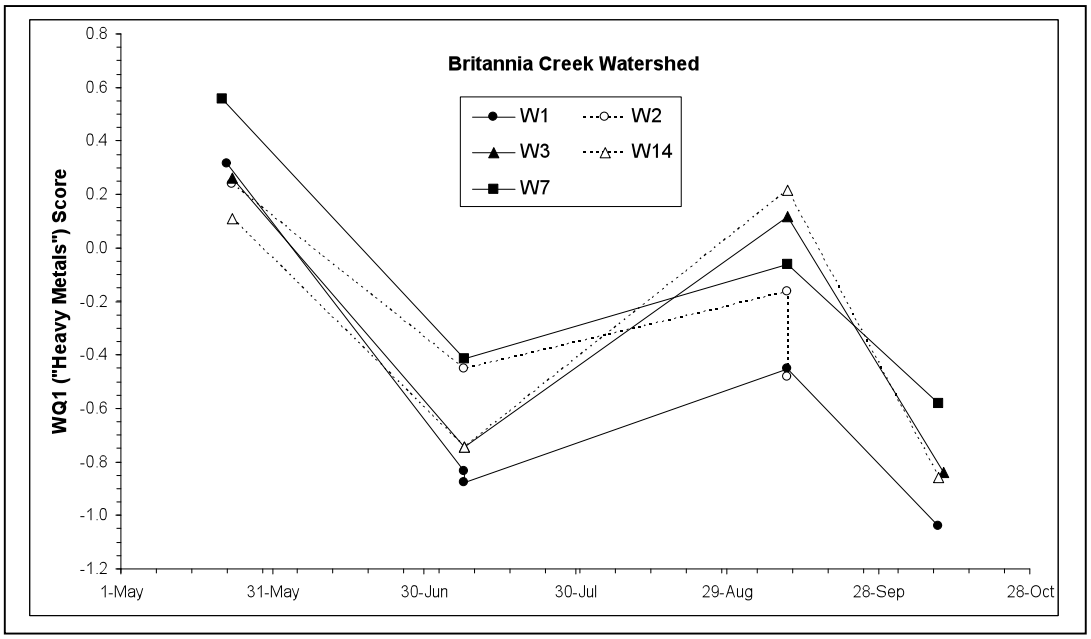


Figure 24. Plot of WQ1 Scores on Sampling Date, Yukon River and Sunshine Creek, Casino Project, 2008



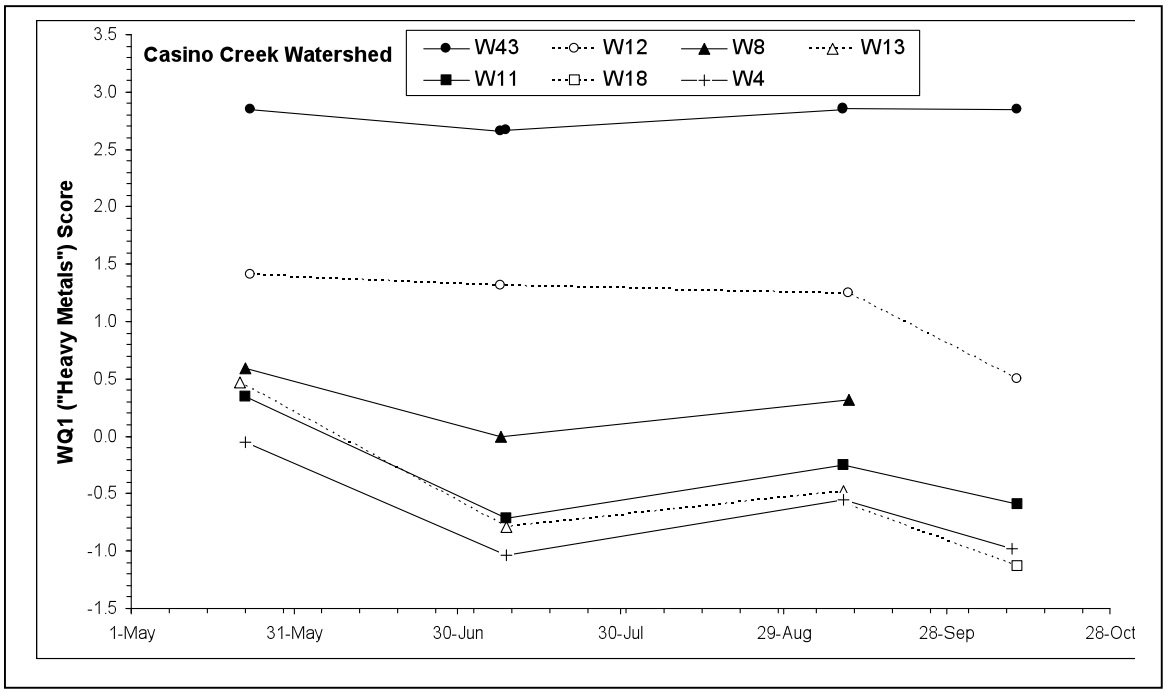
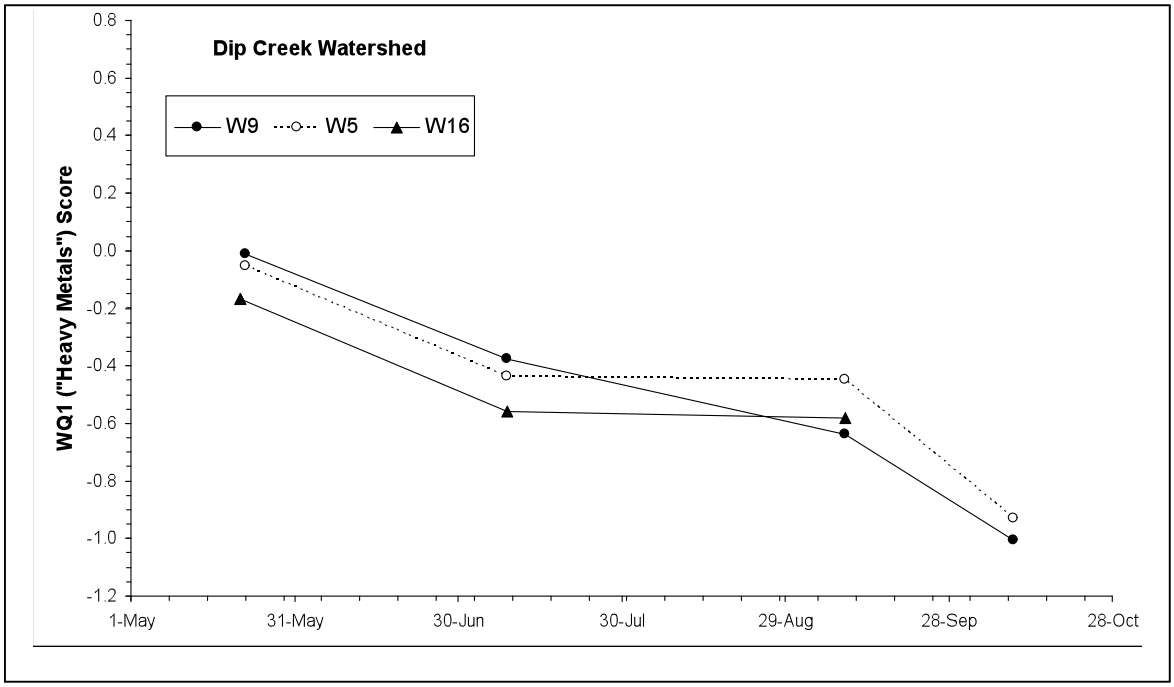


Figure 25. Plot of WQ1 Scores on Sampling Date, Britannia Creek Watershed, Casino Project, 2008

Figure 26. Plot of WQ1 Scores on Sampling Date, Casino Creek Watershed, Casino



Project, 2008

Figure 27. Plot of WQ1 Scores on Sampling Date, Dip Creek Watershed, Casino Project, 2008

In summary, these findings indicate that WQ1 represents the geochemical signal of drainage from the adit of the lower camp, and that adit drainage flows downstream through all of the water quality sampling sites of Casino Creek except for Brynelsen Creek. However, since WQ1 shows spatial and seasonal variation at sites in Dip Creek, Britannia Creek and the Yukon River, it also reflects a geochemical signature found elsewhere in the study area, albeit at lower concentrations than at the adit drainage site.

Spatial and Temporal Variation in WQ2 Scores

The highest mean WQ2 score was observed for site W12 at the head of Casino Creek and the lowest mean WQ2 score was observed at site W43, the adit discharge pipe (Figure 28). Upstream-downstream gradients in mean WQ2 score were observed for the Britannia Creek Watershed and for the upper mainstem of the Dip Creek Watershed (i.e., sites W12, W8 and W13). Mean WQ2 scores were uniformly low for the three sites in the Yukon River. The mean WQ2 score for site W17 in Sunshine Creek was between the values for the Yukon River sites and site W1 in Britannia Creek. Mean WQ2 scores for the three sites in Dip Creek were similar to those at the head of Britannia Creek (i.e., site W7). Therefore, WQ2 reflects the geochemical signature of the surficial geology of Proctor Gulch, the upper Casino Creek and Britannia Creek.

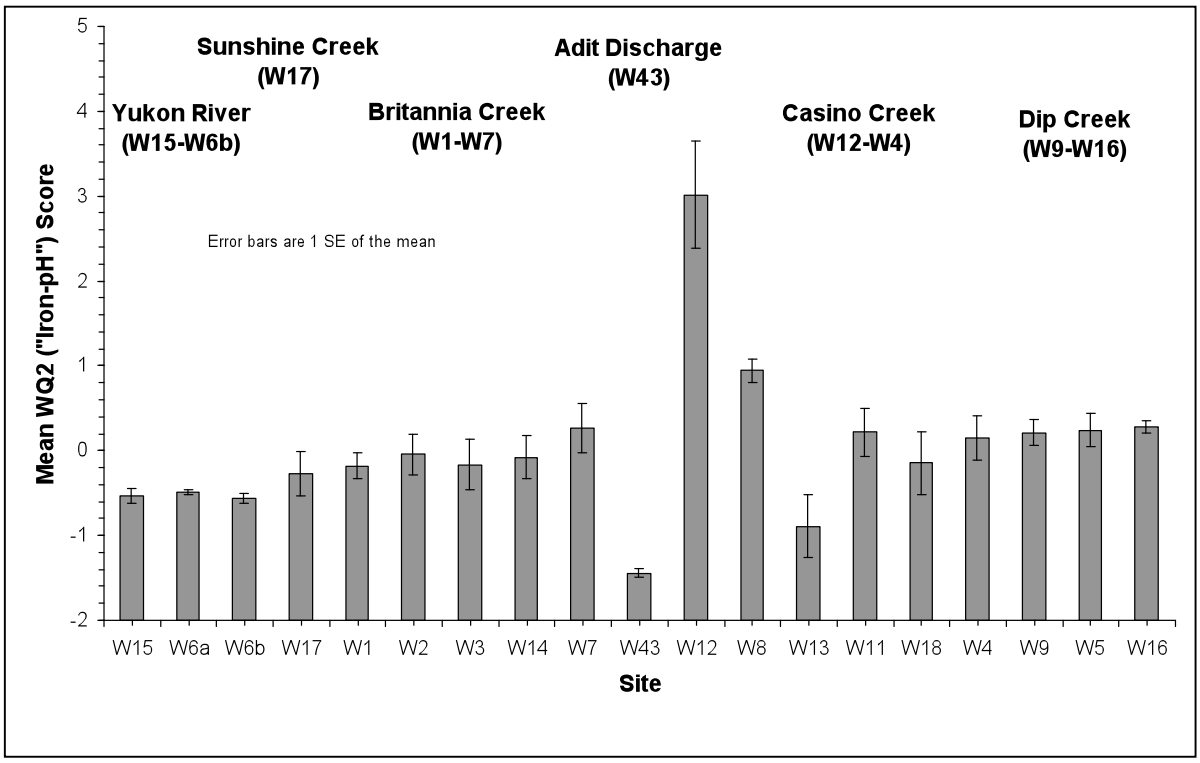


Figure 28. Plot of Mean WQ2 Scores on Sampling Site, Casino Project, 2008

With the exception of sites in the Britannia Creek Watershed, site W17 of Sunshine Creek and site W12 in upper Casino Creek, there was less seasonal variation in WQ2 scores than in WQ1 scores (Figures 29 to 32). As with WQ1, seasonal variation indicates that WQ2 scores vary directly with stream flow.

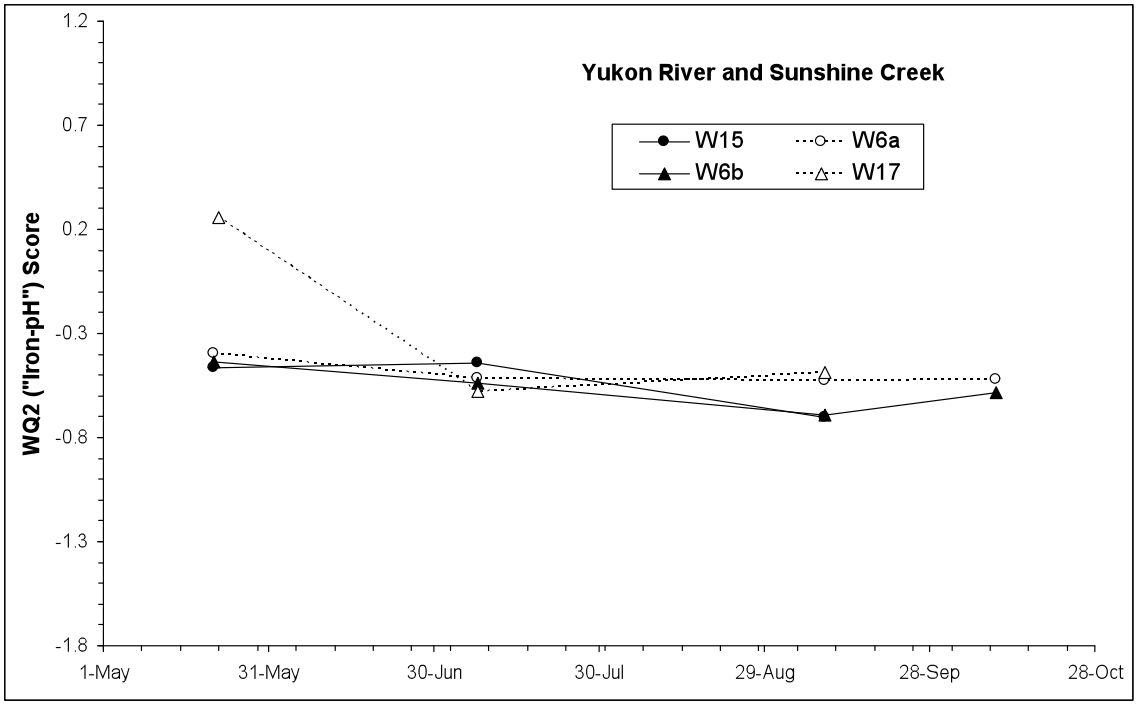


Figure 29. Plot of WQ2 Scores on Sampling Date, Yukon River and Sunshine Creek, Casino Project, 2008

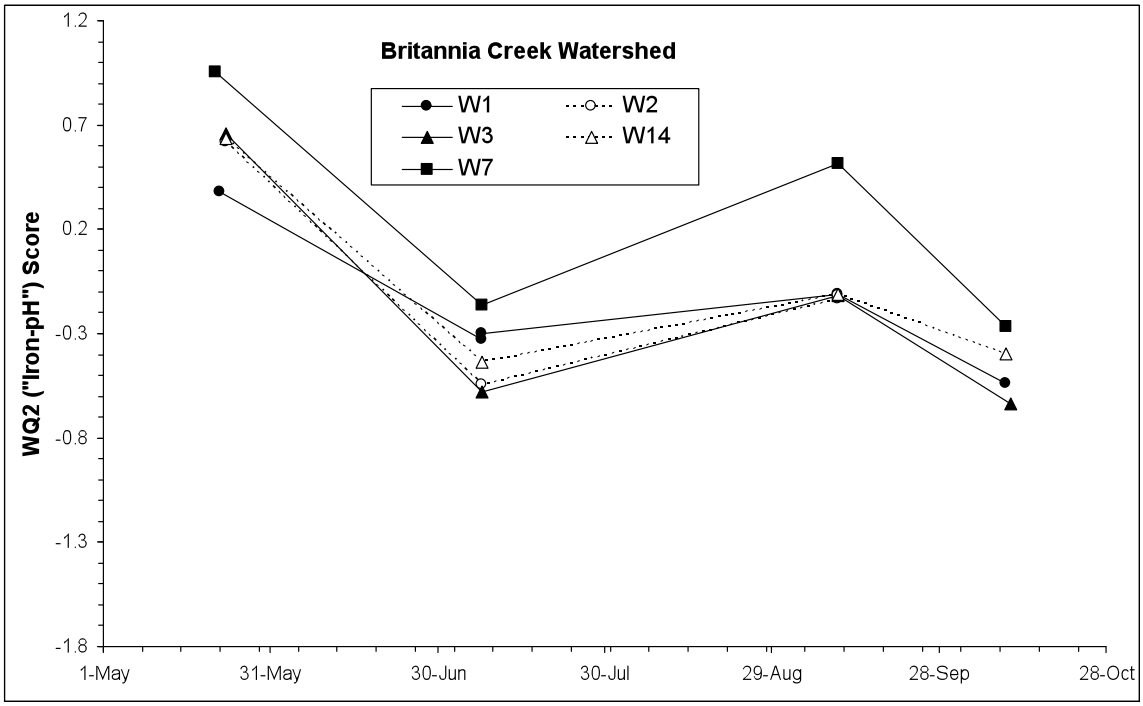


Figure 30. Plot of WQ2 Scores on Sampling Date, Britannia Creek Watershed, Casino Project, 2008

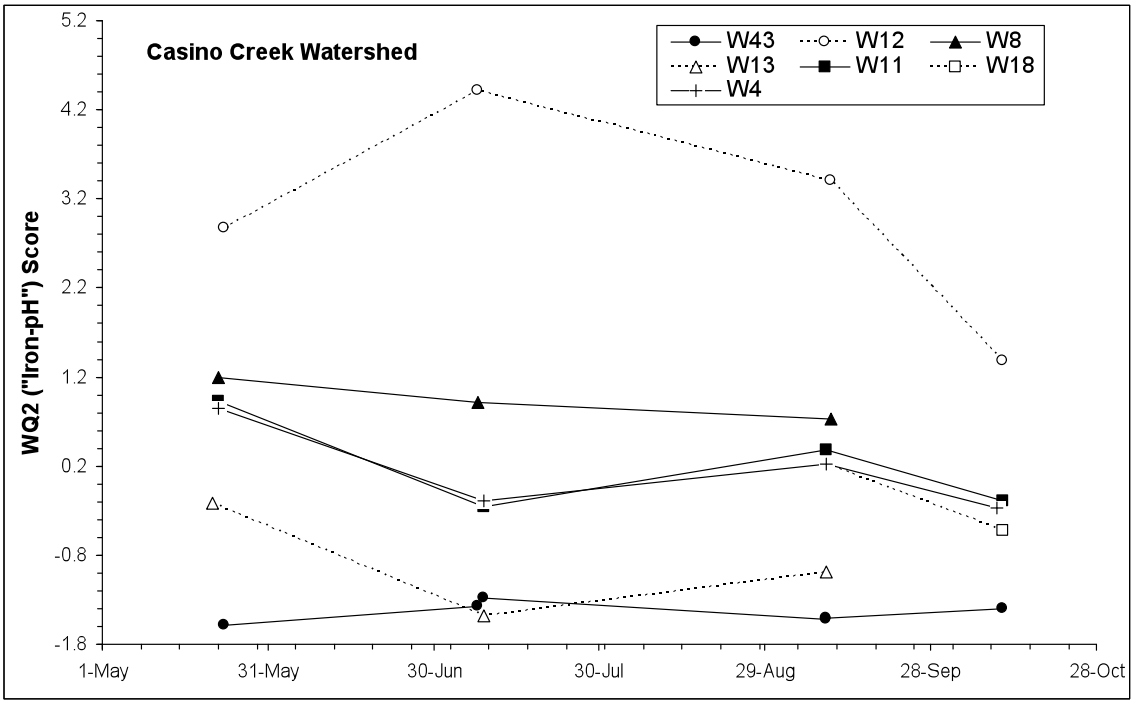


Figure 31. Plot of WQ2 Scores on Sampling Date, Casino Creek Watershed, Casino Project, 2008

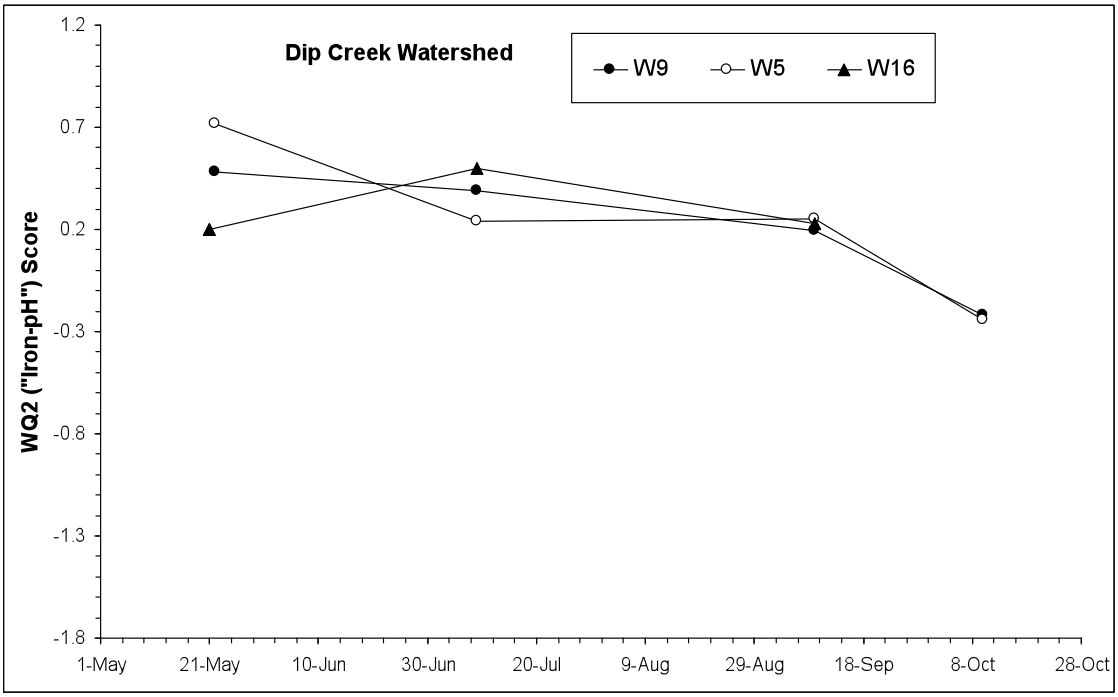


Figure 32. Plot of WQ2 Scores on Sampling Date, Dip Creek Watershed, Casino Project, 2008

In summary, these findings indicate that WQ2 reflects the geochemical signature of the surficial geology of Proctor Gulch, the upper Casino Creek and Britannia Creek. Seasonal trends in WQ2 reflect stream flows.

Spatial Variation in WQ3 Scores

Mean WQ3 scores were lowest for site W7, the uppermost site in Britannia Creek, and highest for site W12 in Proctor Gulch (Figure 33). Since WQ3 is assumed to reflects the influence of groundwater, then site W7 is much less influenced by groundwater than all other sites.

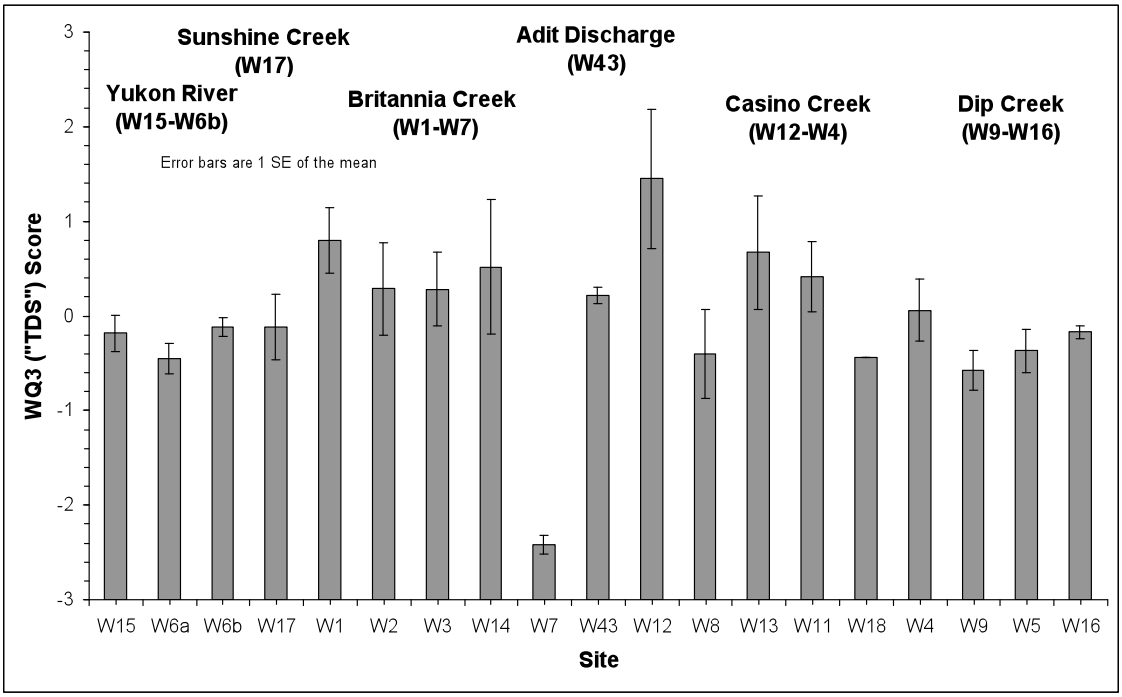


Figure 33. Plot of Mean WQ3 Scores on Sampling Site, Casino Project, 2008

Spatial Variation in WQ4 Scores

Mean WQ4 scores were lowest for sites in Casino Creek and in upper Britannia Creek, and highest for sites in Dip Creek, Britannia Creek, Sunshine Creek and the Yukon River (Figure 34). Therefore, WQ4 represents a geochemical signal found at all sites except those in Casino Creek and upper Britannia Creek.

Spatial Variation in WQ5 Scores

Mean WQ5 scores were highest for sites in the Yukon River (Figure 35). Hence, WQ5 represents a geochemical signal associated with the Yukon River.

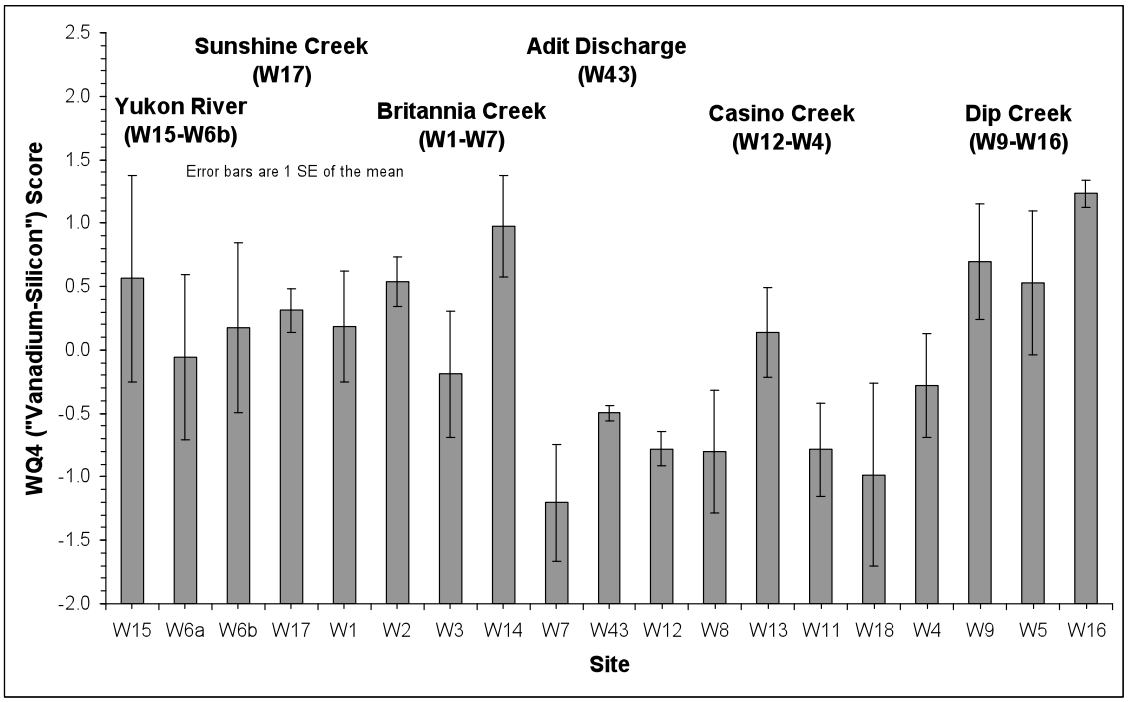


Figure 34. Plot of Mean WQ4 Scores on Sampling Site, Casino Project, 2008

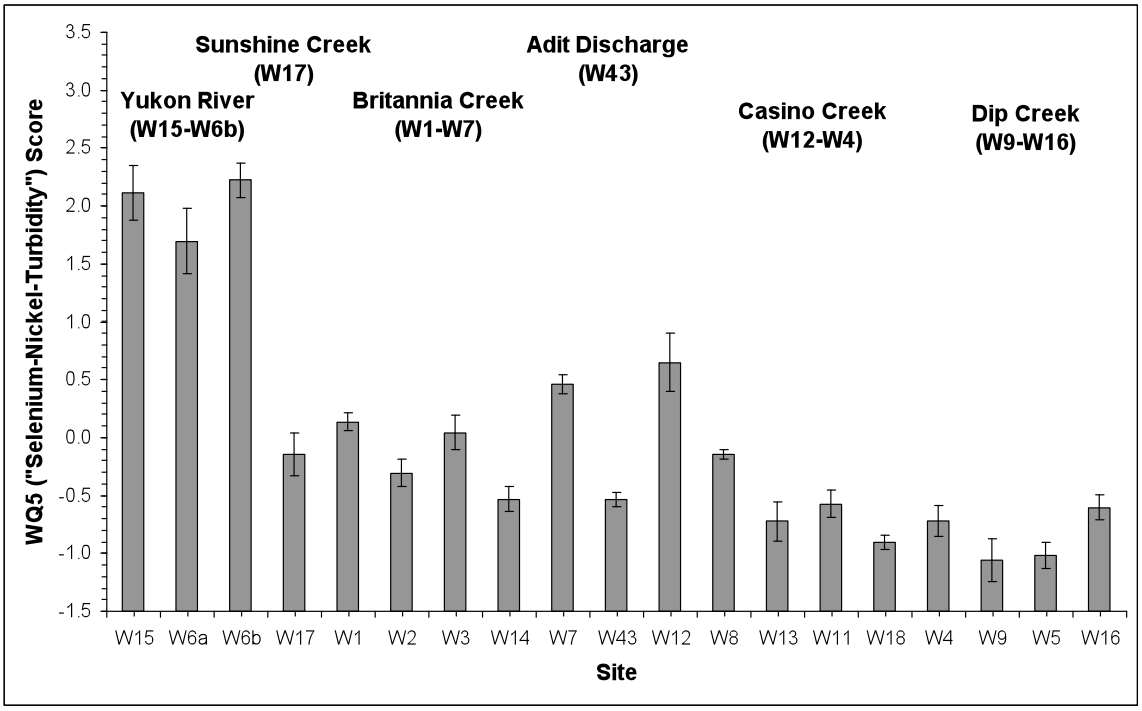


Figure 35. Plot of Mean WQ5 Scores on Sampling Site, Casino Project, 2008

3.2.3 Sediment Quality

3.2.3.1 Exceedances of Sediment Quality Guidelines

Appendix B7 shows the sediment quality data. Table 17 shows that exceedances of CCME sediment guidelines were observed for five total metals: arsenic (As), cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn). All of those metals except arsenic were also observed to exceed CCME water quality guidelines at some stations on some dates.

Table 17. Sediment Quality Parameters Exceeding CCME Guidelines, Casino Project, 2008

Site	Interim Freshwater Sediment Quality Guideline (ISQG)	ISQG and Probable Effects Level (PEL)
W7	As, Cd, Cu	-
W3	-	As
W14	As	-
W2	-	As
W1	As	-
W12	Pb, Zn	As, Cu
W8	Cd, Pb, Zn	As, Cu
W13	Cd, Zn	As, Pb
W11	Cd, Cu, Zn	As, Pb
W4	As	-
W9	As	-
W5	As	-

Dashes indicate sample did not exceed CCME Guidelines.

3.2.3.2 Principal Component Analysis

Mercury and selenium were removed from PCA because all values of those two metals were below detection limits. Of the remaining metals, a total of 10 concentrations below detection limits (or 3% of the total number of values) were replaced with one-half the detection limit. Then, pH and ln-transformed metal concentrations were entered into PCA. The first run extracted six components of which only the first three explained significant amounts of explained variance. Twelve metals (beryllium, calcium, chromium, copper, iron, magnesium, molybdenum, nickel, potassium, strontium, thallium and zirconium) were not highly correlated with those six components, hence they were removed and PCA was run a second time.

Three components were extracted that accounted for 87.7% of the explained variance: 48.1% for SQ1, 28.2% for SQ2 and 11.4% for SQ3. Table 18 shows that SQ1 was positively correlated with manganese, cadmium, cobalt, zinc, lead and antimony; SQ2 was positively correlated with vanadium, titanium, aluminum, tin, phosphorus, sodium and barium; and SQ3 was positively correlated with bismuth, silver and arsenic and negatively correlated with pH.

Table 18. Correlations of Sediment Quality Variables with Principal Components

Variable	SQ1	SQ2	SQ3
Manganese	0.941	0.279	-0.030
Cadmium	0.927	0.007	0.217
Cobalt	0.833	0.064	0.062
Zinc	0.806	0.321	0.467
Lead	0.798	0.255	0.499
Antimony	0.656	-0.079	0.629
Vanadium	0.185	0.952	0.082
Titanium	0.240	0.919	-0.110
Aluminum	0.289	0.905	0.220
Tin	0.269	0.869	0.268
Phosphorous	-0.177	0.862	0.031
Sodium	-0.369	0.796	-0.425
Barium	0.517	0.721	0.229
Bismuth	0.264	0.039	0.789
Silver	0.472	0.206	0.758
Arsenic	0.476	-0.372	0.706
pH	0.242	-0.238	-0.888

A plot of SQ1 scores on sampling site (Figure 36) showed that the highest scores were at three adjacent sites in Casino Creek (W8, W11 and W13). A plot of SQ2 scores on sampling site (Figure 37) showed a general decreasing north-south trend with the lowest scores in reach 1 of Britannia Creek and the highest scores at two sites in Dip Creek and at site W4 in lower Casino Creek. A plot of SQ3 scores on sampling site (Figure 38) showed the highest score at site W12 in the headwaters of Casino Creek.

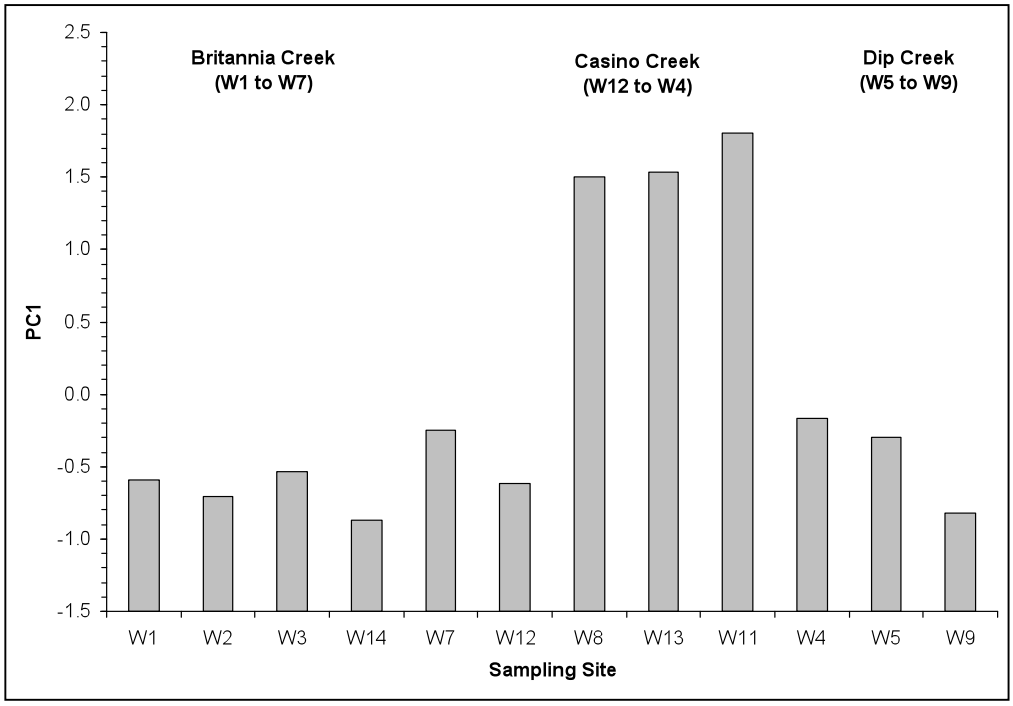


Figure 36. Plot of SQ1 Scores on Sampling Site

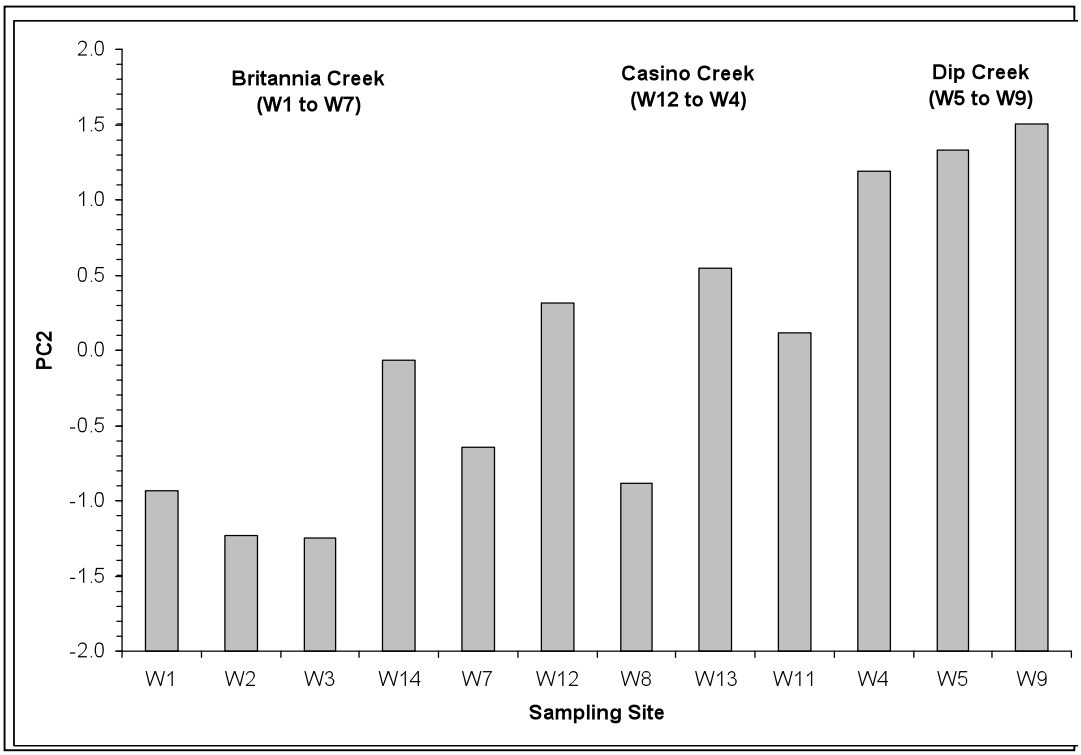


Figure 37. Plot of SQ2 Scores on Sampling Site

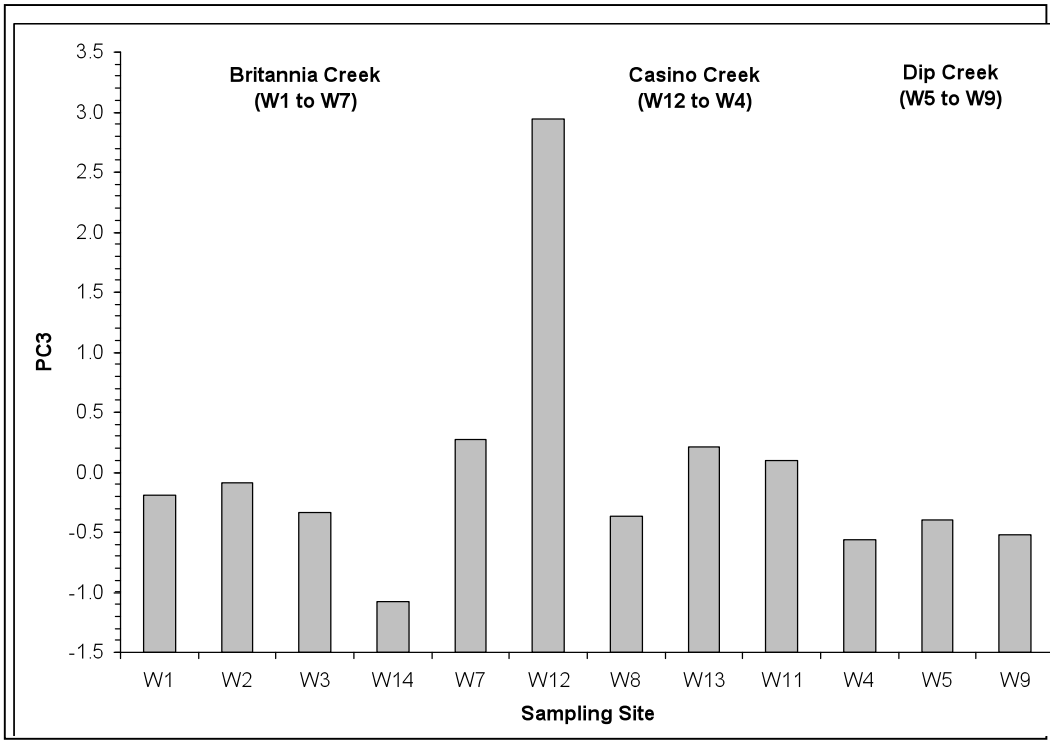


Figure 38. Plot of SQ3 Scores on Sampling Site

3.2.4 Periphyton

Appendix B8 shows the densities (cells/cm^2) by taxa for each of the 35 samples of periphyton collected from the seven sampling sites in September 2008.

Figure 39 shows the mean densities of periphyton for each site. One-way ANOVA of the ln-transformed densities showed there were highly significant differences in mean density among sites ($F_{6,28}$ = 14.34, P<0.001). Post-hoc comparisons of means using the Bonferroni test showed that mean density at sites P8, P7 and P4 were significantly (P<0.05) higher than at other sites.

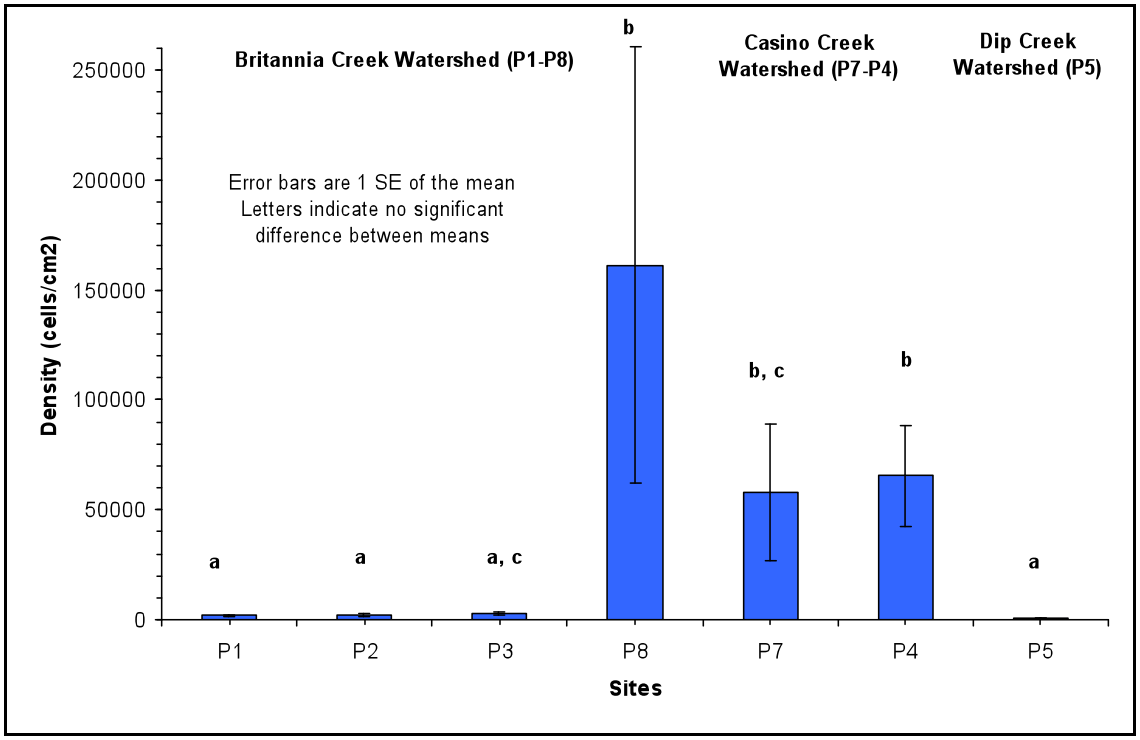


Figure 39. Mean Density of Periphyton by Site, Casino Project, 2008

Table 19 shows the percentage composition of the periphyton community at each sampling site. Britannia Creek sites P1, P2, and P3 were dominated by *Diatoma elongatum* and yellow-brown algae, *Chromulina sp.*, whereas site P8 was dominated by yellow-brown algae, *Homoeothrix varians*, and blue-green algae. Casino Creek site P4 was dominated by two blue-green algae, *Oscillatoria cf. agardhii* and *Homoeothrix varians*, whereas site P7 within the Casino Creek watershed was solely dominated by *Homoeothrix varians*. Dip Creek watershed site,P5 was dominated by blue-green algae, *Chromulina sp.*, followed by *Ceratuneis arcus*.

Table 19. Percentage Composition of Periphyton Communities, Casino Project, 2008

Taxon	Percentage of Number of Cells/cm^2						
	P1	P2	P3	P8	P7	P4	P5
Achnanthes lanceolata	0.00	0.00	0.00	0.04	0.04	0.00	0.00
Achnanthes minutissima	3.22	0.73	0.87	0.01	2.15	1.04	2.26
Achnanthes spp.	0.96	0.76	1.38	0.05	2.62	0.87	2.73
Caloneis spp.	0.00	0.00	0.00	0.00	0.06	0.00	0.00
Ceratoneis arcus	3.13	1.51	2.58	3.15	0.66	3.02	16.70
Cocconeis placentula	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Cymbella cf. cestaii	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Cymbella cistula	0.00	0.00	0.04	0.00	0.00	0.01	0.00
Cymbella minuta	0.52	0.30	0.22	0.00	0.18	0.33	1.08
Cymbella sinuata	0.13	0.52	0.43	0.00	0.11	0.05	1.25
Diatoma elongatum	21.91	37.06	32.69	0.00	0.00	3.16	2.73
Diatoma mesodon	0.01	0.00	0.00	8.82	0.10	0.00	0.00
Didymosphenia geminata	0.00	0.00	0.00	0.00	0.00	0.04	0.00
Eunotia spp.	0.00	0.00	0.00	0.01	0.02	0.00	0.00
Fragilaria capucina	0.00	0.00	0.00	0.00	0.02	0.01	0.37
Fragilaria vaucheriae	5.32	0.73	0.63	0.49	2.24	3.31	5.48
Fragilaria spp.	3.10	1.38	1.23	2.23	0.18	1.43	2.13
Gomphonema acuminatum / parvulum	3.03	0.73	0.35	0.02	0.33	2.56	3.23
Gomphonema spp.	0.09	0.56	0.53	0.04	0.22	3.00	1.95
Meridion circulare	6.37	0.33	0.10	0.49	0.21	0.17	2.61
Navicula radiosa	0.00	0.03	0.04	0.00	0.00	0.00	0.00
Navicula spp.	0.13	0.07	0.09	0.00	0.00	0.03	2.33
Nitzschia spp.	1.83	0.31	0.32	0.01	0.37	0.47	6.13
Pinnularia spp.	0.01	0.08	0.12	0.03	0.23	0.04	0.14
Synedra ulna	0.01	0.34	0.68	0.00	0.00	0.02	0.00
Synedra spp.	1.06	0.41	0.19	0.13	0.06	1.73	2.16
Tabellaria fenestrata	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Tabellaria flocculosa	0.00	0.00	0.00	0.03	0.00	0.00	0.00
UID girdle view	0.00	0.00	0.50	0.00	0.01	0.03	0.14
Chlorophyta							
Stigeoclonium sp.	0.00	0.00	0.00	0.01	0.00	0.00	0.00
UID Chaetophorales	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Hormidium sp.?	0.00	0.00	0.11	0.00	0.00	0.00	0.00
Microspora sp.	0.00	0.00	0.00	0.04	0.00	0.00	0.00
UID Chlorophyta colonial	0.79	0.00	0.00	0.00	0.00	0.00	0.00
UID Chlorophyta filamentous	0.00	0.00	0.79	0.00	0.00	0.00	0.00
UID Chlorophyta unicellular	0.20	0.00	0.09	0.04	0.00	0.00	0.00
Chrysophyta							
Chromulina sp.	38.05	44.68	25.91	22.72	0.06	0.75	34.43
Tribonema spp.	0.00	0.00	0.00	0.05	0.00	0.00	0.00
UID Chrysophyte colonial	2.68	1.92	3.18	0.02	0.00	0.00	0.00
UID Chrysophyte cyst	0.00	0.21	0.00	0.01	0.12	0.01	0.05
UID Chrysophyte flagellate	0.00	0.00	0.01	0.02	0.00	0.00	0.25
UID Chrysophyte unicellular	0.37	0.00	0.00	2.79	0.00	0.00	0.00
Cyanophyta							
Chamaesiphon spp.	0.00	0.00	0.00	11.87	13.38	8.95	0.00
Clastidium setigerum	0.00	0.00	0.00	0.78	8.04	0.03	0.00
UID Chrooccocales	0.00	2.21	3.35	4.95	3.58	4.47	0.00
Nostoc sp. / Anabaena sp.	0.00	0.00	0.00	0.00	0.00	0.16	0.00
Nostoc sp.	0.00	0.00	0.00	0.00	0.14	0.00	0.00
Tolypothrix sp.	0.00	0.00	1.42	0.00	0.00	0.00	0.00
Lyngbya spp.	0.00	0.00	0.32	0.00	0.11	0.00	0.00
Homoeothrix varians	0.00	0.00	0.00	35.00	58.71	25.14	3.47
Microcoleus sp.	0.00	0.00	0.00	0.04	0.00	0.00	0.00

Taxon	Percentage of Number of Cells/cm^2						
	P1	P2	P3	P8	P7	P4	P5
Oscillatoria cf. agardhii	0.00	0.00	15.04	3.77	0.00	27.44	0.00
Oscillatoria spp.	0.00	0.00	0.00	0.08	0.00	0.00	0.00
Pseudoanabaena spp.	0.00	0.26	0.00	0.08	1.23	0.16	0.19
UID Oscillatoriales	0.00	0.00	1.18	0.16	1.54	1.18	0.75
Rhodophyta							
Audouinella sp.	0.00	0.00	0.00	0.04	0.00	1.77	0.00
Batrachospermum sp.	0.00	0.00	0.00	0.00	0.00	4.32	0.00
UID flagellate	0.14	0.00	0.00	0.03	0.00	3.42	0.00
UID colonial	0.00	0.00	0.00	0.00	0.00	0.01	0.61
UID filamentous	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UID unicellular	6.92	4.85	5.57	1.90	3.26	0.88	6.84

**UID = unidentified.*

Figures 40 and 41 show the mean taxonomic richness and Shannon-Wiener diversity index by site. There were no significant differences among sites in diversity ($F_{6,28}$ = 1.94, P = 0.11), but there were highly significant differences among sites in richness ($F_{6,28}$ = 17.70, P < 0.001). Post-hoc tests using Bonferroni test for richness showed that the main cause for variation is the higher richness for sites P8, P7 and P4 compared to most of the other sites.

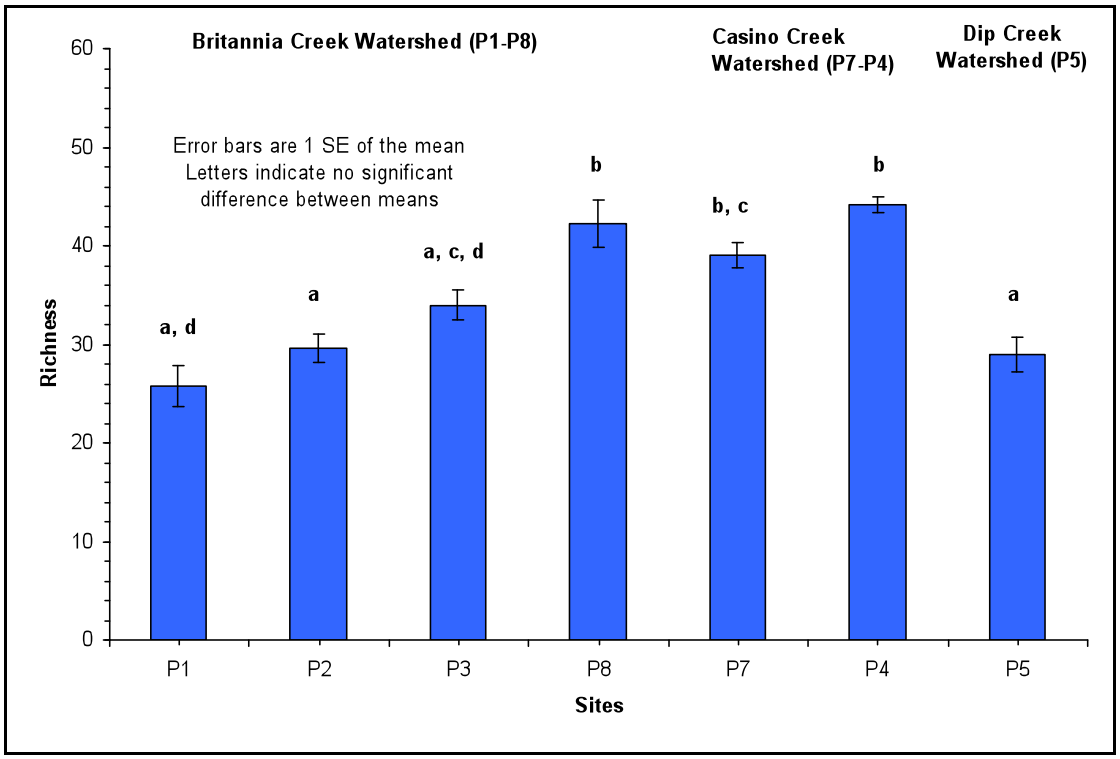


Figure 40. Mean Taxonomic Richness of Periphyton Communities, Casino Project, 2008

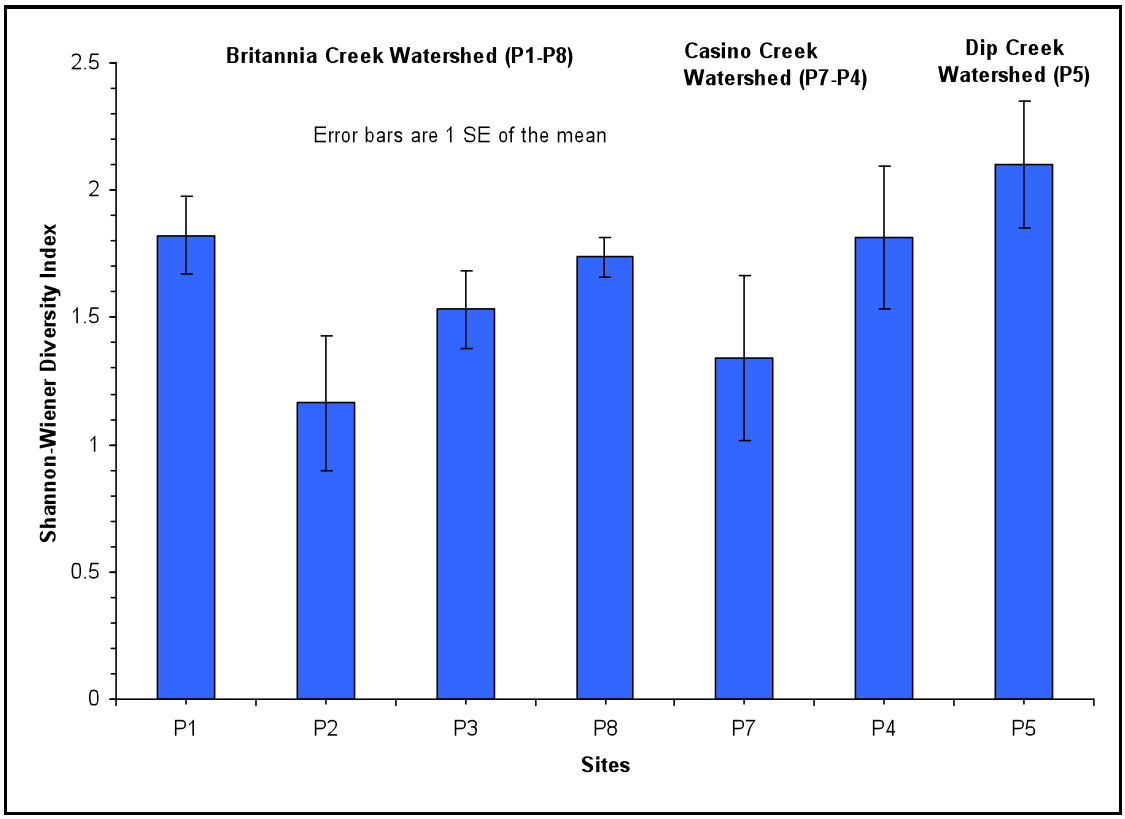


Figure 41. Mean Shannon-Wiener Diversity Index of Periphyton Communities, Casino Project, 2008

3.2.5 Benthic Invertebrates

Appendix B9 shows the number of organisms counted and identified to taxa in each of the 35 samples of benthos collected from the seven sampling sites in September 2008.

Figure 42 shows the mean densities of benthic invertebrates for each site. One-way ANOVA of the ln-transformed densities showed there were highly significant differences in mean density among sites ($F_{5,28}$ = 16.64, P<0.001). Post-hoc comparisons of means using the Bonferroni test showed that mean density at site B8 was significantly higher than the densities at all other sites except for B2 and that mean densities at sites B7 and B4 were significantly lower than mean densities at sites B2 and B3.

Table 20 shows the percentage composition of the benthic invertebrate community at each sampling site. Dipterans dominated the communities at all sites. Over 95% of the organisms at each site belonged to eight taxa: the insect Orders of Diptera, Plecoptera, Ephemeroptera, Trichoptera, Prostigmata and Collembola plus the worms of Class Oligochaeta and Phylum Nematoda.

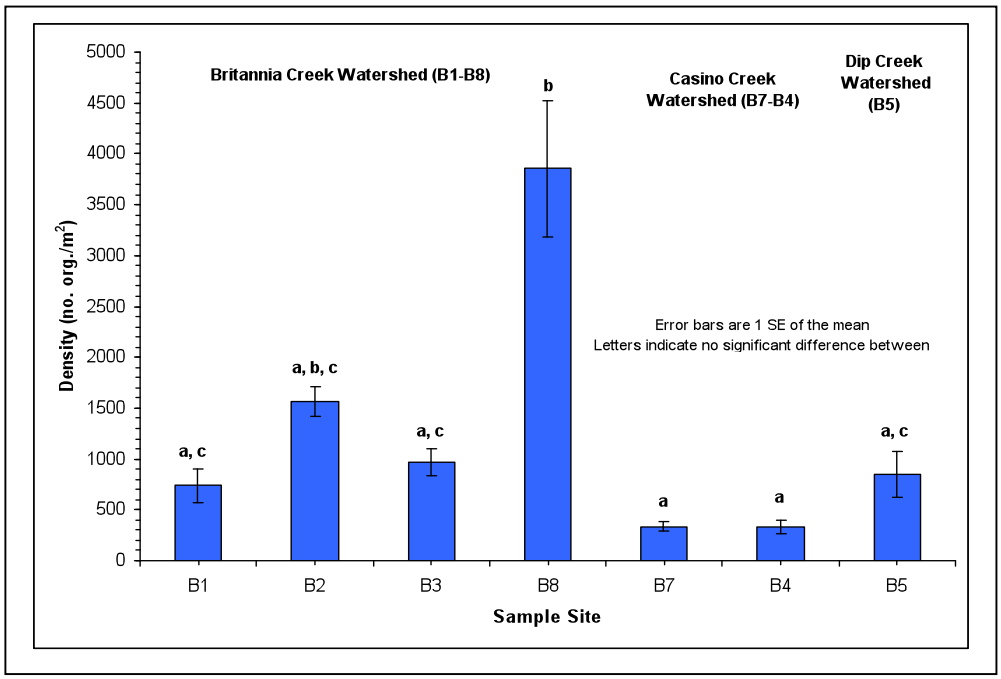


Figure 42. Mean Density of Benthic Invertebrates by Site, Casino Project, 2008

Table 20. Percentage Composition of Benthic Invertebrate Communities, Casino Project, 2008

Taxon	Percent of Total Number of Organisms						
	B1	B2	B3	B4	B5	B7	B8
Order Diptera	43.8	47.7	49.9	31.8	32.8	36.8	31.5
Order Plecoptera	20.4	22.5	7.8	13.2	12.7	29.0	21.7
Order Ephemeroptera	15.4	25.2	31.2	13.2	32.8	1.9	17.3
Class Oligochaeta	9.2	0.3	1.3	17.9	2.8	2.6	25.8
Order Trichoptera	4.4	0.4	1.8	9.9	3.3	0.0	0.2
Order Prostigmata	2.4	1.9	2.2	9.3	9.2	5.8	0.6
Phylum Nematoda	2.1	0.0	0.2	1.3	1.0	5.2	0.4
Order Collembola	1.2	0.8	2.9	0.7	0.8	18.1	2.2
Order Copepoda	0.9	0.3	0.7	2.0	2.3	0.0	0.1
Order Ostracoda	0.3	0.3	0.7	0.0	1.3	0.0	0.3
Order Coleoptera	0.0	0.0	0.2	0.0	0.5	0.0	0.0
Order Lepidoptera	0.0	0.3	0.2	0.7	0.3	0.6	0.0
Order Cladocera	0.0	0.1	0.7	0.0	0.3	0.0	0.0
Order Bivalvia	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Order Gastropoda	0.0	0.1	0.0	0.0	0.0	0.0	0.0

Figures 43 to 45 show the mean taxonomic richness, total EPT abundance and Shannon's index of diversity, respectively, by site. There were highly significant differences among sites in richness ($F_{6,28}$ = 4.79, P<0.001), total EPT ($F_{6,28}$ = 17.07, P<0.001) and in Shannon-Wiener diversity index ($F_{6,28}$ = 7.18, P<0.001). Post-hoc tests using the Bonferroni test showed that the main cause for variation in richness was low richness at site B7 compared to high richness at sites B2 and B5. Post-hoc tests using the Bonferroni test showed that the main cause for variation in total EPT was high total EPT at site B8 compared to low total EPT at all the other sites. Also, site B2 had

significantly higher total EPT than sites B7 and B4. Post-hoc tests using the Bonferroni test showed that the main cause for variation in Shannon-Wiener diversity index was higher diversity for sites B4, B5 and B1 than for sites B2, B3, B8, and B7. Also, diversity was significantly higher for site B4 compared to sites B8 and B7.

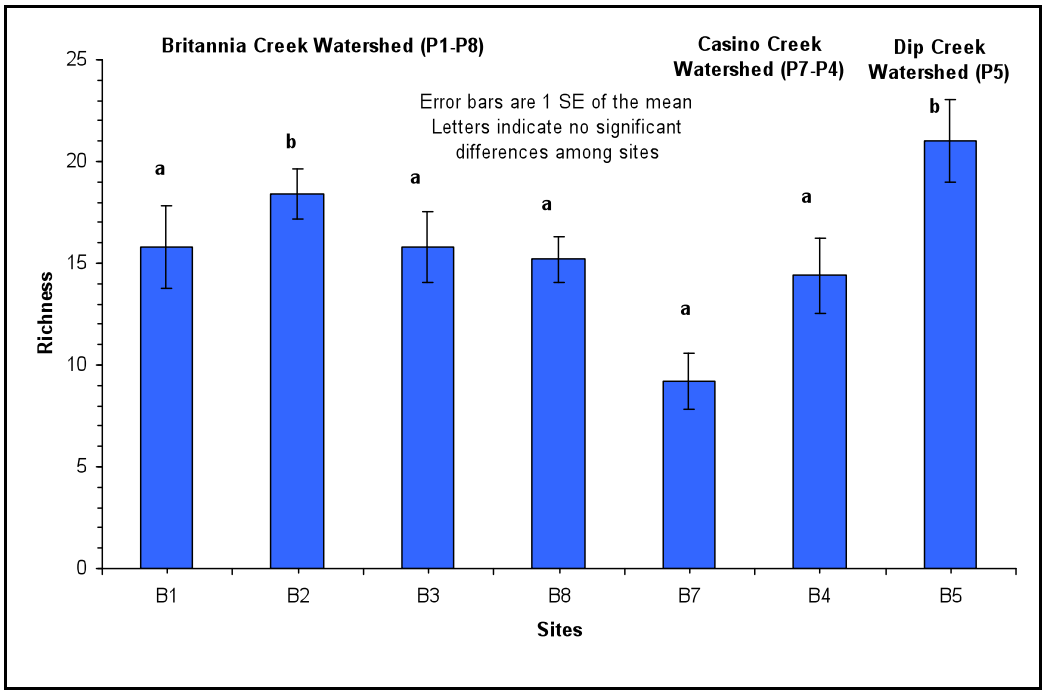


Figure 43. Mean Taxonomic Richness of Benthic Invertebrate Communities, Casino Project, 2008

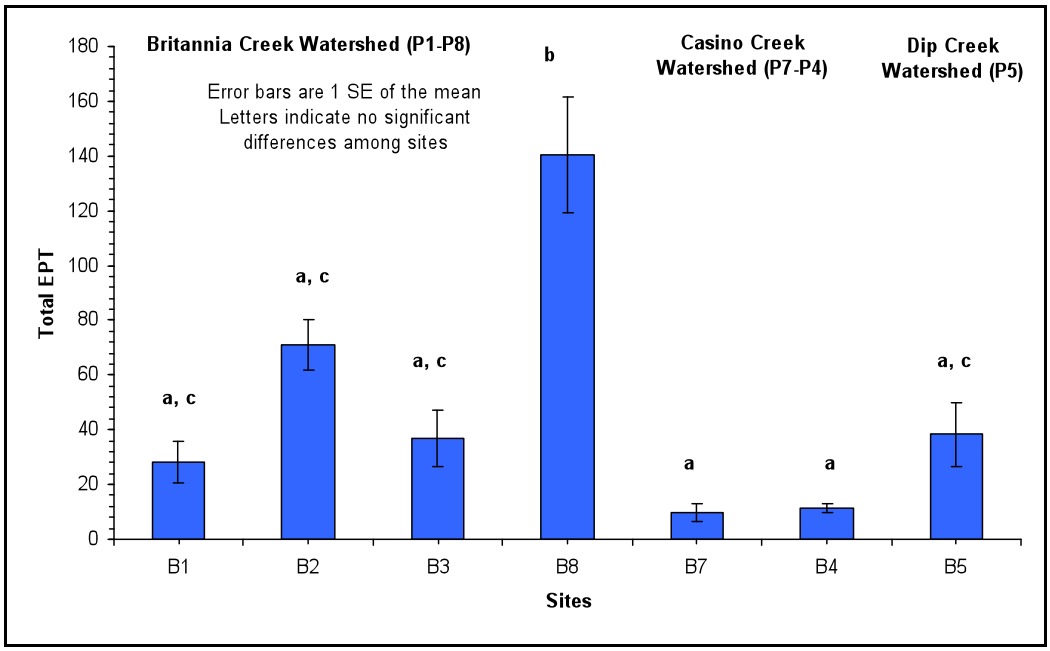


Figure 44. Mean Total EPT of Benthic Invertebrate Communities, Casino Project, 2008

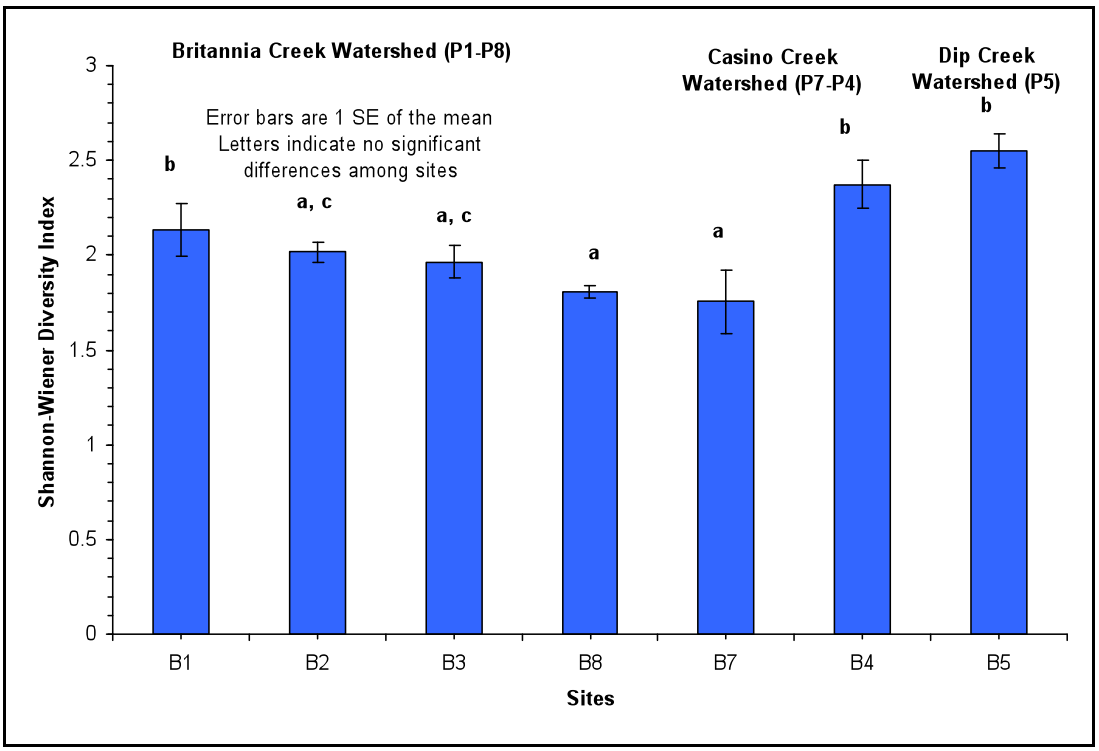


Figure 45. Mean Shannon-Weiner Index of Diversity of Benthic Invertebrate Communities, Casino Project, 2008

3.2.6 Fish Community

3.2.6.1 Catch, Effort and CPUE

Appendices B11, B12 and B13 show the fish catch, effort and CPUE for minnow traps, electrofishing and angling, respectively. A total of 40 fish from two species – Arctic grayling (*Thymallus arcticus*) and slimy sculpin – were captured from the Casino Project LSA in July and September 2008 (Table 21). Apart from one Arctic grayling caught by angling, all were captured by electrofishing.

Only Arctic grayling were found in the Britannia Creek Watershed, but both Arctic grayling and slimy sculpin were found in Casino Creek and Dip Creek watersheds. Slimy sculpin made up the majority of the catch (81 to 86%) in those two watersheds, respectively.

A total of 15 sites were electrofished – 12 in July and three in September. Three sites were electrofished twice. Of those 15 surveys, four were three-pass and 11 were single pass, for a total of 23 separate passes.

Stream sections ranged in length from 75 to 220 m with a mean of 140 m (n = 12, SE = 18). Voltage for each of the passes ranged from 300 to 750 V with a mean of 556 V (n = 23, SE = 23) and effort ranged from 340 to 1,591 sec with a mean of 669 sec (n = 23, SE = 70).

Table 21. Fish Catch, Casino Project, 2008

Gear	Arctic grayling	Slimy sculpin	Total
Britannia Creek Watershed			
Minnow Trap	0	0	0
Electrofishing	7	0	7
Angling	0	0	0
subtotal	7	0	7
Casino Creek Watershed			
Minnow Trap	0	0	0
Electrofishing	6	20	26
Angling	0	0	0
subtotal	5	21	26
Dip Creek Watershed			
Minnow Trap	0	0	0
Electrofishing	0	6	6
Angling	1	0	1
subtotal	1	6	7
Combined			
Minnow Trap	0	0	0
Electrofishing	12	27	39
Angling	1	0	1
Total	13	27	40

Of the four three-pass surveys, one caught no fish (F07 on July 9) and two (F03 on July 8 and F08 on July 9) did not show decreases in catch of Arctic grayling with successive passes. The fourth survey (F13 on July 10) did not show a decrease in catch of Arctic grayling with successive passes, but it did show clear decreases for slimy sculpin. Such decreases are required to estimate total fish number using the three-pass method (e.g., Peterson *et al*. 2004). The low number of three-pass surveys and the general lack of decreasing catch per pass meant that total fish number was not estimated using the three-pass algorithm. Instead, the CPUE of each survey was used as an index of population abundance.

A plot of CPUE on fish sampling site along a north-south trend line (Figure 46) shows that mean CPUE of Arctic grayling in the streams of the LSA was higher in July (mean = 0.10, SE = 0.04, n = 13) than in September (mean = 0.00 fish/100 sec, SE = 0.00, n = 3). This was due to outmigration of Arctic grayling in late summer in search of overwintering habitat. Arctic grayling from the Britannia Creek Watershed migrated to the Yukon River and those from Casino Creek Watershed moved downstream into Dip Creek.

Figure 47 shows that slimy sculpin were absent from the Britannia Creek Watershed in July and September 2008. Unlike Arctic grayling, the mean CPUE of slimy sculpin for Casino and Dip Creeks in September (mean = 0.24, SE = 0.21, n = 3) was not significantly different ($F_{1,8}$ = 0.091, P = 0.08) than the mean for July (mean = 0.16, SE = 0.16, n = 7), indicating that slimy sculpin did not outmigrate from Casino Creek until later in the year.

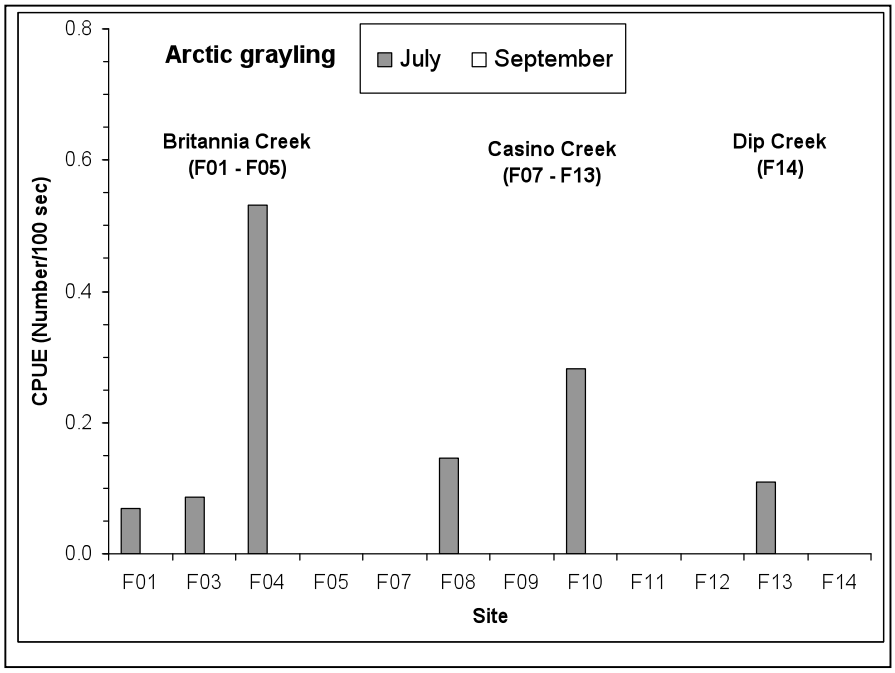


Figure 46. Electrofishing CPUE, Arctic Grayling, Casino Project, 2008

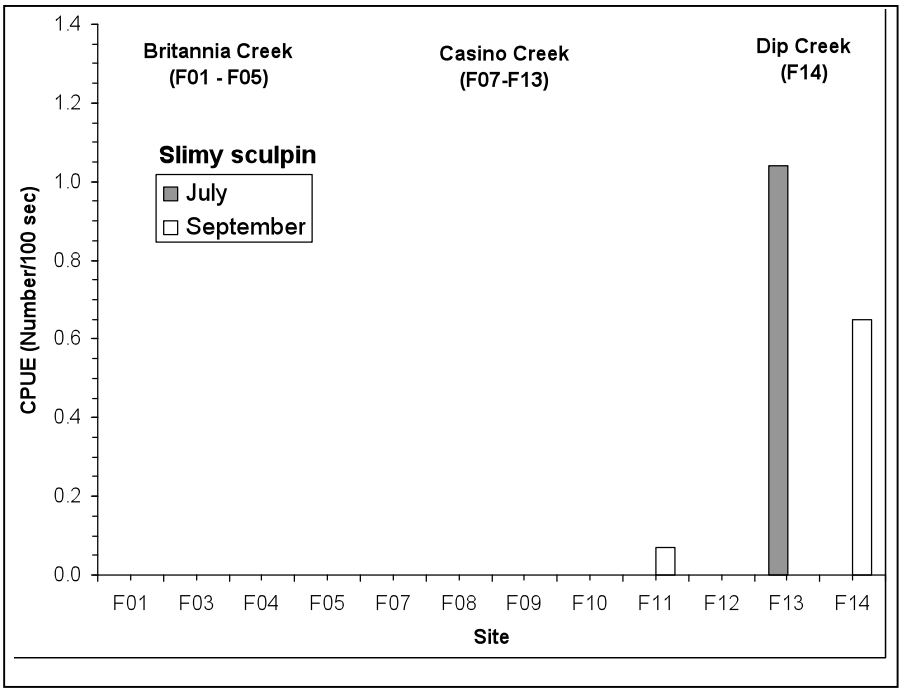


Figure 47. Electrofishing CPUE, Slimy Sculpin, Casino Project, 2008

Although the maximum CPUE of sculpin in Casino and Dip creeks for the combined July and September surveys was higher than the maximum for Arctic grayling in the LSA, the variance of both sets of CPUE was sufficiently high that the mean CPUE of slimy sculpin of Casino and Dip Creeks for the combined July and

September surveys (mean = 0.18, SE = 0.12, n = 10) was not significantly different ($F_{1,20}$ = 0.042, P = 0.52) from the mean CPUE of Arctic grayling in July.

These results were similar to those reported for 1993 and 1994 by Hallam Knight Piésold (1997), but with some important differences. As in 2008, Arctic grayling were observed throughout the Britannia Creek Watershed (Table 22). However, Arctic grayling fry were only observed in lower Britannia Creek near the confluence with the Yukon River in August 1993, indicating that this area provides spawning and rearing habitat for Arctic grayling, but not on a consistent basis.

Table 22. Fish Species in the Aquatics Local Study Area, Casino Project, 1993 to 2008

Species	Life Stage	Britannia Creek Watershed				Casino Creek Watershed		
		1993	1994	2008		1993	1994	2008
Arctic grayling	juveniles/adults fry	Jun, Aug. Sep Aug	Jun, Aug -	Jul -		Jun, Aug, Sep -	Jun, Aug, Sep Aug	Jul
Slimy sculpin	Juveniles/adults	Aug	Aug	-		Jun, Auig, Sep	Jun, Aug, Sep	Jul, Sep
Chinook salmon	juveniles fry	Aug June	- -	- -		- -	- -	- -
Round whitefish	juveniles	Aug	-	-		-	-	-
Burbot	juvenile	Sep	-	-		-	-	-

Unlike 2008, slimy sculpin were observed in the lower reach of Britannia Creek in 1993 and 1994, as were several round whitefish (*Prosopium cylindraceum*), one juvenile burbot (*Lota lota*) and several juvenile chinook salmon (*Oncorhynchus tshawytscha*). Therefore, lower Britannia Creek appears to provide temporary rearing habitat for juvenile fish from the Yukon River fish community. It is not clear why slimy sculpin do not move further upstream in the Britannia Creek Watershed, as they do in the Casino Creek Watershed. The presence of chinook salmon fry in lower Britannia Creek in June 1993 suggests the presence of some chinook salmon rearing habitat in lower Britannia Creek, but the absence of spawners in 1993, 1994 and 2008 indicates little spawning potential.

As in 2008, only slimy sculpin and Arctic grayling were observed in Casino Creek Watershed in 1993 and 1994, but Arctic grayling were found in September 1993 – later than in 2008 – indicating that the time of outmigration varies among years. No Arctic grayling fry were observed in the Casino Creek Watershed in any year, indicating that it offers poor rearing habitat for that species.

3.2.6.2 Size, Age and Growth

Appendix B14 shows lengths, weights and ages for fish captured in the Casino LSA in 2008. There were no significant differences in mean length ($F_{1,10}$ = 1.59, P = 0.24), weight ($F_{1,8}$ = 3.74, P = 0.09) or age ($F_{1,8}$ = 3.6, P = 0.09) of Arctic grayling between Britannia Creek and Casino Creek watersheds, which would be expected based on their geographic proximity. Hence, those data were pooled to calculate mean length, weight and age (Table 23). Since all slimy sculpin were captured from Casino and Dip creeks, which are directly connected, all those data were also pooled to calculate mean length and weight.

Table 23. Mean Size and Age of Fish, Casino Project, 2008

	Arctic Grayling				Slimy Sculpin	
Statistic	Length (mm)	Weight (g)	Age (year)		Length (mm)	Weight (g)
Mean	257	194.2	5		72	4.8
SE	14	25.0	1		9	8.8
n	13	11	11		26	26
minimum	173	44.5	2		29	0.5
maximum	300	260.0	6		129	19.3

SE = standard error and n = sample number.

The length frequency distribution for Arctic grayling shows two modes: one at a length range of 150-199 mm that are assumed to represent juveniles and a second mode at 250-299 mm that are assumed to represent adults (Figure 49). The length frequency distribution for slimy sculpin showed only one mode one at a length range of 50-99 mm that is assumed to represent a mixture of juveniles and adults.

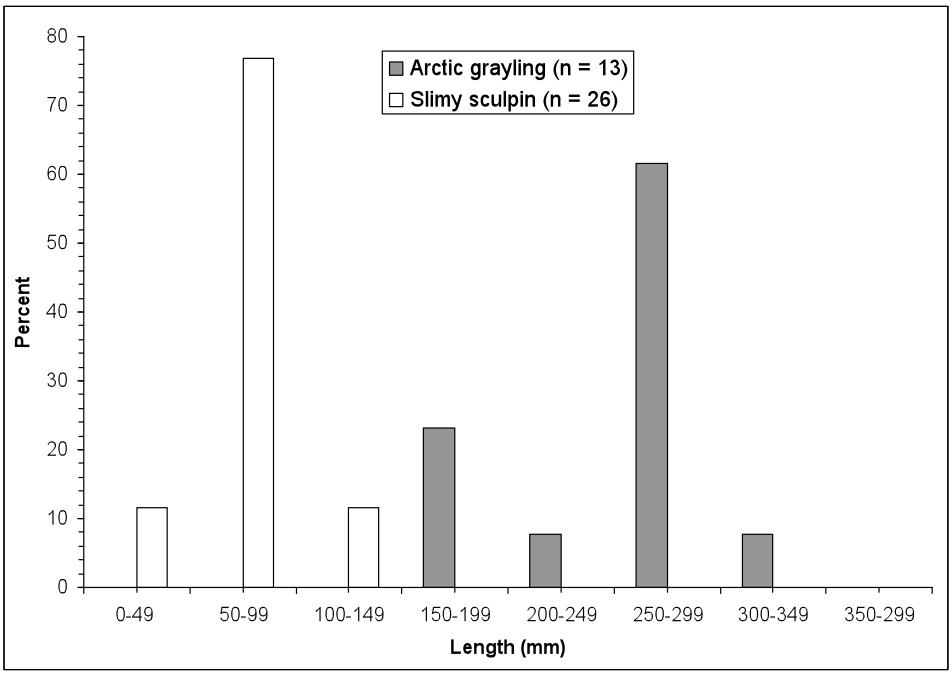


Figure 48. Length Frequencies of Arctic Grayling and Slimy Sculpin, Casino Project, 2008

Linear regressions of weight on length were highly significant for both species and explained between 96 and 97% of the variance in ln(weight) (Figure 50). The slopes of the regressions were both close to the value of 3.0 that is commonly assumed for fish.

The age frequency distribution for Arctic grayling shows two modes: one for fish aged two to three years (juveniles) and a second for fish aged five to six years (adults) (Figure 51). A plot of mean length on age showed that growth rate slows over age and hence mean length begins to approach an asymptote by age five or six years (Figure 52).

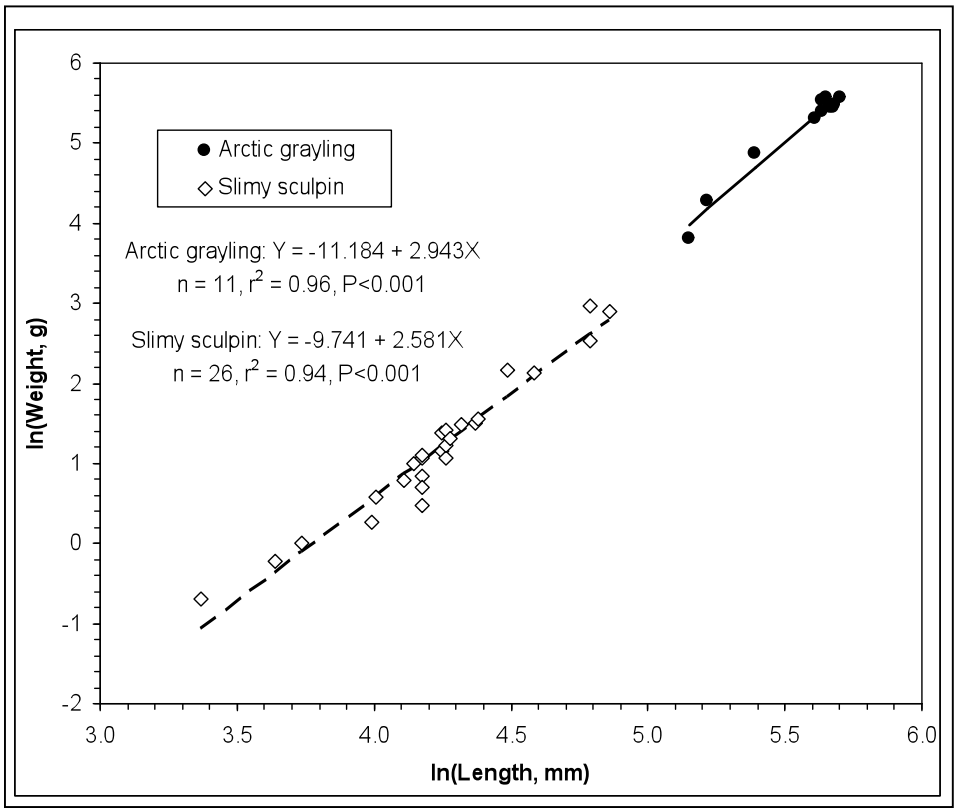


Figure 49. Weight-length Regressions for Arctic Grayling and Slimy Sculpin, Casino Project, 2008

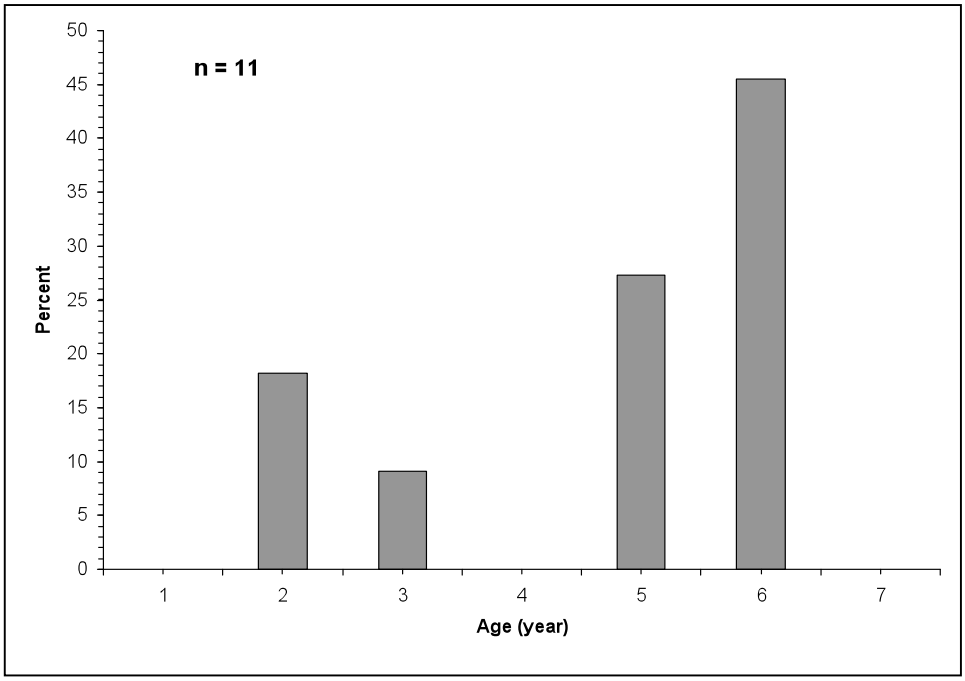


Figure 50. Age Frequency Distribution, Arctic Grayling, Casino Project, 2008

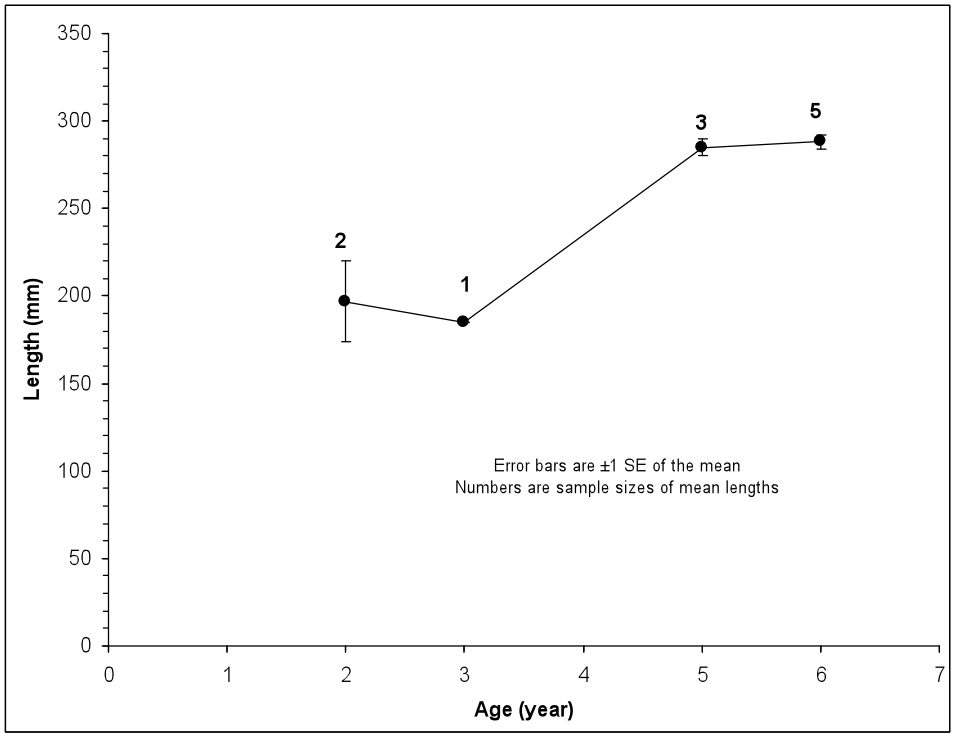


Figure 51. Length-Age Plot, Arctic Grayling, Casino Project, 2008

Too few Arctic grayling were captured in 2008 to permit growth modelling even if data were pooled from both Britannia and Casino watersheds. Therefore, length and age data reported by Hallam Knight Piésold (1997) for 1993 and 1994 were pooled with the 2008 data and von Bertalanffy growth curves were fit to data for Britannia and Casino watersheds separately (Figures 53 and 54). Both models explained 98% or more of the variance in length. There were sufficient data for the Britannia Watershed, particularly length-age data for the critical ages of zero and one years, to provide a good fit to length-at-age data. There were insufficient data for Casino Watershed as is shown by the predicted length at age zero years of 111 mm – twice the value predicted for Britannia Watershed and biologically unrealistic.

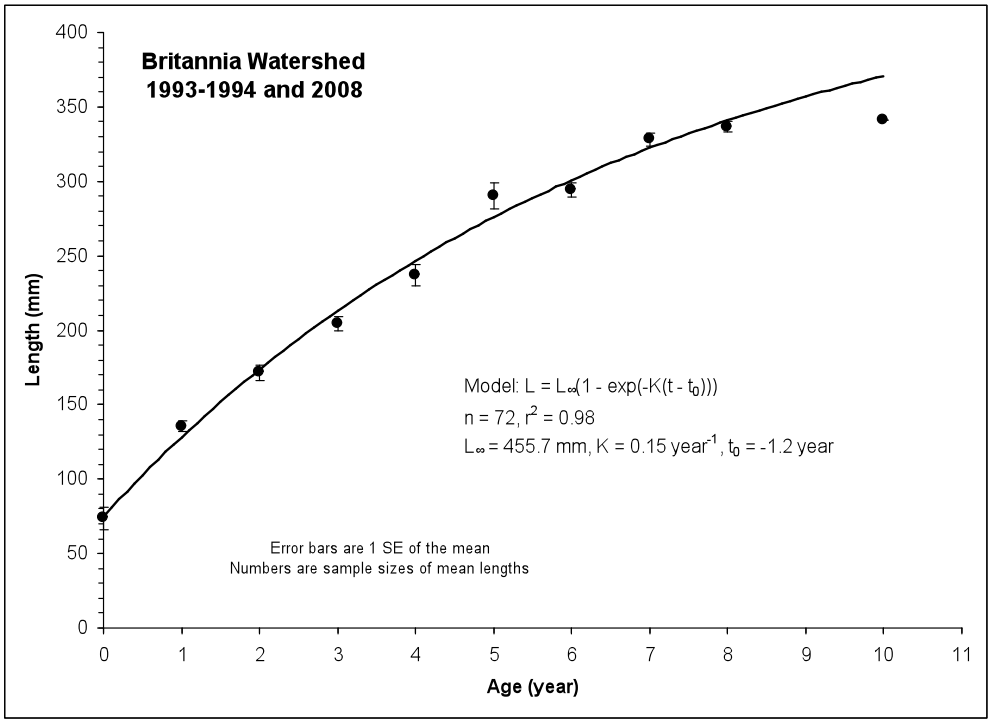


Figure 52. Length-Age Relationship, Arctic Grayling, Britannia Watershed, 1993-1994 and 2008

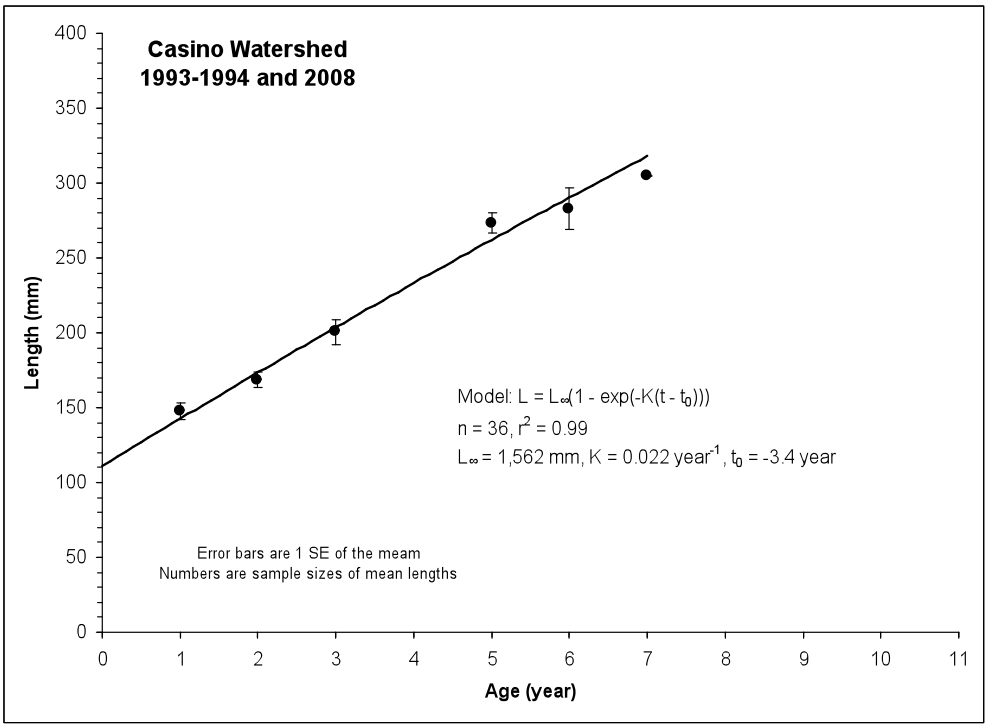


Figure 53. Length-Age Relationship, Arctic Grayling, Casino Watershed, 1993-1994 and 2008

3.2.6.3 Tissue Metals Concentrations

Appendix B15 shows the concentrations of metals measured in nine whole-body samples of slimy sculpin collected from Casino and Dip creeks in July and September 2008. Of the 33 metals, eight (antimony, beryllium, boron, molybdenum, tellurium, thallium, tin and zirconium) were excluded from analysis because all nine values were below detection limits. For the remaining 25 metals, all values below detection limits were replaced by one-half the detection limit to allow statistical analysis. This resulted in replacing 20% of the concentrations (i.e., 44 of 225). Table 24 shows the mean concentrations of metals, sorted in ascending order of mean concentration.

Table 24. Mean Whole-Body Metal Concentrations, Slimy Sculpin, Casino Project, 2008

Metal	Concentration (µg/g wet weight)			
	mean	SE	min	max
Silver	0.006	0.001	0.005	0.010
Mercury	0.040	0.008	0.020	0.090
Cadmium	0.07	0.02	0.00	0.24
Lead	0.08	0.03	0.05	0.30
Nickel	0.08	0.03	0.05	0.30
Chromium	0.09	0.03	0.05	0.30
Cobalt	0.09	0.03	0.05	0.30
Uranium	0.10	0.03	0.02	0.29
Arsenic	0.1	0.02	0.1	0.3
Vanadium	0.48	0.14	0.25	1.50
Selenium	0.7	0.1	0.4	1.1
Copper	1.2	0.1	0.9	2.1
Barium	4.3	0.9	1.2	9.8
Titanium	7.9	2.3	3.7	24.6
Manganese	10.6	2.3	3.1	25.4
Strontium	20.91	4.33	4.89	52.40
Zinc	27.5	3.9	19.2	57.4
Silicon	43	5	22	66
Aluminum	56.8	29.9	9.8	294.0
Iron	143	70	49	693
Magnesium	459	58	295	900
Sodium	1,526	232	1,090	3,360
Potassium	3,447	325	2,510	5,860
Phosphorus	9540	1758	4590	22900
Calcium	13,222	3,196	3,760	37,400

SE = standard error, min = minimum and max = maximum.

N = 9 for all metals.

None of the sculpin had mercury concentrations that exceeded the 0.5 µg/g guideline established by Health Canada (http://www.hc-sc.gc.ca/ahc-asc/media/advisories-avis/_2002/2002_41-eng.php).

PCA extracted two components from the dataset of ln-transformed metals. Four metals – mercury, cadmium, silicon and selenium – were not correlated with either component. Therefore, PCA was run a second time after removing those four metals. The first component, PC1, accounted for 60.8% of the explained variance and the second component, PC2, accounted for another 27.4% for a total of 88.2% of the explained

variance. Table 25 shows the correlations of the metals with each component. PC1 was highly correlated with ten metals including those often associated with metal deposits such as iron, lead and nickel. PC2 was highly correlated with 11 metals many of which are essential biological structural elements such as phosphorus, sodium and calcium and which are present in relatively high concentrations in whole-body tissue samples.

Table 25. Correlations of Principal Components with Slimy Sculpin Tissue Metal Concentrations

Metal	PC1	PC2
iron	0.99	0.13
lead	0.98	0.12
nickel	0.98	0.12
arsenic	0.94	0.30
aluminum	0.94	-0.03
chromium	0.94	-0.07
cobalt	0.93	0.10
titanium	0.91	0.39
vanadium	0.90	0.34
manganese	0.74	0.48
phosphorus	0.09	0.98
sodium	0.11	0.96
calcium	0.10	0.96
magnesium	0.34	0.93
zinc	0.32	0.91
silver	0.14	0.88
strontium	0.08	0.88
potassium	-0.13	0.83
copper	0.13	0.81
barium	0.57	0.74
uranium	0.50	0.68

A plot of PC2 scores on PC1 scores for the nine sculpin showed that seven of the nine fish clustered together in a region with relatively low scores, and that fish from all three sampling sites were present in that cluster (Figure 55). Two fish were outliers; one from site F13 had a relatively high PC2 score and one from site F14 had relatively a high PC1 score.

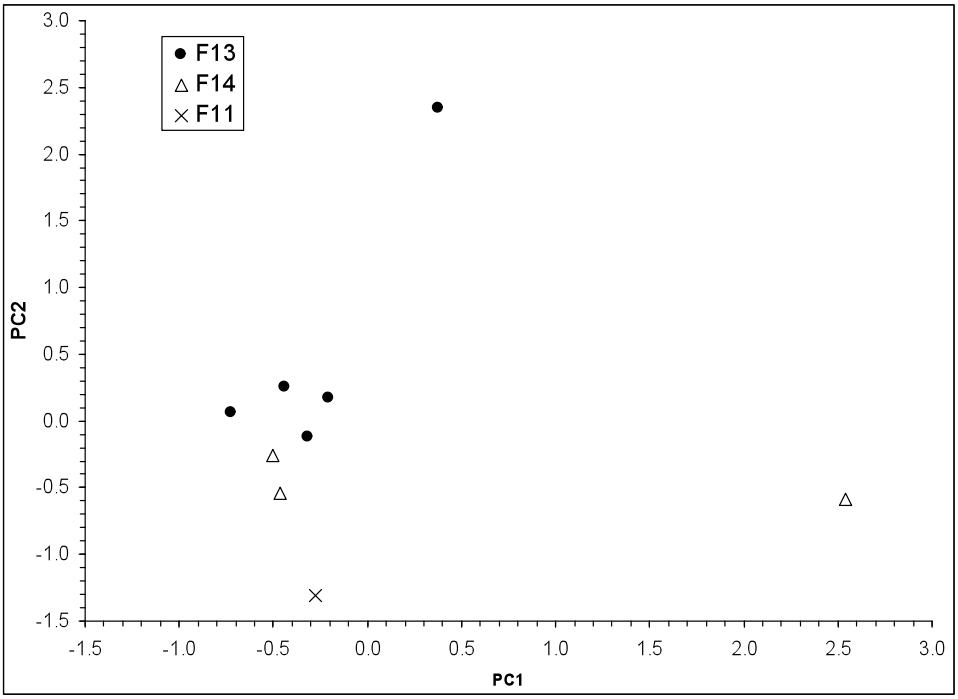


Figure 54. Plot of PC2 Scores on PC1 Scores for Slimy Sculpin Tissue Metal Samples

3.2.6.4 Salmon Spawning Survey

No Pacific salmon spawners were observed during the aerial survey of September 11, but good spawning habitat was observed in 50% of reach 2 of Britannia Creek and approximately 40 m^2 of spawning habitat was observed in Canadian Creek upstream from the confluence with Britannia Creek.

3.2.7 Fish Habitat

3.2.7.1 General

Appendices B16 and B17 show the stream habitat records for the July and September surveys, respectively.

3.2.7.2 Britannia Creek Watershed

The lower reach of Britannia Creek was surveyed on September 11 (Photo 2). At that time the stream stage was classified as high. Habitat consisted of 50% riffles, 30% runs and 20% pools. Gradient was close to 0%. Wetted depth ranged from 0.20 to 0.35 m with a mean of 0.28 m. The substrate was composed of 20% fines, 20% small gravel, 50% small cobble and 10% large cobble. Only 10% of the stream area provided cover and 80% of that area was provided by LWD and 20% by deep pools. Approximately 20% of the stream area consisted of gravel bars. The stream was classified as occasionally confined. This reach was classified as salmonid rearing habitat class II by DFO under the Yukon Placer Authorization (Government of Canada 2000).

Photo 2. Lower Reach of Britannia Creek Looking Upstream, September 11, 2008

The upper reach of Britannia Creek (i.e., reach 2) was also surveyed on September 11 (Photo 3). Habitat consisted of 70% riffle, 20% run and 10% pools. At that time its stage was high, hence its mean wetted width (4.1 m) was the same as its bankfull width. Wetted depth ranged from 0.16 m to 0.42 m with a mean of 0.29 m. Gradient was 1%. The substrate consisted of 30% small gravel, 30% large gravel, 20% large cobble and 10% boulder. Only 10% of the stream area provided cover of which 70% was provided by LWD, 20% by cutbank and 10% by overstream vegetation. The stream was unconfined and contained 10% gravel bars. The crown closure was 20%.

The lower reach of Canadian Creek, upstream of the confluence with Britannia Creek, was surveyed on July 8 (at fish site F03) and on September 11. In early July, the stream stage was low, hence mean wetted width (5.0 m) was lower than mean bankfull width (8.3 m) (Photo 4). Habitat consisted of 90% riffles and 10% pools. Gradient was 3%. The substrate consisted of 10% fines, 15% small gravel, 35% small cobble, 30% large cobble and 10% boulder. Forty five percent of the stream area provided cover of which 40% was provided by LWD, 40% by overhanging vegetation, 15% by cutbanks and 5% by boulders. The stream was unconfined and contained no gravel bars or braids. The crown closure was 7%.

Photo 3. Upper Reach of Britannia Creek Looking Upstream, September 11, 2008

Photo 4. Canadian Creek Above the Confluence with Britannia Creek (Site F03) Looking Upstream, July 8, 2008

In September, habitat consisted of 40% riffle, 40% run and 20% pools. Although the stream stage of the lower reach of Canadian Creek was high, the mean wetted width (4.8 m) was only 61% of the bankfull width (7.9 m) (Photo 5). Wetted depth ranged from 0.26 to 1.00 m with a mean of 0.63 m. Gradient was close to 0%. The substrate consisted of 10% fines, 10% small gravel, 10% large gravel, 20% small cobble and 50% large cobble. Only 10% of the stream area provided cover of which 80% was provided by LWD and 20% by deep pools. The stream was unconfined and contained no gravel bars. The crown closure was 10%.

Photo 5. Lower Reach of Canadian Creek Looking Upstream, September 11, 2008

Reach 2 of Canadian Creek (the cascade pools) was surveyed on July 8 and September 11. In July, the stream stage was low, hence the mean wetted width (5.2 m) was lower than the mean bankfull width (6.5 m) (Photo 6). Habitat consisted of 100% cascade pools. Gradient was 4%. The substrate consisted of 5% fines, 20% large gravel, 15% small cobble, 10% large cobble and 50% boulders. Fifty percent of the stream area provided cover of which 80% was provided by boulders, 10% by LWD and 10% by overhanging vegetation. The stream was unconfined and contained no gravel bars, but it was braided. The crown closure was 17%.

In September, habitat consisted of 100% cascade pools and gradient was 15%. The stream stage of the lower reach of Canadian Creek was high, hence its mean wetted width (8.0 m) was the same as its bankfull width (Photo 7). Wetted depth was 0.43 m. The substrate consisted of 90% boulder, 5% small gravel and 5% fines. Fifty percent of the stream area provided cover of which 100% was provided by boulders. The stream was frequently confined and contained no gravel bars. The crown closure was 0%.

Photo 6. Lower Reach of Canadian Creek (F04) Looking Downstream, July 8, 2008

Photo 7. Reach 2 of Canadian Creek (Cascade Pools) Looking Upstream, September 11, 2008

The upper reach (reach 3) of Canadian Creek was surveyed on September 11 (Photo 8). Habitat consisted of 80% riffles, 10% runs and 10% pools. The stream stage was high, hence its mean wetted width (3.0 m) was the same as its bankfull width. Wetted depth ranged from 0.16 to 0.36 m with a mean of 0.26 m. Gradient was 3%. The substrate consisted of 60% large cobble, 20% boulder, 15% small cobble and 5% fines. Twenty percent of the stream area provided cover of which 100% was provided by boulders. The stream was unconfined and contained no gravel bars. The crown closure was 0%.

Photo 8. Upper Reach (number 3) of Canadian Creek Looking Upstream, September 11, 2008

3.2.7.3 Casino Creek Watershed

The upper reach (reach 2) of Casino Creek was surveyed on September 12 (Photo 9). Habitat consisted of 50% pools, 40% riffles and 10% runs. The stream stage was high, hence its mean wetted width (5.4 m) was the same as its bankfull width. Wetted depth ranged from 0.08 to 0.40 m with a mean of 0.27 m. Gradient was 3%. The substrate consisted of 40% boulders, 20% large cobble, 20% small cobble, 10% large gravel and 10% fines. Thirty percent of the stream area provided cover of which 80% was provided by boulders and 20% by overstream vegetation. The stream was unconfined and contained no gravel bars. The crown closure was 0%.

The lower reach (reach 1) of Casino Creek was surveyed on September 12 (Photo 10). Habitat consisted of 40% runs, 30% riffles and 30% pools. The stream stage was high, hence its mean wetted width (5.7 m) was the same as its bankfull width. Wetted depth ranged from 0.27 to 1.50 m with a mean of 0.71 m. Gradient was 2%. The substrate consisted of 40% large cobble, 30% fines, 20% small cobble, 5% large gravel and 5% small gravel. Thirty percent of the stream area provided cover of which 70% was provided by deep pools and 30% by LWD. The stream was unconfined and contained no gravel bars. The crown closure was 20%.

Photo 9. Upper Reach (number 2) of Casino Creek Looking Upstream, September 12, 2008

Photo 10. Lower Reach (number 1) of Casino Creek Looking Downstream, September 12, 2008

Reach 1 of Meloy Creek, the most upstream named tributary of Casino Creek, was surveyed on September 12 (Photo 11). Habitat consisted of 50% runs, 30% riffles and 20% pools. The stream stage was high, hence its mean wetted width (1.1 m) was the same as its bankfull width. Wetted depth ranged from 0.21 to 0.40 m with a mean of 0.30 m. Gradient was 2.5%. The substrate consisted of 80% fines, 10% boulders, 5% small cobble and 5% small gravel. Seventy percent of the stream area provided cover of which 80% was provided by overstream vegetation and 20% by deep pools. The stream was unconfined and contained no gravel bars. The crown closure was 10%.

Photo 11. Reach 1 of Meloy Creek Looking Upstream, September 12, 2008

The upper reach (Reach 2) of Brynelsen Creek was surveyed on September 12 (Photo 12). Habitat consisted of 70% riffles and 30% pools. The stream stage was high, hence its mean wetted width (4.1 m) was the same as its bankfull width. Wetted depth ranged from 0.35 to 0.40 m with a mean of 0.38 m. Gradient was 2.5%. The substrate consisted of 70% boulders, 20% large cobble and 10% small cobble. Twenty percent of the stream area provided cover of which 80% was provided by boulders and 20% by LWD. The stream was unconfined and contained no gravel bars. The crown closure was 10%.

The lower reach (Reach 1) of Brynelsen Creek was surveyed on September 12 (Photo 13). Habitat consisted of 60% riffles, 20% runs and 20% pools. The stream stage was high, hence its mean wetted width (5.4 m) was the same as its bankfull width. Wetted depth ranged from 0.12 to 0.49 m with a mean of 0.29 m. Gradient was 2%. The substrate consisted of 30% fines, 20% large gravel, 20% small cobble, 20% large cobble and 10% boulders. Ten percent of the stream area provided cover of which 90% was provided by boulders and 10% by overstream vegetation. The stream was unconfined and braided and contained no gravel bars. The crown closure was 10%.

Photo 12. Upper Reach of Brynelsen Creek Looking Upstream, September 12, 2008

Photo 13. Lower Reach of Brynelsen Creek Looking Upstream, September 12, 2008

The upper reach (Reach 2) of Austin Creek was surveyed on September 12 (Photo 14). Habitat consisted of 70% pools, 20% runs and 10% riffles. The stream stage was high, mean wetted width was 1.1 m and mean bankfull width was 0.9 m. Wetted depth ranged from 0.29 to 0.56 m with a mean of 0.43 m. Gradient was not measured. The substrate consisted of 90% fines and 10% boulders. Ninety percent of the stream area provided cover of which 90% was provided by overstream vegetation and 10% by deep pools. The stream was unconfined and braided contained no gravel bars. Crown closure was 0%.

Photo 14. Upper Reach of Austin Creek Looking Upstream, September 12, 2008

The lower reach (Reach 1) of Austin Creek was surveyed on September 12 (Photo 15). Habitat consisted of 70% pools and 30% runs. The stream stage was high, hence the mean wetted width (1.8 m) was the same as mean bankfull width. Wetted depth ranged from 0.39 to 0.54 m with a mean of 0.47 m. Gradient was close to 0%. The substrate consisted of 100% fines. One hundred percent of the stream area provided cover of which all was provided by overstream vegetation. The stream was unconfined and braided contained no gravel bars. Crown closure was 0%.

3.2.7.4 Dip Creek

The reach of Dip Creek that encloses site F14 was surveyed on September 12 (Photo 16). Habitat consisted of 40% riffles, 30% runs and 30% pools. The stream stage was high, hence its mean wetted width (10.5 m) was the same as its bankfull width. Wetted depth was 1.25 m. Gradient was close to 0%. The substrate consisted of 50% fines, 30% small cobble, 10% large cobble and 10% small gravel. Twenty five percent of the stream area provided cover of which 50% was provided by LWD and 50% was provided by deep pools. The stream was unconfined and braided contained no gravel bars. The crown closure was 10%.

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Photo 15. Lower Reach of Austin Creek Looking Upstream, September 12, 2008

Photo 16. Reach of Dip Creek Enclosing Site F14 Looking Downstream, September 12, 2008

3.3 Terrestrial Environment

3.3.1 Soils and Vegetation

Surveys of the Casino LSA in July and September showed that it is characterized by smooth, rolling topography with moderate to deeply incised valleys.

Wildlife habitat consists of a variety of plant communities ranging from sparsely vegetated bare rock, large expanses of heath tundra, wet sedge meadows with tall riparian shrubland and treed slopes dominated by spruce, aspen, birch and willows. Open stands of black spruce and white spruce occur in valleys and lower slopes, with black spruce on wetter sites and white spruce on better drained sites. Willow, shrub birch, Labrador tea, mosses and lichens are principal understory species.

During the July and September surveys, a total of 33 soil pits were dug and plants were sampled and described for the various cover types: spruce, spruce/aspen, spruce/birch, shrub birch/willow, heath tundra, wet sedge meadow, and burns. Appendices C1 and C2 show the data for each of the sampling sites, and Photos 17 to 22 show representative examples of wildlife habitat.

Photo 17. Alpine Habitat, Casino Project, 2008

Photo 18. Felsenmeer Habitat (Exposed Broken Rock), Casino Project, 2008

Photo 19. Aspen Forest Habitat, Casino Project, 2008

Photo 20. Floodplain Habitat, Casino Project, 2008

Photo 21. Island Habitat, Yukon River, Casino Project, 2008

Photo 22. Mixedwood Forest Habitat, Casino Project, 2008

3.3.2 Wildlife Observations

3.3.2.1 General

Appendix C3 shows the observations of wildlife made in July and September of 2008, as well as observations made by other field crews in May and August. Table 26 lists the common names and scientific names of observed wildlife.

Table 26. Common and Scientific Names of Wildlife Observed at the Casino Project Area, 2008

Common Name	Scientific Name	Common Name	Scientific Name
Mammals		**Birds**	
Moose	*Alces alces*	American robin	*Turdus migratorius*
Black bear	*Ursus americanus*	Northern hawk owl	*Surnia ulula*
Grizzly bear	*Ursus arctos horribilis*	Northern harrier	*Circus cyaneus hudsonius*
Beaver	*Castor canadensis*	Spruce grouse	*Dendragapus canadensis*
Wolf	*Canis lupus*	Gray jay	*Perisoreus canadensis*
Caribou	*Rangifer tarandus*	Northern flicker	*Colaptes auratus*
Lynx	*Felis lynx*	Tundra swans	*Cygnus columbianus*
Snowshoe hare	*Lepus americanus*	Ptarmigan	*Lagopus muta*
Porcupine	*Erithizon dorsatum*	Great horned owl	*Bubo virginianus*
Arctic ground squirrel	*Spermophilus parryii*	Golden eagle	*Aquila chrysaetos*
Northern bog lemming	*Synaptomys borealis*		
Vole	*Microtus spp.*		
American red squirrel	*Tamiasciurus hudsonicus*		
Red fox	*Vulpes vulpes*		

Least chipmunk	*Eutamias minimus*		

3.3.2.2 July 7 to 11 Survey

Moose were observed along the Yukon River and along Casino and Dip creeks. The area being considered for the proposed Casino Project appears to be a preferred moose wintering area. No caribou were seen in the LSA, however caribou sign (e.g., pellets, shed antlers, trails, etc.) were found on ridge tops. Several small groups of caribou were observed south of the LSA during the flight from Whitehorse. Terrestrial lichens occur primarily on north-facing slopes and provide an abundant food source for caribou.

Numerous wolf tracks and scats were observed along Dip Creek, suggesting the presence of a den site close by, but it could not be located. Three individual grizzly bears (two blonde and one chocolate brown) and one black bear were observed during the July survey. Bear scats were also observed in the major creek drainages (Canadian, Britannia, Austin, Dip), and on the trails between the airstrip and the lower camp, and the airstrip and tank farm. Bear use appeared to be concentrated at this time of year in areas with buffaloberries, bearberries, and *Hedysarum*.

Small mammals observed in the LSA included snowshoe hare, red squirrel and voles. Well-developed small mammal trails were observed in some spruce habitat.

The rock outcrops on Patton Hill, and various treed habitat types were surveyed by helicopter and on foot for raptors but none were observed or heard. However, waterfowl, upland birds (e.g., ptarmigan) and various songbirds were seen or heard.

3.3.2.3 September 8 to 11 Survey

Wolves were heard howling along Dip Creek, and observed by Casino camp construction personnel on Britannia Creek. Lynx were also seen at the lower camp and on Britannia Creek.

Black and grizzly bears were observed by Casino camp construction personnel on six separate occasions in August and September. Grizzly bear observations included a sow with two, 2-year-old cubs, and a lone, chocolate-brown grizzly bear. Black bear observations included three lone bears, and one sow with two yearling cubs. Bear scats were also observed in the major drainages (Canadian, Britannia, Austin and Dip creeks), and on the trails between the airstrip and the lower camp, and the airstrip and tank farm. Bear use appeared to be concentrated at this time of year in areas with buffaloberries, cranberries, and blueberries.

Moose were observed along the Yukon River, Britannia, Casino and Dip creeks. Caribou were seen in the LSA by Casino camp construction personnel on five separate occasions, and caribou sign (e.g., pellets, shed antlers, trails) were found on ridge tops. One small group of caribou were observed along the proposed road route east of the Casino mine site.

Potential summer and winter range, lambing areas and escape terrain for sheep are limited within the survey area. No thinhorn sheep were observed along the Yukon River bank directly across from Britannia Creek during a survey conducted on September 9.

Small mammals observed in the LSA included snowshoe hare, red squirrel, bog lemmings, Arctic ground squirrel and voles.

The rock outcrops on Patton Hill, and various treed habitat types were surveyed by helicopter and on foot for raptors. Raptors observed or heard included great horned owl, northern harrier, northern hawk owl, and golden eagle. Other birds including tundra swans, ptarmigan, grouse and various songbirds were seen or heard.

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Appendix A

Atmospheric Environment

A1. Casino Mine – Methodology Report for Installation of Meteorological Station

Appendix B

Aquatic Environment

B1. Stream Stage-Discharge Data, Casino Project, 2008

B1. Stream Stage-Discharge Data, Casino Project, 2008

Station	Date	Stage (m)	Discharge (m^3/s)
W1	22-May-08	0.48	2.54
	8-Jul-08	0.32	0.84
	10-Sep-08	0.40	2.14
	10-Oct-08	0.26	0.40
W3	23-May-08	0.49	1.62
	8-Jul-08	0.39	0.33
	10-Sep-08	0.46	1.57
	11-Oct-08	0.38	0.38
W4	22-May-08	0.59	1.50
	9-Jul-08	0.43	0.50
	9-Sep-08	0.70	2.12
	10-Oct-08	0.46	0.81
W9	22-May-08	0.69	4.75
	9-Jul-08	0.59	3.63
	9-Sep-08	0.54	3.25
	10-Oct-08	0.52	1.11
W11	22-May-08	0.38	0.87
	9-Jul-08	0.17	0.14
	9-Sep-08	0.36	0.71
	9-Oct-08	0.35	0.40
W14	23-May-08	0.29	0.86
	8-Jul-08	0.15	0.29
	10-Sep-08	0.28	0.71
	10-Oct-08	0.12	0.15

B2. Surface Water Quality Data, Casino Project, May 2008

Appendix B2. Surface Water Quality Data, Casino Project, May 2008

Station	Detection Limits	Water Quality Guidelines	W7 - Upper Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W14 - Mouth of Britannia Creek	W2 - Canadian Creek downstream of Confluence with Britannia Creek	W1 - Mouth of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W6a - Yukon River downstream of Canadian Creek	W15 - Yukon River far field site	W17 - Sunshine Creek	W43 - Adit discharge pipe at lower camp	W12 - Proctor Gulch before confluence with Casino Creek	W8 - Upper Casino Creek	W13 - Meloy Creek	W11 - Casino Creek (proposed dam outflow)	W4 - Mouth of Casino Creek	W9 - Dip Creek us of Confluence with Casino Creek	W5 - Dip Creek ds Casino confluence	W16 - Dip Creek far field	W41 - Field Blank	Maxxam Travel Blank
Date		CCME [a]	21-May-08	23-May-08	23-May-08	23-May-08	22-May-08	21-May-08	21-May-08	21-May-08	22-May-08	23-May-08	23-May-08	22-May-08	21-May-08	22-May-08	22-May-08	22-May-08	22-May-08	21-May-08		
Physical Tests																						
Temperature C	-		0.1	2	0.1	1.8	3.4	7.9	7.1	9.4	0.7	4.1	4.2	2.5	0	2.6	1.6	0.2	1.1	0	-	-
Conductivity (Field) uS/cm	-		30.7	82	35	72	65.8	163	147	164	87.9	274	203	84	102	101.2	85	60	58.2	127	-	-
pH (Field)	-		6.2	7.4	7.1	7.4	7.5	7.9	8.1	8.1	7.9	6.8	4.0	7.3	7.8	7.5	7.5	7.2	7.4	7.6	-	-
Hardness CaCO3	0.5		15.1	45.8	28.3	41.1	49.6	105	93.4	103	49.9	141	75.8	42.3	59.1	56.1	47.7	37.4	41.4	69	<0.5	<0.5
Conductivity uS/cm	1		34.0	89	49	78	92	170.0	180.0	180.0	96	300	270	91	110	110	92.0	65	74.0	140.0	1	1
pH	-	6.5-9.0	5.5	7.4	7.0	7.1	7.2	7.8	7.8	7.8	7.4	7.5	3.9	6.9	7.5	7.3	7.3	7.2	7.3	7.6	4.5	4.5
Total Suspended Solids	1		34	18	34	25	190	190	140	200	6	<1	14	13	5	4	20	76	58	74	<1	<1
Total Dissolved Solids	1		32	88	46	78	92	130	150	150	94	210	190	90	110	110	92	64	74	120	6	2
Turbidity NTU	0.1		3.4	2.5	1.5	1.7	3.6	21.4	35.1	19.1	0.7	0.4	11.5	1	0.6	0.7	0.8	6.1	4.2	2	0.2	<0.1
Dissolved Anions & Nutrients																						
Ammonia as N	0.005		<0.005	0.031	0.01	0.006	0.011	<0.005	0.017	0.012	<0.005	<0.005	0.012	0.028	<0.005	<0.005	0.044	<0.005	<0.005	<0.005	0.071	<0.005
Alkalinity, Total (as CaCO3)	0.5		0.6	22.0	10.0	15.0	21.0	61.0	61.0	63.0	30.0	90.0	<0.5	8.8	40.0	25.0	25.0	22.0	24.0	45.0	<0.5	<0.5
Chloride (Cl)	0.5		1.10	1.20	1.40	1.20	1.20	0.90	1.00	0.90	1.30	0.50	0.70	1.20	1.10	1.10	1.30	1.00	1.20	1.10	0.9	1.3
Sulfate (SO4)	0.5		<0.5	15.0	<0.5	8.8	17.0	19.0	25.0	24.0	1.6	54.0	93.0	25.0	0.6	21.0	8.8	<0.5	<0.5	18.0	3.5	0.9
Nitrate (as N)	0.002	13	<0.002	0.05	0.046	0.043	0.05	0.019	0.017	0.016	0.052	0.128	0.023	0.011	0.086	0.031	0.038	0.026	0.024	0.026	<0.002	<0.002
Nitrite (as N)	0.002	0.06	0.004	0.004	0.005	0.005	0.003	0.002	0.002	0.002	0.004	0.002	0.003	0.004	0.003	0.003	0.004	0.003	0.004	0.003	<0.002	0.002
Total Kjeldahl Nitrogen	0.02		0.52	0.4	0.54	0.54	0.41	0.190	0.210	0.220	0.44	<0.02	0.4	0.330	0.300	0.45	0.480	0.430	0.420	0.270	<0.02	<0.02
Ortho Phosphate as P	0.001		0.001	<0.001	<0.001	0.002	<0.001	0.001	0.002	0.002	<0.001	0.006	<0.001	0.002	0.002	<0.001	<0.001	0.002	<0.001	0.002	<0.001	<0.001
Cyanide, Weak Acid Diss	0.0005		0.0008	0.0009	0.001	0.0009	0.001	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	0.0007	0.0007	0.0009	0.0008	0.0007	0.0007	<0.0005	<0.0005	<0.0005
Total Cyanide	0.0005	0.005	0.001	0.001	0.0015	0.0012	0.0013	<0.0005	<0.0005	<0.0005	0.001	<0.0005	<0.0005	0.0008	0.0009	0.0009	0.0007	0.0009	0.0008	<0.0005	<0.0005	<0.0005
Total Metals																						
Aluminium	0.0002	0.005-0.1[b]	0.479	0.415	0.542	0.46	0.723	0.678	0.636	0.708	0.214	0.0024	2.43	0.533	0.153	0.308	0.368	0.583	0.489	0.413	<0.0002	<0.0002
Antimony	0.00002		0.00007	0.0002	0.00012	0.00018	0.00019	0.00021	0.00017	0.00023	0.00013	0.00323	0.00009	0.00009	0.00021	0.00012	0.00011	0.00008	0.00009	0.0001	<0.00002	<0.00002
Arsenic	0.00002	0.005	0.00065	0.0012	0.0009	0.0011	0.00162	0.00212	0.00177	0.00204	0.00064	0.00152	0.00027	0.00052	0.00135	0.00065	0.0007	0.00086	0.00077	0.00123	<0.00002	<0.00002
Barium	0.00002		0.0385	0.0381	0.0559	0.0455	0.059	0.148	0.112	0.139	0.0458	0.0465	0.0439	0.0385	0.0517	0.0388	0.0392	0.0526	0.0467	0.0618	<0.00002	0.00006
Beryllium	0.00001		0.00005	0.00004	0.00004	0.00004	0.00006	0.0001	0.00008	0.0001	0.00002	<0.00001	0.00015	0.00004	0.00002	0.00003	0.00003	0.00006	0.00005	0.00004	<0.00001	<0.00001
Bismuth	0.000005		0.000021	0.00001	<0.000005	0.000008	0.000009	0.000013	0.000016	0.000015	<0.000005	<0.000005	0.000014	0.000007	0.000007	<0.000005	0.000005	0.000012	0.000006	0.000006	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017	0.000261	0.000084	0.000028	0.000069	0.00008	0.000621	0.000369	0.000591	0.000022	0.068	0.00799	0.000181	0.000092	0.000093	0.000066	0.000057	0.000054	0.000048	<0.000005	<0.000005
Calcium	0.05		4.49	11.4	7.03	10.3	12.4	28	25.3	27.6	12.5	38.9	22.2	12.6	16.2	15.6	13	9.75	10.9	17.3	<0.05	<0.05
Chromium	0.0001	0.001	0.0004	0.0008	0.0005	0.0007	0.0011	0.0011	0.0011	0.0012	0.0003	<0.0001	0.0003	0.0003	0.0003	0.0003	0.0004	0.0007	0.0006	0.0007	<0.0001	<0.0001
Cobalt	0.000005		0.00064	0.000545	0.000418	0.000492	0.000848	0.00193	0.00116	0.0014	0.000105	0.000247	0.00864	0.00113	0.000081	0.000346	0.000331	0.00052	0.00041	0.000575	<0.000005	<0.000005
Copper	0.00005	0.002-0.004[c]	0.0107	0.0081	0.00245	0.00603	0.00663	0.00808	0.00595	0.00724	0.00199	0.078	0.219	0.0581	0.00294	0.0328	0.0164	0.00333	0.00669	0.00529	0.00009	0.00007
Iron	0.001	0.3	0.574	0.54	0.567	0.549	1.00	2.17	1.56	1.95	0.191	0.112	6.62	0.654	0.162	0.344	0.414	0.931	0.724	1.09	<0.001	0.003
Lead	0.000005	0.001-0.007[d]	0.000513	0.000432	0.000305	0.000443	0.000866	0.0029	0.00183	0.00249	0.000094	0.0178	0.00203	0.000547	0.00314	0.000893	0.000847	0.00213	0.00152	0.00104	0.000014	0.000074
Lithium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	0.0007	0.0026	0.002	0.0026	0.0005	0.003	0.0012	<0.0005	0.0007	0.0007	0.0006	0.0018	0.0014	0.0014	<0.0005	<0.0005
Magnesium	0.05		0.93	4.18	2.61	3.76	4.54	8.47	7.36	8.32	4.5	10.7	4.98	2.65	4.51	4.19	3.73	3.17	3.42	6.28	<0.05	<0.05
Manganese	0.00005		0.0721	0.0329	0.0418	0.0369	0.0689	0.197	0.132	0.173	0.0125	0.351	0.325	0.0557	0.0511	0.029	0.0305	0.107	0.0785	0.133	<0.00005	0.00008
Mercury	0.00001	0.000026	<0.00001	0.00001	0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	<0.00001	0.00001	0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00025	0.00037	0.00009	0.00026	0.0003	0.00059	0.00068	0.00066	0.00021	<0.00005	<0.00005	0.00014	0.00034	0.00035	0.0005	0.00031	0.0004	0.00057	<0.00005	<0.00005
Nickel	0.00002	0.025-0.15[e]	0.00169	0.00211	0.00105	0.00164	0.00227	0.0101	0.00662	0.00925	0.00083	0.00057	0.00263	0.00113	0.00084	0.00092	0.00095	0.00146	0.0011	0.00129	<0.00002	<0.00002
Phosphorous	0.002		0.042	0.03	0.036	0.039	0.084	0.268	0.197	0.234	0.014	0.002	0.02	0.018	0.015	0.015	0.025	0.073	0.052	0.052	<0.002	<0.002
Potassium	0.05		1.12	1.2	1.02	1.15	1.3	1.1	1.07	1.11	1.01	1.62	1.18	0.76	0.98	0.83	0.81	0.65	0.71	0.85	<0.05	<0.05
Selenium	0.00004	0.001	0.00005	0.00006	<0.00004	0.00005	<0.00004	0.00042	0.00031	0.00046	0.00004	<0.00004	0.00008	0.00005	0.00004	<0.00004	0.00005	0.00004	0.00005	0.00005	<0.00004	<0.00004
Silicon	0.1		2.5	2.8	1.6	2.4	2.6	3.2	3.5	3.6	2.3	5.9	2.8	3	3.1	3.2	3.1	2.9	3	3.6	<0.1	<0.1
Silver	0.000005	0.0001	0.000013	0.000013	0.000006	0.000012	0.00001	0.000005	0.000011	0.000012	0.000006	0.000063	0.000026	0.000022	0.000018	0.000016	0.000011	0.000007	0.00001	0.000007	<0.000005	<0.000005
Sodium	0.05		0.92	1.47	0.87	1.3	1.39	1.67	1.87	1.69	1.72	3.75	1.52	1.43	1.84	1.66	1.74	1.5	1.61	2.78	<0.05	<0.05
Strontium	0.00005		0.0309	0.071	0.0546	0.0674	0.0809	0.129	0.123	0.128	0.0888	0.342	0.0675	0.0852	0.103	0.1	0.0803	0.0787	0.0806	0.121	<0.00005	<0.00005
Thallium	0.000002	0.0008	0.000008	0.000008	0.000006	0.000008	0.000011	0.00002	0.000016	0.00002	0.000003	0.000027	0.000023	0.000008	0.000003	0.000006	0.000006	0.000008	0.000007	0.000006	<0.000002	<0.000002
Tin	0.00001		0.00001	<0.00001	<0.00001	0.00003	<0.00001	0.00003	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0103	0.0128	0.0161	0.0134	0.0254	0.0134	0.0172	0.0161	0.0037	<0.0005	0.0029	0.0049	0.0027	0.0034	0.0059	0.0196	0.0138	0.0169	<0.0005	<0.0005
Uranium	0.000002		0.000305	0.00339	0.00125	0.0029	0.00361	0.000975	0.001	0.00105	0.00139	0.00219	0.00276	0.0012	0.00412	0.00278	0.00222	0.0034	0.003	0.00351	0.000005	0.000007
Vanadium	0.0002		0.0009	0.0008	0.0014	0.001	0.002	0.0032	0.0028	0.0032	0.0004	<0.0002	<0.0002	0.0003	0.0004	0.0004	0.0009	0.0023	0.0017	0.0025	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0145	0.0073	0.0026	0.0049	0.0062	0.0436	0.0248	0.0381	0.0014	3.62	0.0575	0.0128	0.0063	0.0072	0.0048	0.0049	0.0042	0.0036	<0.0001	0.0011
Zirconium	0.0001		0.0003	0.0004	0.0004	0.0004	0.0005	0.0003	0.0006	0.0007	0.0003	<0.0001	0.0003	0.0003	0.0003	0.0003	0.0004	0.0005	0.0004	0.0004	<0.0001	<0.0001
Dissolved Metals																						
Aluminium	0.0002		0.337	0.233	0.36	0.272	0.289	0.0809	0.0642	0.0693	0.185	0.0023	2.44	0.434	0.139	0.268	0.247	0.182	0.197	0.0701	0.0017	<0.0002
Antimony	0.00002		0.00005	0.00018	0.0001	0.00016	0.00018	0.00017	0.00013	0.00016	0.00013	0.0033	0.00008	0.00008	0.00022	0.00012	0.0001	0.00006	0.00007	0.00009	<0.00002	<0.00002
Arsenic	0.00002		0.00038	0.00073	0.00054	0.00065	0.0007	0.00055	0.00053	0.00055	0.00053	0.0003	0.00023	0.00035	0.0012	0.00051	0.00047	0.00034	0.00037	0.00053	<0.00002	<0.00002
Barium	0.00002		0.0281	0.0313	0.0429	0.036	0.0368	0.0471	0.0406	0.0434	0.0434	0.048	0.0436	0.0332	0.0476	0.0343	0.0322	0.0293	0.0314	0.0415	<0.00002	<0.00002
Beryllium	0.00001		0.00005	0.00002	0.00003	0.00002	0.00002	0.00001	0.00001	0.00001	0.00002	<0.00001	0.00015	0.00003	0.00002	0.00003	0.00002	0.00002	0.00002	0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.00001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000229	0.000066	0.000018	0.000049	0.000039	0.000094	0.000064	0.000095	0.000018	0.0705	0.000805	0.000156	0.000049	0.000074	0.000031	0.000011	0.000016	0.000011	<0.000005	<0.000005
Calcium	0.05		4.49	11.5	6.83	10.3	12.3	25.5	24.1	25.6	12.9	40.4	22.2	13.1	16.6	15.5	13.3	9.29	10.6	17	<0.05	<0.05
Chromium	0.0001		0.0002	0.0003	0.0004	0.0003	0.0004	0.0002	0.0002	0.0002	0.0003	<0.0001	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002	<0.0001	<0.0001
Cobalt	0.000005		0.00041	0.000255	0.000225	0.000241	0.000204	0.000098	0.000073	0.000083	0.000084	0.000245	0.00855	0.000914	0.000053	0.000234	0.000104	0.000082	0.000086	0.000125	<0.000005	<0.000005
Copper	0.00005		0.00756	0.00724	0.00191	0.00527	0.00508	0.00255	0.00214	0.00261	0.00198	0.07	0.215	0.0493	0.00263	0.0292	0.0146	0.00192	0.00523	0.00314	<0.00005	0.00007
Iron	0.001		0.312	0.227	0.278	0.236	0.236	0.17	0.128	0.159	0.14	0.015	6	0.419	0.108	0.237	0.201	0.207	0.197	0.24	<0.001	0.001
Lead	0.000005		0.000079	0.000083	0.000084	0.000054	0.000064	0.000137	0.000091	0.000125	0.000028	0.00415	0.0019	0.000216	0.00164	0.000407	0.000161	0.000172	0.000157	0.000065	<0.000005	0.000058
Lithium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0002	0.0015	0.002	0.0005	0.0032	0.0012	0.0005	0.0007	0.0007	0.0006	0.0014	0.0012	0.0012	<0.0005	<0.0005
Magnesium	0.05		0.87	4.14	2.43	3.74	4.44	7.7	6.95	7.69	4.73	11	5	2.73	4.56	4.21	3.89	3.1	3.38	6.16	<0.05	<0.05
Manganese	0.00005		0.0548	0.0147	0.023	0.0186	0.016	0.0247	0.0117	0.0131	0.00379	0.361	0.327	0.0446	0.019	0.0158	0.00578	0.0122	0.0106	0.0504	<0.00005	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00078	0.00037	0.00015	0.00028	0.00033	0.00088	0.00101	0.00086	0.00027	<0.00005	<0.00005	0.00018	0.00034	0.00031	0.00056	0.00037	0.00044	0.00067	<0.00005	<0.00005
Nickel	0.00002		0.00148	0.00161	0.0008	0.00129	0.00135	0.00386	0.00252	0.00378	0.0007	0.00061	0.00261	0.00101	0.00075	0.00081	0.00079	0.00069	0.00069	0.00063	<0.00002	<0.00002
Phosphorous	0.002		0.018	0.013	0.014	0.013	0.013	0.01	0.008	0.009	0.011	<0.002	0.016	0.011	0.01	0.01	0.012	0.012	0.013	0.007	<0.002	<0.002
Potassium	0.05		1.14	1.19	1.01	1.15	1.25	1.06	1.03	1.07	1.05	1.68	1.18	0.78	1.01	0.82	0.85	0.62	0.69	0.84	<0.05	<0.05
Selenium	0.00004		0.00006	0.00005	<0.00004	<0.00004	0.00006	0.00048	0.00033	0.00048	0.00004	<0.00004	0.00007	0.00006	0.00005	0.00007	0.00005	0.00004	0.00004	0.00007	<0.00004	<0.00004
Silicon	0.1		2.4	2.4	1.3	2.1	2.2	2.9	3	2.9	2.2	5.7	2.6	3	3.1	3	3	2.4	2.6	3.3	<0.1	<0.1
Silver	0.000005		0.000006	0.000007	<0.000005	0.000006	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000022	0.000019	0.00001	0.000011	0.000011	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		0.99	1.55	0.96	1.4	1.5	1.79	1.98	1.78	1.95	3.95	1.6	1.53	1.85	1.7	1.9	1.63	1.73	2.85	0.07	<0.05
Strontium	0.00005		0.0301	0.0714	0.0528	0.0685	0.0786	0.117	0.114	0.115	0.0903	0.362	0.0696	0.086	0.103	0.099	0.0803	0.0757	0.0803	0.119	<0.00005	<0.00005
Thallium	0.000002		0.000005	<0.000002	<0.000002	<0.000002	0.000005	0.000005	0.000005	0.000005	<0.000002	0.000025	0.000022	0.000006	0.000003	0.000005	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.002	0.0022	0.0039	0.0026	0.0029	0.0022	0.0021	0.0022	0.0017	<0.0005	0.0025	0.0014	0.0014	0.0017	0.0021	0.0023	0.0021	0.0012	<0.0005	<0.0005
Uranium	0.000002		0.000225	0.00317	0.00109	0.00275	0.00304	0.00075	0.000842	0.000799	0.00136	0.00217	0.00269	0.00101	0.00398	0.00263	0.00201	0.00222	0.00223	0.00279	<0.000002	0.000003
Vanadium	0.0002		0.0003	0.0003	0.0005	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	0.0003	0.0004	0.0004	0.0005	<0.0002	<0.0002
Zinc	0.0001		0.0164	0.0098	0.0083	0.0081	0.0069	0.009	0.0069	0.0084	0.0086	3.73	0.0731	0.016	0.0084	0.0098	0.0069	0.0059	0.0053	0.0064	0.0056	0.0008
Zirconium	0.0001		0.0002	0.0003	0.0003	0.0003	0.0004	0.0002	0.0002	0.0002	0.0003	<0.0001	0.0003	0.0003	0.0002	0.0003	0.0003	0.0003	0.0003	0.0002	<0.0001	<0.0001

Foot Notes:

All units mg/l unless otherwise noted

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

b) 0.005mg/L at pH < 6.5, [Ca2+] < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, [Ca2+] ≥ 4 mg/L, DOC ≥ 2 mg/L

c) 0.002 mg/L at [CaCO3] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

d) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

e) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

Italic = results exceed CCME Aquatic Life Guidelines

AECOM

B3. Surface Water Quality Data, Casino Project, July 2008

Appendix B3. Surface Water Quality Data, Casino Project, July 2008

Station	Detection Limits	Water Quality Guidelines	W7 - Upper Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W14 -Mouth of Britannia Creek	W2 - Canadian Creek downstream of Confluence with Britannia Creek	W1 - Mouth of Canadian Creek	W1 - Replicate taken as W101	W6b - Yukon River Upstream of Canadian Creek	W6a - Yukon River downstream of Canadian Creek	W15 - Yukon River far field site	W17 - Sunshine Creek	W43 - Adit discharge pipe at lower camp	W43 - Replicate taken as W102	W12 - Proctor Gulch before confluence with Casino Creek	W8 - Upper Casino Creek	W13 - Meloy Creek	W11 - Casino Creek (proposed dam outflow)	W4 - Mouth of Casino Creek	W9 - Dip Creek us of Confluence with Casino Creek	W5 - Dip Creek ds Casino confluence	W16 - Dip Creek far field	Field Blank (W40)	Maxxam Travel Blank
Date		CCME [a]	8-Jul-08	8-Jul-08	8-Jul-08	8-Jul-08	8-Jul-08	8-Jul-08	8-Jul-08	8-Jul-08	8-Jul-08	8-Jul-08	8-Jul-08	9-Jul-08	8-Jul-08	8-Jul-08	9-Jul-08	9-Jul-08	9-Jul-08	9-Jul-08	9-Jul-08	9-Jul-08	9-Jul-08	5-Jul-08
Physical Tests																								
Temperature C	-		7.9	8.2	5	6.5	7.4	7.4	14.5	13.9	14.2	5.3	3.6	3.6	7	3.1	3	7.5	6.4	5.7	6.1	6.9	-	-
Conductivity (Field) uS/cm	-		107	263	318	287	280	280	187	149	162	185	242	242	1034	281	324	298	232	103	119	141	-	-
pH (Field)	-		7.1	7.7	7.7	7.5	7.9	7.9	8.2	8.0	8.1	7.7	6.7	6.7	3.3	7.4	7.8	7.8	7.7	7.5	7.6	7.5	-	-
Hardness CaCO3	0.5		38.0	121	158	138	143	144	98.1	76.1	84.6	97.4	116	117	411	125	164	146	111	51.6	58.5	68.1	<0.5	<0.5
Conductivity uS/cm	1		110	260	320	290	280	280	190	150	160	190	240	240	1200	280	330	300	230	100	120	140	<1	<1
pH	-	6.5-9.0	7.1	8.0	8.0	8.0	8.1	8.1	8.1	8.1	7.9	7.9	7.5	7.3	3.2	7.8	8.2	8.1	8.0	7.8	7.8	7.8	5.2	5.8
Total Suspended Solids	1		<1	1	7	20	4	4	33	28	32	7	<1	<1	3	5	<1	<1	1	25	17	13	<1	<1
Total Dissolved Solids	1		98	180	220	210	200	200	110	110	100	150	170	160	790	200	210	200	150	94	110	120	2	<1
Turbidity NTU	0.1		0.3	0.4	0.4	0.3	0.5	0.3	6.9	4.2	8.4	0.6	0.2	0.3	2.5	5.1	0.1	0.4	0.2	1.3	1.1	0.9	0.1	<0.1
Dissolved Anions & Nutrients																								
Ammonia as N	0.005		0.013	<0.005	0.006	<0.005	0.013	0.015	0.008	0.008	0.032	0.032	0.016	<0.005	0.050	0.008	0.005	0.014	<0.005	<0.005	<0.005	<0.005	0.009	0.014
Alkalinity, Total (as $CaCO_3$)	0.5		6.9	70	100	83	81	82	71	64	64	68	83	80	<0.5	42	130	83	79	43	48	49	<0.5	<0.5
Acidity (pH 8.3) as $CaCO_3$	0.5		-	-	-	-	-	-	-	-	-	-	-	-	153	-	-	-	-	-	-	-	-	-
Chloride (Cl)	0.5		<0.5	0.7	1.0	0.8	2.5	5.3	0.6	0.6	0.6	1.1	0.8	0.9	0.7	0.7	0.8	0.7	0.9	1.1	1.0	0.9	0.7	<0.5
Sulfate (SO4)	0.5		39	57	91	60	63	59	25	13	17	27	44	45	550	90	47	67	42	7.5	12	24	1.8	1.3
Nitrate (as N)	0.002	13	<0.002	0.096	0.207	0.135	0.169	0.164	0.019	0.024	0.026	0.148	0.214	0.216	0.030	0.073	0.249	0.107	0.087	0.068	0.066	0.035	0.012	<0.002
Nitrite (as N)	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.11	0.32	0.22	0.29	0.24	0.19	0.13	0.11	0.10	0.23	0.07	0.10	0.18	0.15	0.15	0.21	0.16	0.26	0.27	0.39	0.05	0.04
Ortho Phosphate as P	0.001		<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	0.003	<0.001	0.002	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Cyanide, Weak Acid Diss	0.0005		<0.0005	<0.0005	0.0007	<0.0005	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.0005	<0.0005	<0.0005
Total Cyanide	0.0005	0.005	<0.0005	0.0007	0.0007	0.0006	0.0008	0.0008	<0.0005	<0.0005	<0.0005	0.0011	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0010	0.0008	0.0012	<0.0005	<0.0005
Total Metals																								
Aluminum	0.0002	0.005-0.1[b]	0.0388	0.0321	0.134	0.236	0.0821	0.0752	0.244	0.236	0.276	0.136	0.0036	0.0030	12.2	0.534	0.0162	0.0475	0.0446	0.348	0.272	0.256	0.0013	0.0012
Antimony	0.00002		0.00008	0.00044	0.00022	0.00034	0.00028	0.00027	0.00013	0.00009	0.00011	0.00025	0.00342	0.00342	0.00013	0.00010	0.00027	0.00015	0.00014	0.00009	0.00011	0.00010	<0.00002	<0.00002
Arsenic	0.00002	0.005	0.00026	0.00072	0.00066	0.00099	0.00057	0.00059	0.00076	0.00065	0.00073	0.00092	0.00049	0.00048	0.00031	0.00026	0.00180	0.00060	0.00042	0.00059	0.00054	0.00063	<0.00002	<0.00002
Barium	0.00002		0.0406	0.0570	0.0839	0.0744	0.0627	0.0598	0.0585	0.0441	0.0514	0.0695	0.0517	0.0496	0.0102	0.0540	0.0904	0.0643	0.0550	0.0446	0.0455	0.0439	0.00057	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	0.00001	0.00002	0.00001	0.00001	0.00002	0.00001	0.00003	0.00002	<0.00001	<0.00001	0.00059	0.00003	<0.00001	<0.00001	<0.00001	0.00003	0.00002	0.00002	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000011	0.000006	0.000008	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	<0.000005	<0.000005	<0.000005	0.000005	0.000006	0.000006	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017	0.000087	0.000017	0.000011	0.000021	0.000014	0.000011	0.000077	0.000032	0.000056	0.000021	0.0553	0.0550	0.0317	0.000253	0.000026	0.000043	0.000013	0.000017	0.000021	0.000018	0.000006	<0.000005
Calcium	0.05		11.5	31.1	37.7	34.3	35.8	36.1	26.8	21.2	23.5	24.5	32.3	32.7	124	37.4	43.6	39.5	29.6	13.4	15.1	16.4	0.07	<0.05
Chromium	0.0001	0.001	0.0001	0.0002	0.0003	0.0004	0.0003	0.0003	0.0005	0.0005	0.0006	0.0003	<0.0001	<0.0001	0.0006	0.0001	0.0001	<0.0001	0.0002	0.0006	0.0005	0.0006	<0.0001	<0.0001
Cobalt	0.000005		0.000032	0.000050	0.000114	0.000254	0.000099	0.000088	0.000307	0.000298	0.000343	0.000133	0.000164	0.000161	0.0510	0.00222	0.000018	0.000048	0.000045	0.000265	0.000228	0.000268	<0.000005	<0.000005
Copper	0.00005	0.002-0.004[c]	0.00267	0.00258	0.00177	0.00277	0.00243	0.00240	0.00176	0.00156	0.00176	0.00194	0.0608	0.0604	1.13	0.0554	0.00054	0.00787	0.00371	0.00214	0.00228	0.00296	0.00006	<0.00005
Iron	0.001	0.3	0.028	0.042	0.157	0.344	0.104	0.099	0.448	0.400	0.487	0.196	0.025	0.023	32.5	1.03	0.024	0.071	0.076	0.556	0.441	0.524	<0.001	0.003
Lead	0.000005	0.001-0.007[d]	0.000079	0.000032	0.000083	0.000321	0.000059	0.000051	0.000082	0.000074	0.000366	0.000140	0.00567	0.00567	0.00116	0.000225	0.000218	0.000041	0.000028	0.000609	0.000596	0.000222	0.000008	0.000042
Lithium	0.0005		0.0006	0.0005	0.0010	0.0009	0.0009	0.0009	0.0020	0.0013	0.0016	0.0008	0.0024	0.0025	0.0065	0.0010	0.0020	0.0013	0.0010	0.0022	0.0020	0.0013	<0.0005	<0.0005
Magnesium	0.05		2.25	10.4	15.4	12.7	13.0	13.0	7.56	5.61	6.27	8.77	8.58	8.66	25.0	7.68	13.3	11.5	9.11	4.40	5.04	6.57	<0.05	<0.05
Manganese	0.000005		0.00079	0.00355	0.00747	0.0188	0.00454	0.00465	0.0289	0.0236	0.0285	0.0137	0.266	0.268	1.39	0.0676	0.00448	0.0145	0.00498	0.0347	0.0287	0.0294	0.00015	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00033	0.00093	0.00053	0.00071	0.00077	0.00075	0.00094	0.00089	0.00088	0.00040	<0.00005	<0.00005	0.00012	0.00023	0.00083	0.00095	0.00120	0.00050	0.00060	0.00055	<0.00005	<0.00005
Nickel	0.00002	0.025-0.15[e]	0.00067	0.00072	0.00062	0.00090	0.00077	0.00082	0.00210	0.00143	0.00192	0.00071	0.00050	0.00042	0.00782	0.00080	0.00023	0.00030	0.00035	0.00085	0.00077	0.00136	<0.00002	<0.00002
Phosphorous	0.002		0.004	<0.002	0.009	0.022	0.005	0.005	0.034	0.032	0.038	0.009	0.002	0.002	0.004	<0.002	0.003	0.003	0.003	0.021	0.018	0.015	0.043	<0.002
Potassium	0.05		0.56	1.88	1.94	1.93	2.08	2.08	0.77	0.75	0.76	1.16	1.43	1.41	2.19	0.86	1.22	0.99	1.02	0.52	0.57	0.60	<0.05	<0.05
Selenium	0.00004	0.001	0.00006	0.00007	0.00008	0.00008	0.00011	0.00011	0.00047	0.00023	0.00034	0.00007	<0.00004	<0.00004	0.00025	0.00006	0.00005	0.00010	0.00006	0.00006	0.00006	0.00008	<0.00004	<0.00004
Silicon	0.1		7.6	4.8	4.0	4.6	4.5	4.8	3.4	3.3	3.4	4.0	5.8	6.1	9.2	5.6	5.1	4.8	4.9	4.2	4.3	4.2	<0.1	<0.1
Silver	0.000005	0.0001	0.000006	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000009	0.000008	0.000012	0.000008	0.000090	0.000088	0.000026	<0.000005	<0.000005	<0.000005	<0.000005	0.000007	0.000007	<0.000005	<0.000005	<0.000005
Sodium	0.05		3.49	4.25	4.99	4.64	4.39	4.40	1.66	1.61	1.62	3.87	3.52	3.52	7.57	3.86	5.17	4.15	4.13	2.41	2.60	2.72	<0.05	<0.05
Strontium	0.00005		0.0811	0.204	0.316	0.251	0.236	0.234	0.113	0.0908	0.100	0.163	0.280	0.281	0.317	0.250	0.269	0.248	0.177	0.110	0.118	0.111	0.00094	<0.00005
Thallium	0.000002	0.0008	0.000002	0.000003	0.000006	0.000006	0.000004	0.000003	0.000007	0.000006	0.000008	0.000004	0.000023	0.000023	0.000094	0.000006	<0.000002	0.000003	0.000002	0.000006	0.000006	0.000004	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0008	0.0014	0.0071	0.0151	0.0031	0.0027	0.0095	0.0102	0.0106	0.0063	<0.0005	<0.0005	0.0005	<0.0005	0.0005	0.0006	0.0014	0.0159	0.0118	0.0093	<0.0005	<0.0005
Uranium	0.000002		0.000073	0.00708	0.0103	0.00976	0.00928	0.00907	0.000946	0.000860	0.000884	0.00188	0.00149	0.00154	0.0145	0.00217	0.0180	0.00961	0.00558	0.00250	0.00272	0.00178	0.000004	<0.000002
Vanadium	0.0002		0.0002	<0.0002	0.0006	0.0011	0.0004	0.0004	0.0010	0.0009	0.0011	0.0007	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0004	0.0013	0.0011	0.0013	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0061	0.0005	0.0006	0.0016	0.0008	0.0008	0.0061	0.0029	0.0045	0.0012	8.26	2.99	0.237	0.0192	0.0014	0.0018	0.0005	0.0022	0.0020	0.0015	0.0022	0.0008
Zirconium	0.0001		<0.0001	0.0001	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0002	0.0004	0.0003	0.0005	<0.0001	<0.0001
Dissolved Metals																								
Aluminum	0.0002		0.0336	0.0197	0.0493	0.0334	0.0438	0.0429	0.0346	0.0268	0.0334	0.0546	0.0056	0.0254	12.2	0.0569	0.0110	0.0307	0.0329	0.0927	0.0845	0.101	0.0031	0.0024
Antimony	0.00002		0.00008	0.00044	0.00024	0.00036	0.00027	0.00030	0.00012	0.00008	0.00010	0.00025	0.00335	0.00329	0.00013	0.00009	0.00023	0.00015	0.00014	0.00008	0.00009	0.00009	<0.00002	<0.00002
Arsenic	0.00002		0.00024	0.00070	0.00055	0.00062	0.00056	0.00054	0.00045	0.00044	0.00045	0.00069	0.00028	0.00029	0.00031	0.00018	0.00178	0.00056	0.00040	0.00033	0.00034	0.00050	<0.00002	<0.00002
Barium	0.00002		0.0400	0.0554	0.0789	0.0669	0.0591	0.0608	0.0426	0.0345	0.0371	0.0627	0.0495	0.0496	0.0103	0.0525	0.0884	0.0619	0.0555	0.0350	0.0385	0.0392	<0.00002	0.00006
Beryllium	0.00001		<0.00001	<0.00001	0.00001	<0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00059	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	0.00001	0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Calcium	0.05		11.1	31.3	37.6	33.7	33.3	33.5	24.8	20.1	21.4	22.3	30.1	30.9	122	38.1	41.6	38.6	29.2	12.9	14.7	16.3	<0.05	<0.05
Cadmium	0.000005		0.000084	0.000014	0.000006	0.000013	0.000008	0.000008	0.000023	0.000015	0.000023	0.000013	0.0515	0.0531	0.00323	0.000220	0.000023	0.000043	0.000014	0.000011	0.000007	0.000011	0.000008	<0.000005
Chromium	0.0001		0.0002	0.0002	0.0003	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0003	<0.0001	<0.0001	0.0008	0.0001	<0.0001	0.0001	0.0002	0.0003	0.0003	0.0004	<0.0001	<0.0001
Cobalt	0.000005		0.000031	0.000035	0.000047	0.000051	0.000051	0.000042	0.000021	0.000016	0.000020	0.000044	0.000157	0.000161	0.0509	0.00218	0.000010	0.000040	0.000031	0.000052	0.000051	0.000133	<0.000005	<0.000005
Copper	0.00005		0.00272	0.00261	0.00166	0.00219	0.00205	0.00211	0.00089	0.00082	0.00082	0.00153	0.0510	0.0534	1.12	0.0313	0.00056	0.00713	0.00356	0.00159	0.00179	0.00249	0.00010	<0.00005
Iron	0.001		0.016	0.015	0.035	0.025	0.044	0.045	0.029	0.027	0.029	0.053	0.007	0.007	35.1	0.423	0.011	0.045	0.043	0.114	0.105	0.238	<0.001	0.002
Lead	0.000005		0.000011	0.000008	0.000011	0.000065	<0.000005	<0.000005	0.000029	0.000021	0.000022	0.000016	0.00205	0.00218	0.00113	0.000099	0.000029	0.000015	0.000009	0.000062	0.000052	0.000025	<0.000005	0.000043
Lithium	0.0005		0.0007	0.0005	0.0010	0.0008	0.0008	0.0008	0.0017	0.0010	0.0013	0.0008	0.0024	0.0024	0.0064	0.0009	0.0020	0.0013	0.0011	0.0019	0.0018	0.0012	<0.0005	<0.0005
Magnesium	0.05		2.30	10.7	16.0	12.9	12.1	12.4	7.19	5.33	5.89	8.31	8.13	8.33	25.4	7.98	13.1	11.6	9.31	4.35	4.93	6.77	<0.05	<0.05
Manganese	0.000005		0.00052	0.00255	0.00718	0.00287	0.00131	0.00128	0.00226	0.00182	0.00186	0.00325	0.252	0.258	1.39	0.0683	0.00248	0.0136	0.00386	0.00674	0.00681	0.0174	<0.00005	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00033	0.00094	0.00057	0.00083	0.00073	0.00078	0.00100	0.00095	0.00097	0.00040	<0.00005	<0.00005	0.00012	0.00024	0.00085	0.00093	0.00127	0.00052	0.00061	0.00056	<0.00005	<0.00005
Nickel	0.00002		0.00065	0.00077	0.00059	0.00064	0.00075	0.00068	0.00103	0.00067	0.00077	0.00064	0.00045	0.00053	0.00789	0.00079	0.00022	0.00029	0.00034	0.00057	0.00058	0.00116	0.00002	<0.00002
Phosphorous	0.002		<0.002	<0.002	0.003	0.002	<0.002	<0.002	0.002	<0.002	<0.002	0.003	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	0.002	0.005	0.004	0.005	<0.002	<0.002
Potassium	0.05		0.56	1.91	1.95	1.92	1.94	1.95	0.70	0.69	0.69	1.07	1.33	1.36	2.17	0.88	1.20	0.98	1.03	0.50	0.55	0.60	<0.05	<0.05
Selenium	0.00004		0.00005	0.00007	0.00009	0.00008	0.00012	0.00010	0.00048	0.00024	0.00034	0.00008	<0.00004	<0.00004	0.00029	0.00005	0.00006	0.00011	0.00007	0.00006	0.00006	0.00008	<0.00004	<0.00004
Silicon	0.1		7.5	5.0	4.5	4.6	3.8	4.1	3.2	3.2	3.2	4.1	6.0	5.9	10.6	5.8	5.4	5.2	5.3	4.2	4.3	4.3	<0.1	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000026	0.000035	0.000021	<0.000005	<0.000005	0.000006	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		3.69	4.42	5.30	4.84	4.20	4.20	1.66	1.63	1.63	3.71	3.44	3.45	7.78	4.03	5.22	4.15	4.35	2.48	2.70	2.84	0.07	<0.05
Strontium	0.00005		0.0790	0.203	0.306	0.250	0.214	0.217	0.109	0.0866	0.0925	0.157	0.265	0.271	0.307	0.246	0.269	0.246	0.182	0.105	0.116	0.111	<0.00005	0.00008
Thallium	0.000002		0.000002	0.000003	0.000003	0.000003	0.000004	0.000004	0.000004	0.000003	0.000003	0.000002	0.000022	0.000025	0.000095	0.000006	<0.000002	0.000003	0.000002	0.000003	0.000002	0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	0.0007	<0.0005	0.0006	<0.0005	<0.0005	0.0006	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0012	0.0013	0.0017	<0.0005	<0.0005
Uranium	0.000002		0.00009	0.00685	0.00971	0.00923	0.00864	0.00890	0.000863	0.000802	0.000800	0.00172	0.00128	0.00134	0.0145	0.00135	0.0177	0.00898	0.00570	0.00194	0.00238	0.00162	0.000006	0.000004
Vanadium	0.0002		0.0002	<0.0002	0.0004	0.0002	0.0003	0.0003	0.0002	<0.0002	0.0002	0.0003	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0004	0.0004	0.0006	<0.0002	<0.0002
Zinc	0.0001		0.0107	0.0055	0.0058	0.0061	0.0045	0.0042	0.0062	0.0046	0.0065	0.005	2.84	2.93	0.241	0.0182	0.0066	0.0051	0.0052	0.0054	0.0047	0.0039	0.0042	0.0007
Zirconium	0.0001		0.0001	0.0002	0.0003	0.0002	0.0002	0.0002	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0002	0.0003	0.0003	0.0004	<0.0001	<0.0001

Foot Notes:

All units mg/l unless otherwise noted

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

b) 0.005mg/L at pH < 6.5, [Ca2+] < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH $\geq$ 6.5, [Ca2+] $\geq$ 4 mg/L, DOC $\geq$ 2 mg/L

c) 0.002 mg/L at [CaCO3] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

d) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

e) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

Italic results exceed CCME Aquatic Life Guidelines

AECOM

B4. Surface Water Quality Data, Casino Project, September 2008

Appendix B4. Surface Water Quality Data, Casino Project, September 2008

Station	Detection Limits	Water Quality Guidelines	W7 - Upper Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W14 - Mouth of Britannia Creek	W2 - Canadian Creek downstream of Confluence with Britannia Creek	W2 - Replicate	W1 - Mouth of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W6a - Yukon River downstream of Canadian Creek	W15 - Yukon River far field site	W17 - Sunshine Creek	W43 - Adit discharge pipe at lower camp	W43 - Replicate taken as W43B	W12 - Proctor Gulch before confluence with Casino Creek	W8 - Upper Casino Creek	W13 - Meloy Creek	W11 - Casino Creek (proposed dam outflow)	H18 - Casino Creek (downstream of Brynelsen Creek)	W4 - Mouth of Casino Creek	W9 - Dip Creek us of Confluence with Casino Creek	W5 - Dip Creek ds Casino confluence	W16 - Dip Creek far field	Maxxam Travel Blank
Date		CCME [a]	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	10-Sep-08	10-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08
Physical Tests																								
Temperature C	-		2.7	4.5	3	4.1	4.1	4.6	9.6	10.0	9.9	4.1	4.2	4.2	0.7	3.5	1.9	2.5	3.1	2.3	2.5	-	3.9	-
Conductivity (Field) uS/cm	-		117	175	188	179	179	201	220	174	216	179	347	347	690	211	195	207	113	162	129	-	119	-
pH (Field)	-		6.8	7.7	8.0	7.6	7.6	7.8	8.2	8.1	8.1	7.5	7.4	7.4	3.5	7.7	7.5	7.7	7.6	7.8	7.6	-	7.6	-
Hardness CaCO3	0.5		41.0	83.7	90.0	83.0	81.7	89.7	107	83.9	107	83.9	94.4	94.9	235	91.7	93.9	93.4	64.5	78.0	62.7	67.2	68.9	<0.5
Conductivity uS/cm	1		120	180	190	180	180	200	220	180	220	180	220	220	740	210	200	210	140	160	130	140	150	1
pH	-	6.5-9.0	6.8	7.8	7.8	7.9	7.9	7.9	8.1	8.1	8.1	7.9	7.5	7.7	3.4	7.7	8.1	7.9	7.8	7.9	7.9	7.9	7.9	6.2
Total Suspended Solids	1		1	3	2	3	3	3	14	12	32	1	<1	<1	11	14	3	3	2	12	17	25	18	<1
Total Dissolved Solids	1		100	74	150	120	120	140	180	140	140	96	120	130	470	150	94	100	70	92	56	76	92	<1
Turbidity NTU	0.1		0.3	0.7	0.4	0.6	0.5	0.7	8.2	3.7	4.9	0.2	0.8	0.9	18.0	3.4	0.3	1.1	0.5	1.6	4.0	1.7	2.8	<0.1
Dissolved Anions & Nutrients																								
Ammonia as N	0.01		<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.02	0.01
Alkalinity, Total (as $CaCO_3$)	0.5		4.8	45	59	50	50	55	81	72	80	63	67	67	<0.5	35	82	59	45	55	54	55	56	<0.5
Acidity (pH 8.3) as $CaCO_3$	0.5		-	-	-	-	-	-	-	-	-	-	13.2	9.0	82.1	-	-	-	-	-	-	-	-	-
Chloride (Cl)	0.5		<0.5	0.6	0.7	0.6	<0.5	0.8	0.6	0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	0.6	<0.5
Sulfate (SO4)	0.5		43	40	30	38	40	44	32	18	31	26	39	39	240	62	18	43	21	25	9.9	15	18	0.5
Nitrate (as N)	0.002	13	<0.002	0.173	0.255	0.197	0.197	0.202	0.014	0.015	0.011	0.206	0.443	0.454	0.081	0.123	0.361	0.189	0.197	0.169	0.130	0.143	0.109	0.004
Nitrite (as N)	0.002	0.06	<0.002	0.003	0.002	0.003	0.003	0.002	0.003	0.002	0.004	0.002	<0.002	<0.002	0.003	0.002	<0.002	0.002	0.002	0.002	0.003	0.002	0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.12	0.21	0.26	0.21	0.25	0.23	0.09	0.11	0.08	0.20	0.04	0.02	0.13	0.11	0.14	0.15	0.15	0.17	0.15	0.22	0.19	<0.02
Ortho Phosphate as P	0.001		0.002	<0.001	<0.001	<0.001	0.001	0.001	0.006	0.003	0.006	<0.001	0.002	0.002	0.002	0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.002	<0.001
Cyanide, Weak Acid Diss	0.0005		<0.0005	0.0007	0.0008	0.0007	0.0006	0.0008	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.0008	<0.0005	<0.0005	<0.0005	0.0007	<0.00005
Total Cyanide	0.0005	0.005	0.0006	0.0010	0.0017	0.0012	0.0012	0.0012	<0.0005	0.0008	<0.0005	0.0013	<0.0005	<0.0005	<0.0005	0.0006	0.0007	0.0008	0.0013	0.0010	0.0010	0.0010	0.0010	<0.0005
Total Metals																								
Aluminum	0.0002	0.005-0.1[b]	0.112	0.219	0.271	0.105	0.0866	0.0883	0.124	0.0954	0.137	0.0600	0.0235	0.0224	6.35	0.592	0.0452	0.195	0.157	0.192	0.157	0.354	0.203	0.0008
Antimony	0.00002		0.00007	0.00045	0.00033	0.00039	0.00038	0.00034	0.00013	0.00010	0.00015	0.00027	0.00264	0.00263	0.00015	0.00014	0.00024	0.00015	0.00013	0.00013	0.00008	0.00010	0.00010	<0.00002
Arsenic	0.00002	0.005	0.00026	0.00111	0.00103	0.00082	0.00076	0.00070	0.00060	0.00054	0.00064	0.00062	0.00079	0.00077	0.00028	0.00055	0.00089	0.00060	0.00043	0.00050	0.00046	0.00066	0.00063	<0.00002
Barium	0.00002		0.0471	0.0438	0.0699	0.0450	0.0431	0.0449	0.0561	0.0421	0.0597	0.0588	0.0658	0.0649	0.0285	0.0524	0.0718	0.0493	0.0379	0.0447	0.0457	0.0539	0.0466	<0.00002
Beryllium	0.00001		0.00002	0.00003	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002	<0.00001	<0.00001	<0.00001	0.00037	0.00005	<0.00001	0.00002	0.00001	0.00002	0.00002	0.00003	0.00002	<0.00001
Bismuth	0.000005		0.000040	0.000013	0.000018	0.000005	<0.000005	<0.000005	<0.000005	0.000012	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000009	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000008	<0.000005	0.000021
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017	0.000238	0.000068	0.000031	0.000023	0.000019	0.000015	0.000080	0.000041	0.000088	0.000018	0.0425	0.0427	0.00176	0.000260	0.000041	0.000083	0.000032	0.000034	0.000015	0.000035	0.000021	<0.000005
Calcium	0.05		12.2	22.0	21.8	20.9	20.6	22.7	28.8	23.2	28.7	20.8	26.2	26.3	71.3	27.7	26.1	26.1	17.9	21.0	16.5	17.7	17.7	<0.05
Chromium	0.0001	0.001	0.0002	0.0005	0.0007	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0003	<0.0001	<0.0001	0.0005	0.0004	0.0002	0.0002	0.0003	0.0003	0.0004	0.0005	0.0005	<0.0001
Cobalt	0.000005		0.000144	0.000352	0.000219	0.000108	0.000083	0.000079	0.000181	0.000125	0.000199	0.000062	0.000320	0.000313	0.0249	0.00235	0.000031	0.000511	0.000180	0.000233	0.000158	0.000393	0.000228	<0.000005
Copper	0.00005	0.002-0.004[c]	0.00282	0.00521	0.00423	0.00339	0.00303	0.00279	0.00139	0.00114	0.00143	0.00175	0.0748	0.0743	0.650	0.0615	0.00098	0.0206	0.00746	0.00866	0.00163	0.00454	0.00362	<0.00005
Iron	0.001	0.3	0.100	0.208	0.370	0.107	0.084	0.085	0.193	0.152	0.225	0.058	0.047	0.048	14.2	0.873	0.060	0.274	0.156	0.273	0.259	0.567	0.384	<0.001
Lead	0.000005	0.001-0.007[d]	0.000154	0.00147	0.00150	0.000393	0.000059	0.000064	0.000253	0.000169	0.000270	0.000145	0.0120	0.0120	0.00662	0.00137	0.000662	0.000165	0.000090	0.000214	0.000305	0.000732	0.000334	0.000009
Lithium	0.0005		0.0007	<0.0005	0.0007	<0.0005	<0.0005	0.0006	0.0022	0.0014	0.0022	0.0008	0.0020	0.0020	0.0042	0.0010	0.0010	0.0009	0.0007	0.0009	0.0020	0.0018	0.0013	<0.0005
Magnesium	0.05		2.56	6.95	8.63	7.48	7.37	8.04	8.52	6.29	8.50	7.76	7.02	7.07	13.9	5.47	7.00	6.86	4.82	6.19	5.25	5.56	5.99	<0.05
Manganese	0.00005		0.0105	0.0342	0.0138	0.00687	0.00494	0.00404	0.0236	0.0156	0.0243	0.00435	0.524	0.526	0.741	0.0717	0.00758	0.0275	0.0103	0.0166	0.0200	0.0419	0.0297	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00020	0.00063	0.00048	0.00057	0.00055	0.00059	0.00100	0.00101	0.00102	0.00041	<0.00005	<0.00005	0.00015	0.00025	0.00053	0.00054	0.00072	0.00085	0.00059	0.00061	0.00067	<0.00005
Nickel	0.00002	0.025-0.15[e]	0.00100	0.00122	0.00083	0.00087	0.00080	0.00076	0.00221	0.00117	0.00219	0.00057	0.00049	0.00043	0.00438	0.00126	0.00030	0.00065	0.00045	0.00055	0.00060	0.00083	0.00087	<0.00002
Phosphorous	0.002		0.006	0.012	0.017	0.006	0.006	0.005	0.021	0.015	0.021	0.005	0.003	0.003	0.007	0.031	0.004	0.004	0.005	0.011	0.014	0.049	0.018	<0.002
Potassium	0.05		0.41	1.29	1.26	1.20	1.16	1.33	0.72	0.71	0.73	1.01	1.35	1.35	1.49	0.88	0.95	0.74	0.74	0.81	0.57	0.64	0.69	<0.05
Selenium	0.00004	0.001	<0.00004	<0.00004	0.00006	<0.00004	0.00004	0.00006	0.00053	0.00028	0.00053	0.00006	<0.00004	<0.00004	0.00015	0.00004	<0.00004	0.00005	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Silicon	0.1		6.9	4.6	4.2	4.6	4.5	4.9	3.0	3.1	3.5	4.4	5.8	6.2	8.1	5.8	5.0	4.9	5.1	5.2	4.5	4.7	4.7	<0.1
Silver	0.000005	0.0001	<0.000005	0.000005	0.000011	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000007	<0.000005	0.000105	0.000116	0.000016	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		3.38	3.20	3.00	2.77	2.75	2.77	1.86	1.85	1.91	3.03	3.09	3.07	4.51	3.10	3.11	2.89	2.66	3.08	2.74	2.79	2.89	<0.05
Strontium	0.00005		0.0793	0.127	0.171	0.140	0.136	0.148	0.129	0.105	0.131	0.139	0.220	0.220	0.195	0.180	0.161	0.162	0.101	0.125	0.127	0.125	0.118	<0.00005
Thallium	0.000002	0.0008	0.000004	0.000005	0.000007	0.000004	0.000004	0.000004	0.000004	0.000004	0.000005	0.000003	0.000025	0.000026	0.000057	0.000010	0.000002	0.000004	0.000004	0.000004	0.000003	0.000007	0.000003	<0.000002
Tin	0.00001		<0.00001	<0.00001	0.00006	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	0.00003	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0015	0.0050	0.0093	0.0025	0.0021	0.0016	0.0023	0.0024	0.0024	0.0011	<0.0005	<0.0005	<0.0005	0.0058	0.0011	0.0013	0.0018	0.0051	0.0067	0.0196	0.0070	<0.0005
Uranium	0.000002		0.000095	0.00434	0.00349	0.00466	0.00465	0.00464	0.000929	0.000916	0.00104	0.00126	0.00126	0.00126	0.00838	0.00164	0.00637	0.00400	0.00229	0.00294	0.00323	0.00338	0.00254	<0.000002
Vanadium	0.0002		0.0002	0.0006	0.0010	0.0003	0.0002	0.0003	0.0004	0.0004	0.0004	0.0003	<0.0002	<0.0002	<0.0002	0.0004	<0.0002	0.0002	0.0004	0.0008	0.0009	0.0017	0.0012	<0.0002
Zinc	0.0001	0.03	0.0195	0.0133	0.0033	0.0016	0.0011	0.0008	0.0062	0.0028	0.0065	0.0014	2.35	2.38	0.127	0.0214	0.0025	0.0056	0.0022	0.0024	0.0019	0.0035	0.0029	<0.0001
Zirconium	0.0001		0.0002	0.0004	0.0007	0.0004	0.0004	0.0003	0.0001	<0.0001	0.0001	0.0003	<0.0001	<0.0001	0.0002	0.0002	0.0001	0.0002	0.0003	0.0004	0.0004	0.0004	0.0005	<0.0001
Dissolved Metals																								
Aluminum	0.0002		0.0793	-	0.178	0.0782	0.0707	0.0752	0.0234	0.0194	0.0244	0.0672	0.0014	0.0014	6.40	0.0604	0.0228	0.0574	0.104	0.0771	0.0588	0.0673	0.0597	0.0007
Antimony	0.00002		0.00006	-	0.00032	0.00038	0.00039	0.00036	0.00013	0.00010	0.00013	0.00027	0.00257	0.00252	0.00014	0.00011	0.00024	0.00016	0.00013	0.00013	0.00008	0.00010	0.00009	<0.00002
Arsenic	0.00002		0.00020	-	0.00078	0.00076	0.00074	0.00074	0.00044	0.00044	0.00045	0.00062	0.00047	0.00046	0.00030	0.00022	0.00083	0.00049	0.00037	0.00038	0.00033	0.00037	0.00045	<0.00002
Barium	0.00002		0.0456	-	0.0637	0.0442	0.0445	0.0454	0.0469	0.0378	0.0459	0.0594	0.0631	0.0620	0.0291	0.0467	0.0704	0.0500	0.0372	0.0407	0.0406	0.0410	0.0420	<0.00002
Beryllium	0.00001		0.00002	-	0.00002	0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00037	0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00001	<0.00001
Bismuth	0.000005		<0.000005	-	0.000006	<0.000005	<0.000005	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000008	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000007
Boron	0.05		<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000224	-	0.000021	0.000019	0.000020	0.000017	0.000033	0.000017	0.000035	0.000018	0.0414	0.0418	0.00179	0.000190	0.000033	0.000071	0.000025	0.000021	0.000007	0.000012	0.000008	<0.000005
Calcium	0.05		12.5	-	22.1	21.3	21.3	23.8	28.7	23.7	29.1	21.5	26.8	26.7	74.0	27.6	26.0	26.7	16.9	20.2	16.2	17.6	18.2	<0.05
Chromium	0.0001		0.0002	-	0.0005	0.0003	0.0003	0.0003	<0.0001	0.0001	0.0001	0.0002	<0.0001	<0.0001	0.0005	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	<0.0001
Cobalt	0.000005		0.000112	-	0.000140	0.000075	0.000070	0.000075	0.000024	0.000023	0.000025	0.000055	0.000316	0.000312	0.0262	0.00227	0.000020	0.000464	0.000131	0.000125	0.000063	0.000090	0.000091	<0.000005
Copper	0.00005		0.00270	-	0.00317	0.00331	0.00321	0.00315	0.00098	0.00133	0.00102	0.00245	0.0709	0.0703	0.681	0.0323	0.00098	0.0164	0.00544	0.00706	0.00130	0.00323	0.00277	<0.00005
Iron	0.001		0.047	-	0.174	0.077	0.059	0.092	0.024	0.024	0.025	0.066	0.010	0.010	15.1	0.264	0.021	0.136	0.083	0.092	0.097	0.105	0.141	0.001
Lead	0.000005		0.000022	-	0.000786	0.000577	0.000099	0.000262	0.000031	0.000045	0.000106	0.000103	0.00666	0.00680	0.00124	0.000105	0.000080	0.000117	0.000029	0.000043	0.000073	0.000042	0.000054	0.000017
Lithium	0.0005		0.0007	-	0.0007	0.0005	0.0005	0.0006	0.0021	0.0013	0.0021	0.0008	0.0020	0.0020	0.0043	0.0010	0.0009	0.0009	0.0006	0.0008	0.0019	0.0015	0.0013	<0.0005
Magnesium	0.05		2.57	-	8.52	7.49	7.49	8.44	8.32	6.31	8.37	7.75	7.03	7.00	14.3	5.54	6.81	6.86	4.50	5.84	5.10	5.37	6.11	<0.05
Manganese	0.00005		0.00729	-	0.00834	0.00411	0.00423	0.00308	0.00395	0.00260	0.00195	0.00333	0.537	0.543	0.757	0.0624	0.00359	0.0260	0.00712	0.00787	0.00899	0.0123	0.0140	0.00006
Mercury	0.00001		<0.00001	-	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00019	-	0.00043	0.00057	0.00057	0.00062	0.00105	0.00105	0.00107	0.00040	<0.00005	<0.00005	0.00014	0.00020	0.00052	0.00055	0.00076	0.00091	0.00064	0.00072	0.00076	<0.00005
Nickel	0.00002		0.00105	-	0.00077	0.00084	0.00084	0.00083	0.00154	0.00094	0.00157	0.00069	0.00047	0.00064	0.00467	0.00095	0.00029	0.00056	0.00045	0.00044	0.00070	0.00044	0.00064	<0.00002
Phosphorous	0.002		0.003	-	0.010	0.004	0.003	0.005	0.002	0.002	0.003	0.004	0.002	0.002	0.005	0.002	<0.002	0.003	0.003	0.003	0.005	0.005	0.005	<0.002
Potassium	0.05		0.42	-	1.27	1.21	1.20	1.41	0.71	0.73	0.72	1.04	1.39	1.38	1.53	0.77	0.94	0.77	0.75	0.78	0.56	0.63	0.71	<0.05
Selenium	0.00004		0.00007	-	0.00008	0.00008	0.00008	0.00007	0.00057	0.00029	0.00056	0.00008	<0.00004	<0.00004	0.00018	0.00007	<0.00004	0.00008	0.00004	0.00004	0.00004	0.00005	0.00006	<0.00004
Silicon	0.1		7.9	-	4.6	5.0	5.0	4.7	3.3	3.1	3.2	4.2	5.6	5.8	8.9	6.3	4.7	5.4	4.8	4.9	4.8	4.9	4.8	<0.1
Silver	0.000005		<0.000005	-	0.000008	0.000008	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000023	0.000022	0.000022	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		3.42	-	2.95	2.81	2.82	2.93	1.83	1.86	1.84	3.05	2.99	2.96	4.64	3.07	3.02	2.91	2.51	2.91	2.68	2.75	2.96	<0.05
Strontium	0.00005		0.0801	-	0.174	0.143	0.142	0.151	0.133	0.110	0.131	0.141	0.226	0.224	0.202	0.178	0.162	0.168	0.0970	0.124	0.125	0.124	0.124	<0.00005
Thallium	0.000002		0.000002	-	0.000006	0.000004	0.000003	0.000004	0.000003	0.000002	0.000003	0.000002	0.000025	0.000025	0.000060	0.000007	<0.000002	0.000004	0.000003	0.000003	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	-	0.00002	0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0006	-	0.0041	0.0016	0.0010	0.0024	<0.0005	0.0009	0.0007	0.0009	<0.0005	<0.0005	0.0023	0.0010	<0.0005	0.0007	0.0011	0.0010	0.0014	0.0022	0.0011	<0.0005
Uranium	0.000002		0.000078	-	0.00359	0.00480	0.00486	0.00477	0.000941	0.000926	0.00102	0.00131	0.00126	0.00125	0.00871	0.00108	0.00634	0.00405	0.00213	0.00281	0.00308	0.00293	0.00253	<0.000002
Vanadium	0.0002		<0.0002	-	0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0003	0.0004	<0.0002
Zinc	0.0001		0.0195	-	0.0029	0.0016	0.0013	0.0012	0.0018	0.0016	0.0023	0.0023	2.28	2.28	0.133	0.0125	0.0021	0.0057	0.0017	0.0020	0.0038	0.0010	0.0012	<0.0001
Zirconium	0.0001		0.0001	-	0.0007	0.0004	0.0004	0.0003	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	0.0002	0.0001	0.0001	0.0002	0.0003	0.0003	0.0003	0.0003	0.0004	<0.0001

Foot Notes:

All units mg/l unless otherwise noted

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

b) 0.005mg/L at pH < 6.5, [Ca2+] < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, [Ca2+] ≥ 4 mg/L, DOC ≥ 2 mg/L

c) 0.002 mg/L at [CaCO3] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

d) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

e) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

Italic Results exceed CCME Aquatic Life Guidelines

AECOM

B5. Surface Water Quality Data, Casino Project, October 2008

Appendix B5. Surface Water Quality Data, Casino Project, October 2008

Station	Detection Limits	Water Quality Guidelines	W7 - Upper Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W14 - Mouth of Britannia Creek	W1 - Mouth of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W6a - Yukon River downstream of Canadian Creek	W43 - Adit discharge pipe at lower camp	W12 - Proctor Gulch before confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W18 - Brynelsen Creek	W4 - Mouth of Casino Creek	W9 - Dip Creek us of Confluence with Casino Creek	W5 - Dip Creek ds Casino confluence
Date		**CCME [a]**	**10-Oct-08**	**11-Oct-08**	**10-Oct-08**	**10-Oct-08**	**10-Oct-08**	**10-Oct-08**	**11-Oct-08**	**11-Oct-08**	**11-Oct-08**	**11-Oct-08**	**10-Oct-08**	**10-Oct-08**	**10-Oct-08**
Physical Tests															
Temperature C	-		0.0	1.8	0.3	1.9	4.3	3.6	1.5	0.4	0.0	0.0	0.0	0.1	0.4
Conductivity (Field) uS/cm	-		136	265	294	298	183	225	228	1026	278	165	240	172	198
pH (Field)	-		6.9	8.0	7.6	7.8	8.0	8.0	6.8	*3.5*	6.9	7.6	7.7	7.5	7.6
Hardness CaCO3	0.5		44.7	119	139	138	109	84.2	99.1	335	125	70.3	110	79.7	88.2
Conductivity uS/cm	1		130	260	300	300	220	180	220	1000	270	160	240	170	190
pH	-	6.5-9.0	7.1	8.0	8.1	8.1	8.1	8.1	7.6	*3.3*	8.1	8.0	8.0	8.0	8.0
Total Suspended Solids	1		1	<1	<1	<1	14	12	4	2	1	1	2	3	2
Total Dissolved Solids	1		110	210	230	240	180	130	170	1000	220	110	190	130	150
Turbidity NTU	0.1		0.3	0.2	0.3	0.2	11.0	3.6	0.9	10.0	1.0	0.3	0.7	0.4	0.5
Dissolved Anions & Nutrients															
Ammonia as N	0.01		<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01
Alkalinity, Total (as $CaCO_3$)	0.5		7.3	72	91	82	81	73	67	<0.5	80	60	80	74	75
Acidity (pH 8.3) as $CaCO_3$	0.5		-	-	-	-	-	-	13.7	131	-	-			
Chloride (Cl)	0.5		0.6	1.2	1.5	1.5	0.8	0.8	5.0	1.0	0.6	0.6	1.0	1.4	2.5
Sulfate (SO4)	0.5		47	50	52	42	33	19	49	450	50	25	40	15	25
Nitrate (as N)	0.002	13	0.004	0.236	0.304	0.249	0.015	0.014	0.296	0.032	0.245	0.236	0.203	0.191	0.189
Nitrite (as N)	0.002	0.06	<0.002	0.002	0.002	0.004	<0.002	0.002	0.002	0.005	0.003	0.003	0.003	0.003	<0.002
Total Kjeldahl Nitrogen	0.02		0.11	0.20	0.28	0.39	0.09	0.09	0.07	0.16	0.13	0.10	0.08	0.13	0.12
Ortho Phosphate as P	0.001		0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.003	0.002	0.003	0.002	0.005	0.002
Cyanide, Weak Acid Diss	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0038	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Total Cyanide	0.0005	0.005	<0.0005	0.0007	0.0010	0.0008	<0.0005	<0.0005	<0.0005	*0.0101*	<0.0005	0.0005	0.0005	0.0009	<0.0005
Total Organic Carbon	0.5		2.8	8.0	11.5	8.6	3.9	3.6	1.4	3.0	2.9	4.7	5.1	6.6	5.8
Total Metals															
Aluminum	0.0002	0.005-0.1[b]	0.0253	0.0159	0.0494	0.0222	*0.208*	*0.107*	0.0139	*10.3*	0.0889	0.0325	0.0519	0.0354	0.0307
Antimony	0.00002		0.00005	0.00035	0.00023	0.00027	0.00013	0.00010	0.00272	0.00016	0.00015	0.00014	0.00013	0.00009	0.00010
Arsenic	0.00002	0.005	0.00016	0.00057	0.00050	0.00050	0.00059	0.00051	0.00072	0.00027	0.00054	0.00034	0.00038	0.00028	0.00034
Barium	0.00002		0.0472	0.0528	0.0782	0.0597	0.0579	0.0427	0.0652	0.0108	0.0623	0.0404	0.0550	0.0515	0.0498
Beryllium	0.00001		0.00001	<0.00001	0.00001	<0.00001	0.00002	0.00001	<0.00001	0.00053	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	0.000005	<0.000005	0.000010	<0.000005	<0.000005	<0.000005	<0.000005	0.000011	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017	*0.000135*	0.000014	0.000007	0.000011	*0.000097*	*0.000061*	*0.04773*	*0.02044*	*0.000064*	0.000008	*0.000028*	<0.000005	0.000015
Calcium	0.05		13.2	30.4	32.7	34.2	28.7	23.0	27.3	99.1	34.0	19.0	29.2	20.6	22.9
Chromium	0.0001	0.001	<0.0001	<0.0001		<0.0001	0.0003	0.0002	<0.0001	0.0006	<0.0001	<0.0001	<0.0001	0.0001	<0.0001
Cobalt	0.000005		0.000033	0.000044	0.000050	0.000042	0.000219	0.000138	0.000366	0.0409	0.000245	0.000027	0.000074	0.000050	0.000047
Copper	0.00005	0.002-0.004[c]	0.00139	*0.00217*	0.00158	0.00194	0.00159	0.00121	*0.0686*	*0.92*	*0.0118*	0.00079	*0.00528*	0.00091	*0.00226*
Iron	0.001	0.3	0.019	0.016	0.037	0.017	*0.368*	0.169	0.063	*26.2*	0.198	0.025	0.094	0.072	0.058
Lead	0.000005	0.001-0.007[d]	0.000031	0.000010	0.000072	0.000030	0.000224	0.000275	*0.0181*	0.000661	0.000100	0.000018	0.000074	0.000073	0.000065
Lithium	0.0005		0.0007	<0.0005	0.0009	0.0007	0.0023	0.0015	0.0022	0.0059	0.0012	0.0006	0.0011	0.0023	0.0018
Magnesium	0.05		2.83	10.5	14.0	12.7	9.01	6.52	7.51	21.2	9.84	5.53	8.95	6.87	7.52
Manganese	0.00005		0.00127	0.00675	0.00294	0.00171	0.0220	0.0152	0.472	1.04	0.0264	0.00263	0.00964	0.0127	0.0104
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00027	0.00088	0.00055	0.00077	0.00096	0.00100	<0.00005	0.00021	0.00071	0.00123	0.00112	0.00070	0.00082
Nickel	0.00002	0.025-0.15[e]	0.00063	0.00066	0.00050	0.00060	0.00314	0.00160	0.00055	0.00642	0.00036	0.00019	0.00027	0.00032	0.00031
Phosphorous	0.002		<0.002	<0.002	0.004	<0.002	0.017	0.015	0.003	0.004	<0.002	<0.002	0.003	0.005	0.002
Potassium	0.05		0.47	1.63	1.65	1.81	0.70	0.70	1.27	1.80	0.87	0.89	0.94	0.64	0.74
Selenium	0.00004	0.001	0.00006	0.00006	0.00007	0.00010	0.00068	0.00033	<0.00004	0.00024	0.00013	<0.00004	0.00005	<0.00004	<0.00004
Silicon	0.1		9.9	5.3	4.6	5.1	3.8	3.1	4.6	6.8	6.5	5.6	5.6	5.2	5.4
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	0.000007	<0.000005	*0.000146*	0.000021	<0.000005	<0.000005	<0.000005	<0.000005	0.000007
Sodium	0.05		4.40	3.89	4.44	4.12	1.91	1.92	3.38	6.26	3.76	3.30	4.20	3.64	3.81
Strontium	0.00005		0.0908	0.198	0.286	0.223	0.135	0.107	0.245	0.287	0.220	0.104	0.180	0.169	0.165
Thallium	0.000002	0.0008	0.000002	0.000002	0.000003	0.000003	0.000005	0.000003	0.000027	0.000082	0.000003	0.000002	<0.000002	0.000003	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	0.0010	0.0006	0.0045	0.0022	<0.0005	<0.0005	<0.0005	0.0006	0.0009	0.0015	0.0006
Uranium	0.000002		0.000043	0.0101	0.00833	0.0102	0.00102	0.000968	0.00128	0.0125	0.00820	0.00300	0.00627	0.00583	0.00558
Vanadium	0.0002		0.0002	<0.0002	0.0002	<0.0002	0.0006	0.0003	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0002
Zinc	0.0001	0.03	0.0126	0.0006	0.0006	0.0003	0.0093	0.0074	*2.64*	*0.189*	0.0040	0.0005	0.0017	0.0007	0.0010
Zirconium	0.0001		<0.0001	0.0002	0.0004	0.0002	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0002	0.0002
Dissolved Metals															
Aluminum	0.0002	0.005-0.1[b]	0.0176	0.0142	0.0404	0.0179	0.0241	0.0224	0.0013	2.58	0.0207	0.0250	0.0210	0.0219	0.0187
Antimony	0.00002		0.00005	0.00034	0.00023	0.00024	0.00012	0.00009	0.00243	<0.001	0.00013	0.00013	0.00012	0.00007	0.00009
Arsenic	0.00002	0.005	0.00012	0.00053	0.00045	0.00045	0.00036	0.00036	0.00029	0.0001	0.00042	0.00030	0.00032	0.00026	0.00028
Barium	0.00002		0.0427	0.0505	0.0732	0.0525	0.0433	0.0361	0.0590	0.0089	0.0584	0.0386	0.0528	0.0478	0.0489
Beryllium	0.00001		<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.00003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017	0.000120	0.000019	<0.000005	0.000010	0.000038	0.000037	0.0438	0.00005	0.000052	0.000006	0.000018	<0.000005	0.000010
Calcium	0.05		12.5	29.0	30.0	32.6	26.8	22.5	25.4	83.7	32.5	18.6	27.4	19.5	21.7
Chromium	0.0001	0.001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000024	0.000042	0.000044	0.000042	0.000025	0.000027	0.000332	0.00063	0.000229	0.000020	0.000058	0.000055	0.000039
Copper	0.00005	0.002-0.004[c]	0.00131	0.00212	0.00149	0.00189	0.00099	0.00084	0.0623	0.0162	0.00704	0.00077	0.00363	0.00086	0.00182
Iron	0.001	0.3	0.007	0.015	0.031	0.014	0.028	0.025	0.011	0.355	0.036	0.014	0.030	0.042	0.035
Lead	0.000005	0.001-0.007[d]	0.000010	0.000065	0.000086	0.000014	0.000065	0.000185	0.00626	0.00005	0.000025	0.000022	0.000020	0.000040	0.000010
Lithium	0.0005		0.0006	<0.0005	0.0008	0.0007	0.0021	0.0014	0.0021	0.006	0.0011	<0.0005	0.0010	0.0023	0.0018
Magnesium	0.05		2.72	10.1	13.0	12.4	8.36	6.38	6.93	0.34	9.42	5.40	8.41	6.64	7.09
Manganese	0.00005		0.00074	0.00663	0.00220	0.00137	0.00238	0.00427	0.430	0.0154	0.0242	0.00184	0.00684	0.0104	0.00963
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00025	0.00084	0.00051	0.00070	0.00096	0.00098	<0.00005	<0.0003	0.00065	0.00115	0.00105	0.00070	0.00078
Nickel	0.00002	0.025-0.15[e]	0.00062	0.00064	0.00046	0.00056	0.00216	0.00111	0.00048	0.0002	0.00033	0.00018	0.00024	0.00028	0.00028
Phosphorous	0.002		<0.002	<0.002	0.003	<0.002	<0.002	0.003	<0.002	<0.01	<0.002	<0.002	<0.002	0.003	<0.002
Potassium	0.05		0.44	1.54	1.53	1.72	0.64	0.67	1.18	2.28	0.84	0.88	0.88	0.62	0.71
Selenium	0.00004	0.001	0.00005	0.00007	0.00008	0.00011	0.00062	0.00031	<0.00004	<0.0002	0.00009	<0.00004	0.00004	<0.00004	<0.00004
Silicon	0.1		8.8	4.9	4.3	5.0	3.0	2.8	5.2	4.0	5.2	4.8	5.1	4.5	5.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000023	<0.00003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		4.13	3.68	4.11	3.93	1.77	1.85	3.05	1430	3.55	3.21	3.82	3.41	3.50
Strontium	0.00005		0.0852	0.189	0.258	0.195	0.125	0.105	0.226	0.281	0.212	0.0996	0.176	0.160	0.169
Thallium	0.000002	0.0008	<0.000002	<0.000002	0.000003	0.000002	0.000003	0.000002	0.000024	0.00007	0.000003	0.000003	<0.000002	<0.000002	0.000002
Tin	0.00001		<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.000039	0.00954	0.00767	0.00915	0.000906	0.000942	0.00116	0.00033	0.00762	0.00287	0.00590	0.00543	0.00539
Vanadium	0.0002		0.0003	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.001	<0.0002	0.0002	<0.0002	0.0002	<0.0002
Zinc	0.0001	0.03	0.0114	0.0009	0.0007	0.0004	0.0023	0.0051	2.47	0.0034	0.0031	0.0005	0.0012	0.0005	0.0007
Zirconium	0.0001		<0.0001	0.0001	0.0004	0.0002	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	0.0001	0.0001	0.0002	0.0001

Foot Notes:

All units mg/l unless otherwise noted

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

b) 0.005mg/L at pH < 6.5, [Ca2+] < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, [Ca2+] ≥ 4 mg/L, DOC ≥ 2 mg/L

c) 0.002 mg/L at [CaCO3] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

d) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

e) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

Italic results exceed CCME Aquatic Life Guidelines

B6. Surface Water Quality Replicate Data, Casino Project, 2008

Appendix B6. Surface Water Quality Replicate Data, Casino Project, May 2008

Station	W1	W1-R (W42)	RPD	Station	W1	W1-R (W42)	RPD
Date	5/22/08	5/22/08	%	Date	5/22/08	5/22/08	%
Physical Tests				**Dissolved Anions & Nutrients**			
Conductivity (µs/cm)	92	92	0%	Alkalinity-Total	21	21	0%
Dissolved Hardness	48.9	48.6	1%	Alkalinity (PP as $CaCO_3$)	<0.5	<0.5	n/c
pH	7.2	7.2	0%	Ammonia Nitrogen	0.011	0.009	20%
Total Suspended Solids	190	150	24%	Bicarbonate (HCO_3)	26	25	4%
Total Dissolved Solids	92	92	0%	Carbonate (CO_3)	<0.5	<0.5	n/c
Tubidity (NTU)	3.6	2.4	**40%**	Chloride Cl	1.2	1.2	0%
Cyanide + Thiocyanate	0.0013	0.0012	8%	Hydroxide (OH)	<0.5	<0.5	n/c
Total Hardness	49.6	48.9	1%	Nitrate Nitrogen	0.05	0.048	4%
Weak Acid Dissoc. Cyanide	0.001	0.0009	11%	Nitrite Nitrogen	0.003	0.003	0%
				Nitrate plus Nitrite	0.053	0.051	4%
				Ortho Phosphate as P	<0.001	<0.001	n/c
				Sulphate	17	13	**27%**
				Total Kjeldahl Nitrogen	0.41	0.32	25%
				Total Nitrogen	0.46	0.37	22%
Total Metals				**Dissolved Metals**			
Aluminum	0.723	0.579	22%	Aluminum	0.289	0.29	0%
Antimony	0.00019	0.00018	5%	Antimony	0.00018	0.00017	6%
Arsenic	0.00162	0.00134	19%	Arsenic	0.0007	0.0007	0%
Barium	0.059	0.0552	7%	Barium	0.0368	0.0365	1%
Beryllium	0.00006	0.00005	18%	Beryllium	0.00002	0.00003	**40%**
Bismuth	0.000009	0.000015	**50%**	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.00008	0.000084	5%	Cadmium	0.000039	0.000037	5%
Calcium	12.4	12.3	1%	Calcium	12.3	12.2	1%
Chromium	0.0011	0.0009	20%	Chromium	0.0004	0.0004	0%
Cobalt	0.000848	0.00066	25%	Cobalt	0.000204	0.000208	2%
Copper	0.00663	0.00634	4%	Copper	0.00508	0.00508	0%
Iron	1.00	0.709	**34%**	Iron	0.236	0.24	2%
Lead	0.000866	0.000625	**32%**	Lead	0.000064	0.000061	5%
Lithium	0.0007	0.0006	15%	Lithium	<0.0005	<0.0005	n/c
Magnesium	4.54	4.41	3%	Magnesium	4.44	4.39	1%
Manganese	0.0689	0.0612	12%	Manganese	0.016	0.0161	1%
Mercury	0.00001	0.00001	0%	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.0003	0.0003	0%	Molybdenum	0.00033	0.0003	10%
Nickel	0.00227	0.00208	9%	Nickel	0.00135	0.00134	1%
Phosphorus	0.084	0.062	**30%**	Phosphorus	0.013	0.014	7%
Potassium	1.3	1.27	2%	Potassium	1.25	1.24	1%
Selenium	<0.00004	<0.00004	n/c	Selenium	0.00006	0.00006	0%
Silicon	2.6	2.4	8%	Silicon	2.2	2.2	0%
Silver	0.00001	0.000008	22%	Silver	<0.000005	0.000005	n/c
Sodium	1.39	1.38	1%	Sodium	1.5	1.5	0%
Strontium	0.0809	0.0798	1%	Strontium	0.0786	0.0792	1%
Sulfur	6	6	0%	Sulfur	7	6	15%
Tellurium	<0.00002	<0.00002	n/c	Tellurium	<0.00002	<0.00002	n/c
Thallium	0.000011	0.000011	0%	Thallium	0.000005	0.000005	0%
Thorium	0.000275	0.000251	9%	Thorium	0.000227	0.000231	2%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0254	0.0165	**42%**	Titanium	0.0029	0.0031	7%
Tungsten	0.00002	0.00002	0%	Tungsten	<0.00001	<0.00001	n/c
Uranium	0.00361	0.00343	5%	Uranium	0.00304	0.00302	1%
Vanadium	0.002	0.0015	**29%**	Vanadium	0.0003	0.0003	0%
Zinc	0.0062	0.0051	19%	Zinc	0.0069	0.0072	4%
Zirconium	0.0005	0.0005	0%	Zirconium	0.0004	0.0003	**29%**

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Pratical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"-"	*Not Analyzed.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix B6. Surface Water Quality Replicate Data, Casino Project, May 2008

Station	W5	W5-R (W40)	RPD	Station	W5	W5-R (W40)	RPD
Date	5/22/08	5/22/08	%	Date	5/22/08	5/22/08	%
Physical Tests				**Dissolved Anions & Nutrients**			
Conductivity (µs/cm)	74	74	0%	Alkalinity-Total	24	24	0%
Dissolved Hardness	40.3	39.8	1%	Alkalinity (PP as $CaCO_3$)	<0.5	<0.5	n/c
pH	7.3	7.3	0%	Ammonia Nitrogen	<0.005	0.022	n/c
Total Suspended Solids	58	24	**83%**	Bicarbonate	29	30	3%
Total Dissolved Solids	74	76	3%	Carbonate	<0.5	<0.5	n/c
Tubidity (NTU)	4.2	2.5	**51%**	Chloride	1.2	1.2	0%
Cyanide + Thiocyanate	0.0008	0.0008	0%	Hydroxide	<0.5	<0.5	n/c
Total Hardness	41.4	40.4	2%	Nitrate Nitrogen	0.024	0.026	8%
Weak Acid Dissoc. Cyanide	0.0007	0.0008	13%	Nitrite Nitrogen	0.004	0.003	**29%**
				Nitrate plus Nitrite	0.028	0.029	4%
				Ortho Phosphate as P	<0.001	<0.001	n/c
				Sulphate	<0.5	<0.5	n/c
				Total Kjeldahl Nitrogen	0.42	0.46	9%
				Total Nitrogen	0.45	0.49	9%
Total Metals				**Dissolved Metals**			
Aluminum	0.489	0.476	3%	Aluminum	0.197	0.201	2%
Antimony	0.00009	0.00008	12%	Antimony	0.00007	0.00007	0%
Arsenic	0.00077	0.00077	0%	Arsenic	0.00037	0.00036	3%
Barium	0.0467	0.0455	3%	Barium	0.0314	0.0295	6%
Beryllium	0.00005	0.00005	0%	Beryllium	0.00002	0.00002	0%
Bismuth	0.000006	0.000008	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000054	0.000047	14%	Cadmium	0.000016	0.000024	n/c
Calcium	10.9	10.7	2%	Calcium	10.6	10.6	0%
Chromium	0.0006	0.0005	18%	Chromium	0.0003	0.0003	0%
Cobalt	0.00041	0.000402	2%	Cobalt	0.000086	0.000084	2%
Copper	0.00669	0.00653	2%	Copper	0.00523	0.00483	8%
Iron	0.724	0.714	1%	Iron	0.197	0.2	2%
Lead	0.00152	0.00146	4%	Lead	0.000157	0.000153	3%
Lithium	0.0014	0.0014	0%	Lithium	0.0012	0.0012	0%
Magnesium	3.42	3.32	3%	Magnesium	3.38	3.26	4%
Manganese	0.0785	0.0741	6%	Manganese	0.0106	0.0103	3%
Mercury	0.00001	0.00001	0%	Mercury	<0.00001	0.00001	n/c
Molybdenum	0.0004	0.00037	8%	Molybdenum	0.00044	0.00039	12%
Nickel	0.0011	0.00103	7%	Nickel	0.00069	0.00064	8%
Phosphorus	0.052	0.047	10%	Phosphorus	0.013	0.011	17%
Potassium	0.71	0.69	3%	Potassium	0.69	0.69	0%
Selenium	0.00005	0.00005	0%	Selenium	0.00004	0.00006	n/c
Silicon	3	2.8	7%	Silicon	2.6	2.7	4%
Silver	0.00001	0.000011	10%	Silver	<0.000005	<0.000005	n/c
Sodium	1.61	1.57	3%	Sodium	1.73	1.61	7%
Strontium	0.0806	0.08	1%	Strontium	0.0803	0.0768	4%
Sulfur	<3	<3	n/c	Sulfur	<3	<3	n/c
Tellurium	<0.00002	<0.00002	n/c	Tellurium	<0.00002	<0.00002	n/c
Thallium	0.000007	0.000007	0%	Thallium	<0.000002	0.000003	n/c
Thorium	0.000192	0.000214	11%	Thorium	0.000157	0.000114	**32%**
Tin	<0.00001	<0.00001	n/c	Tin	0.00001	<0.00001	n/c
Titanium	0.0138	0.0152	10%	Titanium	0.0021	0.0021	0%
Tungsten	0.00003	0.00003	0%	Tungsten	<0.00001	0.00002	n/c
Uranium	0.003	0.00296	1%	Uranium	0.00223	0.00212	5%
Vanadium	0.0017	0.0017	0%	Vanadium	0.0004	0.0003	**29%**
Zinc	0.0042	0.0036	15%	Zinc	0.0053	0.0049	8%
Zirconium	0.0004	0.0005	22%	Zirconium	0.0003	0.0002	**40%**

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Pratical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"-"	*Not Analyzed.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix B6. Surface Water Quality Replicate Data, Casino Project, July 2008

Station	W1	W1-R (W101)	RPD	Station	W1	W1-R (W101)	RPD
Date	7/08/08	7/08/08	%	Date	7/08/08	7/08/08	%
Physical Tests				**Dissolved Anions & Nutrients**			
Conductivity (µs/cm)	280	280	0%	Alkalinity-Total	81	82	1%
Dissolved Hardness	133	135	1%	Alkalinity (PP as $CaCO_3$)	<0.5	<0.5	n/c
pH	8.1	8.1	0%	Ammonia Nitrogen	0.013	0.015	14%
Total Suspended Solids	4	4	0%	Bicarbonate (HCO_3)	99	100	1%
Total Dissolved Solids	200	200	0%	Carbonate (CO_3)	<0.5	<0.5	n/c
Tubidity (NTU)	0.5	0.3	**50%**	Chloride Cl	2.5	5.3	**72%**
Cyanide + Thiocyanate	0.0008	0.0008	0%	Hydroxide (OH)	<0.5	<0.5	n/c
Total Hardness	143	144	1%	Nitrate Nitrogen	0.169	0.164	3%
Weak Acid Dissoc. Cyanide	0.0005	<0.0005	n/c	Nitrite Nitrogen	<0.002	<0.002	n/c
				Nitrate plus Nitrite	0.169	0.164	3%
				Ortho Phosphate as P	0.001	<0.001	n/c
				Sulphate	63	59	7%
				Total Kjeldahl Nitrogen	0.24	0.19	23%
				Total Nitrogen	0.41	0.35	16%
Total Metals				**Dissolved Metals**			
Aluminum	0.0821	0.0752	9%	Aluminum	0.0438	0.0429	2%
Antimony	0.00028	0.00027	4%	Antimony	0.00027	.00030	11%
Arsenic	0.00057	0.00059	3%	Arsenic	0.00056	0.00054	4%
Barium	0.0627	0.0598	5%	Barium	0.0591	0.0608	3%
Beryllium	0.00001	0.00001	0%	Beryllium	0.00001	0.00001	0%
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000014	0.000011	24%	Cadmium	0.000008	0.000008	0%
Calcium	35.8	36.1	1%	Calcium	33.3	33.5	1%
Chromium	0.0003	0.0003	0%	Chromium	0.0003	0.0002	**40%**
Cobalt	0.000099	0.000088	12%	Cobalt	0.000051	0.000042	19%
Copper	0.00243	0.00240	1%	Copper	0.00205	0.00211	3%
Iron	0.104	0.099	5%	Iron	0.044	0.045	2%
Lead	0.000059	0.000051	15%	Lead	<0.000005	<0.000005	n/c
Lithium	0.0009	0.0009	0%	Lithium	0.0008	0.0008	0%
Magnesium	13.0	13.0	0%	Magnesium	12.1	12.4	2%
Manganese	0.00454	0.00465	2%	Manganese	0.00131	0.00128	2%
Mercury	<0.00001	<0.00001	n/c	Mercury	0.00001	0.00001	0%
Molybdenum	0.00077	0.00075	3%	Molybdenum	0.00073	0.00078	7%
Nickel	0.00077	0.00082	6%	Nickel	0.00075	0.00068	10%
Phosphorus	0.005	0.005	0%	Phosphorus	<0.002	<0.002	n/c
Potassium	2.08	2.08	0%	Potassium	1.94	1.95	1%
Selenium	0.00011	0.00011	0%	Selenium	0.00012	.00010	18%
Silicon	4.5	4.8	6%	Silicon	3.8	4.1	8%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	4.39	4.40	0%	Sodium	4.20	4.20	0%
Strontium	0.236	0.234	1%	Strontium	0.214	0.217	1%
Sulfur	23	22	4%	Sulfur	21	21	0%
Thallium	0.000004	0.000003	**29%**	Thallium	0.000004	0.000004	0%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0031	0.0027	14%	Titanium	0.0006	<0.0005	n/c
Uranium	0.00928	0.00907	2%	Uranium	0.00864	.00890	3%
Vanadium	0.0004	0.0004	0%	Vanadium	0.0003	0.0003	0%
Zinc	0.0008	0.0008	0%	Zinc	0.0045	0.0042	7%
Zirconium	0.0002	0.0002	0%	Zirconium	0.0002	0.0002	0%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Pratical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"-"	*Not Analyzed.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix B6. Surface Water Quality Replicate Data, Casino Project, July 2008

Station	W43	W43-R (W102)	RPD	Station	W43	W43-R (W102)	RPD
Date	7/08/08	7/08/08	%	Date	7/08/08	7/08/08	%
Physical Tests				**Dissolved Anions & Nutrients**			
Conductivity (µs/cm)	240	240	0%	Alkalinity-Total	83	80	4%
Dissolved Hardness	109	112	3%	Alkalinity (PP as $CaCO_3$)	<0.5	<0.5	n/c
pH	7.5	7.3	3%	Ammonia Nitrogen	0.016	<0.005	n/c
Total Suspended Solids	<1	<1	n/c	Bicarbonate (HCO_3)	100	98	2%
Total Dissolved Solids	170	160	6%	Carbonate (CO_3)	<0.5	<0.5	n/c
Tubidity (NTU)	0.2	0.3	**40%**	Chloride Cl	0.8	0.9	12%
Cyanide + Thiocyanate	<0.0005	<0.0005	n/c	Hydroxide (OH)	<0.5	<0.5	n/c
Total Hardness	116	117	1%	Nitrate Nitrogen	0.214	0.216	1%
Weak Acid Dissoc. Cyanide	<0.0005	<0.0005	n/c	Nitrite Nitrogen	<0.002	<0.002	n/c
				Nitrate plus Nitrite	0.214	0.216	1%
				Ortho Phosphate as P	<0.001	<0.001	n/c
				Sulphate	44	45	2%
				Total Kjeldahl Nitrogen	0.07	0.10	**35%**
				Total Nitrogen	0.28	0.31	10%
Total Metals				**Dissolved Metals**			
Aluminum	0.0036	0.0030	18%	Aluminum	0.0056	0.0254	**128%**
Antimony	0.00342	0.00342	0%	Antimony	0.00335	0.00329	2%
Arsenic	0.00049	0.00048	2%	Arsenic	0.00028	0.00029	4%
Barium	0.0517	0.0496	4%	Barium	0.0495	0.0496	0%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.0553	0.0550	1%	Cadmium	0.0515	0.0531	3%
Calcium	32.3	32.7	1%	Calcium	30.1	30.9	3%
Chromium	<0.0001	<0.0001	n/c	Chromium	<0.0001	<0.0001	n/c
Cobalt	0.000164	0.000161	2%	Cobalt	0.000157	0.000161	3%
Copper	0.0608	0.0604	1%	Copper	0.0510	0.0534	5%
Iron	0.025	0.023	8%	Iron	0.007	0.007	0%
Lead	0.00587	0.00567	3%	Lead	0.00205	0.00218	6%
Lithium	0.0024	0.0025	4%	Lithium	0.0024	0.0024	0%
Magnesium	8.58	8.66	1%	Magnesium	8.13	8.33	2%
Manganese	0.266	0.268	1%	Manganese	0.252	0.258	2%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	<0.00005	<0.00005	n/c	Molybdenum	<0.00005	<0.00005	n/c
Nickel	.00050	0.00042	17%	Nickel	0.00045	0.00053	16%
Phosphorus	0.002	0.002	0%	Phosphorus	<0.002	<0.002	n/c
Potassium	1.43	1.41	1%	Potassium	1.33	1.36	2%
Selenium	<0.00004	<0.00004	n/c	Selenium	<0.00004	<0.00004	n/c
Silicon	5.8	6.1	5%	Silicon	6.0	5.9	2%
Silver	0.000090	0.000088	2%	Silver	0.000026	0.000035	**30%**
Sodium	3.52	3.52	0%	Sodium	3.44	3.45	0%
Strontium	0.280	0.281	0%	Strontium	0.265	0.271	2%
Sulfur	14	15	7%	Sulfur	15	16	6%
Thallium	0.000023	0.000023	0%	Thallium	0.000022	0.000025	13%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00149	0.00154	3%	Uranium	0.00128	0.00134	5%
Vanadium	<0.0002	<0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	3.06	2.99	2%	Zinc	2.84	2.93	3%
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Pratical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"-"	*Not Analyzed.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix B6. Surface Water Quality Replicate Data, Casino Project, September 2008

Station	W43	W43-R (W43-B)	RPD	Station	W43	W43-R (W43-B)	RPD
Date	9/09/08	9/09/08	%	Date	9/09/08	9/09/08	%
Physical Tests				**Dissolved Anions & Nutrients**			
Conductivity (µs/cm)	220	220	0%	Alkalinity-Total	67	67	0%
Dissolved Hardness	95.8	95.4	0%	Ammonia Nitrogen	<0.01	<0.01	n/c
pH	7.5	7.7	3%	Chloride Cl	<0.5	<0.5	n/c
Total Suspended Solids	<1	<1	n/c	Nitrate Nitrogen	0.443	0.454	2%
Total Dissolved Solids	120	130	8%	Nitrite Nitrogen	<0.002	<0.002	n/c
Tubidity (NTU)	0.8	0.9	12%	Nitrate plus Nitrite	0.443	0.454	2%
Cyanide + Thiocyanate	<0.0005	<0.0005	n/c	Ortho Phosphate as P	0.002	0.002	0%
Total Hardness	94.4	94.9	1%	Sulphate	39	39	0%
Weak Acid Dissoc. Cyanide	<0.0005	<0.0005	n/c	Total Kjeldahl Nitrogen	0.04	0.02	**67%**
				Total Nitrogen	0.48	0.47	2%
Total Metals				**Dissolved Metals**			
Aluminum	0.0235	0.0224	5%	Aluminum	0.0014	0.0014	0%
Antimony	0.00264	0.00263	0%	Antimony	0.00257	0.00252	2%
Arsenic	0.00079	0.00077	3%	Arsenic	0.00047	0.00046	2%
Barium	0.0658	0.0649	1%	Barium	0.0631	0.0620	2%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.0425	0.0427	0%	Cadmium	0.0414	0.0418	1%
Calcium	26.2	26.3	0%	Calcium	26.8	26.7	0%
Chromium	<0.0001	<0.0001	n/c	Chromium	<0.0001	<0.0001	n/c
Cobalt	0.000320	0.000313	2%	Cobalt	0.000316	0.000312	1%
Copper	0.0748	0.0743	1%	Copper	0.0709	0.0703	1%
Iron	0.047	0.048	2%	Iron	0.010	0.010	0%
Lead	0.0120	0.0120	0%	Lead	0.00666	0.00680	2%
Lithium	0.0020	0.0020	0%	Lithium	0.0020	0.0020	0%
Magnesium	7.02	7.07	1%	Magnesium	7.03	7.00	0%
Manganese	0.524	0.526	0%	Manganese	0.537	0.543	1%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	<0.00005	<0.00005	n/c	Molybdenum	<0.00005	<0.00005	n/c
Nickel	0.00049	0.00043	13%	Nickel	0.00047	0.00064	**31%**
Phosphorus	0.003	0.003	0%	Phosphorus	0.002	0.002	0%
Potassium	1.35	1.35	0%	Potassium	1.39	1.38	1%
Selenium	<0.00004	<0.00004	n/c	Selenium	<0.00004	<0.00004	n/c
Silicon	5.8	6.2	7%	Silicon	5.6	5.8	4%
Silver	0.000105	0.000116	10%	Silver	0.000023	0.000022	4%
Sodium	3.09	3.07	1%	Sodium	2.99	2.96	1%
Strontium	0.220	0.220	0%	Strontium	0.226	0.224	1%
Sulfur	14	14	0%	Sulfur	14	13	7%
Thallium	0.000025	0.000026	4%	Thallium	0.000025	0.000025	0%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00126	0.00126	0%	Uranium	0.00126	0.00125	1%
Vanadium	<0.0002	<0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	2.35	2.38	1%	Zinc	2.28	2.28	0%
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Pratical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"-"	*Not Analyzed.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

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B7. Sediment Quality Data, Casino Project, September 2008

Appendix B7. Sediment Quality Data, Casino Project, September 2008

Station	Detection Limits	CCME Sediement Quality Guidelines for the Protection of Aquatic Life[a]		W7 - Upper Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W14 - Mouth of Britannia Creek	W2 - Canadian Creek downstream of Confluence with Britannia Creek	W1 - Mouth of Canadian Creek	W12 - Proctor Gulch before confluence with Casino Creek	W8 - Upper Casino Creek	W13 - Meloy Creek	W11 - Casino Creek (proposed dam outflow)	W4 - Mouth of Casino Creek	W9 - Dip Creek us of Confluence with Casino Creek	W5 - Dip Creek ds Casino confluence
Date		ISQG[b]	PEL[c]	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08
Physical Tests															
Moisture %	0.3			20	20	23	21	23	35	23	25	29	37	30	31
pH	0.01			6.45	7.27	7.37	7.38	7.45	3.28	7.16	7.41	7.29	6.66	6.92	6.59
Total Metals															
Aluminum	100			6810	6160	6690	5940	6900	11100	8010	10800	11200	11800	12000	13200
Antimony	0.1			0.8	1.0	0.8	0.9	0.9	2.4	1.2	2.3	2.6	0.8	0.6	0.7
Arsenic	0.2	5.9	17	*13.1*	***18.5***	*12.2*	***18.4***	*15.5*	***46.0***	***24.5***	***25.8***	***27.5***	*13.0*	*6.4*	*10.0*
Barium	0.1			144	98.9	159	96.8	96.7	188	140	272	217	156	169	206
Beryllium	0.1			0.2	0.2	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.2	0.4	0.4
Bismuth	0.1			0.5	0.1	<0.1	0.2	0.1	0.9	0.3	0.2	0.3	0.1	0.2	0.2
Cadmium	0.05	0.6	3.5	*0.68*	0.21	0.08	0.19	0.15	0.35	*1.80*	*1.55*	*1.78*	0.35	0.19	0.26
Calcium	100			1200	1860	2250	1850	2300	1170	2030	3780	3920	3590	5440	5090
Chromium	1	37.3	90	6	15	9	12	17	13	5	12	9	14	18	15
Cobalt	0.3			8.3	7.3	6.6	6.9	8.0	10.1	29.1	10.4	23.2	11.1	8.5	10.5
Copper	0.5	35.7	197	*57.0*	18.0	6.4	15.8	20.3	***223***	***292***	15.0	*191*	33.4	12.6	19.8
Iron	100			16500	13900	16700	13800	16000	83500	36600	27300	34900	29100	25700	27500
Lead	0.1	35	91.3	11.4	10.5	4.4	7.8	9.6	*73.9*	*42.9*	***192***	***111***	24.9	11.8	14.3
Magnesium	100			3560	4840	3890	4800	4890	3460	2880	4970	4440	6040	5370	5590
Manganese	0.2			450	343	355	354	336	407	1200	1400	1390	500	514	709
Mercury	0.05	0.17	0.486	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	0.1			5.5	2.5	0.4	2.7	2.4	5.0	2.9	1.2	2.4	1.5	1.1	1.1
Nickel	0.8			5.1	13.8	6.0	13.3	13.0	7.5	6.4	9.4	9.9	8.2	12.2	12.5
Phosphorous	10			337	374	431	428	405	577	434	498	444	584	965	703
Potassium	100			1310	1360	1280	1190	1480	880	665	2120	1300	2170	1080	1480
Selenium	0.5			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	0.05			0.12	0.05	<0.05	0.06	0.18	0.62	0.12	0.38	0.29	0.08	0.10	0.11
Sodium	100			<100	<100	107	<100	<100	<100	<100	<100	<100	176	197	156
Strontium	0.1			9.7	11.6	14.6	12.4	13.5	9.2	14.8	25.4	28.1	17.6	33.2	36.3
Thallium	0.05			0.17	0.12	0.12	0.12	0.12	0.17	0.13	0.32	0.22	0.25	0.15	0.22
Tin	0.1			0.3	0.2	0.3	0.2	0.2	0.5	0.2	0.7	0.5	0.5	0.5	0.5
Titanium	1			443	292	568	254	365	471	342	859	722	974	748	888
Vanadium	2			30	23	36	23	27	46	31	50	45	70	54	53
Zinc	1	123	315	65	40	34	41	43	*169*	*180*	*226*	*192*	94	64	76
Zirconium	0.5			1.1	0.7	0.6	0.7	0.8	0.8	0.9	1.0	0.9	0.9	1.3	1.5

Foot Notes:

All units mg/kg dry weight unless otherwise noted.

a) Canadian Sediment quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2008

b)ISQG: Interim Freshwater Sediment Quality Guidelines

c)PEL: Probable Effects Levels

Italic	*results exceed ISQG*
Italic	*results exceed ISQG & PEL*

AECOM

B8. Periphyton Taxonomy, Casino Project, September 2008

Appendix B8. Periphyton Taxonomy, Casino Project, September 2009															
FES Sample Number			080476	080477	080478	080479	080480	080481	080482	080483	080484	080485	080486	080487	080488
Sample Site			P1-1	P1-2	P1-3	P1-4	P1-5	P2-1	P2-2	P2-3	P2-4	P2-5	P3-1	P3-2	P3-3
Sampling Date			11-Sep-08	11-Sep-08	11-Sep-08	11-Sep-08	11-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08
Area Sampled (cm^2)			214.58	199.16	220.90	322.84	240.39	102.71	243.87	217.29	246.39	313.23	214.84	152.00	135.23
Phylum	Order	Genera and Species													
		Cyclotella sp.													<1.2
		Melosira sp.													
	Pennales	*Achnanthes flexella*						<3.1	<1.0	<1.5			<1.2		
		Achnanthes lanceolata													
		Achnanthes minutissima	12.8	33.6	<1.3	33.6	53.6	37.2	12.0	9.0	6.4	4.2	1.2	40.2	2.4
		Achnanthes spp.	9.6	2.8	7.8	16.8	26.8	6.2	8.0	12.0	16.0	4.2	4.8	120.6	9.6
		Amphipleura pellucida					<1.7								<1.2
		Amphora spp.													
		Caloneis spp.		<1.4										<1.7	<1.2
		Caloneis sp.?													
		Ceratoneis arcus	120.0	14.0	15.6	15.4	78.2	117.8	6.0	9.0	38.4	14.0	26.4	93.8	26.4
		Cocconeis placentula								<1.5	<1.6				
		Cymbella cf. cestaii	<1.6					3.1	<1.0			<0.7	<1.2	1.7	<1.2
		Cymbella cistula	<1.6					<3.1		<1.5	<1.6	<0.7	<1.2	6.8	<1.2
		Cymbella minuta	16.0	2.8	<1.3	6.6	20.4	6.2	2.0	3.0	9.6	1.4		17.0	4.8
		Cymbella sinuata	<1.6	<1.4	2.6	2.2	<1.7	9.3	1.0	15.0	6.4	0.7	1.2	6.8	7.2
		Cymbella spp.	<1.6			<1.1		<3.1	<1.0		<1.6	<0.7		<1.7	
		Denticula sp.	<1.6				<1.7	<3.1	<1.0		<1.6	<0.7			<1.2
		Diatoma elongatum	1,108.8	67.2	117.6	268.8	415.4	3,642.6	144.0	471.5	430.5	270.4	211.2	1,130.8	385.4
		Diatoma mesodon	<1.6	<1.4	<1.3	<1.1	1.7	<3.1		<1.5		<0.7	<1.2		
		Diatomella sp.													
		Didymosphenia geminata													
		Diploneis spp.												<1.7	
		Epithemia spp.													
		Eunotia spp.						<3.1			<1.6				<1.2
		Fragilaria capucina	<1.6												
		Fragilaria construens									<1.6				
		Fragilaria crotonensis													
		Fragilaria vaucheriae	216.0	2.8	18.2	117.6	241.2	62.0		9.0	16.0	1.4	2.4	40.2	2.4
		Fragilaria spp.	9.6	11.2	10.4	33.6	174.2	62.0	4.0	27.0	22.4	7.0	4.8	107.2	9.6
		Frustulia sp.													
		Gomphonema acuminatum / parvulum	19.2	25.2	7.8	50.4	40.8	99.2	2.0	6.0	9.6	<0.7	<1.2	20.4	9.6
		Gomphonema spp.	6.4	<1.4	<1.3		6.8	74.4	<1.0	9.0	3.2	<0.7	1.2	20.4	7.2
		Hanitzschia sp.													
		Meridion circulare	180.0	25.2	28.6	109.2	160.8	3.1	<1.0	9.0	6.4	<0.7	<1.2	6.8	4.8
		Navicula radiosa					<1.7	<3.1	<1.0	<1.5	1.6			6.8	<1.2
		Navicula spp.	1.6			6.6	6.8	12.4	<1.0	<1.5	1.6	<0.7	<1.2	10.2	2.4
		Neidium spp.													
		Nitzschia spp.	36.0	19.6	2.6	8.8	6.8	6.2	1.0	6.0	6.4	2.8	<1.2	20.4	9.6
		Pinnularia spp.	<1.6	<1.4	<1.3	1.1	<1.7	6.2	<1.0	<1.5	3.2	0.7	<1.2	10.2	4.8
		Rhopalodia sp.													
		Stauroneis spp.												<1.7	<1.2
		Surirella spp.													
		Synedra ulna	1.6	<1.4		<1.1	<1.7	37.2	<1.0	1.5	9.6	<0.7	4.8	23.8	7.2
		Synedra spp.	6.4	5.6	9.8	11.0	13.6	12.4	1.0	9.0	6.4	2.8	<1.2	17.0	4.8
		Tabellaria fenestrata												<1.7	
		Tabellaria flocculosa	<1.6												<1.2
		UID girdle view			<1.3					<1.5	<1.6		9.6	3.4	2.4
Chlorophyta	Chaetophorales	*Stigeoclonium sp.*													
		UID Chaetophorales													
	Chlorococcales	*Oocystis spp.*	<1.6												
	Oedogoniales	*Oedogonium spp.*													

Appendix B8. Periphyton Taxonomy, Casino Project, September 2009															
FES Sample Number			080476	080477	080478	080479	080480	080481	080482	080483	080484	080485	080486	080487	080488
Sample Site			P1-1	P1-2	P1-3	P1-4	P1-5	P2-1	P2-2	P2-3	P2-4	P2-5	P3-1	P3-2	P3-3
Sampling Date			11-Sep-08	11-Sep-08	11-Sep-08	11-Sep-08	11-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08
	Ulothricales	*Hormidium sp.?*											<1.2	<1.7	12.0
		Microspora sp.													
		Ulothrix spp.	<1.6			<1.1									
		UID Ulothricales													
	Zygnematales	*Closterium spp.*													
		Cosmarium spp.	<1.6												
		Cylindrocystis spp.													
		Mougeotia spp.													
		Roya sp.													
Chlorophyta		UID Chlorophyta colonial		11.2											
		UID Chlorophyta filamentous										<0.7	16.8		<1.2
		UID Chlorophyta unicellular		2.8									1.2		
Chrysophyta	Chromulinales	*Chromulina sp.*	1,663.2		205.8	1,328.4	930.6	840.6	800.8	207.0	172.2	2,772.0	28.8	1,028.0	1,089.0
		Hudrurus sp.									<1.6	<0.7			
	Tribonematales	*Tribonema spp.*	<1.6												
Chrysophyta		UID Chrysophyte colonial	22.4	11.2	7.8	81.4	80.4			24.0	73.8	20.8			363.0
		UID Chrysophyte cyst			<1.3						12.3	1.4	<1.2		
		UID Chrysophyte flagellate													
		UID Chrysophyte unicellular	12.0	2.8	2.6										
Cyanophyta	Chamaesiphonale	*Chamaesiphon spp.*													
		Clastidium setigerum													
	Chroococcales	*Aphanocapsa spp.*													
		UID Chrooccocales						24.3	8.0		110.7	20.8	57.6	67.0	<1.2
	Nostocales	*Anabaena sp. ?*					<1.7								
		Calothrix sp. ?													<1.2
		Nostoc sp. / Anabaena sp.										<0.7			
		Nostoc sp.													<1.2
		Tolypothrix sp.											13.2		91.2
		UID Nostocales				<1.1		<3.1							
	Oscillatoriales	*Lyngbya spp.*							<1.0		<1.6	<0.7			36.0
		Homoeothrix varians										<0.7			
		Microcoleus sp.													
		Oscillatoria cf. agardhii													
		Oscillatoria spp.													
		Phormidium sp.?													
		Pseudoanabaena spp.	<1.6		<1.3	<1.1				<1.5	16.0	<0.7	<1.2	<1.7	<1.2
		UID Oscillatoriales	<1.6	<1.4	<1.3		<1.7		<1.0	<1.5	<1.6	<0.7	<1.2	<1.7	79.2
Rhodophyta	Nemalionales	*Audouinella sp.*													
		Batrachospermum sp.													
		UID flagellate	12.0			8.4									
		UID colonial											<1.2		<1.2
		UID filamentous							<1.0	<1.5			<1.2		
		UID unicellular	138.6	44.8	39.2	97.2	51.7	93.4	8.0	11.5	236.5	26.0	38.4	257.0	108.9

Appendix B8. Periphyton Taxonomy, Casino Proj															
FES Sample Number			080489	080490	080491	080492	080493	080494	080495	080496	080497	080498	080499	080500	080501
Sample Site			P3-4	P3-5	P4-1	P4-2	P4-3	P4-4	P4-5	P5-1	P5-2	P5-3	P5-4	P5-5	P7-1
Sampling Date			10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08
Area Sampled (cm^2)			167.48	134.26	225.42	238.90	227.48	283.93	128.71	122.45	103.48	142.45	73.16	176.26	155.61
Phylum	Order	Genera and Species													
		Cyclotella sp.													
		Melosira sp.											<1.9		
	Pennales	*Achnanthes flexella*	<1.6			<2.7		<1.3	<2.6		<1.8				
		Achnanthes lanceolata			<1.3	2.7		<1.3						<1.3	5.8
		Achnanthes minutissima	100.8	16.0	30.0	208.0	3,393.6	147.0	102.5	13.0	10.8	16.0	3.8	2.6	113.0
		Achnanthes spp.	25.2	19.2	60.0	187.2	2,181.6	52.5	123.0	10.4	7.2	24.0	11.4	7.8	203.4
		Amphipleura pellucida													
		Amphora spp.			<1.3			<1.3	<2.6						<2.9
		Caloneis spp.					<2.0	2.6				<1.0	<1.9	<1.3	
		Caloneis sp.?			<1.3										
		Ceratoneis arcus	28.8	38.4	180.0	2,723.4	2,908.8	683.4	1,260.8	58.8	126.9	118.4	22.8	41.6	90.4
		Cocconeis placentula			1.3	5.4	<2.0	<1.3	<2.6	<1.3			<1.9	<1.3	
		Cymbella cf. cestaii		<1.6	<1.3		<2.0	<1.3	<2.6		<1.8				
		Cymbella cistula	<1.6	<1.6		2.7	8.0	5.2	<2.6			<1.0			<2.9
		Cymbella minuta	9.6	3.2	13.0	166.4	666.6	63.0	164.0	10.4	1.8	8.0	<1.9	<1.3	23.2
		Cymbella sinuata	12.8	22.4	5.2	41.6	31.6	2.6		7.8	10.8	4.0			11.6
		Cymbella spp.		<1.6	<1.3		<2.0		<2.6	<1.3		<1.0			<2.9
		Denticula sp.	<1.6												
		Diatoma elongatum	415.8	1,047.2	90.0	1,201.5	8,847.6	442.2	1,260.8	10.4	14.4	12.0	11.4	5.2	
		Diatoma mesodon	<1.6		<1.3	<2.7	2.0	2.6	<2.6		<1.8		<1.9	<1.3	2.9
		Diatomella sp.													<2.9
		Didymosphenia geminata				<2.7	<2.0	31.2	109.2	<1.3					<2.9
		Diploneis spp.			<1.3	<2.7		<1.3	<2.6	<1.3					
		Epithemia spp.													
		Eunotia spp.			<1.3	<2.7					<1.8			<1.3	<2.9
		Fragilaria capucina			<1.3	10.8	12.0	<1.3	31.2		5.4	4.0	<1.9	<1.3	<2.9
		Fragilaria construens			<1.3										5.8
		Fragilaria crotonensis						<1.3							
		Fragilaria vaucheriae	12.6	19.2	190.0	2,242.8	3,030.0	884.4	2,364.0	15.6	25.2	32.0	30.4	7.8	316.4
		Fragilaria spp.	6.4	19.2	130.0	801.0	848.4	361.8	472.4	2.6	14.4	8.0	11.4	7.8	22.6
		Frustulia sp.				<2.7			<2.6						
		Gomphonema acuminatum / parvulum	19.2	6.4	13.0	270.4	11,756.4	21.0	41.0	7.8	14.4	12.0	22.8	3.9	67.8
		Gomphonema spp.	16.0	22.4	10.4	145.6	13,938.0	63.0	61.5	5.2	7.2	36.0	3.8	2.6	11.6
		Hanitzschia sp.													
		Meridion circulare	3.2	<1.6	7.8	75.6	158.0	49.4	246.0	15.6	10.8	10.0	7.6	3.9	29.0
		Navicula radiosa	<1.6	<1.6	<1.3	<2.7	2.0	1.3	2.6	<1.3	<1.8	<1.0	<1.9		
		Navicula spp.	1.6		2.6	<2.7	<2.0	13.0	10.4		21.6	20.0	11.4		<2.9
		Neidium spp.			<1.3										<2.9
		Nitzschia spp.	3.2	9.6	50.0	83.2	363.6	105.0	184.5	18.2	25.2	96.0	15.4	5.2	17.4
		Pinnularia spp.	<1.6	1.6	5.2	5.4	<2.0	13.0	15.6	<1.3	1.8	2.0	<1.9	<1.3	11.6
		Rhopalodia sp.							<2.6						
		Stauroneis spp.		<1.6	<1.3	<2.7	<2.0	<1.3	<2.6			<1.0			
		Surirella spp.	<1.6			<2.7	<2.0	<1.3				<1.0			
		Synedra ulna	12.8	19.2	1.3	27.0	<2.0	2.6	10.4		<1.8	<1.0	<1.9	<1.3	
		Synedra spp.	<1.6	3.2	50.0	640.8	3,999.6	361.8	1,182.0	7.8	3.6	16.0	11.4	7.8	5.8
		Tabellaria fenestrata		<1.6		2.7	<2.0		5.2						<2.9
		Tabellaria flocculosa			<1.3	2.7	<2.0	<1.3	<2.6			<1.0			<2.9
		UID girdle view			2.6		63.2	2.6			<1.8	6.0	<1.9		5.8
Chlorophyta	Chaetophorales	*Stigeoclonium sp.*													
		UID Chaetophorales													
	Chlorococcales	*Oocystis spp.*													
	Oedogoniales	*Oedogonium spp.*										<1.0			

Appendix B8. Periphyton Taxonomy, Casino Proj															
FES Sample Number			080489	080490	080491	080492	080493	080494	080495	080496	080497	080498	080499	080500	080501
Sample Site			P3-4	P3-5	P4-1	P4-2	P4-3	P4-4	P4-5	P5-1	P5-2	P5-3	P5-4	P5-5	P7-1
Sampling Date			10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08
	Ulothricales	*Hormidium sp.?*	<1.6	<1.6											
		Microspora sp.													
		Ulothrix spp.					<2.0	<1.3							
		UID Ulothricales													
	Zygnematales	*Closterium spp.*					<2.0		<2.6		<1.8				
		Cosmarium spp.		<1.6		<2.7							<1.9	<1.3	
		Cylindrocystis spp.	<1.6												<2.9
		Mougeotia spp.									<1.8				<2.9
		Roya sp.													
Chlorophyta		UID Chlorophyta colonial													
		UID Chlorophyta filamentous	<1.6					<1.3					<1.9		
		UID Chlorophyta unicellular		3.2	<1.3										<2.9
Chrysophyta	Chromulinales	*Chromulina sp.*	580.8	618.8	80.0	41.6	909.0	160.8	41.0	39.2	56.4	333.0	88.8	453.2	45.2
		Hudrurus sp.													
	Tribonematales	*Tribonema spp.*				<2.7									
Chrysophyta		UID Chrysophyte colonial	<1.6												<2.9
		UID Chrysophyte cyst			2.6	<2.7	<2.0		<2.6			2.0			17.4
		UID Chrysophyte flagellate	3.2								<1.8		3.8		
		UID Chrysophyte unicellular													
Cyanophyta	Chamaesiphonale	*Chamaesiphon spp.*			490.0	665.6	4,908.6	5,185.8	6,146.4						8,246.0
		Clastidium setigerum					47.4	10.5	61.5						4,774.0
	Chroococcales	*Aphanocapsa spp.*		<1.6											
		UID Chrooccocales	<1.6	19.2	770.0	41.6	303.0	402.0	394.0		<1.8		<1.9		607.6
	Nostocales	*Anabaena sp. ?*													
		Calothrix sp. ?													
		Nostoc sp. / Anabaena sp.			31.2										
		Nostoc sp.		<1.6	<1.3		<2.0	<1.3	<2.6						
		Tolypothrix sp.	<1.6	<1.6											
		UID Nostocales												<1.3	
	Oscillatoriales	*Lyngbya spp.*													<2.9
		Homoeothrix varians			660.0	47,739.6	6,120.6	5,668.2	19,069.6			30.0	22.8	39.0	110,583.2
		Microcoleus sp.													
		Oscillatoria cf. agardhii	4,132.8	<1.6	26.0	48.6	32,239.2	7,477.2	92,038.4						<2.9
		Oscillatoria spp.													
		Phormidium sp.?									<1.8				
		Pseudoanabaena spp.		<1.6			94.8	168.0		<1.3	<1.8	8.0			
		UID Oscillatoriales	64.0	25.6	220.0	124.8				<1.3	14.4	<1.0	<1.9	<1.3	156.6
Rhodophyta	Nemalionales	*Audouinella sp.*			13.0	232.2		1,900.5	512.5						
		Batrachospermum sp.			249.6	11,169.6		33.8							
		UID flagellate	<1.6		385.0	5,286.6									
		UID colonial					47.4					26.0			
		UID filamentous								<1.3					
		UID unicellular	48.4	95.2	77.0	400.5	1,212.0	120.6	157.6	39.2	14.1	22.2	29.6	20.6	434.0

Appendix B8. Periphyton Taxonomy, Casino Proj											
FES Sample Number			080502	080503	080504	080505	080506	080507	080508	080509	080510
Sample Site			P7-2	P7-3	P7-4	P7-5	P8-1	P8-2	P8-3	P8-4	P8-5
Sampling Date			10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08
Area Sampled (cm^2)			199.81	304.84	117.23	114.00	168.77	154.97	185.16	192.39	275.81
Phylum	Order	Genera and Species									
		Cyclotella sp.									
		Melosira sp.			<4.9						
	Pennales	*Achnanthes flexella*		<1.4	<4.9						
		Achnanthes lanceolata	<5.8	<1.4	19.6	50.4	500.5	4.0	15.9	60.4	2.6
		Achnanthes minutissima	267.6	99.0	414.7	1,490.4	214.5				
		Achnanthes spp.	490.6	66.0	377.0	1,555.2	357.5	2.0	21.2	90.6	7.8
		Amphipleura pellucida									
		Amphora spp.	<5.8	<1.4	<4.9						
		Caloneis spp.	5.8	2.8	19.6	8.4	18.6		<0.7	3.9	<1.3
		Caloneis sp.?									
		Ceratoneis arcus	81.2	36.8	127.4	235.2	26,979.4	347.8	1,359.6	5,224.5	135.2
		Cocconeis placentula	<5.8								
		Cymbella cf. cestaii			<4.9						
		Cymbella cistula		<1.4	<4.9	<8.4					
		Cymbella minuta	23.2	8.4	39.2	67.2				<3.9	<1.3
		Cymbella sinuata	34.8	<1.4	<4.9	16.8	9.3	1.0		7.8	<1.3
		Cymbella spp.	<5.8	<1.4		<8.4	<9.3		<0.7	<3.9	<1.3
		Denticula sp.									
		Diatoma elongatum									
		Diatoma mesodon	<5.8		49.0	67.2	99,108.0	400.4	3,296.0	15,441.3	343.2
		Diatomella sp.				<8.4					
		Didymosphenia geminata			<4.9	<8.4					
		Diploneis spp.									
		Epithemia spp.			<4.9						
		Eunotia spp.		<1.4	9.8	8.4	55.8	4.0	2.8	31.2	2.6
		Fragilaria capucina	<5.8	4.2	<4.9	<8.4	18.6	<1.0	4.2	<3.9	
		Fragilaria construens		<1.4		<8.4				<3.9	
		Fragilaria crotonensis								<3.9	
		Fragilaria vaucheriae	401.4	77.0	263.9	1,620.0	2,477.7	74.0	247.2	928.8	31.2
		Fragilaria spp.	11.6	8.4	37.7	324.0	24,226.4	118.4	576.8	5,688.9	166.4
		Frustulia sp.									
		Gomphonema acuminatum / parvulum	58.0	11.2	58.8	33.6	286.0	<1.0	5.3	30.2	<1.3
		Gomphonema spp.	23.2	8.4	58.8	84.0	214.5	4.0	21.2	120.8	
		Hanitzschia sp.		<1.4				<1.0	<0.7	<3.9	
		Meridion circulare	46.4	5.6	19.6	67.2	4,404.8	6.0	247.2	906.0	7.8
		Navicula radiosa									
		Navicula spp.	<5.8								
		Neidium spp.	<5.8			<8.4			<0.7	<3.9	
		Nitzschia spp.	58.0	22.4	58.8	33.6	143.0	6.0	<0.7	7.8	5.2
		Pinnularia spp.	46.4	8.4	29.4	33.6	55.8	12.0	18.2	3.9	10.4
		Rhopalodia sp.									
		Stauroneis spp.		<1.4							
		Surirella spp.						<1.0			
		Synedra ulna									
		Synedra spp.	11.6	1.4	9.8	33.6	1,651.8	14.8	21.1	181.2	41.6
		Tabellaria fenestrata			<4.9		223.2	<1.0	8.4	39.0	<1.3
		Tabellaria flocculosa	<5.8	<1.4	<4.9		241,8	<1.0	9.8	140.4	5.2
		UID girdle view	<5.8	2.8			9.3	2.0		<3.9	1.3
Chlorophyta	Chaetophorales	*Stigeoclonium sp.*					55.8		4.2	46.8	
		UID Chaetophorales	<5.8				<9.3	10.0			
	Chlorococcales	*Oocystis spp.*					<9.3				
	Oedogoniales	*Oedogonium spp.*		<1.4							

Appendix B8. Periphyton Taxonomy, Casino Proj											
FES Sample Number			080502	080503	080504	080505	080506	080507	080508	080509	080510
Sample Site			P7-2	P7-3	P7-4	P7-5	P8-1	P8-2	P8-3	P8-4	P8-5
Sampling Date			10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08
	Ulothricales	*Hormidium sp.?*									
		Microspora sp.				<8.4	130.2	<1.0	21.0	109.2	
		Ulothrix spp.									
		UID Ulothricales			<4.9				<0.7		
	Zygnematales	*Closterium spp.*					<9.3		<0.7	3.9	
		Cosmarium spp.					9.3		<0.7		
		Cylindrocystis spp.		<1.4			55.8		2.8	15.6	
		Mougeotia spp.							<0.7	<3.9	<1.3
		Roya sp.					<9.3		<0.7		
Chlorophyta		UID Chlorophyta colonial									
		UID Chlorophyta filamentous					<9.3				<1.3
		UID Chlorophyta unicellular				<8.4	214.5	4.0	10.6	60.4	20.8
Chrysophyta	Chromulinales	*Chromulina sp.*		2.8	19.6	50.4	56,711.8	11,554.4	8,981.6	13,235.4	2,406.0
		Hudrurus sp.									
	Tribonematales	*Tribonema spp.*					930.0	<1.0	2.8	148.2	
Chrysophyta		UID Chrysophyte colonial					<9.3	8.0			31.2
		UID Chrysophyte cyst	23.2	5.6	9.8	33.6	143.0		5.3	30.2	2.6
		UID Chrysophyte flagellate							10.6	60.4	
		UID Chrysophyte unicellular					14,866.2	514.8	1,112.4	5,572.8	401.0
Cyanophyta	Chamaesiphonale	*Chamaesiphon spp.*	267.6	1,941.2	1,583.4	2,916.0	22,574.6	1,258.4	1,277.2	24,845.4	13,643.0
		Clastidium setigerum	579.8	1,139.4	263.9	2,656.8	825.9	143.0			1,443.6
	Chroococcales	*Aphanocapsa spp.*									
		UID Chrooccocales	401.4	295.4	453.3	1,993.6	12,113.2	1,172.6	618.0	5,108.4	5,373.4
	Nostocales	*Anabaena sp. ?*									
		Calothrix sp. ?									
		Nostoc sp. / Anabaena sp.		<1.4			<9.3	<1.0	<0.7		
		Nostoc sp.	<5.8	<1.4	78.8			<1.0	<0.7	<3.9	
		Tolypothrix sp.		<1.4	<4.9	<8.4					
		UID Nostocales									
	Oscillatoriales	*Lyngbya spp.*		25.2	<4.9	<8.4					
		Homoeothrix varians	2,988.2	803.0	6,371.3	125,596.8	256,579.6	5,548.4	3,357.8	87,075.0	17,563.8
		Microcoleus sp.						40.0			
		Oscillatoria cf. agardhii					3,360.5	1,235.8	114.8	5,828.6	4,090.2
		Oscillatoria spp.							65.8	234.0	<1.3
		Phormidium sp.?									
		Pseudoanabaena spp.	174.0	42.0	274.4	470.4	1,358.5		16.8	156.0	
		UID Oscillatoriales	356.8	56.0	117.6	252.0	2,073.5		95.4	<3.9	
Rhodophyta	Nemalionales	*Audouinella sp.*					<9.3			<3.9	83.2
		Batrachospermum sp.									
		UID flagellate					275.3	7.4			20.8
		UID colonial	<5.8								
		UID filamentous						<1.0	<0.7		
		UID unicellular	515.4	126.6	580.4	996.8	9,360.2	143.0	1,359.6	1,625.4	120.3

AECOM

B9. Benthic Invertebrate Taxonomy, Casino Project, September 2008

Appendix B9. Benthic Invertebrate Taxonomy, Casino Project, September 2008

	Sample ID:	B1-1	B1-2	B1-3	B1-4	B1-5	B2-1	B2-2	B2-3	B2-4	B2-5	B3-1	B3-2	B3-3
	CC#:	080450	080451	080452	080453	080454	080455	080456	080457	080458	080459	080460	080461	080462
Order: Ephemeroptera	adult			1		4	3	3	1	1	1			
Order: Ephemeroptera	nymph (dam./juv.)	1				1			1					
Family: Ameletidae														
Ameletus sp.	nymph	1	1	1		6	2		1	2	2	4	2	1
Family: Baetidae	nymph (dam./juv.)					1	3	4		8		3	1	
Baetis sp.	nymph	4	1	2		2		3	12	4	18	14	1	7
Baetis bicaudatus	nymph	2		2	1		1	2	3	5	5			2
Baetis tricaudatus	nymph					1								
Acentrella sp.	nymph			1		1								
Family: Heptageniidae	nymph		1	2	1	2	7	4	25	8	12	17	2	7
Cinygmula sp.	nymph	3				1		1		1				
Epeorus sp.	nymph						1		3		2	6		1
Family: Ephemerellidae	nymph		1			1	1		3	1	1	1		
Serratella sp.	nymph			1		1								
Ephemerella sp.	nymph													
Drunella sp.	nymph													
Drunella doddsi	nymph	2		4		2	3	3	10	8	11	12	6	14
Drunella coloradensis	nymph			1						1				1
Order: Plecoptera	adult									2				
Order: Plecoptera	nymph (dam./juv.)	1	1				7	1	2	8	3	3		
Family: Chloroperlidae	nympg (dam./juv.)					1			1					
Suwallia sp.	nymph		1	2		1	1		4	3	6			
Family: Perlodidae	nymph (dam./juv.)	17	5	4	3	9	2	1	2	4				4
Skwala sp.	nymph			1										
Isoperla sp.	nymph										3			
Megarcys sp.	nymph													
Family: Nemouridae	nymph (dam./juv.)													
Podmosta sp.	nymph						1	28	11	6	13			
Ostrocerca sp.	nymph										1			
Zapada oregonensis/haysi	nymph							1				1		
Family: Taeniopterygidae														
Taenionema sp.	nymph			1				1		2		1		
Family: Capniidae	nymph (dam./juv.)	4	3	6	1	8	3	19	6	15	5	7	1	5
Capnia sp.	nymph													
Order: Trichoptera	larvae (dam./juv.)					2								
Family: Apataniidae														
Apatania sp.	larvae													
Family: Glossosomatidae														
Glossosoma sp.	larvae			1				1						1
Family: Limnephilidae	larvae (dam./juv.)	6	1	1				1						
Ecclisomyia sp.	larvae			1		3					1	1		5
Hydratophylax/Pycnopsyche sp.	larvae													
Family: Rhyacophilidae														
Rhyacophila sp.	larvae													
Order: Diptera UID	larvae	1	1	1	1	3		3	2		2		9	4
Order: Diptera UID	pupae	3	2			3	1		3					
Family: Muscidae	larvae (juv./dam.)									1				
Family: Ceratopogonidae														
Bezzia/Metachela sp.	larvae													
Family: Tipulidae	larvae (juv./dam.)			1					1			1		
Tipula sp.	larvae	1	2					1						
Limonia sp.	larvae		1											
Dicranota sp.	larvae							1						
Family: Psychodidae UID	larvae													2
Pericoma sp.	larvae	1		2		1								
Family: Empididae	larvae (juv.)	1												
Chelifera/Metachela sp.	larvae	1	1				1	1						1
Clinocera sp.	larvae													
Family: Simuliidae	pupae					2	2	3		1		1	1	2
Simulium sp.	larvae													
Prosimulium sp.	larvae						2	3	1	3	1	2		3
Family: Chironomidae	larvae													
Family: Chironomidae	pupae		2	3		4	5	2		1			6	13
Subfamily : Orthocladiinae	larvae											1	1	
Cricotopus/Orthocladius sp.	larvae	2	1				1		2		2			4
Eukiefferiella sp.	larvae			8	2	5	11	4		11	7			6
Hydrobaenus sp.	larvae													
Parasmittia sp.	larvae											3		
Metriocnemus sp.	larvae													
Tvetenia sp.	larvae			2	1	2	2	6	3	5	4			
Subfamily : Diamesinae	larvae													
Diamesa sp.	larvae	14	5	40	4	7	25	65	36	53	46	32	21	11
Pseudodiamesa sp.	larvae					1				1				
Pagastia sp.	larvae	2	2	8		4	4	3	8	3	1	5	2	15
Potthastia sp.	larvae													
Subfamily : Chironominae	larvae													
Tribelos sp.	larvae												1	
Subfamily : Tanypodinae	larvae													1
Subfamily : Podonominae	larvae													
Trichotanypus sp.	larvae													
Order: Coleoptera														

Appendix B9. Benthic Invertebrate Taxonomy, Casino Project, September 2008

	Sample ID:	B1-1	B1-2	B1-3	B1-4	B1-5	B2-1	B2-2	B2-3	B2-4	B2-5	B3-1	B3-2	B3-3
	CC#:	080450	080451	080452	080453	080454	080455	080456	080457	080458	080459	080460	080461	080462
Family: Dytiscidae	larvae (juv./dam.)													
Family: Curculionidae	adult													
Order: Lepidoptera	larvae								1		1		1	
Order: Collembola	larvae	3	1				2	1	1	2		3	4	3
Class: Crustacea														
Order: Ostracoda			1				1		1			1	1	
Order: Copepoda				3						2			2	1
Order: Cladocera								1					2	
Order: Bivalvia													1	
Order: Gastropoda														
Family: Hydrobiidae								1						
Phylum: Annelida														
Class: Oligochaeta				3					1			1		1
Family: Lumbriculidae			20		2	6		1					3	
Phylum: Nematoda			1	3		3							1	
Order: Prostigmata UID	adult													
Order: Prostigmata	deutonymph		1											
Family: Hydrozetidae	adult	1		2	1	2	3	2	3			1	2	2
Family: Aturidae														
Aturus	adult													
Family: Hygrobatidae														
Hygrobates	adult													
Family: Limnesiidae														
Limnesia	adult													
Family: Sperchontidae														
Sperchon	adult									1				
Family: Lebertiidae														
Lebertia	adult							1				1		1
Family: Feltridae														
Feltria	adult			1					2	2		1		
TOTAL NUMBER		**71**	**56**	**108**	**17**	**86**	**92**	**169**	**149**	**164**	**147**	**123**	**71**	**118**
DENSITY (no. org./m^2)		**763**	**602**	**1,161**	**183**	**925**	**989**	**1,817**	**1,602**	**1,763**	**1,581**	**1,323**	**763**	**1,269**
juv. = juvenile, dam. = damaged														

Appendix B9. Benthic Invertebrate

	Sample ID:	B3-4	B3-5	B4-1	B4-2	B4-3	B4-4	B4-5	B5-1	B5-2	B5-3	B5-4	B5-5	B7-1
	CC#:	080463	080464	080465	080466	080467	080468	080469	080470	080471	080472	080473	080474	080475
Order: Ephemeroptera	adult	1		1	1									
Order: Ephemeroptera	nymph (dam./juv.)											2	1	
Family: Ameletidae														
Ameletus sp.	nymph	1					1	1	4		1			
Family: Baetidae	nymph (dam./juv.)	1			1								1	
Baetis sp.	nymph		8						6		3	2	3	
Baetis bicaudatus	nymph		2				1	1	7		2	1	8	
Baetis tricaudatus	nymph													
Acentrella sp.	nymph											2		
Family: Heptageniidae	nymph	5	8	1	2		3	2	13	1		2	4	
Cinygmula sp.	nymph		1		3				8	4	4	1	3	
Epeorus sp.	nymph		1	1			1		13	3	5	6	5	
Family: Ephemerellidae	nymph								2		1	1	1	
Serratella sp.	nymph													
Ephemerella sp.	nymph		1											
Drunella sp.	nymph										1			
Drunella doddsi	nymph	4	5			1	1		5	1	1		1	
Drunella coloradensis	nymph		1											
Order: Plecoptera	adult													
Order: Plecoptera	nymph (dam./juv.)						1		2			1	1	1
Family: Chloroperlidae	nympg (dam./juv.)			2										3
Suwallia sp.	nymph	1	1			1	6	2	8	1	2	3	3	2
Family: Perlodidae	nymph (dam./juv.)		3		1				5	2	6	3	3	6
Skwala sp.	nymph					1								
Isoperla sp.	nymph													
Megarcys sp.	nymph													
Family: Nemouridae	nymph (dam./juv.)													
Podmosta sp.	nymph													
Ostrocerca sp.	nymph													
Zapada oregonensis/haysi	nymph			1					2			2		
Family: Taeniopterygidae														
Taenionema sp.	nymph													
Family: Capniidae	nymph (dam./juv.)	3	5	2	1	1	1		2		1	1	2	
Capnia sp.	nymph													
Order: Trichoptera	larvae (dam./juv.)													
Family: Apataniidae														
Apatania sp.	larvae							1						
Family: Glossosomatidae														
Glossosoma sp.	larvae													
Family: Limnephilidae	larvae (dam./juv.)	1			1	3	2		4			2		
Ecclisomyia sp.	larvae			3	2	1		1		2			4	
Hydratophylax/Pycnopsyche sp.	larvae								1					
Family: Rhyacophilidae														
Rhyacophila sp.	larvae				1									
Order: Diptera UID	larvae	2	3	2	2		4	3	4	3	3	6	5	1
Order: Diptera UID	pupae											1		
Family: Muscidae	larvae (juv./dam.)								1					
Family: Ceratopogonidae														
Bezzia/Metachela sp.	larvae													
Family: Tipulidae	larvae (juv./dam.)										1			
Tipula sp.	larvae					1				1				
Limonia sp.	larvae													
Dicranota sp.	larvae						1		1					
Family: Psychodidae UID	larvae													
Pericoma sp.	larvae				1	2		1		1	2	1		
Family: Empididae	larvae (juv.)								1					
Chelifera/Metachela sp.	larvae			4	2		1			3	1			
Clinocera sp.	larvae											1		
Family: Simuliidae	pupae	2							1	1		1		
Simulium sp.	larvae													
Prosimulium sp.	larvae						1				1	1	1	
Family: Chironomidae	larvae													
Family: Chironomidae	pupae	12	5	2	4					2	2		3	
Subfamily : Orthocladiinae	larvae													
Cricotopus/Orthocladius sp.	larvae	2							3		4	5	5	
Eukiefferiella sp.	larvae	6		3					11	2	2	3		
Hydrobaenus sp.	larvae													
Parasmittia sp.	larvae													
Metriocnemus sp.	larvae											1		
Tvetenia sp.	larvae	2												
Subfamily : Diamesinae	larvae													
Diamesa sp.	larvae	10	24	4	4			2	15	3				16
Pseudodiamesa sp.	larvae				1									
Pagastia sp.	larvae	4	4				3		6	3		9	6	
Potthastia sp.	larvae												1	
Subfamily : Chironominae	larvae													
Tribelos sp.	larvae													
Subfamily : Tanypodinae	larvae													
Subfamily : Podonominae	larvae													
Trichotanypus sp.	larvae									1				
Order: Coleoptera														

Appendix B9. Benthic Invertebrate

	Sample ID:	B3-4	B3-5	B4-1	B4-2	B4-3	B4-4	B4-5	B5-1	B5-2	B5-3	B5-4	B5-5	B7-1
	CC#:	080463	080464	080465	080466	080467	080468	080469	080470	080471	080472	080473	080474	080475
Family: Dytiscidae	larvae (juv./dam.)		1								1			
Family: Curculionidae	adult								1					
Order: Lepidoptera	larvae				1							1		
Order: Collembola	larvae	3					1		1		1	1		2
Class: Crustacea														
Order: Ostracoda		1							2	1	1	1		
Order: Copepoda				1	1		1		5		2	1	1	
Order: Cladocera		1							1					
Order: Bivalvia														
Order: Gastropoda														
Family: Hydrobiidae														
Phylum: Annelida														
Class: Oligochaeta		1			7					1	1			
Family: Lumbriculidae				13	2		3	2	9					
Phylum: Nematoda				1	1				3				1	
Order: Prostigmata UID	adult			1					1	1	2			1
Order: Prostigmata	deutonymph	1		1										
Family: Hydrozetidae	adult			1	1	1	2	1	5	1	3	3	3	
Family: Aturidae														
Aturus	adult								2					
Family: Hygrobatidae														
Hygrobates	adult			2	1		1		4	1	1	4	1	
Family: Limnesiidae														
Limnesia	adult													
Family: Sperchontidae														
Sperchon	adult									1				
Family: Lebertiidae														
Lebertia	adult	1						1			1	1		
Family: Feltridae														
Feltria	adult							1			1			
TOTAL NUMBER		**64**	**73**	**45**	**40**	**12**	**35**	**19**	**159**	**40**	**57**	**70**	**67**	**32**
DENSITY (no. org./m^2)		**688**	**785**	**484**	**430**	**129**	**376**	**204**	**1,710**	**430**	**613**	**753**	**720**	**344**
juv. = juvenile, dam. = damaged														

Appendix B9. Benthic Invertebrate

	Sample ID:	B7-2	B7-3	B7-4	B7-5	B8-1	B8-2	B8-3	B8-4	B8-5
	CC#:	080476	080477	080478	080479	080480	080481	080482	080483	080484
Order: Ephemeroptera	adult					1				
Order: Ephemeroptera	nymph (dam./juv.)									
Family: Ameletidae										
Ameletus sp.	nymph					3	2	1	2	3
Family: Baetidae	nymph (dam./juv.)									
Baetis sp.	nymph									
Baetis bicaudatus	nymph								2	
Baetis tricaudatus	nymph									
Acentrella sp.	nymph									
Family: Heptageniidae	nymph	1		1	1	106	21	85	46	29
Cinygmula sp.	nymph					4	1	2	1	2
Epeorus sp.	nymph									
Family: Ephemerellidae	nymph									
Serratella sp.	nymph									
Ephemerella sp.	nymph									
Drunella sp.	nymph									
Drunella doddsi	nymph									
Drunella coloradensis	nymph									
Order: Plecoptera	adult									
Order: Plecoptera	nymph (dam./juv.)				7	9	5	11	9	3
Family: Chloroperlidae	nympg (dam./juv.)			3	7					
Suwallia sp.	nymph		1		1					
Family: Perlodidae	nymph (dam./juv.)	4	1	3	1					
Skwala sp.	nymph				1	1			1	2
Isoperla sp.	nymph									
Megarcys sp.	nymph							5	2	
Family: Nemouridae	nymph (dam./juv.)				1	4	6	19	8	7
Podmosta sp.	nymph					9	15	13	20	15
Ostrocerca sp.	nymph							4	3	
Zapada oregonensis/haysi	nymph									
Family: Taeniopterygidae										
Taenionema sp.	nymph									
Family: Capniidae	nymph (dam./juv.)		1		2	48	37	53	36	42
Capnia sp.	nymph								1	
Order: Trichoptera	larvae (dam./juv.)									
Family: Apataniidae										
Apatania sp.	larvae									
Family: Glossosomatidae										
Glossosoma sp.	larvae									
Family: Limnephilidae	larvae (dam./juv.)									
Ecclisomyia sp.	larvae								2	1
Hydratophylax/Pycnopsyche sp.	larvae									
Family: Rhyacophilidae										
Rhyacophila sp.	larvae									
Order: Diptera UID	larvae				2			1		
Order: Diptera UID	pupae									
Family: Muscidae	larvae (juv./dam.)									
Family: Ceratopogonidae										
Bezzia/Metachela sp.	larvae	2		2						
Family: Tipulidae	larvae (juv./dam.)									
Tipula sp.	larvae					3			1	2
Limonia sp.	larvae									
Dicranota sp.	larvae					1			1	
Family: Psychodidae UID	larvae									
Pericoma sp.	larvae									
Family: Empididae	larvae (juv.)						1			
Chelifera/Metachela sp.	larvae							1	2	3
Clinocera sp.	larvae					2	1	1	5	1
Family: Simuliidae	pupae	1				1	1	1	3	
Simulium sp.	larvae							1		
Prosimulium sp.	larvae				1	1		3	1	1
Family: Chironomidae	larvae									
Family: Chironomidae	pupae		1				3	12	11	5
Subfamily : Orthocladiinae	larvae									
Cricotopus/Orthocladius sp.	larvae					27	2			
Eukiefferiella sp.	larvae					16	12	87	23	45
Hydrobaenus sp.	larvae					1				
Parasmittia sp.	larvae									
Metriocnemus sp.	larvae									
Tvetenia sp.	larvae									
Subfamily : Diamesinae	larvae									
Diamesa sp.	larvae	10	2	6	13	17		125	66	67
Pseudodiamesa sp.	larvae									
Pagastia sp.	larvae					6				
Potthastia sp.	larvae									
Subfamily : Chironominae	larvae									
Tribelos sp.	larvae									
Subfamily : Tanypodinae	larvae									
Subfamily : Podonominae	larvae									
Trichotanypus sp.	larvae					1				
Order: Coleoptera										

Appendix B9. Benthic Invertebrate

	Sample ID:	B7-2	B7-3	B7-4	B7-5	B8-1	B8-2	B8-3	B8-4	B8-5
	CC#:	080476	080477	080478	080479	080480	080481	080482	080483	080484
Family: Dytiscidae	larvae (juv./dam.)									
Family: Curculionidae	adult									
Order: Lepidoptera	larvae				1					
Order: Collembola	larvae	3	10	11	2	4	4	23	3	5
Class: Crustacea										
Order: Ostracoda						2	2	1		
Order: Copepoda									1	
Order: Cladocera										
Order: Bivalvia										
Order: Gastropoda										
Family: Hydrobiidae										
Phylum: Annelida										
Class: Oligochaeta		1								
Family: Lumbriculidae				2	1	139	34	60	151	78
Phylum: Nematoda				6	2	3		1	1	2
Order: Prostigmata UID	adult									
Order: Prostigmata	deutonymph	1								
Family: Hydrozetidae	adult	3	1	1	1	1		2	2	1
Family: Aturidae										
Aturus	adult									
Family: Hygrobatidae										
Hygrobates	adult									
Family: Limnesiidae										
Limnesia	adult					1				
Family: Sperchontidae										
Sperchon	adult									
Family: Lebertiidae										
Lebertia	adult									
Family: Feltridae										
Feltria	adult	1						4		
TOTAL NUMBER		**27**	**17**	**35**	**44**	**410**	**147**	**516**	**404**	**314**
DENSITY (no. org./m^2)		**290**	**183**	**376**	**473**	**4,409**	**1,581**	**5,548**	**4,344**	**3,376**
juv. = juvenile, dam. = damaged										

B10. FISS Reports for Watersheds of the Aquatic Regional Study Area of the Casino Project

FISS Search Results

Fisheries and Oceans Canada | Pêches et Océans Canada

REFERENCE INFORMATION			
Waterbody Names			
Gazetteer Name:	BRITANNIA CREEK	Alias1:	
		Alias2:	
Waterbody Codes			
Watershed code:	800787800000000000000000000000000000		
SISS/RAB code:	603769000000000000000	Lake Seq. No.:	0
Confluence Information			
Map No:		Confluence ID:	
	Zone:	7	
Easting:	6179	Northing:	69735
Comments			
FLOWS NE AND N INTO YUKON R., YUKON TERRITORY. DRAINAGE BASIN AREA =115KM SQUARE.			

STREAM INFORMATION				
MapNo	ID	Station	Reference	Mean Annual Runoff

PROVINCIAL FISHERIES MANAGEMENT OBJECTIVES				
Habitat Type	Mgmt Obj.1		Mgmt Obj.2	

ENHANCEMENT AND MANAGEMENT ACTIVITIES										
MapNo	ID	Type	Activity	Project	Start	Finish	Species			Reference
		W	M				SA			800001
			THE LOWER SECTION OF THIS CREEK IS CLASSIFIED AS TYPE II - SALMONID REARING STREAM, BY THE YUKON PLACER AUTHORIZATION. THE REST OF THE WATERSHED IS CLASSIFIED AS TYPE IV							

115J15	5	U	MA		93	SA				800001
			YPA TYPE II							
115J15	6	U	MA		93					800001
115J15	5	D	YPA TYPE IV							
115J15	17	P	MSB	94	94					110121
			TEMPERATURE AND TDS DATA. NO FISH CAPTURED. NOTICEABLY NAIVE ARTIC GRAYLING AND ROUND WHITEFISH OBSERVED							
115J15	18	P	MSB	94	94					110121
			TEMPERATURE AND TDS DATA. NO FISH CAPTURED. ARCTIC GRAYLING OBSERVED DOWNSTREAM OF STATION							
		W	MSS	93	93	GR	WF	CH		110121
			FISH SCALE AGING RESULTS FOR THE CASINO PROJECT - FISHERIES ASSESSMENT PART 1. JUNE 1993							
		W	MSS							80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM - ELECTROFISHING AND MINNOW TRAPS. JUNE, AUGUST, AND SEPTEMBER 1993							830006
		W	MSB	00	00	CH				110121
			AERIAL SURVEY-1 ADULT CHINOOK CARCASS FOUND (AUGUST-2000)							
		W	MSS	00	00	CH				110121
			MINNOW TRAPPING- JUVENILE CHINOOK CAPTURED (JULY 2000							
		W	MSS	93	93	GR	CH	WF		110121
			CASINO PROJECT SAMPLING DATA-AGE/ SPECIES							

RESOURCE USE INFORMATION

MapNo	ID	Type	Code	Catch Mean	High	Low	Effort Mean	High	Low	Reference

FISHERIES POTENTIAL AND CONSTRAINTS

MapNo	ID	Type	Activity	P	L	Species		Reference
		W	WC	G				110121
			PHOTOGRAPH SHOWING WATER COLOUR AND TURBIDITY RESULTS OF MINING					
115J15	2004	P	W	G				80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM INITIATED SAMPLING HERE IN JUNE 1993					
115J15	19	P	W	G				80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM INITATED SAMPLING HERE IN JUNE 1993					
		W	W	G				830006
			AERIAL PHOTGRAPHS OF CREEK					
115J15	25	U	WDP	C		SA		110121
			AUGUST 2000. A PLACER OPERATION ON CANADIAN CREEK WAS DISCHARGING UNSETTLED, TURBID EFFLUENT INTO BRITTANIA CREEK, DETRIMENTAL TO HATCHED SALMON FRY.					
		W	HS	P		CH		110121
			AUGUST 17, 2000. SINGLE DEAD SALMON CARCASS OBSERVED AT CREEK OUTLET. NUMEROUS JUVENILE CHINOOK WERE CAPTURED IN JULY 2000 MINNOW TRAPS. ADULT CHINOOK SALMON ARE UTILIZING THE CREEK AS A SPAWNING AREA.					

OBSTRUCTIONS

MapNo	ID	Type	OBS	Height	Length	Species Blocked	Reference

LAND USE

MapNo	ID	Type	Land Use	Start Date	Reference
		W	MI		11057
			UPPER WATERSHED EXTENSIVELY PLACER MINED. EXTENSIVE QUARTZ MINING EXPLORATION IN THE UPPER WATERSHED		
		W	PM		110121
			PHOTOGRAPH SHOWING RESLTS OF MINING		
		W	RD		830006
			1994 - ACCESS ROAD TO CASINO MINE SITE RUNS ALONG BRITANNIA CREEK FROM THE YUKON RIVER		

VALUE COMMENTS

MapNo	ID	Type	Value Code	Reference

SENSITIVITY COMMENTS

MapNo	ID	Type	Sensitivity Code	Reference

SPECIES / STOCK IDENTIFICATION

Species	Char	Stock	Stock Type	Mgmt Class
CH				
GR				
RW				
SA				

FISH DISTRIBUTION

MapNo	ID	Species	Type	Activity	Reference
		CH	W	REA	110121
				FRY REARING IN THIS STREAM	
		GR	W	OBL	110121
				PRESENCE NOTED	

115J15	18	RW	P	OBL	110121
				FISH NOTICEABLY NAIVE; ALLOWED APPROACH TO WITHIN 2 - 0.5 M. THIS IS NOT NORMAL	
115J15	5	SA	U	REA	800001
115J15	17	GR	P	OBL	110121
				LARGE CONGREGATION OF GRAYLING OBSERVED. FISH NOTICEABLY NAIVE; ALLOWED APPROACH TO WITHIN 2 - .5 M	
115J15	20	GR	P	OBL	830006
				PRELIMINARY ASSESSMENT OF FISHERIES - ELECTROFISHING DATA: LENGTH, WEIGHT AND AGE OF CAPTURED FISH (CASINO MINE PROJECT)	
115J15	21	GR	P	OBL	830006
				PRELIMINARY ASSESSMENT OF FISHEREIES - ELECTROFISHING DATA: LENGTH, WEIGHT AND AGE OF CAPTURED FISH (CASINO MINE PROJECT)	
115J15	2004	CH	P	OBL	110121
				1 ADULT CHINOOK CARCASS OBSERVED (AUGUST 2000)	
		CH	W	OBL	110121
				NUMEROUS JUVENILE CHINOOK SALMON CAPTURED (JULY 2000)	

Return to the search screen.

FISS Search Results

Fisheries and Oceans Canada | Pêches et Océans Canada

REFERENCE INFORMATION			
Waterbody Names			
Gazetteer Name:	CANADIAN CREEK	Alias1:	
		Alias2:	
Waterbody Codes			
Watershed code:	800787850000000000000000000000000000		
SISS/RAB code:		Lake Seq. No.:	0
Confluence Information			
Map No:		Confluence ID:	
	Zone:		
Easting:		Northing:	
Comments			
TRIBUTARY TO BRITTANICA			

STREAM INFORMATION				
MapNo	**ID**	**Station**	**Reference**	**Mean Annual Runoff**

PROVINCIAL FISHERIES MANAGEMENT OBJECTIVES				
Habitat Type	Mgmt Obj.1		Mgmt Obj.2	

ENHANCEMENT AND MANAGEMENT ACTIVITIES									
MapNo	**ID**	**Type**	**Activity**	**Project**	**Start**	**Finish**	**Species**		**Reference**
		W	MA			93			800001
			YPA TYPE IV						
		W	MSS		93	93	GR		110121
			FISH SCALE AGING RESULTS FOR THE CASINO PROJECT -						

		FISHERIES ASSESSMENT PART 1. JUNE 1993								
	W	MSS		93	93					80092
		CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM - ELECTROFISHING AND MINNOW TRAPS: JUNE, AUG. AND SEPT. 1993								830006

RESOURCE USE INFORMATION

MapNo	ID	Type	Code	Catch Mean	High	Low	Effort Mean	High	Low	Reference

FISHERIES POTENTIAL AND CONSTRAINTS

MapNo	ID	Type	Activity	P	L	Species		Reference
115J15	13	P	W	G				80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM INITIATED WATER SAMPLING HERE IN JUNE 1993					
115J15	14	P	W	G				80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM INITIATED WATER SAMPLING HERE IN JUNE 1993					
		W	H	G				830006
			AERIAL PHOTOGRAPHS OF CREEK					

OBSTRUCTIONS

MapNo	ID	Type	OBS	Height	Length	Species Blocked	Reference

LAND USE

MapNo	ID	Type	Land Use	Start Date	Reference
		W	MI		830006
			1993 - HEADWATERS IN CASINO MINE EXPLORATION SITE		

VALUE COMMENTS				
MapNo	ID	Type	Value Code	Reference

SENSITIVITY COMMENTS				
MapNo	ID	Type	Sensitivity Code	Reference

SPECIES / STOCK IDENTIFICATION				
Species	Char	Stock	Stock Type	Mgmt Class
GR				

FISH DISTRIBUTION					
MapNo	ID	Species	Type	Activity	Reference
115J15	13	GR	P	OBL	830006
				PRELIMINARY ASSESSMENT OF FISHERIES - CASINO MINE PROJECT. ELCTROFISHING DATA: LENGTH, AGE, EFFORT	

Return to the search screen.

FISS Search Results

Fisheries and Oceans Canada | Pêches et Océans Canada

REFERENCE INFORMATION			
Waterbody Names			
Gazetteer Name:	CASINO CREEK	Alias1:	
		Alias2:	
Waterbody Codes			
Watershed code:	843102510971100000000000000000000000		
SISS/RAB code:		Lake Seq. No.:	0
Confluence Information			
Map No:		Confluence ID:	
	Zone:		
Easting:		Northing:	
Comments			
TRIBUTARY OF DIP CREEK WHICH DRAINS INTO KLOTTASIN, THEN DONJEK R. AND INTO WHITE RIVER			

STREAM INFORMATION

MapNo	ID	Station	Reference	Mean Annual Runoff

PROVINCIAL FISHERIES MANAGEMENT OBJECTIVES

Habitat Type	Mgmt Obj.1		Mgmt Obj.2	

ENHANCEMENT AND MANAGEMENT ACTIVITIES

MapNo	ID	Type	Activity	Project	Start	Finish	Species				Reference
115J10	6	P	MSS		93	93	GR	CCG			13085
			HABITAT CHARACTERISTICS; ELECTROFISHING; CALCULATED WATER FLOW; METAL ANALYSIS SAMPLES (GR). JUNE								

115J10	7	P	MSS		93	93	GR				13085
			HABITAT; ELECTROFISHING; STOP NETS; CALCULATED WATER FLOW. AGING, METAL ANALYSIS SAMPLES. JUNE								
115J10	9	P	MSS		93	93	NF				13085
			HABITAT; ELECTROFISHING. JUNE.								
115J10	6	P	MSS		93	93	GR	CCG			13086
			STOPNETS, ELECTROSHOCKING; MINNOW TRAPS (3). AUGUST.								
115J10	7	P	MSS		93	93	GR	CCG			13086
			STOPNETS; ELECTROSHOCKING; MINNOW TRAPS (3). AUGUST.								
115J10	8	P	MSS		93	93	NF				13086
			ELECTROSHOCKING; MINNOW TRAPS (3). AUGUST.								
115J16	6	P	MSS		93	93	GR	CCG			13087
			STOPNETS, ELECTROSHOCKING; MINNOW TRAPS (3); PHYSICAL CHARACTERISTICS. SEPTEMBER.								
115J10	8	P	MSS		93	93	NF				13087
			ELECTROFISHING; MINNOW TRAPS (3) PHYSICAL CHARACTGERISTICS. SEPTEMBER.								
115J10	7	P	MS		93	93	GR	CCG			13087
			STOPNETS, ELECTROSHOCKING; MINNOW TRAPS (3) PHYSICAL CHARACTERISTICS. SEPTEMBER.								
		W	MSS		93	93	GR				110121
			FISH SCALE AGING RESULTS FOR THE CASINO PROJECT - FISHERIES ASSESSMENT PART I. JUNE 1993.								
		W	MSS		93	93					80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM - ELECTROFISHING AND MINNOW TRAPS. JUNE, AUGUST AND SEPTEMBER 1993.								830006

RESOURCE USE INFORMATION										
MapNo	ID	Type	Code	Catch Mean	High	Low	Effort Mean	High	Low	Reference

FISHERIES POTENTIAL AND CONSTRAINTS								
MapNo	ID	Type	Activity	P	L	Species		Reference
115J10	6	P	W	G				80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM WATER QUALITY SAMPLING INITIATED HERE JUNE 1993.					
115J10	14	P	W	G				80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM WATER QUALITY SAMPLING INITIATED HERE JUNE 1993.					
		W	H	G				830006
			AERIAL PHOTOGRAPHS OF CREEK					

OBSTRUCTIONS							
MapNo	ID	Type	OBS	Height	Length	Species Blocked	Reference

LAND USE					
MapNo	ID	Type	Land Use	Start Date	Reference
		W	MI	1993-01-01 00:00:00.0	830006
			HEADWATERS IN CASINO MINE EXPLORATION SITE.		

VALUE COMMENTS				
MapNo	ID	Type	Value Code	Reference

SENSITIVITY COMMENTS				
MapNo	ID	Type	Sensitivity Code	Reference

SPECIES / STOCK IDENTIFICATION				
Species	Char	Stock	Stock Type	Mgmt Class
GR				
GR	RS			
CCG	RS			

FISH DISTRIBUTION					
MapNo	ID	Species	Type	Activity	Reference
115J10	6	CCG	P	OBL	13085
					13086
115J10	7	CCG	P	OBL	13087
115J10	6	GR	P	OBL	830006
				PRELIMINARY ASSESSMENT OF FISHERIES - CASINO MINE PROJECT - ELECTROFISHING DATA: EFFORT, LENGTH, AGE, WEIGHT.	
115J10	7	GR	P	OBL	830006
				PRELIMINARY ASSESSMENT OF FISHERIES - CASINO MINE PROJECT. ELECTROFISHING DATA: EFFORT, LENGTH, AGE, WEIGHT.	
115J10	6	GR	P	OBL	13085
				METAL ANALYSIS SAMPLES TAKEN; SOME GR SHOWED EVIDENCE OF GILL LICE.	
115J10	7	GR	P	OBL	13085
				METAL ANALYSIS SAMPLES; AGING.	
115J10	6	GR	P	OBL	13086
				LENGTH/WEIGHT MEASUREMENTS; SCALES TAKEN FOR AGING; EVIDENCE OF GILL LICE.	13087
115J10	7	GR	P	OBL	13086
				LENGTH/WEIGHT MEASUREMENTS; SCALES TAKEN FOR AGING.	13087

Return to the search screen.

FISS Search Results

Fisheries and Oceans Canada | Pêches et Océans Canada

REFERENCE INFORMATION			
Waterbody Names			
Gazetteer Name:	DIP CREEK	Alias1:	
		Alias2:	
Waterbody Codes			
Watershed code:	843102510900000000000000000000000000		
SISS/RAB code:		Lake Seq. No.:	0
Confluence Information			
Map No:		Confluence ID:	
	Zone:		
Easting:		Northing:	
Comments			
TRIBUTARY TO KLOTASSIN R.			

STREAM INFORMATION

MapNo	ID	Station	Reference	Mean Annual Runoff
115J11	1		DFO0011	

PROVINCIAL FISHERIES MANAGEMENT OBJECTIVES

Habitat Type	AR	Mgmt Obj.1	PR	Mgmt Obj.2	

ENHANCEMENT AND MANAGEMENT ACTIVITIES

MapNo	ID	Type	Activity	Project	Start	Finish	Species			Reference
		W	MS		94	94				110121
			HELICOPTER SURVEY - HABITAT. SET UP STATIONS.							

115J11	1	P	MSS		94	94	CH	CCG	BB		110121
115J11	2	P	MSS		94	94	CCG				110121
115J10	1	P	MSS		94	94	CCG				110121
115J10	5	P	MSS		93	93	CCG				13085
			HABITAT CHARACTERISTICS; ELECTROFISHING. JUNE.								
115J10	5	P	MSS		93	93	CCG	GR			13086
			ELECTROFISHING, MINNOW TRAPS. AUGUST.								
115J10	5	P	MSS		93	93	CCG				13087
			ELECTROSHOCKING; MINNOW TRAPS (3). SEPTEMBER.								
115J10	17	P	MSS		93	93					80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM - ELECTROFISHING AND MINNOW TRAPS: JUNE, AUGUST AND SEPTEMBER, 1993.								830006
115J10	18	P	MSB		93	93					830006
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM - JUNE, AUGUST AND SEPTEMBER 1993. WATER QUALITY AND HYDROLOGY STATION.								80092
115J10	19	P	MSS		93	93					830006
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM - JUNE AUGUST AND SEPTEMBER 1993. WATER QUALITY STATION.								80092
		W	MS	YRP	98	98	CH				DFO0011
			IDENTIFY AREAS UTILIZED BY CHINOOK, PILOT SURVEY FOR FUTURE ENHANCEMENT AND RESTORATION								
115J11	3	P	MSS	YRP	98	98	CH				DFO0011
			2 MINNOW TRAPS SET								

RESOURCE USE INFORMATION										
MapNo	ID	Type	Code	Catch Mean	High	Low	Effort Mean	High	Low	Reference

FISHERIES POTENTIAL AND CONSTRAINTS							
MapNo	ID	Type	Activity	P	L	Species	Reference
115J10	18	P	W	G			80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM WATE QUALITY SAMPLING INITIATED HERE JUNE 1993.				
115J10	19	P	W	G			80092
			CASINO PROJECT ENVIRONMENTAL MONITORING PROGRAM WATER QUALITY SAMPLING INITIATED HERE JUNE 1993.				
		W	NS	G			830006
			AERIAL PHOTOGRAPHY OF CREEK.				
		W	FAN	G		CH	DFO0011
			DIFFICULT TO REACH BY BOAT OR HELICOPTER				
		W	EHS	P	M	CH	DFO0011
			ALTHOUGH RESULTS OF TRAPPING INDICATED FEW JUVINILE CHINOOK, SCHOOLS WERE SEEN IN AREA BUT RELUCTANT TO ENTER TRAPS				

OBSTRUCTIONS							
MapNo	ID	Type	OBS	Height	Length	Species Blocked	Reference

LAND USE					
MapNo	ID	Type	Land Use	Start Date	Reference
115J11	0001	P	PM		800001
			STREAM CLASSIFICATION.		

VALUE COMMENTS				
MapNo	ID	Type	Value Code	Reference

SENSITIVITY COMMENTS				
MapNo	ID	Type	Sensitivity Code	Reference
115J11	0002	P	HAB	110121
			CH REARING.	

SPECIES / STOCK IDENTIFICATION				
Species	Char	Stock	Stock Type	Mgmt Class
CH	AN			
GR				
BB	RS			
GR	RS			
CCG	RS			
RW				WI
BB				WI

FISH DISTRIBUTION					
MapNo	ID	Species	Type	Activity	Reference
115J11	1	BB	P	OBL	110121
115J11	2	BB	P	OBL	110121
115J11	1	CCG	P	OBL	110121
115J10	5	CCG	P	OBL	13085 13086
115J10	5	CCG	P	OBL	13087

115J11	2	CH	P	REA	110121
		CH	W	REA	110121
				NO CHINOOK SPAWNING IN 1993.	
115J10	17	GR	P	OBL	830006
				PRELIMINARY ASSESSMENT OF FISHERIES - CASINO MINE PROJECT, ELECTROFISHING DATA: LENGTH, WEIGHT, AGE, EFFORT.	
115J10	5	GR	P	OBL	13086
				WEIGHT, LENGTH MEASUREMENTS; SCALES TAKEN FOR AGING.	
115J11	3	CH	P	OBL	DFO0011
				2 MINNOW TRAPS SET (JULY 9, 1998) 1 JUVINILE CHINOOK CAUGHT	
115J11	3	RW	P	OBL	DFO0011
				2 MINNOW TRAPS SET (JULY 9, 1998) 24 FISH CAUGHT	
115J11	3	BB	P	OBL	DFO0011
				2 MINNOW TRAPS SET (JULY 9, 1998) 1 FISH CAUGHT	
115J11	6	CH	P	OBL	110121
				1 ADULT CHINOOK OBSERVED AND SAMPLED	
		CH	W	OBL	110121
				A PAIR OF ADULT CHINOOK OBSERVED	

Return to the search screen.

FISS Search Results

Fisheries and Oceans Canada | Pêches et Océans Canada

REFERENCE INFORMATION			
Waterbody Names			
Gazetteer Name:	EXCELSIOR CREEK	Alias1:	
		Alias2:	
Waterbody Codes			
Watershed code:	800782700000000000000000000000000000		
SISS/RAB code:	603619000000000000000	Lake Seq. No.:	0
Confluence Information			
Map No:		Confluence ID:	
	Zone:	7	
Easting:	6040	Northing:	69742
Comments			
FLOWS NE INTO YUKON R., YUKON TERRITORY			

STREAM INFORMATION				
MapNo	**ID**	**Station**	**Reference**	**Mean Annual Runoff**

PROVINCIAL FISHERIES MANAGEMENT OBJECTIVES				
Habitat Type	Mgmt Obj.1		Mgmt Obj.2	

ENHANCEMENT AND MANAGEMENT ACTIVITIES								
MapNo	**ID**	**Type**	**Activity**	**Project**	**Start**	**Finish**	**Species**	**Reference**
		W	M				SA	800001
			THE LOWER END OF THIS CREEK IS CLASSIFIED AS TYPE II - SALMONID REARING STREAM, BY THE YUKON PLACER AUTHORIZATION					

115J15	2	U	MA	93	SA				800001
			YPA TYPE II						

RESOURCE USE INFORMATION										
MapNo	ID	Type	Code	Catch Mean	High	Low	Effort Mean	High	Low	Reference

FISHERIES POTENTIAL AND CONSTRAINTS							
MapNo	ID	Type	Activity	P	L	Species	Reference

OBSTRUCTIONS							
MapNo	ID	Type	OBS	Height	Length	Species Blocked	Reference

LAND USE					
MapNo	ID	Type	Land Use	Start Date	Reference

VALUE COMMENTS				
MapNo	ID	Type	Value Code	Reference

SENSITIVITY COMMENTS				
MapNo	ID	Type	Sensitivity Code	Reference

SPECIES / STOCK IDENTIFICATION				
Species	Char	Stock	Stock Type	Mgmt Class
CH				
SA				

FISH DISTRIBUTION					
MapNo	ID	Species	Type	Activity	Reference

		CH	W	UNC	11057
				SUSPECTED REARING IN THIS STREAM	
115J15	2	SA	U	REA	800001

Return to the search screen.

B11. Minnow Trapping Catch, Effort and CPUE, Casino Project, 2008

Appendix B11. Minnow Trapping Catch, Effort and CPUE, Casino Project, 2008

			Catch			CPUE (number/trap-day)		
Date	Site	Trap	ARGR	SLSC	Total	ARGR	SLSC	Total
11-Jul	F07	A	0	0	0	0	0	0
11-Jul	F07	B	0	0	0	0	0	0
11-Jul	F07	C	0	0	0	0	0	0
11-Jul	F09	A	0	0	0	0	0	0
11-Jul	F09	B	0	0	0	0	0	0
11-Jul	F09	C	0	0	0	0	0	0
11-Jul	F05	A	0	0	0	0	0	0
11-Jul	F05	B	0	0	0	0	0	0
11-Jul	F05	C	0	0	0	0	0	0
11-Jul	F01	A	0	0	0	0	0	0
11-Jul	F01	B	0	0	0	0	0	0
11-Jul	F01	C	0	0	0	0	0	0
11-Jul	F14	A	0	0	0	0	0	0
11-Jul	F14	B	0	0	0	0	0	0
11-Jul	F14	C	0	0	0	0	0	0
12-Sep	F14	A	0	0	0	0	0	0
12-Sep	F14	B	0	0	0	0	0	0
12-Sep	F11	A	0	0	0	0	0	0
12-Sep	F11	B	0	0	0	0	0	0
12-Sep	F08	A	0	0	0	0	0	0
12-Sep	F08	B	0	0	0	0	0	0

ARGR = Arctic grayling, SLSC = slimy sculpin and CPUE = catch-per-unit-effort.
All traps were soaked for one day.

B12. Electrofishing Effort, Catch and CPUE, Casino Project, 2008

Appendix B12. Electrofishing Effort, Catch and CPUE, Casino Project, 2008

Date	Site	Section length (m)	Pass	Voltage	Effort (sec)	Catch ARGR	Catch SLSC	Catch Total	CPUE (number/100 sec) ARGR	CPUE SLSC	CPUE Total	Comments
8-Jul	F03	75	1	600	1,190	1	0	1	0.08	0.00	0.08	-
8-Jul	F03	75	2	750	834	0	0	0	0.00	0.00	0.00	Saw 1 ARGR (~150 mm long)
8-Jul	F03	38	3	750	269	1	0	1	0.37	0.00	0.37	Only half of section electrofished.
	sum				2,293	2	0	2	0.09	0.00	0.09	
8-Jul	F04	200	1	600	754	4	0	4	0.53	0.00	0.53	-
9-Jul	F07	75	1	600	476	0	0	0	0.00	0.00	0.00	-
9-Jul	F07	75	2	600	437	0	0	0	0.00	0.00	0.00	-
9-Jul	F07	75	3	600	420	0	0	0	0.00	0.00	0.00	-
	sum				1,333	0	0	0	0.00	0.00	0.00	
9-Jul	F08	75	1	550	447	1	0	1	0.22	0.00	0.22	-
9-Jul	F08	75	2	550	512	0	0	0	0.00	0.00	0.00	-
9-Jul	F08	75	3	550	419	1	0	1	0.24	0.00	0.24	-
	sum				1,378	2	0	2	0.15	0.00	0.15	
9-Jul	F09	168	1	550	340	0	0	0	0.00	0.00	0.00	-
9-Jul	F10	168	1	530	709	2	0	2	0.28	0.00	0.28	Saw 3 ARGR (~300 mm long)
9-Jul	F05	226	1	550	577	0	0	0	0.00	0.00	0.00	-
10-Jul	F11	220	1	550	1,591	0	0	0	0.00	0.00	0.00	-
10-Jul	F12	200	1	500	353	0	0	0	0.00	0.00	0.00	Section length was approximate.
10-Jul	F13	75	1	600	787	0	11	11	0.00	1.40	1.40	-
10-Jul	F13	75	2	600	600	0	8	8	0.00	1.33	1.33	-
10-Jul	F13	75	3	600	438	1	1	2	0.23	0.23	0.46	-
		sum			1,825	1	20	21	0.05	1.10	1.15	
10-Jul	F01	100	1	650	707	1	0	1	0.14	0.00	0.14	-
11-Jul	F01	100	1	550	707	0	0	0	0.00	0.00	0.00	-
12-Sep	F14		1	300	922	0	6	6	0.00	0.65	0.65	-
12-Sep	F11		1	360	1,377	0	1	1	0.00	0.07	0.07	One SLSC seen, but it escaped.
12-Sep	F08		1	300	523	0	0	0	0.00	0.00	0.00	-

ARGR = Arctic grayling, SLSC = slimy sculpin and CPUE = catch-per-unit-effort.
Dashes indiacte no data were available or no comments.

B13. Angling Catch, Casino Project, 2008

Appendix B13. Angling Catch, Casino Project, 2008

Date	Site	Catch			Comments
		ARGR	SLSC	Total	
10-Jul	F08	0	0	0	Observed 1 ARGR (~150 mm)
10-Jul	F14	1	0	1	Fish was not measured (~200 mm)

ARGR = Arctic grayling, SLSC = slimy sculpin.

B14. Fish Biological Characteristics, Casino Project, 2008

Appendix B14. Fish Biological Characteristics, Casino Project, 2008

Date	Watershed	Site	Gear	Fish ID	Species	Length (mm)	Weight (g)	Scales?	Age (year)	Tissue?	Comments
8-Jul	Britannia	F03	EF	1	ARGR	280	200+	No	-	No	Too heavy for balance.
8-Jul	Britannia	F03	EF	2	ARGR	190	200+	No	-	No	Too heavy for balance.
8-Jul	Britannia	F04	EF	3	ARGR	280	220.0	Yes	5	No	-
8-Jul	Britannia	F04	EF	4	ARGR	285	260.0	Yes	6	No	-
8-Jul	Britannia	F04	EF	5	ARGR	290	230.0	Yes	6	No	-
8-Jul	Britannia	F04	EF	6	ARGR	280	250.0	Yes	5	No	-
9-Jul	Casino	F08	EF	7	ARGR	185	71.6	Yes	3	No	-
9-Jul	Casino	F08	EF	8	ARGR	173	44.5	Yes	2	No	-
9-Jul	Casino	F10	EF	9	ARGR	293	230.0	Yes	6	No	-
9-Jul	Casino	F10	EF	10	ARGR	300	260.0	Yes	6	No	-
10-Jul	Casino	F13	EF	11	SLSC	120	19.3	No	-	No	-
10-Jul	Casino	F13	EF	12	SLSC	72	3.7	No	-	No	-
10-Jul	Casino	F13	EF	13	SLSC	70	3.2	No	-	No	-
10-Jul	Casino	F13	EF	14	SLSC	71	2.9	No	-	No	-
10-Jul	Casino	F13	EF	15	SLSC	71	4.1	No	-	No	-
10-Jul	Casino	F13	EF	16	SLSC	61	2.2	No	-	No	-
10-Jul	Casino	F13	EF	17	SLSC	120	12.5	No	-	Yes	-
10-Jul	Casino	F13	EF	18	SLSC	98	8.4	No	-	Yes	-
10-Jul	Casino	F13	EF	19	SLSC	71	3.4	No	-	Yes	-
10-Jul	Casino	F13	EF	20	SLSC	65	2.3	No	-	Yes	-
10-Jul	Casino	F13	EF	21	SLSC	65	2.9	No	-	Yes	-
10-Jul	Casino	F13	EF	22	ARGR	294	240.0	Yes	-	No	-
10-Jul	Casino	F13	EF	23	SLSC	129	18.1	No	-	No	-
10-Jul	Casino	F13	EF	24	SLSC	55	1.8	No	-	No	-
10-Jul	Casino	F13	EF	25	SLSC	79	4.5	No	-	No	-
10-Jul	Casino	F13	EF	26	SLSC	65	1.6	No	-	No	-
10-Jul	Casino	F13	EF	27	SLSC	75	4.4	No	-	No	-
10-Jul	Casino	F13	EF	28	SLSC	54	1.3	No	-	No	-
10-Jul	Casino	F13	EF	29	SLSC	65	2.0	No	-	No	-
10-Jul	Casino	F13	EF	30	SLSC	65	3.0	No	-	No	-
10-Jul	Casino	F13	EF	31	ARGR	220	130.0	Yes	2	No	-
10-Jul	Britannia	F01	EF	32	ARGR	274	200.0	Yes	6	No	-
10-Jul	Dip	F14	AN	33	ARGR	~200	-	No	-	No	-
12-Sep	Dip	F14	EF	34	SLSC	70	4.0	No	-	Yes	-
12-Sep	Dip	F14	EF	35	SLSC	80	4.7	No	-	Yes	-
12-Sep	Dip	F14	EF	36	SLSC	63	2.7	No	-	Yes	-
12-Sep	Dip	F14	EF	37	SLSC	42	1.0	No	-	No	-
12-Sep	Dip	F14	EF	38	SLSC	29	0.5	No	-	No	-
12-Sep	Dip	F14	EF	39	SLSC	38	0.8	No	-	No	-
12-Sep	Casino	F11	EF	40	SLSC	89	8.7	No	-	Yes	-

EF = electrofishing, AN = angling, ARGR = Arctic grayling and SLSC = slimy sculpin.

B15. Fish Tissue Metal Concentrations, Casino Project, 2008

Analysis Report

CANTEST

REPORT ON: Amended Report - Analysis of Tissue Samples

REPORTED TO: Gartner Lee Limited
490-6400 Roberts St
Burnaby, BC
V5G 4C9

Att'n: Genevieve Martin

CHAIN OF CUSTODY: 188716
PROJECT NAME: Casino
PROJECT NUMBER: 80049

NUMBER OF SAMPLES: 5

REPORT DATE: December 11, 2008

DATE SUBMITTED: July 15, 2008

GROUP NUMBER: 90716049

SAMPLE TYPE: Tissue

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Mercury in Tissue - samples were digested using a nitric acid-hydrogen peroxide digestion procedure based on EPA Method 200.3. Analysis was performed using Cold Vapour Atomic Absorption Spectrophotometry or Cold Vapour Atomic Fluorescence Spectrophotometry.

Metals in Tissue - samples were digested using a nitric acid-hydrogen peroxide digestion procedure based on EPA Method 200.3. Analysis was performed using Inductively Coupled Argon Plasma Spectroscopy (ICP), or ICP Mass Spectrometry (ICP/MS).

COMMENTS:

Amended Report - This report supercedes final hard copy sent on August 6, 2008 via mail. The tissue results are based on a wet weight basis - not dry weight as indicated in the footnotes of the report. cjw December 11, 2008

TEST RESULTS:

(See following pages)

CANTEST LTD.

Per

Anna Becalska, PhD
Coordinator, Trace Metals

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90716049

CANTEST

Metals Analysis in Tissue

CLIENT SAMPLE IDENTIFICATION:		F13 CCG-7	F13 CCG-8	F13 CCG-9	F13 CCG-10	
DATE SAMPLED:		Jul 10/08	Jul 10/08	Jul 10/08	Jul 10/08	DETECTION LIMIT
CANTEST ID:		807160139	807160141	807160142	807160145	
Aluminum	Al	43.7	23.3	23	9.8	0.5
Antimony	Sb	<	<	<	<	0.1
Arsenic	As	0.2	0.1	0.1	0.1	0.1
Barium	Ba	9.8	3.9	3.1	3.1	0.1
Beryllium	Be	<	<	<	<	0.02
Boron	B	<	<	<	<	2
Cadmium	Cd	0.24	0.07	0.06	0.04	0.02
Calcium	Ca	37400	15100	11300	12800	1
Chromium	Cr	0.1	<	<	<	0.1
Cobalt	Co	0.1	<	0.1	<	0.1
Copper	Cu	2.1	1.1	1.1	1.1	0.1
Iron	Fe	161	70	63	49	5
Lead	Pb	0.1	<	<	<	0.1
Magnesium	Mg	900	450	427	437	0.5
Manganese	Mn	17.9	8.1	10.3	5.8	0.1
Mercury	Hg	0.09	0.07	0.03	0.02	0.01
Molybdenum	Mo	<	<	<	<	0.1
Nickel	Ni	0.1	<	<	<	0.1
Phosphorus	P	22900	10300	8500	9470	0.5
Potassium	K	5860	3060	3190	3710	1
Selenium	Se	0.9	0.4	0.7	0.7	0.2
Silicon	Si	66	22	35	31	10
Silver	Ag	0.01	<	<	<	0.01
Sodium	Na	3360	1450	1420	1300	1
Strontium	Sr	52.4	23	16.8	24.1	0.05
Tellurium	Te	<	<	<	<	0.1
Thallium	Tl	<	<	<	<	0.02
Tin	Sn	<	<	<	<	0.1
Titanium	Ti	13.1	5.6	4.9	4.9	0.3
Uranium	U	0.29	0.11	0.05	<	0.04
Vanadium	V	0.8	<	<	<	0.5
Zinc	Zn	57.4	30.2	21.7	22.4	0.5
Zirconium	Zr	<	<	<	<	3

Results expressed as micrograms per gram, dry basis (µg/g)
< = Less than detection limit

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90716049

CANTEST

Metals Analysis in Tissue

CLIENT SAMPLE IDENTIFICATION:		F13 CCG-11	
DATE SAMPLED:		Jul 10/08	DETECTION LIMIT
CANTEST ID:		807160146	
Aluminum	Al	46.1	0.5
Antimony	Sb	<	0.1
Arsenic	As	0.1	0.1
Barium	Ba	3.9	0.1
Beryllium	Be	<	0.02
Boron	B	<	2
Cadmium	Cd	0.1	0.02
Calcium	Ca	10700	1
Chromium	Cr	<	0.1
Cobalt	Co	<	0.1
Copper	Cu	1.9	0.1
Iron	Fe	81	5
Lead	Pb	<	0.1
Magnesium	Mg	412	0.5
Manganese	Mn	7.8	0.1
Mercury	Hg	0.02	0.01
Molybdenum	Mo	<	0.1
Nickel	Ni	<	0.1
Phosphorus	P	8380	0.5
Potassium	K	3380	1
Selenium	Se	0.7	0.2
Silicon	Si	45	10
Silver	Ag	<	0.01
Sodium	Na	1350	1
Strontium	Sr	15.1	0.05
Tellurium	Te	<	0.1
Thallium	Tl	<	0.02
Tin	Sn	<	0.1
Titanium	Ti	6.2	0.3
Uranium	U	0.2	0.04
Vanadium	V	0.5	0.5
Zinc	Zn	25.8	0.5
Zirconium	Zr	<	3

Results expressed as micrograms per gram, dry basis (µg/g)
< = Less than detection limit

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90716049

CANTEST

Batch Quality Control for Dissolved Metals Analysis in Tissue (QC# 111086)

Parameter		Blank (ug/g)	Blank Limits	Duplicate (R.P.D.) 807160241	Duplicate Limits	Duplicate (R.P.D.) 807170051	Duplicate Limits
Aluminum	Al	< 0.5	0.2	-	-	-	-
Antimony	Sb	< 0.1	0.001	-	-	-	-
Arsenic	As	< 0.1	0.002	NC	20	-	-
Barium	Ba	< 0.1	0.001	-	-	-	-
Beryllium	Be	< 0.02	0.001	-	-	-	-
Boron	B	< 2	0.02	-	-	-	-
Cadmium	Cd	< 0.02	0.0004	NC	20	5.1	20
Calcium	Ca	< 1	0.3	6.1	20	-	-
Chromium	Cr	< 0.1	0.001	-	-	-	-
Cobalt	Co	< 0.1	0.001	-	-	-	-
Copper	Cu	< 0.1	0.001	PASS	20	-	-
Iron	Fe	< 5	0.05	NC	20	-	-
Lead	Pb	< 0.1	0.002	NC	20	NC	20
Magnesium	Mg	< 0.5	0.2	PASS	20	-	-
Manganese	Mn	< 0.1	0.01	NC	20	-	-
Molybdenum	Mo	< 0.1	0.002	-	-	-	-
Nickel	Ni	< 0.1	0.003	-	-	-	-
Phosphorus	P	< 0.5	0.1	2.6	20	-	-
Potassium	K	< 1	0.3	0	20	-	-
Selenium	Se	< 0.2	0.004	-	-	-	-
Silver	Ag	< 0.01	0.001	-	-	-	-
Sodium	Na	< 1	0.5	2.3	20	-	-
Strontium	Sr	< 0.05	0.002	-	-	-	-
Tellurium	Te	< 0.1	0.002	-	-	-	-
Thallium	Tl	< 0.02	0.002	-	-	-	-
Tin	Sn	< 0.1	0.01	-	-	-	-
Titanium	Ti	< 0.3	0.01	-	-	-	-
Uranium	U	< 0.04	0.002	-	-	-	-
Vanadium	V	< 0.5	0.002	-	-	-	-
Zinc	Zn	< 0.5	0.04	NC	20	-	-
Zirconium	Zr	< 3	0.04	-	-	-	-

ug/g = micrograms per gram, dry basis
R.P.D. = Relative Percent Difference
PASS = Duplicate sample results were in the range of one to five times the detection limit. R.P.D. calculation is not applicable in this range. Acceptance criteria is a maximum difference between the duplicates equivalent to the value of the detection limit.
NC = Not Calculated. Duplicate sample results were less than the detection limit. Relative Percent Difference calculation is not defined for analyte levels of less than detection limit.

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90716049

CANTEST

Batch Quality Control for Dissolved Metals Analysis in Tissue (QC# 111086)

Parameter		Duplicate (R.P.D.) 807170062	Duplicate Limits	NRC TORT-2, "Lobster Tissue" (% Recovery)	NRC TORT-2, "Lobster Tissue" Limits
Arsenic	As	-	-	87	66 - 113
Cadmium	Cd	0	20	88	63 - 118
Chromium	Cr	-	-	65	60 - 120
Cobalt	Co	-	-	78	60 - 120
Copper	Cu	-	-	87	60 - 120
Iron	Fe	-	-	90	60 - 120
Lead	Pb	NC	20	86	39 - 150
Manganese	Mn	-	-	87	60 - 120
Mercury	Hg	-	-	93	78 - 122
Molybdenum	Mo	-	-	95	60 - 120
Nickel	Ni	-	-	80	50 - 122
Selenium	Se	-	-	89	67 - 118
Strontium	Sr	-	-	93	60 - 120
Vanadium	V	-	-	116	60 - 120
Zinc	Zn	-	-	83	53 - 125

ug/g = micrograms per gram, dry basis
R.P.D. = Relative Percent Difference
NC = Not Calculated. Duplicate sample results were less than the detection limit. Relative Percent Difference calculation is not defined for analyte levels of less than detection limit.

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REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90716049

CANTEST

Instrument Quality Control for the Mercury Monitor (QC# 216250)

QC Type: Calibration Verification

Parameter	% Recovery	Limits
Mercury Hg	93	90 - 110

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Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90716049

CANTEST

Batch Quality Control Frequency Summary

Metals Plant Tissue Digestion (Batch# 111086)

QC Type	No. Samples
NRC TORT-2, "Lobster Tissue"	1
Blank	2
Duplicate	3
Batch Size	21

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

Analysis Report

CANTEST

REPORT ON: Amended Report - Analysis of Tissue Samples

REPORTED TO: Gartner Lee Limited
490-6400 Roberts St
Burnaby, BC
V5G 4C9

Att'n: Genevieve Martin

CHAIN OF CUSTODY: 2106142
PROJECT NAME: Casino
PROJECT NUMBER: 80049

NUMBER OF SAMPLES: 4

REPORT DATE: December 11, 2008

DATE SUBMITTED: September 16, 2008

GROUP NUMBER: 90917022

SAMPLE TYPE: Tissue

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Mercury in Tissue - samples were digested using a nitric acid-hydrogen peroxide digestion procedure based on EPA Method 200.3. Analysis was performed using Cold Vapour Atomic Absorption Spectrophotometry or Cold Vapour Atomic Fluorescence Spectrophotometry.

Metals in Tissue - samples were digested using a nitric acid-hydrogen peroxide digestion procedure based on EPA Method 200.3. Analysis was performed using Inductively Coupled Argon Plasma Spectroscopy (ICP), or ICP Mass Spectrometry (ICP/MS).

COMMENTS:

Amended Report - This report supercedes final hard copy sent on October 15, 2008 via mail. The tissue results are based on a wet weight basis - not dry weight as indicated in the footnotes of the report. cjw December 11, 2008

TEST RESULTS:

(See following pages)

CANTEST LTD.

Per Anna Becalska, PhD
Coordinator, Trace Metals

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90917022

CANTEST

Metals Analysis in Tissue

CLIENT SAMPLE IDENTIFICATION:		F14-1	F14-2	F14-3	F11-1	
DATE SAMPLED:		Sep 12/08	Sep 12/08	Sep 12/08	Sep 12/08	DETECTION LIMIT
CANTEST ID:		809170067	809170068	809170069	809170070	
Aluminum	Al	19.5	294	16.2	35.6	0.5
Antimony	Sb	<	<	<	<	0.1
Arsenic	As	0.1	0.3	0.1	0.1	0.1
Barium	Ba	3.2	7.3	3.1	1.2	0.1
Beryllium	Be	<	<	<	<	0.02
Boron	B	<	<	<	<	2
Cadmium	Cd	0.03	0.04	<	0.03	0.02
Calcium	Ca	9630	10100	8210	3760	1
Chromium	Cr	<	0.3	<	0.1	0.1
Cobalt	Co	<	0.3	<	<	0.1
Copper	Cu	1	1.1	0.9	0.9	0.1
Iron	Fe	51	693	51	71	5
Lead	Pb	<	0.3	<	<	0.1
Magnesium	Mg	363	486	360	295	0.5
Manganese	Mn	8.2	25.4	8.8	3.1	0.1
Mercury	Hg	0.032	0.038	0.034	0.027	0.01
Molybdenum	Mo	<	<	<	<	0.1
Nickel	Ni	<	0.3	<	<	0.1
Phosphorus	P	7450	7660	6610	4590	0.5
Potassium	K	3320	2670	2510	3320	1
Selenium	Se	0.8	0.7	0.7	1.1	0.2
Silicon	Si	41	64	49	38	10
Silver	Ag	<	<	<	<	0.01
Sodium	Na	1250	1260	1250	1090	1
Strontium	Sr	17.4	17	17.5	4.89	0.05
Tellurium	Te	<	<	<	<	0.1
Thallium	Tl	<	<	<	<	0.02
Tin	Sn	<	<	<	<	0.1
Titanium	Ti	4.2	24.6	3.9	3.7	0.3
Uranium	U	0.05	0.13	<	<	0.04
Vanadium	V	<	1.5	<	<	0.5
Zinc	Zn	21.6	28	21.2	19.2	0.5
Zirconium	Zr	<	<	<	<	3

Results expressed as micrograms per gram, dry basis (µg/g)
< = Less than detection limit

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Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90917022

CANTEST

Batch Quality Control for Dissolved Metals Analysis in Tissue (QC# 113690)

Parameter		Blank (ug/g)	Blank Limits	Duplicate (R.P.D.) 809170495	Duplicate Limits	Duplicate (R.P.D.) 809170515	Duplicate Limits
Aluminum	Al	< 0.5	0.2	8.6	20	4.2	20
Antimony	Sb	< 0.1	0.001	NC	20	NC	20
Arsenic	As	< 0.1	0.002	NC	20	PASS	20
Barium	Ba	< 0.1	0.001	0.2	20	2.1	20
Beryllium	Be	< 0.02	0.001	NC	20	NC	20
Boron	B	< 2	0.02	PASS	20	5.7	20
Cadmium	Cd	< 0.02	0.0004	PASS	20	PASS	20
Calcium	Ca	< 1	0.3	2.3	20	3.5	20
Chromium	Cr	< 0.1	0.001	0	20	11.8	20
Cobalt	Co	< 0.1	0.001	PASS	20	PASS	20
Copper	Cu	< 0.1	0.001	6.7	20	2.2	20
Iron	Fe	< 5	0.05	5.6	20	5	20
Lead	Pb	< 0.1	0.002	NC	20	PASS	20
Magnesium	Mg	< 0.5	0.2	5.6	20	2.1	20
Manganese	Mn	< 0.1	0.01	8.5	20	1	20
Molybdenum	Mo	< 0.1	0.002	0	20	0	20
Nickel	Ni	< 0.1	0.003	3.3	20	0	20
Phosphorus	P	< 0.5	0.1	3.5	20	0.5	20
Potassium	K	< 1	0.3	2.2	20	0.9	20
Selenium	Se	< 0.2	0.004	NC	20	PASS	20
Silver	Ag	< 0.01	0.001	NC	20	NC	20
Sodium	Na	< 1	0.5	11.8	20	8.7	20
Strontium	Sr	< 0.05	0.002	2.6	20	6.4	20
Tellurium	Te	< 0.1	0.002	NC	20	NC	20
Thallium	Tl	< 0.02	0.002	PASS	20	NC	20
Tin	Sn	< 0.1	0.01	NC	20	NC	20
Titanium	Ti	< 0.3	0.01	6.1	20	0	20
Uranium	U	< 0.04	0.002	NC	20	NC	20
Vanadium	V	< 0.5	0.002	NC	20	NC	20
Zinc	Zn	< 0.5	0.04	3.6	20	4.3	20
Zirconium	Zr	< 3	0.04	NC	20	NC	20

ug/g = micrograms per gram, dry basis
R.P.D. = Relative Percent Difference
PASS = Duplicate sample results were in the range of one to five times the detection limit. R.P.D. calculation is not applicable in this range. Acceptance criteria is a maximum difference between the duplicates equivalent to the value of the detection limit.
NC = Not Calculated. Duplicate sample results were less than the detection limit. Relative Percent Difference calculation is not defined for analyte levels of less than detection limit.

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90917022

CANTEST

Batch Quality Control for Dissolved Metals Analysis in Tissue (QC# 113690)

Parameter		Duplicate (R.P.D.) 809180212	Duplicate Limits	NIST1573a Tomato Leaves (% Recovery)	NIST1573a Tomato Leaves Limits	NRC TORT-2, "Lobster Tissue" (% Recovery)	NRC TORT-2, "Lobster Tissue" Limits
Aluminum	Al	-	-	32	7 - 91	-	-
Arsenic	As	-	-	195	80 - 283	88	66 - 113
Boron	B	-	-	96	62 - 142	-	-
Cadmium	Cd	-	-	79	30 - 124	89	63 - 118
Calcium	Ca	3.4	20	97	60 - 120	-	-
Chromium	Cr	-	-	50	28 - 97	75	60 - 120
Cobalt	Co	-	-	97	50 - 150	95	60 - 120
Copper	Cu	5.3	20	85	59 - 125	89	60 - 120
Iron	Fe	0.3	20	87	52 - 167	87	60 - 120
Lead	Pb	-	-	-	-	87	39 - 150
Magnesium	Mg	6	20	-	-	-	-
Manganese	Mn	6.2	20	101	62 - 131	88	60 - 120
Mercury	Hg	-	-	(*)	88.24 - 111.8	119	78 - 122
Molybdenum	Mo	-	-	-	-	94	60 - 120
Nickel	Ni	-	-	63	28 - 143	80	50 - 122
Phosphorus	P	9.6	20	110	60 - 120	-	-
Potassium	K	2.8	20	105	60 - 120	-	-
Selenium	Se	-	-	-	-	89	67 - 118
Sodium	Na	6.5	20	84	60 - 120	-	-
Strontium	Sr	-	-	-	-	86	60 - 120
Vanadium	V	-	-	62	50 - 150	100	60 - 120
Zinc	Zn	4.7	20	87	49 - 109	92	53 - 125

ug/g = micrograms per gram, dry basis
R.P.D. = Relative Percent Difference
(*) = Quality Control results exceeded internally set limits; after review by Quality Assurance Unit, non-conformance overridden and batch sample analysis results released for reporting

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Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90917022

CANTEST

Instrument Quality Control for the Mercury Monitor (QC# 221756)

QC Type: Calibration Verification

Parameter	% Recovery	Limits
Mercury Hg	96	90 - 110

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Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: Gartner Lee Limited

REPORT DATE: December 11, 2008

GROUP NUMBER: 90917022

CANTEST

Batch Quality Control Frequency Summary

Metals Plant Tissue Digestion (Batch# 113690)

QC Type	No. Samples
NIST1573a Tomato Leaves	1
NRC TORT-2, "Lobster Tissue"	1
Blank	2
Duplicate	3
Batch Size	25

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AECOM

B16. Fish Habitat Data, Casino Project, July 2008

Table 4. Habitat Assessment Cards
July 8, 2008

AECOM

Appendix B15. Fish Habitat Data, Casino Project, July 2008.

Site	Date	Distance Surveyed (m)	STREAM CHARACTERISTICS				Habitat Type (%)					Side Channel (%)	Bed Material (%)							Cover Type (%)						
														Gravels		Larges										
			Stage (H/M/L)	Gradient (%)	Wet Width (m)	Channel Width (m)	Pool	Run	Riffle	Cascade	Other		Fines	Small (2-16mm)	Large (16-64mm)	Small Cobble (64-128mm)	Large Cobbles (128-256mm)	Boulder (>256mm)	Bedrock	Total Overall	Deep Pool	LOD	Boulder	Cutbank	Instream Veg	Overstream Veg
F08	9-Jul	75	Low	3.0	2.9	3.3	40	0	0	60	0	0	10	30	0	0	40	20	0	30	20	0	70	5	0	5
					4.5	5.8																				
					2.2	5.6																				
F07	9-Jul	75	Low	9.0	3.4	4.7	Cascade Pool					0	20	10	0	5	15	50	0	30	3	0	85	2	0	10
					4.4	6.2																				
					5.4	8.1																				
F03	8-Jul	75	Low	3.0	4.7	6.2	10	0	90	0	0	0	10	15	0	35	30	10	0	45	0	40	5	15	0	40
					7.0	7.0																				
					4.5	9.5																				
					3.7	10.3																				
F04	8-Jul	200	Low	4.0	5.6	5.6	Cascade Pool					0-10	5	0	20	15	10	50	0	50	0	10	80	0	0	10
					5.0	8.8																				
					5.0	5.1																				

Table 4. Habitat Assessment Cards
July 8, 2008

AECOM

Appendi

Site	Crown Closure (%)	Banks (F, G, L, R)	Confinement (EN, CO, FC, OC, UC, N/A)	Braided (Y or N)	pH	Water Temp (^oC)	TDS (g/L)	Conductivity (25^oC) (µs/cm)	DO (%)	DO (mg/L)	Comments
F08	5	F, L	UC	N	7.39	5.93	0.173	264	86.8	10.81	Casino Creek, Cascade Pool habitat
F07	5	F, L	UC	N	6.9	3.4	0.181	278	92.9	12.36	Upper Reach of Casino Creek, Cascade Pool habitat
F03	7	F, L	UC	N	7.45	9	0.167	256	95.5	11.0	Upstream of Britannia Creek
F04	17	F, L	UC	Y	6.53	6.34	0.075	111	93.4	11.45	Upstream of F03, Cascade Pool habitat

AECOM

B17. Fish Habitat Data, Casino Project, September 2008

Appendix B17. Fish Habitat Data, Casino Project, September 2008

Site ID	Date	Reach	Co-ordinates		STREAM CHARACTERISTICS					Habitat Type (%)				Side Channel %	Bed Material (%)							Cover Type (%)							Crown Closure (%)	Bars (%)	Confinement (EN, CO, FC, OC, UC, N/A)	Braided (Y or N)
																Gravels		Larges														
			Easting	Northing	Stage (H/M/L)	Gradient (%)	Wet Width (m)	Channel Width (m)	Depth (m)	Pool	Run	Riffle	Other		Fines	Small (2-16mm)	Large (16-64mm)	Small Cobble (64-128mm)	Large Cobbles (128-256mm)	Boulder (>256mm)	Bedrock	Total overall	Deep pool	LOD	Boulder	Cutbank	Instream veg	Overstream Veg				
Lower Reach of Britannia Creek	11-Sep	1	617,126	6,970,199	High	0.0	-	-	0.35	20	30	50	0	(only 1)	20	20	0	50	10	0	0	10	20	80	0	0	0	0	10	20	OC	N
									0.20																							
Upper Reach of Britannia Creek	11-Sep	2	616,279	6,966,540	High	1.0	4.2	4.2	0.21	10	20	70	0		0	30	30	0	20	20	0	10	0	70	0	20	0	10	20	10	UC	
							3.9	3.9	0.42																							
									0.16																							
									0.42																							
									0.23																							
Lower Reach of Canadian Creek	11-Sep	1	615,314	6,966,030	High	0.0	4.8	7.9	1.00	20	40	40	0		10	10	10	20	50	0	0	10	20	80	0	0	0	0	10	0	UC	N
									0.26																							
Cascade pools on Canadian Creek	11-Sep	2	609,160	690,684	High	15.0	8.0	8.0	0.43						5	0	5	0	0	90	0	50	0	0	100	0	0	0	0	0	FC	N
Upper Reach of Canadian Creek	11-Sep	3	609,622	6,958,679	High	3.0	4.0	4.0	0.36	10	10	80	0		5	0	0	15	60	20	0	20	0	0	100	0	0	0	0	0	UC	N
							1.95	1.95	0.16																							
At site F14 on Dip Creek	12-Sep	1	609,367	6,947,025	High	0.0	11.0	11.0	1.25	30	30	40	0		50	10	0	30	10	0	0	25	50	50	0	0	0	0	10	0	UC	Y
							10.0	10.0																								
Meloy Creek	12-Sep	1	611,661	6,954,143	High	2 to 3	1.8	1.8	0.40	20	50	30	0		80	5	0	5	0	10	0	70	20	0	0	0	0	80	10	0	UC	N
							1.1	1.1	0.21																							
							0.5	0.5																								
Upper Reach of Casino Creek	12-Sep	2	613,087	6,954,573	High	3.0	6.1	6.1	0.34	50	10	40	0		10	0	10	20	20	40	0	30	0	0	80	0	0	20	0	0	UC	N
							4.7	4.7	0.08																							
									0.40																							
Lower Reach of Casino Creek	12-Sep	1	610,515	6,950,136	High	2.0	5.8	5.8	1.50	30	40	30	0		30	5	5	20	40	0	0	30	70	30	0	0	0	0	20	0	UC	N
							5.6	5.6	0.40																							
									0.27																							
									0.65																							
Lower Reach of Brynelson Creek	12-Sep	1	610,209	6,952,288	High	2.0	6.1	6.1	0.12	20	20	60	0		30	0	20	20	20	10	0	10	0	0	90	0	0	10	10	0	UC	Y
							4.7	4.7	0.26																							
									0.49																							
									0.30																							
Upper Reach of Brynelson Creek	12-Sep	2	609,448	6,953,393	High	2 to 3	4.1	4.1	0.40	30		70	0		0	0	0	10	20	70	0	20	0	20	80	0	0	0	10	0	UC	N
									0.35																							
									0.40																							
Lower Reach of Austin Creek	12-Sep	1	610,157	6,949,620	High	0.0	1.9	1.9	0.54	70	30		0		100	0	0	0	0	0	0	100	0	0	0	0	0	100	0	0	UC	Y
							1.6	1.6	0.39																							
Upper Reach of Austin Creek	12-Sep	2	608,816	6,951,236	High		1.08	1.08	0.56	70	20	10	0		90	0	0	0	0	10	0	90	10	0	0	0	0	90	0	0	UC	Y
								0.80	0.29																							

Appendix B17. Fish Habitat Data, Casino Proj

Site ID	Date	Reach	Co-ordinates		YSI 556						Hanna Combo Pen		
			Easting	Northing	pH	Water Temperature (°C)	TDS (g/L)	Conductivity (25°C) (µs/cm)	DO %	DO (mg/L)	Water Temperature (°C)	Conductivity (25°C) (µs/cm)	pH
Lower Reach of Britannia Creek	11-Sep	1	617,126	6,970,199	7.16	5.42	0.126	195	95.5	12.04	5.9	-	8.04
Upper Reach of Britannia Creek	11-Sep	2	616,279	6,966,540	9.73	3.08	0.117	175	96	12.9	3	150	7.96
Lower Reach of Canadian Creek	11-Sep	1	615,314	6,966,030	7.01	5.65	0.102	161	88.1	11.06	-	-	-
Cascade pools on Canadian Creek	11-Sep	2	609,160	690,684	6.92	4.01	0.073	108	84.5	11.08	-	-	-
Upper Reach of Canadian Creek	11-Sep	3	609,622	6,958,679	6.82	3.17	0.075	118	79.2	10.6	-	-	-
At site F14 on Dip Creek	12-Sep	1	609,367	6,947,025	6.91	2	0.1	152	85.2	11.79	-	-	-
Meloy Creek	12-Sep	1	611,661	6,954,143	6.69	1.99	0.128	188	85	11.75	-	-	-
Upper Reach of Casino Creek	12-Sep	2	613,087	6,954,573	7	3.39	0.133	202	87.7	11.66	-	-	-
Lower Reach of Casino Creek	12-Sep	1	610,515	6,950,136	7	4.64	0.19	180	84.9	10.97	-	-	-
Lower Reach of Brynelson Creek	12-Sep	1	610,209	6,952,288	6.92	2.56	0.077		93.1	12.69	2.9	92	7.96
Upper Reach of Brynelson Creek	12-Sep	2	609,448	6,953,393	6.78	3.01	0.067	105	90.1	12.12	-	-	-
Lower Reach of Austin Creek	12-Sep	1	610,157	6,949,620	7	2.85	0.135	208	87.2	11.75	-	-	-
Upper Reach of Austin Creek	12-Sep	2	608,816	6,951,236	5.82	1.94	0.068	110	90.1	12.43	-	-	-

Appendix C

Terrestrial Environment

AECOM

C1. Ecosystem Classification Data, Casino Project, July 2008

AECOM

C2. Ecosystem Classification Data, Casino Project, September 2008

C3. Wildlife Survey Data, Casino Project, 2008

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Casino Project:

2009 Aquatic Studies Report

Prepared for

Western Copper Corporation

March 2011

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

1199 West Hastings Street, Suite 800, Vancouver, BC V6E 3T5
t: 604.687.2038 f: 604.687.3141

March 25, 2011

Jesse Duke
Western Copper Corporation
2050-1111 West Georgia Street
Vancouver, BC
V6E 4M3

Dear Mr. Duke,

Re: Casino Project: 2009 Aquatic Studies Report
P1101, task 8.2.3

Palmer Environmental Consulting Group Inc. (PECG) is pleased to submit the attached report describing the studies conducted in 2009 on the aquatic environment of the Casino Project area. If there are any questions or comments on this report, then please contact the undersigned. Thank you for the opportunity to work with you on this project.

Yours truly,

Palmer Environmental Consulting Group Inc.

R. Palmer

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Senior Fisheries Biologist

RP:mq

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Revision #	Revised By	Date	Issue / Revision Description
1	Rick Palmer	June 7, 2010	Senior review
2	May Quach	March 25, 2011	Final Report
3	Rick Palmer	March 25, 2011	Final Review

Signatures

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Executive Summary

This report describes the studies conducted in 2009 on the aquatic environment of the Casino Project area. The Casino Project is a proposed porphyry copper-gold-molybdenum mine located at 612,000E, 6,955,100N in west-central Yukon, approximately 300 km northwest of the territorial capital of Whitehorse.

Surveys of the aquatic environment in 2009 were completed on May 19, June 29-July 1, August 5-10, September 22, October 5 7, November 4 and December 1-2. The objectives were to sample water quality, stream sediment quality, periphyton communities, benthic invertebrate communities and fish communities and to describe fish habitat.

A total of 22 sites were chosen for water quality sampling. Water samples were collected from each site in May, June, August, September, October, November and December and analyzed for the full suite of physical parameters, anions, nutrients and total and dissolved metals. Exceedances of the Canadian Council of Ministers of the Environment (CCME) guidelines for protection of freshwater aquatic life were observed for seven parameters. The number of exceedances was highest for cadmium, copper, aluminum, and least for pH. Exceedances were most numerous in June, similar between August and September and least in October, November and December, indicating a seasonal trend most likely directly related to hydrological factors such as snow melt and stream flow.

Sediment samples were collected from two stream sites in August and pH and total metal concentrations were measured. Exceedances of CCME sediment guidelines were identified for five metals: arsenic, cadmium, copper, lead and zinc.

Five samples each of periphyton and benthic invertebrate communities were collected from eight sampling sites in August. There were highly significant differences in mean periphyton density with sites P1 and P2 in Britannia Creek, P4 in lower Casino Creek and PR2 in Dip Creek having significantly higher mean density than other sites. There were also significant differences among sites in mean periphyton taxonomic richness and mean periphyton diversity. Significant differences in richness were caused mainly by high richness in sites P2 and PR2, and significant differences in diversity were from low diversity in site P7 (upper Casino Creek).

Over 95% of the benthic organisms at each site belonged to six taxa: the insect Orders of Diptera, Ephemeroptera, Trichoptera, Plecoptera plus the mite of Superorder Acariformes and the worm of Phylum Annelida. There were significant differences in mean density, where density at B7 was significantly lower than the density at all other sites and density at BR2 in Dip Creek was significantly higher than density at all other sites. There were significant differences in mean taxonomic richness, total EPT abundance, and mean diversity as well. Site B7 in upper Casino Creek was significantly lower in richness and diversity than all other sites and sites B5 and BR2 in Dip Creek were significantly higher in EPT abundance than all other sites except B4.

Fish communities at 17 stream sites were sampled in September with an electrofisher. In addition, a chinook spawning assessment was conducted on August 9 in the upper reach of Britannia Creek (none were observed).

At total of 150 fish from five species – Arctic grayling (*Thymallus arcticus*), slimy sculpin (*Cottus cognatus*), burbot (*Lota lota*), round whitefish (*Prosopium cylindraceum*), and chinook salmon (*Oncorhynchus tsawytscha*) – were captured. Arctic grayling and slimy sculpin were found in all watersheds; burbot was found in the Casino Creek watershed. Round whitefish was found in the Dip Creek watershed. Chinook was found in the Britannia Creek watershed. Slimy sculpin made up the majority of the total catch (70%) and comprised > 64% of the catch within each of watersheds.

Mean catch-per-unit-effort (CPUE) of Arctic grayling was highest for site F10 in Brynelsen Creek (1.87) and lowest for site F12 in Austin Creek (0.00). CPUE of slimy sculpin was highest in Y1 in Britannia Creek (3.32) and absent from F01, F10, and F12.

Arctic grayling ranged in length from 22 to 375 mm, in weight from 0.4 to 500 g, and in age from 1 to 8 years, indicating the presence of adults, juveniles and fry in some of the watersheds. Slimy sculpin ranged in length from 5 to 131 mm and in weight from 0.3 to 19.5 g, indicating the presence of juveniles and adults. Round whitefish and burbot caught in the Casino/Dip Creek watershed were juveniles and the single chinook salmon captured in the Britannia Creek watershed was a fry.

Twenty-four slimy sculpin were collected from the Casino, Dip and Britannia watersheds and subjected to whole-body tissue metals analysis. In all samples, concentrations of mercury were below Health Canada guidelines.

Acknowledgements

The studies described in this report were carried out by the following staff:

- Project Management:
  - Rick Palmer, M.Sc., R.P.Bio. Senior Fisheries Biologist
- Report Preparation/editing:
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- Fish and Fish Habitat:
  - Jennifer Sarchuk, B.Sc., Aquatic Biologist
  - Scott Seward, B.A. Environmental Technician

In 2011, the Aquatic program described in this report was transferred from AECOM to Palmer Environmental Consulting Group Ltd. (PECG). At that time, this report had some outstanding comments from senior reviewers. Final edits and completion of this report was carried out by PECG.

Acronyms and Abbreviations

ANOVA	Analysis of variance
BC MOE	British Columbia Ministry of Environment
CABIN	Canadian Aquatic Biomonitoring Network
CCME	Canadian Council of Ministers of the Environment
CO	Confined
CPUE	Catch-per-Unit-Effort
CVAAS	Cold Vapour Atomic Absorption Spectrophotometry
DFO	Fisheries and Oceans Canada
DIAND	Department of Indian Affairs and Northern Development
DOC	Dissolved Organic Carbon
EEM	Environmental Effects Monitoring
EN	Entrenched
EPT	Ephemeroptera-Plecoptera-Trichoptera
FC	Frequently confined
FES	Fraser Environmental Services Ltd.
FISS	Fisheries Information Summary System
GPS	Global Positioning System
H’	Shannon-Weiner diversity index
HKP	Hallam Knight Piésold Ltd.
ICP-AES	Inductively Coupled Atomic Emission Spectrometry
ICP-MS	Inductively Coupled Mass Spectroscopy
INAC	Indian and Northern Affairs Canada
ISQG	Interim Sediment Quality Guideline
LSA	Local Study Area
LWD	Large Woody Debris
MMER	Metal Mining Effluent Regulations
µS	micro-Siemens
NA	Not applicable
NAN	Not a Number
NS	Not sampled
NTU	Nephelometric unit
NWRI	National Water Research Institute
OC	Occasionally confined
P	Probability of making a Type I error
PEL	Probable Effects Level
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
r^2	coefficient of determination
RDL	Reported Detection Limit
RPD	Relative Percent Difference
RSA	Regional Study Area

S	Taxonomic richness
SE	Standard error
TDS	Total Dissolved Solids
TIA	Tailings Impoundment Area
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TSS	Total Suspended Solids
UC	Unconfined
U.S. EPA	United States Environmental Protection Agency
YESAB	Yukon Environmental and Socio-Economic Assessment Board

Table of Contents

Letter
Executive Summary
Acknowledgements
Acronyms and Abbreviations

1 Introduction 1
1.1 Overview 1
1.2 Study Areas 4
1.3 Study Objectives 7

2 Methods 8
2.1 Dates and Locations of Sampling Surveying 8
2.1.1 General 8
2.1.2 Water Quality 8
2.1.3 Sediment Quality 10
2.1.4 Periphyton and Benthic Invertebrates 10
2.1.5 Fish Communities 11
2.1.6 Fish Habitat 12
2.1.7 Fish Tissue Metals Concentrations 13
2.2 Sample Collection 13
2.2.1 Water Quality 13
2.2.2 Sediment Quality 14
2.2.3 Periphyton 15
2.2.4 Benthic Invertebrates 15
2.2.5 Fish Community 16
2.2.6 Fish Tissue Metals Concentrations 17
2.2.7 Fish Habitat 18
2.3 QA/QC 19
2.3.1 Water Quality 19
2.3.2 Sediment Quality 21
2.3.3 Periphyton and Benthic Invertebrates 21
2.3.4 Fish and Fish Habitat 22
2.4 Data Analysis 22
2.4.1 Water Quality 22
2.4.2 Sediment Quality 23
2.4.3 Periphyton and Benthic Invertebrates 23
2.4.4 Fish and Fish Habitat 24

3 Results and Discussion 24
3.1 Water Quality 24
3.1.1 Statistical Summary 24

3.1.2 Exceedances of Water Quality Guidelines 29
3.2 Sediment Quality 32
3.2.1 Exceedances of Sediment Quality Guidelines 32
3.3 Periphyton 32
3.4 Benthic Invertebrates 37
3.5 Periphyton and Benthic Invertebrate Summary 40
3.6 Fish Community 41
3.6.1 Catch, Effort and CPUE 41
3.6.2 Fish Habitat Assessment 51

4 References 53

List of Figures

Figure 1. Aquatic Regional Study Area in Relation to the Yukon River 2
Figure 2. Proposed Casino Mine Site Layout 3
Figure 3. Aquatic Regional Study Area Near the Casino Property with Sampling Sites 5
Figure 4. Aquatic Regional Study Area with Sampling Sites on the Klotassin River 6
Figure 5. Water Quality Exceedances of CCME Guidelines, Casino Project, 2009 30
Figure 6. Median Concentration of Total Cadmium in Sampling Sites, Casino Project, 2009 31
Figure 7. Median Concentration of Total Aluminum in Sampling Sites, Casino Project, 2009 31
Figure 8. Median Concentration of Total Copper in Monitoring Stations, Casino Project, 2009 32
Figure 9. Mean Density of Periphyton by Site, Casino Project, 2009 33
Figure 10. Mean Taxonomic Richness of Periphyton Communities, Casino Project, 2009 36
Figure 11. Mean Shannon-Wiener Diversity Index of Periphyton Communities, Casino Project, 2009 36
Figure 12. Mean Density of Benthic Invertebrates by Site Using Kicknet, Casino Project, 2009 37
Figure 13. Mean Density of Benthic Invertebrates by Site Using Surber Sampler, Casino Project, 2009 38
Figure 14. Mean Taxonomic Richness of Benthic Invertebrate Communities, Casino Project, 2009 39
Figure 15. Mean Total EPT of Benthic Invertebrate Communities, Casino Project, 2009 39
Figure 16. Mean Shannon-Weiner Index of Diversity of Benthic Invertebrate Communities, Casino Project, 2009 40
Figure 17. Electrofishing CPUE, Arctic Grayling, Casino Project, 2009 42
Figure 18. Electrofishing CPUE, Slimy Sculpin, Casino Project, 2009 42
Figure 19. Length Frequency for Arctic Grayling in Casino Creek, Dip Creek and Britannia Creek watersheds, Casino Project, 2009 44
Figure 20. Length Frequency for Slimy Sculpin in Casino Creek, Dip Creek and Britannia Creek watersheds, Casino Project, 2009 45
Figure 21. Age Frequency for Arctic Grayling in Casino Creek, Dip Creek and Britannia Creek watersheds, Casino Project, 2009 46
Figure 22. Length Frequencies of Arctic Grayling, Casino Project, 2009 47
Figure 23. Length Frequencies of Slimy Sculpin, Casino Project, 2009 47
Figure 24. Weight-length Regressions for Arctic Grayling, Casino Project, 2009 48

Figure 25. Weight-length Regressions for Slimy Sculpin, Casino Project, 2009 48
Figure 26. Age Frequency Distribution, Arctic Grayling, Casino Project, 2009 49
Figure 27. Length-Age Plot, Arctic Grayling, Casino Project, 2009 49

List of Tables

Table 1. Sampling Trips, Aquatic Environment, Casino Project, 2009 8
Table 2. Summary of Water Quality Sampling Sites, Casino Project, 2009 9
Table 3. Summary of Benthos and Periphyton Sampling Sites and Dates, Casino Project, 2009 10
Table 4. Summary of Fish and Fish Habitat Sampling Sites, Dates, and Coordinates, Casino Project, 2009 12
Table 5. Location of Fish Habitat Surveys, August 5-8, 2009. 13
Table 6. Location of Slimy Sculpin Captured for Tissue Metal Analysis, August 5-8, 2009 13
Table 7. Water Quality Parameters and Detection Limits 14
Table 8. Sediment Quality Parameters and Detection Limits 15
Table 9. Fish Tissue Metals and Detection Limits 17
Table 10. RPD Analysis of Replicate Water Quality Samples, Casino Project, 2009 20
Table 11. RPD Analysis of Replicate Sediment Quality Samples, Casino Project, 2009 21
Table 12. Water Quality Summary Statistics, Casino Creek Watershed, 2009 25
Table 13. Water Quality Summary Statistics, Dip Creek Watershed, 2009 26
Table 14. Water Quality Summary Statistics, Britannia Creek Watershed, 2009 27
Table 15. Water Quality Summary Statistics, Yukon River Watershed, 2009 28
Table 16. Water Quality Parameters Exceeding CCME Guidelines, Casino Project, 2009 29
Table 17. Sediment Quality Parameters Exceeding CCME Guidelines, Casino Project, 2009 32
Table 18. Percentage Composition of Periphyton Communities, Casino Project, 2009 34
Table 19. Percentage Composition of Benthic Invertebrate Communities, Casino Project, 2009 38
Table 20. Fish Data Electrofishing, Casino Project, 2009 41
Table 21. Fish Species in the Aquatics Local Study Area, Casino Project, 1993 to 2009 43
Table 22. Mean Whole-Body Metal Concentrations, Slimy Sculpin, Casino Project, 2009 50

List of Appendices

A1. Surface Water Quality Data, Casino Project, May 2009
A2. Surface Water Quality Data, Casino Project, June-July 2009
A3. Surface Water Quality Data, Casino Project, August 2009
A4. Surface Water Quality Data, Casino Project, September 2009
A5. Surface Water Quality Data, Casino Project, October 2009
A6. Surface Water Quality Data, Casino Project, November 2009
A7. Surface Water Quality Data, Casino Project, December 2009
A8. Surface Water Quality Replicate Data, Casino Project, 2009
B1. Sediment Quality Data, Casino Project, August 2009
B2. Sediment Quality Replicate Data, Casino Project, 2009
C. Periphyton Taxonomy, Casino Project, August 2009
D. Benthic Invertebrate Taxonomy, Casino Project, August 2009
E1. Electrofishing Effort, Catch and CPUE, Casino Project, 2009
E2. Fish Biological Characteristics, Casino Project, 2009
E3. Fish Tissue Metal Concentrations, Casino Project, 2009
E4. Fish Habitat Data, Casino Project, August 2009

1 Introduction

1.1 Overview

This report describes the studies conducted in 2009 on the aquatic environments of the Casino Project area. Studies conducted in 2009 on hydrology, climate and meteorology, hydrogeology and geochemistry are reported separately. The purpose of these studies was to characterize the pre-development environment in support of the permitting process for the Casino Project.

The Casino Project is owned by the Western Copper Corporation (WCC). It is a proposed porphyry copper-gold-molybdenum mine located at 612,000E and 6,955,100N in west-central Yukon, approximately 300 km northwest of the territorial capital of Whitehorse. Figure 1 shows the location of the Casino Project, surrounded by the aquatic Regional Study Area (RSA), in relation to the Yukon River – to which all of the streams in the Casino Project area eventually discharge.

In August 2008, a pre-feasibility study of the Casino Project was completed (M3 Engineering, 2008). It envisioned a conventional truck-shovel, open pit mine. Heap leach, ore stockpile, oxide waste will be stored in the interior of the impoundment (Figure 2). Tailings, process water, treated sewage effluent, leachate from the waste rock dumps and surface runoff from the mine site will be directed to Tailings Impoundment Area (TIA) located in the headwaters of Casino Creek. Historical studies on the aquatic ecosystem of the Casino property were conducted from 1993 to 1995 (Hallam Knight Piésold 1997). In 1994, Fisheries and Oceans Canada (DFO) and Indian and Northern Affairs Canada (INAC), then known as Department of Indian Affairs and Northern Development (DIAND), conducted an overview investigation of waters that may be affected by the Casino project (DFO, 1994). This included the Klotassin River, Dip Creek, Britannia Creek, Selwyn River and Hayes Creek. In 1998, White River First Nation commissioned a study to identify areas of the Lower Donjek River drainage utilized by chinook salmon (Otto, 1998). This was conducted in order to serve as a pilot study to develop a strategic plan for future chinook salmon restoration and enhancement work in the lower Donjek. Otherwise, there are limited data available on the aquatic environment of the Casino area. Fisheries and Oceans Canada (DFO) has conducted surveys of fish and fish habitat in watersheds in the area, including the reaches of the Yukon River adjacent to the Casino property and the lower reaches of Dip Creek and the Klotassin, Donjek and White rivers. These were conducted for the purposes of managing Pacific salmon fisheries in the Yukon River, and for classifying fish habitat in support of the Yukon Placer Authorization (Government of Canada, 2000). The results of the DFO surveys are reported in Appendix B10 of AECOM (2009).

Recent studies of the aquatic ecosystem of the RSA began with a reconnaissance survey on May 9, 2008, followed by sampling trips on May 20-24, July 7-11, September 9-13 and October 9-11 of 2008. Study components included stream flows, water quality, sediment quality, periphyton, benthic invertebrates, fish and fish habitat. The results of those surveys were reported in "*Casino Project: 2008 Environmental Studies Report*" (AECOM, 2009). The studies conducted in 2009 and reported here and are a continuation of the 2008 program.

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UTM Zone 7N, NAD 83

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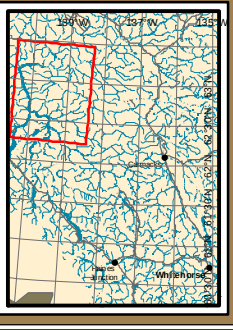
- Aquatic Regional Study Area
- Access Road
- Watercourse
- Waterbody

Topography

- Contour (Index 1000 ft)



Western Copper Corporation

Aquatic Regional Study Area in Relation to the Yukon River

December 2009

AECOM

Figure 1

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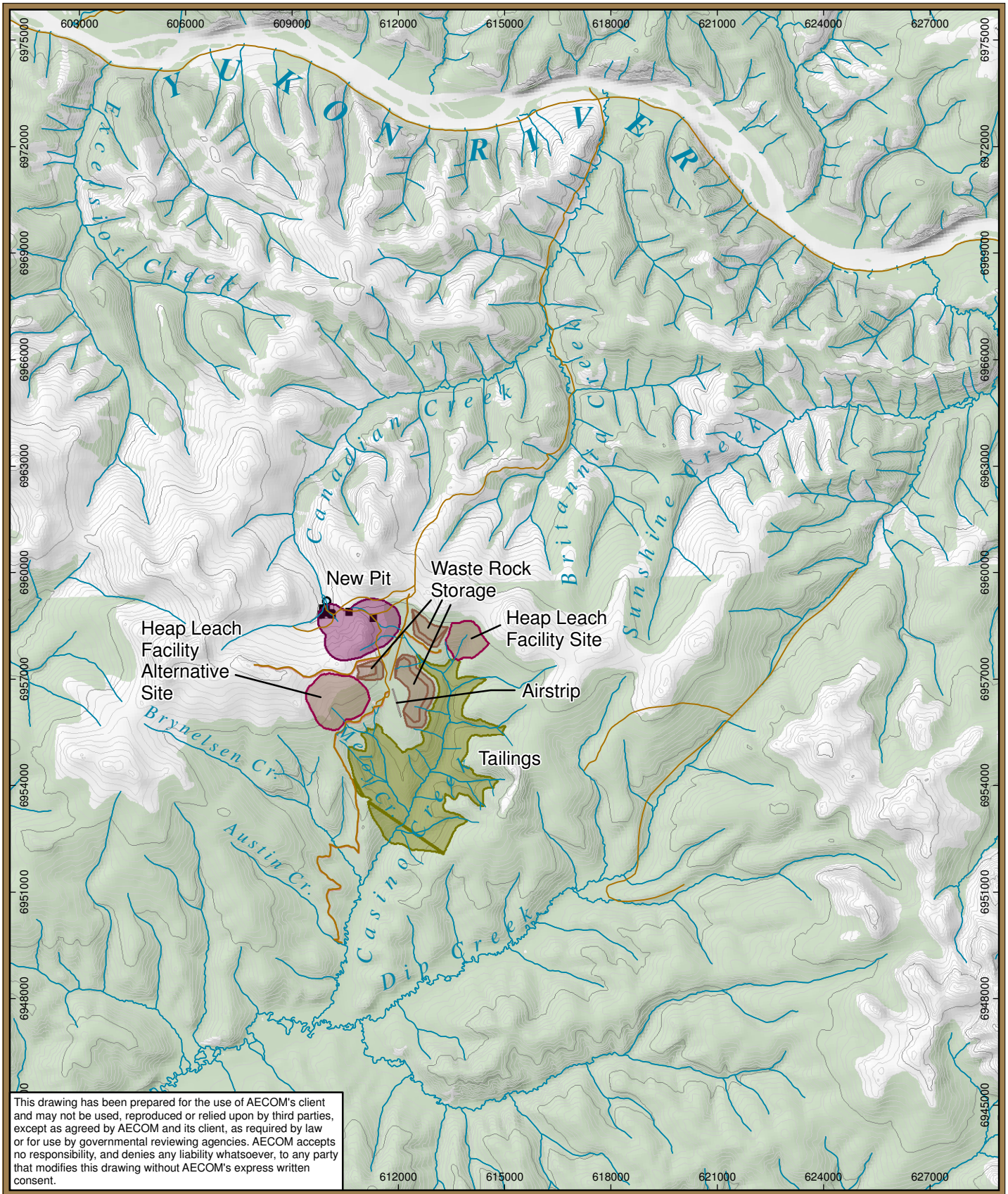

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- Watercourse
- Waterbody

Topography

- Contour (Index 1000 ft)
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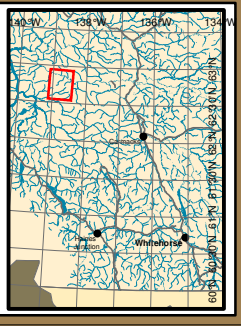
overview map



Western Copper Corporation

Proposed Casino Mine Site Layout

April 2010

AECOM

Figure 2

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1.2 Study Areas

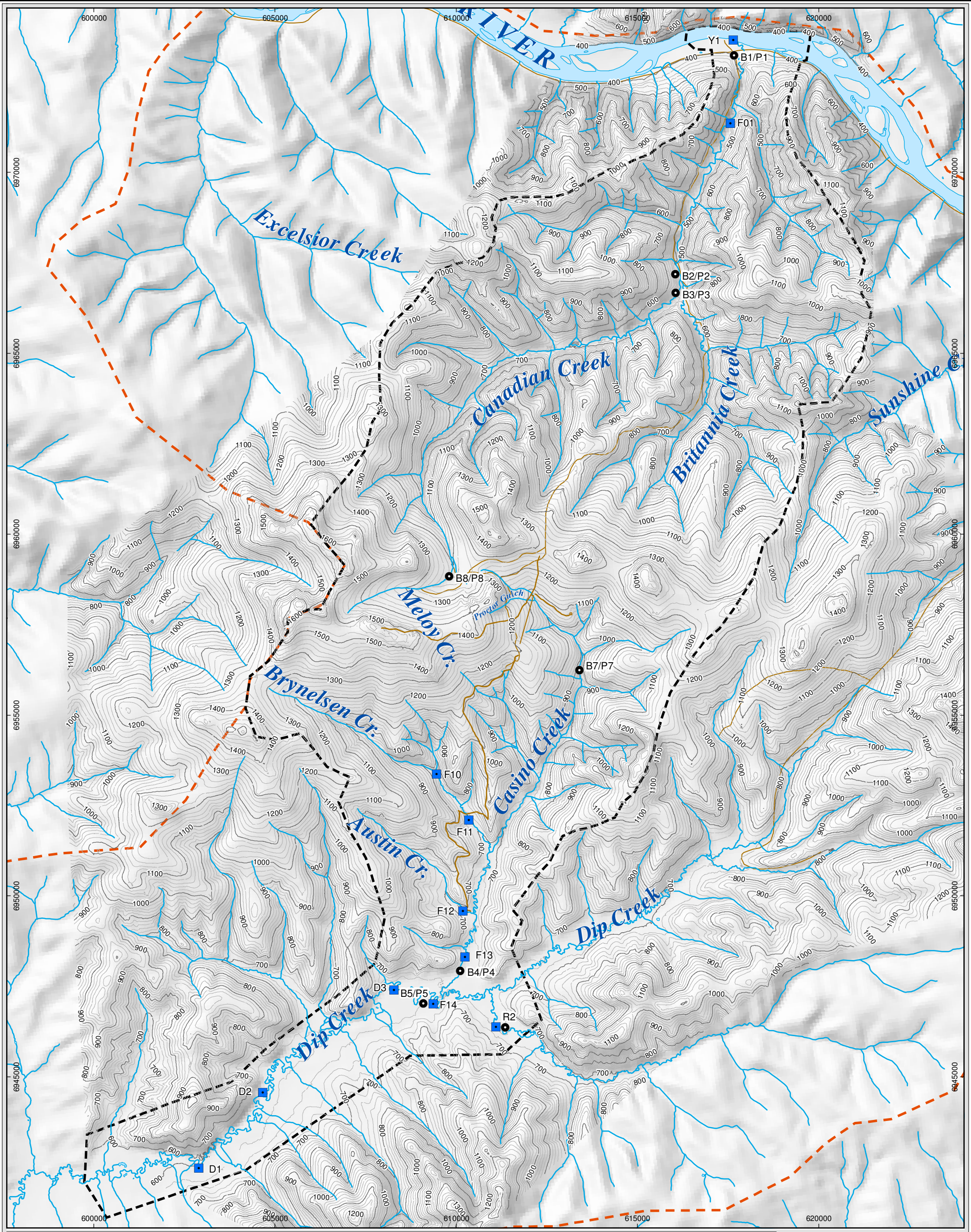
In 2008, the Local Study Area (LSA) for the aquatic ecosystems of the Casino project was defined by the boundaries of the two watersheds surrounding the Casino deposit: the Britannia Creek Watershed to the north and the Casino Creek Watershed to the south. This area includes the direct footprint of the proposed Casino mine and near-field effects. The boundaries of the LSA are shown as dotted line in Figure 3.

Most of the proposed mine infrastructure will be in the Casino Creek Watershed, but some (e.g., the northern corner of the open pit) will be in the Britannia Creek Watershed. The northern part of the LSA is drained by Britannia Creek and one of its tributaries, Canadian Creek. Britannia Creek flows into the Yukon River. The northern edge of the LSA includes a 2 km-long reach of the Yukon River. The southern part of the property is drained by Casino Creek which flows south to Dip Creek and thence to the Yukon River via the Klotassin, Donjek and White rivers. The southern edge of the LSA includes a 2 km-long reach of Dip Creek.

In 2008, the aquatics Regional Study Area (RSA) was defined as the LSA plus four adjacent areas:

- ***Dip Creek Watershed***. The headwaters of Dip Creek are not expected to be affected by Project activities, but the reaches of Dip Creek downstream of the confluence of Dip and Casino creeks may be affected by reduction in flows from Casino Creek caused by the impoundment of its headwaters. The effects of those flow reductions may decrease with downstream distance from the confluence of Dip and Casino creeks. One water quality site (W16) was placed approximately 11 km downstream of the confluence to monitor far-field effects.
- **Sunshine Creek Watershed**. This watershed, located to the east of the Britannia Creek Watershed, is not expected to be affected by Project activities. For that reason a reference water quality station – site W17 – was located on Sunshine Creek upstream of its confluence with the Yukon River.
- ***Excelsior Creek Watershed***. This watershed, located to the west of Britannia Creek Watershed, is also not expected to be affected by Project activities. It was originally intended to be the site of a reference water quality site, but that site (W17) was eventually moved to Sunshine Creek for logistical reasons. This watershed may serve as a location for a reference site in the future.
- ***Yukon River***. This river will be the receiving environment for flows from Britannia Creek. Therefore, water quality sampling stations were placed upstream (W6b – a reference site) and downstream (W6a and W15) of the confluence of Britannia Creek and the Yukon River.

In September 2009, the RSA was extended in a south-western direction to the confluence of Dip Creek and the Klotassin River (Figure 4). The RSA includes waterbodies not directly impacted but are either indirectly affected or suitable for providing references sites (mid-to-far field effects). Two water sampling stations (W20 and W21) were established in the Klotassin River: W20 downstream of the Dip Creek confluence and W21 upstream of the confluence. In addition to W20 and W21, another reference site, R2, was established on a tributary to Dip Creek in August 2009 for water quality sampling, benthos, periphyton and fish communities.



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Legend

- Fish Sample Site
- Benthic Macroinvertebrate and Periphyton Sample Site
- Watercourse

Other Features

- Local Study Area
- Regional Study Area
- Road
- Access Road/Trail

Topography

- Contour (Interm. 20m)
- Contour (Index 100m)

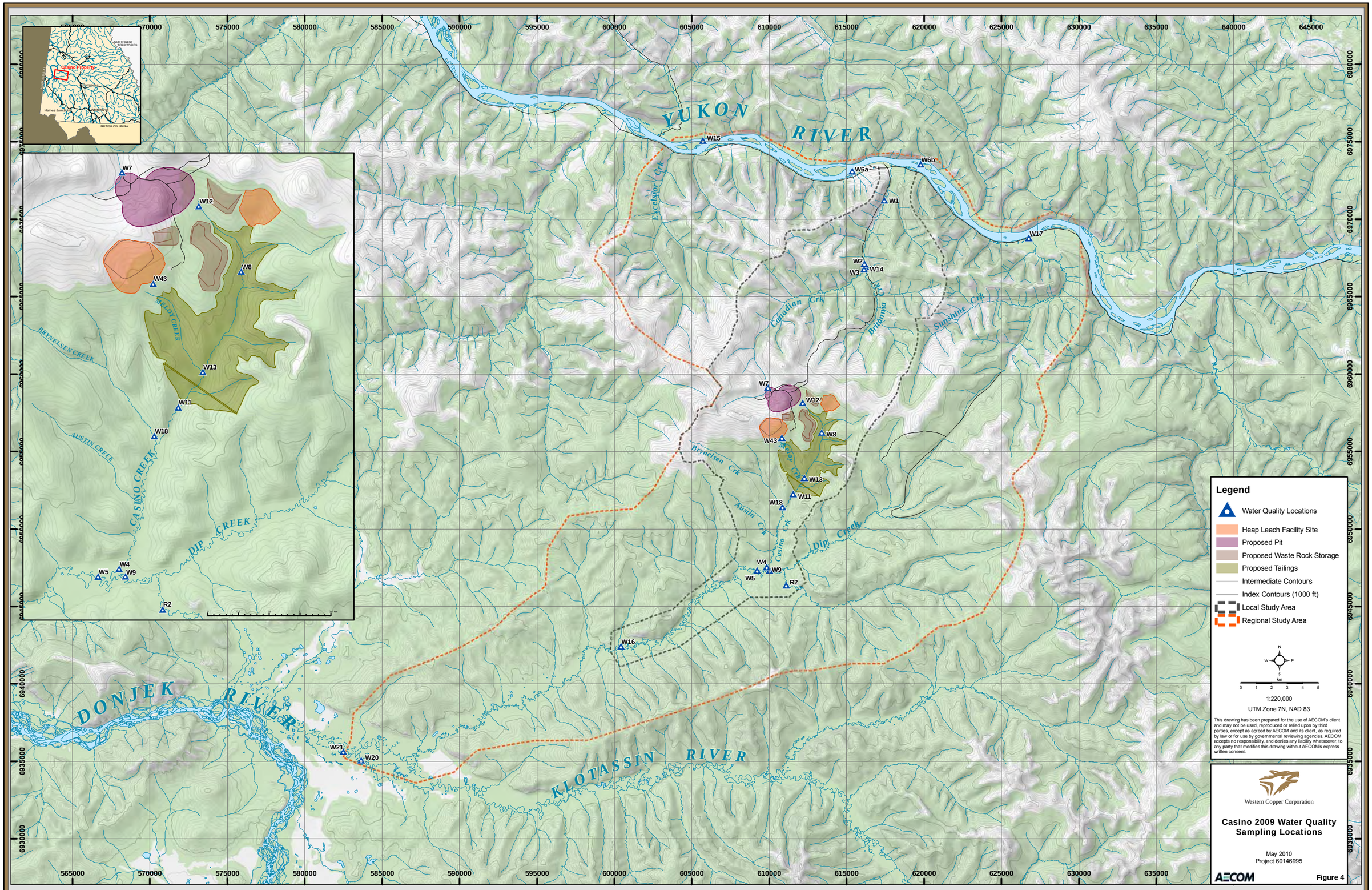
Western Copper Corporation

Casino 2009 Fish, Benthic Invertebrate and Periphyton Sampling Locations

April 2010

AECOM

Figure 3



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1.3 Study Objectives

As in 2008, the overall objective of the 2009 aquatic studies was to collect information that will be used to characterize the pre-development aquatic environment of the Casino Project area. The sampling strategy was to use, as much as was possible, the same sampling sites or areas and methods that were monitored by Hallam Knight Piésold Ltd. from 1993 to 1995 in order to develop further a multi-year database that will allow assessment of natural inter-annual variability. New sampling sites were established in 2009 as a result of the evolution of project planning.

The specific objectives for the 2009 aquatic studies were the following:

- Continue to sample stream water quality at all sites in the LSA and RSA throughout the open-water season. As well, from September 2009 onwards, the frequency of water quality sampling shifted to monthly at all stations in order to prepare a continuous monthly record for at least one year prior to submission of the Casino Project Proposal to the Yukon Environmental and Socio-Economic Assessment Board (YESAB).
- Sample stream sediment quality at sites in the LSA and RSA that were not sampled in 2008.
- Measure the density and taxonomic composition of the mid-summer periphyton communities in the LSA and RSA. Periphyton is the term given to the algal community that grows attached to stream substrates. It is the principal source of primary production for stream ecosystems and, because it is fixed to the substrate, it is useful for assessing mine effects on the aquatic environment.
- Measure the density and taxonomic composition of the stream benthic invertebrate communities in the LSA and RSA. Benthic invertebrates are a major source of prey for fish and, because they are sedentary and constantly exposed to effects of pollution, are useful for assessing mine effects on the aquatic environment. Benthic invertebrates are a required component of the Environmental Effects Monitoring (EEM) guidelines of the Metal Mining Effluent Regulations (MMER) (Environment Canada 2002).
- Identify the fish species present in the LSA, describe their spatial distributions and measure their relative abundance and biological characteristics. Fish are the principal predators in stream communities and are a required monitoring component in the EEM guidelines of the MMER.
- Continue to measure the whole-body tissue metal concentrations of slimy sculpin (*Cottus cognatus*) from each watershed in the LSA. Slimy sculpin were chosen because they are a resident species and a relatively sedentary species, hence their tissue metal concentrations will reflect local background metal concentrations in water. Tissue metal concentrations are a required monitoring component of the EEM guidelines of the MMER.
- Measure the key physical characteristics of stream fish habitat in the LSA for stations that were not surveyed in 2008.

2 Methods

2.1 Dates and Locations of Sampling Surveying

2.1.1 General

The study design for the 2009 aquatics work was similar to the study design used in 2008. With a few exceptions, the same sampling locations were used and similar sampling techniques were employed. Six sampling trips were made from May to December (Table 1). For each trip, a fixed-wing aircraft was chartered from Alkan Air to fly from Whitehorse to the Casino property. While on the property, aquatic biologists travelled to sampling sites by helicopter, by all-terrain vehicles or by foot, depending on weather and trail conditions.

Table 1. Sampling Trips, Aquatic Environment, Casino Project, 2009

Date	Water Quality	Sediment Quality	Periphyton and Benthos	Fish and Fish Habitat
May 19	X	-	-	-
Jun 29-Jul 1	X	-	-	-
Aug 5-10	X	X	X	X
Sep 22	X	-	-	-
Oct 5-7	X	-	-	-
Nov 4	X	-	-	-
Dec 1-2	X	-	-	-

Dashes indicate no data were collected.

2.1.2 Water Quality

A total of 22 sites were chosen for water quality sampling (Table 2). Seven sites were in the Casino Creek Watershed:

- W12 in Proctor Gulch, the uppermost reach of Casino Creek;
- W8 in the upper reach of Casino Creek upstream of the confluence of Meloy Creek;
- W43 on the adit discharge pipe of the lower camp (which discharges into upper Meloy Creek);
- W13 on Meloy Creek upstream of its confluence with Casino Creek;
- W11 in the upper reach of Casino Creek outside of the southern edge of the proposed TIA;
- W18 on Brynelsen Creek upstream of its confluence with Casino Creek; and
- W4 on Casino Creek upstream of its confluence with Dip Creek.

Table 2. Summary of Water Quality Sampling Sites, Casino Project, 2009

Watershed	Creek/River	Site	UTM Co-ordinates	
			Easting	Northing
Casino Creek	Casino	W12	612,163	6,958,175
	Casino	W8	613,398	6,956,258
	Casino	W11	611,557	6,952,289
	Casino	W4	609,833	6,947,575
	Meloy	W43	610,823	6,955,906
	Meloy	W13	612,275	6,953,326
	Brynelsen	W18	610,893	6,951,180
Dip Creek	Dip	W9*	610,018	6,947,352
	Dip	W5	609,219	6,947,348
	Dip	W16	600,423	6,942,454
	Dip	R2*	611,102	6,946,387
Britannia Creek	Britannia	W1	617,439	6,971,241
	Britannia	W2	616,158	6,967,156
	Britannia	W14	616,205	6,966,952
	Canadian	W3	616,141	6,966,789
	Canadian	W7	609,913	6,959,158
Yukon River	Yukon	W6a	615,375	6,973,129
	Yukon	W6b*	619,781	6,973,576
	Yukon	W15	605,721	6,975,108
Sunshine Creek	Sunshine	W17*	626,775	6,968,802
Klotassin River	Klotassin	W20	583,656	6,935,082
	Klotassin	W21	582,490	6,935,640

Dashes indicate no data were available.

**reference site.*

Four sites were in the Dip Creek Watershed:

- W9 on Dip Creek upstream of its confluence with Casino Creek;
- W5 on Dip Creek downstream of its confluence with Casino Creek;
- W16 on Dip Creek 11 km west of site W5 – a far-field site; and
- R2 on a tributary to Dip Creek upstream of its confluence with Casino Creek.

Five sites were in the Britannia Creek Watershed:

- W1 on the lower reaches of Britannia Creek;
- W3 on Canadian Creek upstream of the confluence of Canadian and Britannia creeks;
- W14 on Britannia Creek upstream of its confluence with Canadian Creek;
- W2 on Britannia Creek just downstream of the confluence of Canadian and Britannia creeks; and
- W7 located on upper Canadian Creek.

Three sites were located on the Yukon River:

- W6a downstream from the outflow of Britannia Creek;
- W6b upstream of the outflow of Britannia Creek; and
- W15 upstream of the outflow of Excelsior Creek.

Two sites were located on the Klotassin River:

- W20 upstream from its confluence with Dip Creek – a far-field site; and
- W21 downstream from its confluence with Dip Creek – a far-field site.

One site – W17 – was on Sunshine Creek upstream of its confluence with the Yukon River.

Of these 22 sites, four – W9, W17, W6b and R2 – are reference sites, 17 sites are potentially affected by future mine activities, and one – W43 – has already been disturbed by the adit discharge pipe releasing groundwater, a source of natural ARD.

2.1.3 Sediment Quality

A total of two stream sites were sampled for sediment quality between August 5 and 8:

- one site in the Casino Creek Watershed (W12); and
- one site in the tributary to Dip Creek (R2).

The co-ordinates of the sites are shown in Table 2. Twelve stream sites in Britannia Creek, Casino Creek and Dip Creek watersheds (W1, W2, W3, W7, W14, W4, W11, W12, W8, W13, W9 and W5) were previously sampled in 2008 for sediment quality.

2.1.4 Periphyton and Benthic Invertebrates

Periphyton and benthic invertebrates were sampled from August 5 to 8. The two communities were sampled at that date to adhere to the temporal sampling guidelines established by the Aquatic Health Monitoring Protocol of the Yukon Placer Aquatic Health Working Group (Yukon Placer Secretariat, 2008), which states that: "Sampling will take place over a 3-week period beginning no earlier than the second week of July and extending no later than the start of the second week of August."

Four sites were sampled in the Britannia Creek Watershed (Figure 4 and Table 3):

- B1/P1 (where "B" refers to benthic invertebrates and "P" to periphyton) in lower Britannia Creek upstream of its confluence with the Yukon River;
- B2/P2 in Britannia Creek downstream of the confluence of Canadian and Britannia creeks;
- B3/P3 in Canadian Creek upstream of the confluence of Canadian and Britannia creeks; and
- B8/P8 at the head of Canadian Creek in an area that is proposed to become part of the open pit of the Casino Mine.

Table 3. Summary of Benthos and Periphyton Sampling Sites and Dates, Casino Project, 2009

Watershed	Creek	Site	GPS Co-ordinates		Date
			Easting	Northing	
Britannia Creek	Britannia	B1/P1	617,661	6,973,246	August 6
	Britannia	B2/P2	616,163	6,967,197	August 7
	Canadian	B3/P3	616,043	6,966,702	August 8
	Canadian	B8/P8	609,807	6,958,838	August 8
Casino Creek	Casino	B7/P7	613,396	6,956,247	August 6
	Casino	B4/P4	610,115	6,947,946	August 5
Dip Creek	Dip	B5/P5	609,363	6,947,024	August 5
	Dip	BR2*/PR2*	611,102	6,946,387	August 5

**on Figure 3, this site is labeled as "R2"*

Two sites were sampled in the Casino Creek Watershed – site B4/P4 located upstream of the confluence of Dip and Casino creeks, and site B7/P7 located at the head of Casino Creek in an area that is proposed to be covered by the Casino TIA.

Two sites were sampled in the Dip Creek Watershed – B5/P5 on Dip Creek, downstream of the confluence of Casino and Dip creeks and BR2/PR2 on a tributary to Dip Creek, upstream of the confluence of Casino and Dip creeks.

BR2/PR2 ("R2" on Figure 3) are reference sites. All other sites are potentially affected by future mine activities.

2.1.5 Fish Communities

Fish communities were sampled from August 5-8 in 2009.

Two sites were sampled for fish in the Britannia Creek Watershed (Figure 4 and Table 4):

- F01 (where "F" refers to fish) on lower Britannia Creek upstream of site B1/P1; and
- Y1 on Britannia Creek just upstream from the confluence with the Yukon River.

Y1 was added in 2009 to try to capture more Slimy sculpin for metal analysis.

Four sites were sampled for fish in the Casino Creek Watershed:

- F10 and F11 on Brynelsen Creek, a tributary to Casino Creek;
- F12 on Austin Creek upstream of its confluence with Casino Creek; and
- F13 on lower Casino Creek upstream of its confluence with Dip Creek.

Four sites were sampled for fish in the Dip Creek Watershed:

- F14 on Dip Creek downstream of its confluence with Casino Creek
- D1, D2, and D3 – three non-permanent sites along Dip Creek to complement site F14 in determining the fish species present in Dip Creek. Fish habitat assessments were not conducted on these sites as they are not permanent sampling sites.

A reference site for fish, R2, was added in 2009. R2 is a tributary upstream from the confluence of Dip Creek and Casino Creek. All other sites may potentially be affected by future mine activities, except for R2. In particular, F07, F08 and F09 are located in an area of Casino Creek that is proposed to be covered by the TIA.

Three fish sampling locations in the Casino Creek Watershed were not sampled due to equipment failure:

- F07 on upper Casino Creek downstream of the confluence of an unnamed tributary;
- F08 on upper Casino Creek approximately 2 km downstream of site F07 at the confluence of another unnamed tributary; and
- F09 on Meloy Creek, a tributary of Casino Creek.

Also, three fish sampling locations from 2008 in the Britannia Creek Watershed were not sampled due to equipment failure:

- F03 on lower Britannia Creek below the confluence of Canadian and Britannia creeks;
- F04 on Canadian Creek approximately mid-way between sites F03 and F05; and
- F05 on upper Canadian Creek.

Table 4. Summary of Fish and Fish Habitat Sampling Sites, Dates, and Coordinates, Casino Project, 2009

Watershed	Creek	Site	Fish Habitat Assessment date	Electrofishing date	Electrofishing UTM Coordinates	
					Easting	Northing
Britannia Creek	Britannia	F01	-	7-Aug	617,561	6,971,369
	Britannia	Y1	-	7-Aug	617,641	6,973,666
Casino Creek	Brynelsen	F10	-	6-Aug	609,456	6,953,369
	Brynelsen	F11	-	6-Aug	610,346	6,952,105
	Austin	F12	-	6-Aug	610,087	6,949,723
	Casino	F13	-	6-Aug	610,245	6,948,318
Dip Creek	Dip	F14	-	5-Aug	609,367	6,947,025
	Dip	D1	-	5-Aug	602,898	6,942,475
	Dip	D2	-	5-Aug	604,666	6,944,580
	Dip	D3	-	5-Aug	608,284	6,947,399
	Reference Trib	R2	5-Aug	5-Aug	610,965	6,946,908

Dashes indicate no sampling at that site and date.

In addition to direct sampling of fish communities, on August 9th a chinook spawning assessment was conducted on a 3.4 km section of the upper reach of Britannia Creek starting at the confluence of Canadian Creek. This was accomplished by a foot survey to visually assess the creek for signs of chinook spawning activity. A typical sign of such activity include the presence of redds, which are self-constructed nests created in the stream bottom by the female chinook. In the Yukon, chinook salmon start their migration to spawning areas in July, therefore late-July to mid-September is the ideal time to observe spawners.

2.1.6 Fish Habitat

In 2009 a habitat assessment was conducted for the new site, R2. Fish habitat assessments for all other sites were completed in 2008. Table 5 shows the coordinates of the fish habitat location assessed in 2009.

Table 5. Location of Fish Habitat Surveys, August 5, 2009.

Site	UTM Co-ordinates		Date
	Easting	Northing	
Reference Site (R2)	610,965	6,946,908	5-Aug

2.1.7 Fish Tissue Metals Concentrations

Slimy sculpins were collected during August 5-8, 2009 for analysis of whole-body tissue metals concentrations. Table 6 shows the location where fish were captured.

Table 6. Location of Slimy Sculpin Captured for Tissue Metal Analysis, August 5-8, 2009

Sample	Waterbody
REF 1 CCG# 3	R2
REF 1 CCG# 5	
REF 1 CCG# 12	
REF 1 CCG# 13	
REF 1 CCG# 15	
D1 CCG# 8	Dip Creek
D1 CCG# 9	
D1 CCG# 10	
D1 CCG# 11	
D2 CCG# 6	
D2 CCG# 7	
D2 CCG# 9	
D2 CCG# 10	
D3 CCG# 4	
D3 CCG# 6	
F13 PASS 1 CCG# 5	Casino Creek
F13 PASS 1 CCG# 11	
F13 PASS 2 CCG# 4	
F13 PASS 3 CCG# 1	
F11 PASS 1 CCG# 5	Brynelson Creek
F11 PASS 1 CCG# 8	
Y1 CCG# 13	Britannia Creek
Y1 CCG# 19	
Y1 CCG# 23	

2.2 Sample Collection

2.2.1 Water Quality

All surface water samples were grab samples, collected in mid-stream approximately 20 cm under the surface with the bottle mouths facing upstream. Water quality samples were collected for general chemical parameters in two pre-cleaned 1 L plastic bottles supplied by the analytical laboratory. Samples for total metals were collected in 120 mL acid-washed plastic bottles supplied by the laboratory and preserved in the field with laboratory-supplied nitric acid. Samples for dissolved metals were filtered in the field through 0.45-micron disposable filterware and preserved with laboratory-supplied nitric acid immediately after filtration. Samples for nutrients – ammonia, total Kjeldhal nitrogen (TKN), Total Organic Carbon (TOC), and dissolved orthophosphate – were collected in 120 mL bottles and preserved in the

field with laboratory-supplied sulphuric acid. Total cyanide was collected in 120 mL bottles and preserved in the field with laboratory-supplied sodium hydroxide.

All samples were kept cold and were not allowed to freeze. They were shipped via air cargo from Whitehorse to Maxxam Analytics in Vancouver, BC. Maxxam Analytics is accredited by the Canadian Association for Environmental Analytical Laboratories. Chain of Custody forms accompanied all samples. Table 7 shows the water quality variables that were measured and their Reported Detection Limits (RDL).

Table 7. Water Quality Parameters and Detection Limits

Parameter	Units	RDL	Parameter	Units	RDL
Physical			**Total and Dissolved Metals**		
Conductivity	µS/cm	1	Boron	mg/L	0.005
pH	pH units	0.1	Cadmium	mg/L	0.000005
Hardness	mg/L $CaCO_3$	0.5	Calcium	mg/L	0.05
Total Dissolved Solids (TDS)	mg/L	1	Chromium	mg/L	0.0001
Total Suspended Solids (TSS)	mg/L	1	Cobalt	mg/L	0.000005
Turbidity	NTU	0.1	Copper	mg/L	0.00005
Anions			Iron	mg/L	0.001
Alkalinity	mg/L $CaCO_3$	0.5	Lead	mg/L	0.000005
Acidity (pH 8.3)	mg/L $CaCO_3$	0.5	Lithium	mg/L	0.0005
Bromide	mg/L	0.1	Magnesium	mg/L	0.05
Chloride	mg/L	0.5	Manganese	mg/L	0.00005
Fluoride	mg/L	0.01	Mercury	mg/L	0.00001
Sulphate	mg/L	0.5	Molybdenum	mg/L	0.00005
Cyanide (Total)	mg/L	0.0005	Nickel	mg/L	0.00002
Cyanide (Weak Acid Dissociable)	mg/L	0.0005	Phosphorus	mg/L	0.002
Nutrients			Potassium	mg/L	0.05
Ammonia (as N)	mg/L	0.005	Selenium	mg/L	0.00004
Nitrate (as N)	mg/L	0.005	Silicon	mg/L	0.1
Nitrite (as N)	mg/L	0.002	Silver	mg/L	0.000005
Total Kjeldahl Nitrogen	mg/L	0.02	Sodium	mg/L	0.05
Ortho-phosphate (as P)	mg/L	0.001	Strontium	mg/L	0.00005
Total and Dissolved Metals			Thallium	mg/L	0.000002
Aluminum	mg/L	0.0002	Tin	mg/L	0.00001
Antimony	mg/L	0.00002	Titanium	mg/L	0.0005
Arsenic	mg/L	0.00002	Uranium	mg/L	0.000002
Barium	mg/L	0.00002	Vanadium	mg/L	0.0002
Beryllium	mg/L	0.00001	Zinc	mg/L	0.0001
Bismuth	mg/L	0.000005	Zirconium	mg/L	0.0001

RDL = Reported Detection Limit from Maxxam Analytics.

µS = micro-Siemens, and NTU = nephelometric units.

Field measurements of pH, temperature and specific electrical conductivity were made at each site using a YSI Pro 556 pH/conductivity/temperature meter.

2.2.2 Sediment Quality

Sediment samples were collected using established protocols from depositional areas of the stream. Where possible, sediment samples were collected using the jar provided by the analytical lab as a scoop. Appropriate measures were taken to reduce potential for sample contamination. For example, field staff

wore disposable nitrile gloves when sampling. All samples were kept cold at all times between sample collection and delivery to the laboratory. Chain of Custody forms accompanied all samples. Table 8 shows the sediment quality variables that were measured and their detection limits.

Table 8. Sediment Quality Parameters and Detection Limits

Parameter	Units	RDL	Parameter	Units	RDL
Physical					
Percent moisture		0.3	Manganese	mg/kg	0.2
pH	pH units	0.01	Mercury	mg/kg	0.05
Total Metals			Molybdenum	mg/kg	0.1
Aluminum	mg/kg	100	Nickel	mg/kg	0.8
Antimony	mg/kg	0.1	Phosphorus	mg/kg	10
Arsenic	mg/kg	0.2	Potassium	mg/kg	100
Barium	mg/kg	0.1	Selenium	mg/kg	0.5
Beryllium	mg/kg	0.1	Silver	mg/kg	0.05
Bismuth	mg/kg	0.1	Sodium	mg/kg	100
Cadmium	mg/kg	0.05	Strontium	mg/kg	0.1
Calcium	mg/kg	100	Thallium	mg/kg	0.05
Chromium	mg/kg	1	Tin	mg/kg	0.1
Cobalt	mg/kg	0.3	Titanium	mg/kg	1
Copper	mg/kg	0.5	Vanadium	mg/kg	2
Iron	mg/kg	100	Zinc	mg/kg	1
Lead	mg/kg	0.1	Zirconium	mg/kg	0.5
Magnesium	mg/kg	100			

RDL = Reported Detection Limit from Maxxam Analytics.

All units are mg/kg dry weight unless otherwise noted.

2.2.3 Periphyton

Five samples of periphyton were collected from each of the eight sampling sites from August 5 to 8, for a total of 40 samples. Each sample was collected from one rock selected from the stream bed. For each sample, a surface area of 100 cm^2 was determined in the field using a ruler. Each rock was scraped with a scalpel and the scrapings were washed into a sterile 500 mL plastic bottle jar with a squeeze bottle containing stream water. Each sample was preserved by adding Lugol's iodine solution.

All samples were stored in coolers and kept cool until they could be shipped to Fraser Environmental Services Ltd. (FES) of Surrey, BC, for analysis of taxonomic composition. Chain of Custody forms accompanied all samples.

Periphyton density (cells/cm^2) was calculated for each sample by dividing the total number of cells estimated for a sample by the surface area that was scraped for each sample. Sub-sampling was required to estimate numbers of cells (FES, 1994).

2.2.4 Benthic Invertebrates

Five samples of benthic invertebrates were collected from each of the eight sampling sites from August 5 to 8; an additional two sets of five samples were collected using a different method at B1 and B2, for a total of 50 samples. In 2008, benthic invertebrate samples were collected using the Surber method.

However, in keeping with the RISC standard for the British Columbia Ministry of Environment (MOE 2009), the Canadian Aquatic Biomonitoring Network (CABIN) approach (NWRI, 2009) to benthic invertebrate sampling was followed in 2009. At sites B1 and B2, benthic invertebrate samples were collected using both the Surber sampler and the kick net sampler (the CABIN approach) to assess variability between the methods.

A Lamotte D-net with a 30 cm rim and 500 µm mesh was used as for kick sampling. Starting from the edge of the stream bank, the sampler placed the net facing into the stream current with the flat side of the net resting on the substrate of the stream. The sampler then walked backward in the upstream direction, dragging the net along the bottom of the stream as the sampler walked and kicked the substrate to disturb it to a depth of ~5-10 cm. Sampling was zig-zagged over the stream bottom from bank to bank in an upstream direction for a timed period of three minutes.

The Surber sampler has a surface area of 0.093 m^2 and mesh size of 250 µm. It was placed facing into the stream current with the hinged frame resting on the streambed. Substrate within the area defined by the frame was disturbed by hand for approximately five minutes to dislodge benthic organisms, which were swept into the net by the stream current.

The organisms caught in the sampling nets were then washed into a sample bottle and preserved with 85% ethanol. This was repeated four more times at nearby areas to obtain five replicate samples at each site. Samples of benthos were shipped to Cordillera Consulting in Summerland, BC, for taxonomic identification to the lowest practical taxonomic level, which was to the Order level for most aquatic insects, to the Class level for oligochaetes and to the Phylum level for nematodes. Chain of Custody forms accompanied all samples. All organisms in each sample were counted and identified – no sub-sampling was required.

Total density of benthic invertebrates collected by the Surber sampler was calculated by dividing the total number of organisms counted from a sample by the sampling area of the Surber sampler. Total density of benthic invertebrates collected by the kick net sampler was calculated by total number of organisms from a sample per kick net.

2.2.5 Fish Community

Electrofishing was the only method used in 2009 for sampling fish communities. A mixture of single-pass and three-pass electrofishing was conducted. In 2008, three-pass electrofishing was conducted at sites where flows were low enough that blocking nets could be installed in streams. At many sites flows were too high and blocking nets were washed out; for those sites, only single pass electrofishing with no blocking nets were used. In 2009, three-pass electrofishing was attempted for those sites in which this method was successful in 2008. However, due to equipment failure, only two sites in total were successfully sampled using the three-pass method.

For three-pass electrofishing, blocking nets were installed at the upstream and downstream ends of a stream section, approximately 75 m in length. A two-person crew walked the stream section in an upstream direction repeatedly sweeping the stream from bank to bank with the wand (anode) of the electrofishing unit. Fish were captured with a dipnet and stored in a bucket of freshwater. After a pass was complete, the crew processed the captured fish and waited 30 minutes before the next pass was

conducted. After three passes, the blocking nets were removed and all processed fish were released live back into the stream except for those sculpin that were retained for tissue metals analysis.

All fish were identified to species and counted. Fork length was measured to the nearest 1 mm with a measuring board (total length was measured for slimy sculpin), and wet weight was measured to the nearest 0.1 g or 1.0 g with a balance (depending on size of fish). Scales were collected from Arctic grayling for age analysis. Scales were taken on the side of the fish mid-way between the lateral line and the dorsal fin. Arctic grayling scales were sent to North Shore Environmental Services Ltd. In Thunder Bay, ON, where the scales were mounted on micro-fiches and the annuli were counted. A Chain of Custody form accompanied the samples.

2.2.6 Fish Tissue Metals Concentrations

A sub-set of 24 slimy sculpins captured by electrofishing in August were collected for analysis of whole-body tissue metals concentrations. Each fish was placed in a labelled plastic bag and frozen immediately. The samples were sent to Maxxam analytics in Vancouver, BC. Chain of Custody forms accompanied all samples. At Maxxam, samples were digested using a nitric acid-hydrochloric acid mixture based on U.S. EPA method 200.8 (Creed *et al*., 1994). The concentrations of 29 metals were measured using Inductively Coupled Atomic Emission Spectrometry (ICP-AES) or ICP Mass Spectroscopy (ICP-MS) (Table 9). The concentrations of mercury were measured using Cold Vapour Atomic Absorption Spectrophotometry (CVAAS).

Table 9. Fish Tissue Metals and Detection Limits

Metal	RDL	Metal	RDL
Aluminum	1	Manganese	0.1
Antimony	0.1	Mercury	0.01
Arsenic	0.01	Molybdenum	0.1
Barium	0.1	Nickel	0.1
Beryllium	0.1	Phosphorus	10
Bismuth	0.1	Potassium	10
Boron	5	Selenium	0.01
Cadmium	0.01	Silver	0.05
Calcium	10	Sodium	10
Chromium	0.5	Strontium	0.1
Cobalt	0.1	Thallium	1
Copper	0.5	Uranium	0.05
Iron	10	Vanadium	2
Lead	0.01	Zinc	0.1
Magnesium	10		

All units are mg/kg wet weight.

RDL = Reported Detection Limit.

2.2.7 Fish Habitat

Fish habitat was characterized following the methods described in the Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Site Card Field Guide (RIC, 2008). Stream length and stream width (i.e., wetted and bankfull width) were measured with a surveyor's measuring tape. Gradient was measured with a clinometer. Stream depth was measured with a meter stick. Stream stage was visually assessed as low, medium or high by comparing stream surface and bankfull heights. Habitat was visually assessed and categorized into one of the following five types:

- ***Pools -*** slow-moving water with a zero gradient and a concave bottom;
- ***Runs*** (also called glides) - sections of non-turbulent, fast-flowing water;
- ***Riffles*** - areas of turbulent, fast-flowing water with gravel or cobble substrates and obvious surface turbulence;
- ***Cascades*** - steep, stepped "riffles" of bedrock, emergent cobble or boulders in channels with gradients greater than about 4%;
- ***Other*** - includes wetland complexes that lack an identifiable primary channel, sloughs, lakes, areas of sub-surface flow or areas where the channel cannot be observed (e.g., under large log jams).

Stream substrate was visually assessed and categorized into the following classes:

- fines (<0.2 cm)
- gravels (0.2 – 6.4 cm)
- cobbles (6.4 – 25.6 cm)
- boulders (>25.6 cm)
- rock (>400 cm)

The percent of the stream surface that provided fish with cover was visually assessed using the following classes:

- deep pool;
- large woody debris (LWD);
- boulder;
- cutbank;
- instream vegetation; and
- overhanging vegetation.

Stream confinement was visually assessed. The following descriptions were used for each category of stream confinement:

- unconfined (UC) – the stream bank is not touching the valley wall;
- occasionally confined (OC) – the stream bank is occasionally confined by the valley wall or terraces;
- frequently confined (FC) – the stream bank is frequently confined by the valley wall or terraces;
- confined (CO) – the stream bank is in continuous or repeated contact at the outside of meander bends;

- entrenched (EN) – the stream bank is in continuous contact with the valley walls or terraces due to downcutting; and
- not applicable (NA) – no valley walls exist (e.g., alluvial fans).

The stream section was classified as braided or non-braided and the percent of the stream surface area made up of gravel bars was recorded.

2.3 QA/QC

2.3.1 Water Quality

All field equipment was maintained in good working condition and measuring instruments were calibrated frequently. For example, the pH meter was calibrated prior to each field trip using prepared solutions with pHs of 4, 7 and 10, and the conductivity meter was checked prior to each field trip using the standard 1,413 µS/cm conductivity solution.

Water quality samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency. All water samples were collected using industry standard sampling protocols. Appropriate measures were taken to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used bottles and preservative supplied by the analytical laboratory. All samples were collected with the mouth of the sampling bottle facing upstream. Care was taken to insure that no upstream disturbances occurred as the result of walking within the creek bed prior to sampling.

Approximately ten percent of the number of water quality samples were replicated, hence a total of twelve replicate samples were collected: one in May, two each in June, August, September, October and November and one in December. Replicate sample locations were chosen randomly. Appendix A8 shows the results of analysis of replicate samples. Relative Percent Difference (RPD) was used to assess analytical variability. RPD was defined as:

$$\%RPD = \frac{2(X_1 - X_2)}{(X_1 + X_2)} * 100$$

where X_1 = the concentration of a parameter in the first sample and X_2 = the concentration of the same parameter in the second sample (i.e., the replicate). An RPD less than 25% is considered an acceptable difference, and an RPD greater than 25% warrants further examination to ensure that the result was not due to sampling error or analytical error. RPD is only relevant when both values are greater than the Practical Quantitation Limit (PQL), which was defined for this project as three times the detection limit. The PQL is considered the lowest concentration that can be accurately measured, as opposed to just detected.

As shown in Appendix A8 and Table 10, between one and eight of the 90 parameters that were measured from each sample had RPDs greater than 25% and met PQL restrictions. This was equivalent to between 1% and 9% of all parameters, which is considered to be an acceptable level of variability.

Table 10. RPD Analysis of Replicate Water Quality Samples, Casino Project, 2009

Month	Replicate	Number of Parameters with RPD>25%	Percent of Parameters with RPD>25%
May	1	6	6.7
June	2	8	8.9
June	3	3	3.3
August	4	2	2.2
August	5	1	1.1
September	6	3	3.3
September	7	3	3.3
October	8	3	3.3
October	9	3	3.3
November	10	4	4.4
November	11	4	4.4
December	12	2	2.2

A total of 90 parameters were measured from each sample.

The sites, dates and parameters for which RPD was greater than 25% were as follows:

- W2, May, ammonia, TKN, total lead, total titanium, total vanadium and dissolved zinc;
- W2, June, turbidity, TKN, total chromium, total cobalt, total zinc, dissolved lead, dissolved titanium and dissolved zinc;
- W15, June, TSS, total cadmium and dissolved lead;
- W3, August, Total Organic Carbon and dissolved lead;
- W43, August, turbidity;
- W7, September, conductivity, TKN, and dissolved uranium;
- W15, September, total lead, dissolved iron and dissolved zinc;
- W1, October, TKN, total cobalt and total zinc;
- R2, October, total nickel, total zinc and dissolved cobalt;
- W6b, November, turbidity, TKN, total cobalt and total phosphorus;
- W20, November, TDS, ammonia, TKN, dissolved zinc; and
- W16, December, total and dissolved lead.

The results of the field and travel blanks are shown in Appendices A1 to A7. A total of five field blanks and four travel blanks were collected. The field blanks collected in May and June showed slightly elevated concentrations of TOC, sulphate, chloride, nitrate, TKN, dissolved orthophosphate, total aluminium, total bismuth, total copper, total lead, total phosphorus, total tin, total uranium, total vanadium and total zinc. This indicates there may have been minor contamination associated with either field or lab technique. All other values were below detection limits, indicating no contamination of samples.

Maxxam Analytics, which conducted the analyses of water and sediment samples, is a certified member of the Canadian Association of Environmental Analytical Laboratories. Maxxam split several samples into duplicates and analyzed each one separately to provide a measure of their laboratories analytical

precision. Duplicates were chosen randomly by Maxxam. The results, which are not reported here, met Maxxam's standards for QA/QC.

2.3.2 Sediment Quality

Sediment quality samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency. All sediment samples were collected using industry standard sampling protocols. Appropriate measures were taken to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used sample bottles supplied by the analytical laboratory.

Both sediment samples in August were replicated, hence a total of two replicate samples were collected. Appendix B2 shows the results of analysis of replicate samples. Relative Percent Difference (RPD) was used to assess analytical variability. RPD was defined above in Section 2.3.1, however, as natural heterogeneity in a soil matrix is more prominent than in water samples, accepted RPD values is 50%. The PQL for sediment samples was defined as five times the detection limit.

As shown in Appendix B2 and Table 11, between zero and twelve of the 32 parameters that were measured from each sample had RPDs greater than 50% and met PQL restrictions. This was equivalent to between 0% and 37.5% of all parameters and although this is a high level of variability, this is considered acceptable as the expected degree of replicability is generally lower in a soil matrix due to its inherent heterogenenity.

Table 11. RPD Analysis of Replicate Sediment Quality Samples, Casino Project, 2009

Month	Replicate	Number of Parameters with RPD>50%	Percent of Parameters with RPD>50%
August	1	0	0
August	2	12	37.5

A total of 32 parameters were measured from each sample.

2.3.3 Periphyton and Benthic Invertebrates

Periphyton and benthic invertebrate samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency.

Fraser Environmental Services Ltd. (FES) has over fifteen years experience in analysis of periphyton from streams and rivers of western Canada. FES has the following standard QA/QC procedures (FES 1994):

- all microscopes are calibrated on a regular basis;
- consistent sample concentration and sub-sampling techniques are employed for identifications;
- taxonomic identifications are verified by comparison with reference collections, including an in-house reference collection;

- difficult, typical or dominant specimens are sent to external experts for confirmation. Part of this process includes compiling a list of experts for different groups of organisms. Verified specimens are incorporated into FES' reference collection; and
- all FES personnel actively participate in a taxonomists' working group.

Cordillera Consulting has over ten years experience in taxonomic analysis of benthic invertebrates from streams, rivers and lakes of western Canada. The following QA/QC procedures are followed by Cordillera Consulting (http://www.cordilleraconsulting.com):

- sorting efficiency – 10% of the whole sample number was resorted with an expectation of >90% efficiency in the sorting process.
- taxonomic efficiency – 10% of the identified sample vials were sent to another taxonomist. The two results were compared with simple statistics and the taxonomists discussed how best to correct their differences and make appropriate changes to the results.
- taxonomic precision – an externally verified reference collection is maintained by Cordillera Consulting. Any new specimens are sent away to experts of that taxon and the collection is reviewed every five years.

2.3.4 Fish and Fish Habitat

All fish and fish habitat field data were recorded on waterproof paper field notes and then transferred to electronic spreadsheets in the office. The spreadsheets were compared with the field notes to identify and correct transcription errors. A variety of other measures were taken to further ensure the validity of the data. For example, fish weights were plotted against fish lengths for each species separately to identify outliers that may have been due to errors in recording or transcription. Outliers were then corrected, if possible, or excluded from the analyzed dataset.

Quality Assurance was run by Maxxam Analytics for the batch of Slimy sculpin tissue that was analyzed for metals concentration. Appendix E3 shows those data. For quality assurance Maxxam Analytics uses spiked blank, method blank, and QC standard. A spiked blank is a blank matrix with a known amount of added analyte. A method blank is a blank matrix containing all reagents used in the analytical procedure. A QC standard is a blank matrix with a known amount of added analyte. All blanks were within the QC limits, indicating no contamination of equipment.

2.4 Data Analysis

2.4.1 Water Quality

The minimum, median and maximum concentrations of selected water quality parameters were calculated for each site sampled in 2009. The median, rather than the arithmetic mean, was assumed to be the best estimate of the central tendency of the data because many water quality variables tend not to be normally distributed. To calculate statistics, all data for each site were pooled over the May-December sampling period and values below detection limits were replaced with one-half the detection limit.

Concentrations of water quality parameters were compared to guidelines for the protection of freshwater aquatic life issued by the Canadian Council of the Ministers of the Environment (CCME) (CCME, 2007), and parameters exceeding the guidelines were identified.

2.4.2 Sediment Quality

The minimum, median and maximum concentrations of each sediment quality parameter were not calculated because samples were only taken once in August 2009.

The 2009 sediment quality data were compared to the CCME (2002) sediment guidelines for the protection of freshwater aquatic life. There are two classes of guidelines: the Probable Effects Level (PEL), which defines the level above which adverse effects are expected to occur frequently and the Interim Sediment Quality Guideline (ISQG), which is lower than the PEL and defines the concentration below which minimal effects on the aquatic environment are expected.

2.4.3 Periphyton and Benthic Invertebrates

One-way Analysis of Variance (ANOVA) was used to compare mean densities of periphyton and of benthic invertebrates between sites. ANOVA assesses the statistical significance of differences using F-ratios. Significance was assessed as none ($P>0.05$), low ($0.01<P<0.05$), medium ($0.001<P<0.01$) and high ($P<0.001$), where P is the probability of making a Type I error (i.e., rejecting a true null hypothesis). Density values were transformed using natural logarithmic values to normalize the frequency distributions and to satisfy the assumption of equal variances – two prerequisites of parametric statistics.

Post-hoc comparisons of means were calculated using the Bonferroni test to show which sites were significantly different from one another. This is denoted on the graphs using letters; sites that are not significantly different are labelled with the same letter, while sites that are significantly different will not share the same letters.

The taxonomic composition of periphyton and benthos communities were assessed using tabular means after pooling replicates for each site.

Two indices of taxonomic diversity were calculated for each sample of periphyton and three indices were calculated for each sample of benthic invertebrates using the protocols recommended by the Canadian Aquatic Biomonitoring Network (CABIN), which is supported by the National Water Research Institute (NWRI) of Environment Canada (NWRI 2008):

- taxonomic richness (S), calculated as the total number of families in a sample, regardless of their relative abundances;
- EPT abundance (EPT), defined as the total number of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) in a sample. These three orders of aquatic insects are typically most sensitive to habitat disturbance. EPT was not calculated for periphyton; and
- Shannon-Weiner diversity index (H'), calculated as $-\Sigma(p_i \ln(p_i))$, where $p_i = n_i/N$, n_i = the total number of individuals in the ith species, N = the total number of organisms in the sample, and H' was calculated by summing over all species (i.e., over S).

For the purposes of calculating S and H', those taxa that could not be identified to the family or species level (e.g., unidentified flagella for periphyton and Phylum Nematoda for benthos) were treated as if they were a family or a species. The periphyton data reported by Fraser Environmental Services included less than signs (<) for some species or genus, indicating that the species or genus were present in the sample but not in sufficient numbers to allow density to be calculated. Those data were used to calculate periphyton richness, but they were not used to calculate densities and Shannon-Wiener diversity indices.

2.4.4 Fish and Fish Habitat

The standard error (SE) was the index of dispersion for all arithmetic means shown in this report, and n was the sample size.

Total catch-per-unit-effort (CPUE) of electrofishing CPUE was defined as the number of fish captured per 100 seconds of electrofishing effort.

Fulton Condition Factor (K) were calculated for each fish as:

$$K = (W/L^3) * 100{,}000$$

where *W* = weight (g) and *L* = fork length (mm).

Weight-length regressions for fish were calculated as W = a + b(L), where W = weight (g) and L = fork length (mm), a = the intercept of the regression and b = the slope of the regression.

3 Results and Discussion

3.1 Water Quality

3.1.1 Statistical Summary

Appendices A1 to A7 show the surface water quality data for the months of May, June, August, September, October, November and December 2009, and Table 12, Table 13, Table 14, and Table 15 show the minimum, median and maximum values for selected water quality parameters for sites in Casino Creek, Dip Creek, Britannia Creek, and the Yukon River watersheds, respectively.

Table 12. Water Quality Summary Statistics, Casino Creek Watershed, 2009

Station	Hardness (mg/L $CaCO_3$)	Conductivity (µS/cm)	pH	Total Suspended Solids	Total Alkalinity (as mg/L $CaCO_3$)	Sulfate	Total Cyanide	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Total Zinc
CCME[a]			6.5-9.0				0.005	0.005-0.1[b]	0.005	0.000017[c]	0.001	0.002-0.004[d]	0.3	0.001-0.007[e]	0.073	0.025-0.15[f]	0.001	0.03
W43 - Pipe outflow of portal near lower camp																		
Min	105	220	6.9	0.5	71	35	0.00025	0.0023	0.00043	*0.0458*	0.00005	*0.0463*	0.026	*0.00429*	0.000025	0.00039	0.00002	*2.4*
Median	115	250	7.1	0.5	82	40	0.00025	0.0099	0.00061	*0.0475*	0.00005	*0.0549*	0.038	*0.00707*	0.000025	0.000435	0.00002	*2.5*
Max	125	279	7.2	0.5	93	44	0.00025	0.0175	0.00078	*0.0492*	0.00005	*0.0635*	0.049	*0.00985*	0.000025	0.00048	0.00002	*2.6*
n	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
W12 - Proctor Gulch before confluence with Casino Creek																		
Min	164	520	*3.3*	5	0.25	190	0.00025	*5.3*	0.00042	*0.0014*	0.0004	*0.465*	*12.9*	0.00102	0.00011	0.00364	0.00016	*0.101*
Median	185	599	*3.6*	19	0.25	200	0.00025	*5.3*	0.00043	*0.0014*	0.0007	*0.473*	*18.3*	0.00145	0.00025	0.00384	0.00022	*0.105*
Max	403	1100	*3.9*	54	0.25	430	0.0005	*11.4*	0.00197	*0.0032*	0.0008	*1.02*	*36.1*	0.00164	0.00031	0.00732	0.00027	*0.221*
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W8 - Upper Reach of Casino Creek us of confluence with Meloy Creek																		
Min	154	340	7.6	7	46	110	0.00025	*0.621*	0.00023	*0.00029*	0.00005	*0.0643*	*1.55*	0.00119	0.00027	0.00083	0.00007	0.0224
Median	154	340	7.6	7	46	110	0.00025	*0.621*	0.00023	*0.00029*	0.00005	*0.0643*	*1.55*	0.00119	0.00027	0.00083	0.00007	0.0224
Max	154	340	7.6	7	46	110	0.00025	*0.621*	0.00023	*0.00029*	0.00005	*0.0643*	*1.55*	0.00119	0.00027	0.00083	0.00007	0.0224
n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W13 - Mouth of Meloy Creek																		
Min	139	271	8.0	22	110	29	0.00025	0.0138	0.00113	*0.000046*	0.00005	0.00046	0.022	0.000755	0.00068	0.0002	0.00002	0.0025
Median	139	271	8.0	22	110	29	0.00025	0.0138	0.00113	*0.000046*	0.00005	0.00046	0.022	0.000755	0.00068	0.0002	0.00002	0.0025
Max	139	271	8.0	22	110	29	0.00025	0.0138	0.00113	*0.000046*	0.00005	0.00046	0.022	0.000755	0.00068	0.0002	0.00002	0.0025
n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W11 - Casino Creek (proposed dam outflow)																		
Min	45.1	85	7.2	0.5	25	9	0.00025	0.04	0.00055	*0.00004*	0.00005	*0.00441*	0.035	0.000158	0.00025	0.00024	0.00008	0.0018
Median	160	312	7.9	1	89	64	0.00025	*0.12*	0.00059	*0.00007*	0.0001	*0.0126*	0.251	0.000307	0.0008	0.00035	0.00014	0.0044
Max	203	380	8.1	53	120	79	0.0008	*0.63*	0.00117	*0.00028*	0.0005	*0.0266*	*0.698*	*0.0748*	0.00089	0.00123	0.00018	0.0211
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
W18 - Brynelsen Creek																		
Min	36.3	63	7.2	0.5	24	0.3	0.00025	0.0099	0.0003	0.000003	0.00005	0.00054	0.005	0.0000025	0.00045	0.00013	0.00002	0.0002
Median	88.9	191	7.9	0.5	73	23	0.00025	0.0279	0.0004	0.000012	0.0001	0.00083	0.019	0.000029	0.00142	0.00023	0.00004	0.0005
Max	124	244	8.0	46	92	36	0.0009	*0.709*	0.0007	0.000038	0.0006	0.00299	*0.617*	0.000444	0.00205	0.00102	0.00006	0.004
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
W4 - Mouth of Casino Creek																		
Min	52.8	100	7.3	0.5	33	10	0.00025	0.012	0.00029	0.000013	0.00005	0.00176	0.011	0.00003	0.00037	0.00016	0.00006	0.0009
Median	133	273	7.9	0.5	91	43	0.0007	0.033	0.00038	0.000017	0.00005	*0.00376*	0.068	0.000053	0.00118	0.00023	0.00008	0.0009
Max	176	320	8.0	130	110	58	0.092	*0.821*	0.00152	*0.000271*	0.0006	*0.0278*	*1.08*	*0.119*	0.00138	0.00146	0.00008	0.0238
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

All units mg/L unless otherwise noted

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

0.231 result exceeds CCME Aquatic Life Guidelines

Table 13. Water Quality Summary Statistics, Dip Creek Watershed, 2009

Station	Hardness (mg/L $CaCO_3$)	Conductivity (µS/cm)	pH	Total Suspended Solids	Total Alkalinity (as mg/L $CaCO_3$)	Sulfate	Total Cyanide	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Total Zinc
CCME[a]			**6.5-9.0**				**0.005**	**0.005-0.1[b]**	**0.005**	**0.000017[c]**	**0.001**	**0.002-0.004[d]**	**0.3**	**0.001-0.007[e]**	**0.073**	**0.025-0.15[f]**	**0.001**	**0.03**
W9 - Dip Creek us of Confluence with Casino Creek																		
Min	49.2	110	7.4	0.5	45	3	0.00025	0.0106	0.0002	0.0000025	0.00005	0.00065	0.039	0.000018	0.00034	0.00024	0.00002	0.0003
Median	89.6	183	7.8	0.5	79	15	0.00025	0.0221	0.0003	0.000006	0.00005	0.00084	0.059	0.000035	0.00071	0.00032	0.00004	0.0004
Max	116	227	7.9	160	99	19	0.0013	*0.777*	0.0014	*0.000054*	0.001	*0.00526*	*1.44*	0.00132	0.00081	0.0021	0.00007	0.0060
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
W5 - Dip Creek ds Casino confluence																		
Min	56.3	110	7.4	0.5	41	8	0.00025	0.0107	0.00026	0.0000025	0.00005	0.00104	0.039	0.000018	0.00049	0.00023	0.00005	0.0003
Median	107	211	7.9	0.5	83	24	0.00025	0.0235	0.00034	0.000007	0.0001	0.00169	0.059	0.000042	0.00089	0.00025	0.00005	0.0007
Max	135	262	8.0	96	100	33	0.0011	*0.469*	0.00087	*0.000061*	0.0007	*0.00929*	*0.784*	0.00292	0.00099	0.00122	0.00006	0.0043
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
R2 - Tributary to Dip Creek																		
Min	68.7	139	7.7	0.5	60	12	0.00025	0.0155	0.00015	0.0000025	0.00005	0.00073	0.011	0.000006	0.00081	0.00026	0.00005	0.0002
Median	75.5	165	7.8	0.5	66	17	0.00025	0.0236	0.0002	0.000005	0.0001	0.00086	0.029	0.000023	0.0009	0.00031	0.00006	0.0005
Max	94.2	174	7.9	2	73	19	0.00025	0.0426	0.00025	0.000009	0.0003	0.00104	0.063	0.000124	0.00095	0.00039	0.00008	0.0006
n	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
W16 - Lower Reach of Dip Creek																		
Min	64.8	130	7.4	0.5	47	15	0.00025	0.0102	0.00031	0.0000025	0.00005	0.00101	0.078	0.000015	0.00054	0.00032	0.00004	0.0004
Median	109	221	7.9	1	83	29	0.00025	0.0327	0.00047	0.00001	0.0001	0.00154	0.168	0.000098	0.00096	0.00047	0.00006	0.0007
Max	140.5	269.5	8.0	37	110	35	0.0013	*0.342*	0.00098	0.000073	0.0005	*0.00892*	*0.676*	0.00301	0.00104	0.00125	0.00009	0.0044
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
W20 - Klotassin River us of Dip Creek																		
Min	75.3	157	7.6	0.5	64	14	0.00025	0.0074	0.00033	0.0000025	0.0001	0.00066	0.150	0.000009	0.00058	0.00044	0.00008	0.0002
Median	81.1	163.5	7.8	0.75	66.5	16	0.00025	0.0115	0.00044	0.0000043	0.00015	0.000865	0.278	0.000039	0.00062	0.00053	0.00010	0.0004
Max	83	170	7.9	1	69	18	0.0005	0.0201	0.00106	0.000012	0.0003	0.00118	*0.815*	0.000091	0.00063	0.00057	0.00011	0.0007
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
W21 - Klotassin River ds of Dip Creek																		
Min	81.8	169	7.7	0.5	69	17	0.00025	0.0085	0.00039	0.0000025	0.0001	0.00089	0.226	0.000017	0.00062	0.0005	0.00008	0.0003
Median	86.05	174	7.8	0.5	72	20	0.00025	0.012	0.00047	0.0000065	0.00015	0.000955	0.284	0.000030	0.000685	0.00053	0.00009	0.0005
Max	91.2	185	7.9	1	73	23	0.0006	0.0204	0.00053	0.000015	0.0002	0.00114	*0.393*	0.000128	0.00072	0.00055	0.00010	0.0014
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

All units mg/L unless otherwise noted

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

0.231 result exceeds CCME Aquatic Life Guidelines

Table 14. Water Quality Summary Statistics, Britannia Creek Watershed, 2009

Station	Hardness (mg/L $CaCO_3$)	Conductivity (µS/cm)	pH	Total Suspended Solids	Total Alkalinity (as mg/L $CaCO_3$)	Sulfate	Total Cyanide	Total Aluminum	Total Arsenic	Total Cadmium	cd guideline	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Total Zinc
CCME[a]			**6.5-9.0**				**0.005**	**0.005-0.1[b]**	**0.005**	**0.000017[c]**		**0.001**	**0.002-0.004[d]**	**0.3**	**0.001-0.007[e]**	**0.073**	**0.025-0.15[f]**	**0.001**	**0.03**
W7 - Upper Canadian Creek																			
Min	28	75	*6.4*	1	3.5	25	0.00025	*0.023*	0.00018	*0.000113*	0.000011	0.00005	0.00133	0.027	0.00006	0.00015	0.00065	0.00006	0.0102
Median	47.8	134	7.1	3.5	7.5	44	0.00025	*0.102*	0.00029	*0.000148*	0.000018	0.00013	*0.00277*	0.096	0.00021	0.00027	0.00079	0.00007	0.0105
Max	61.3	217	8.0	11	11	54	0.0009	*0.173*	0.0005	*0.000185*	0.000022	0.0003	*0.00506*	0.179	0.00065	0.00037	0.00115	0.00007	0.0205
n	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4	4	4
W3 - Canadian Creek us of confluence with Britannia Creek																			
Min	71	140	7.4	0.5	38	32	0.00025	0.009	0.00041	0.000008	0.000025	0.00005	0.00153	0.006	0.00001	0.0005	0.00051	0.00005	0.0005
Median	129	259	7.9	0.5	70	54	0.0006	0.020	0.00066	0.000019	0.000041	0.0002	0.00238	0.022	0.00003	0.0009	0.00069	0.00007	0.0013
Max	179	346	8.0	34	94	79	0.0012	*0.186*	0.00119	0.000054	0.000055	0.0005	*0.00552*	*0.343*	0.00049	0.0014	0.00141	0.00009	0.0034
n	7	7	7	7	7	7	7	7	7	7		7	7	7	7	7	7	7	7
W14 - Mouth of Britannia Creek																			
Min	54	94	7.3	0.5	31	9	0.00025	0.012	0.00034	0.0000025	0.000019	0.00005	0.00119	0.011	0.000009	0.00018	0.00016	0.00004	0.0003
Median	142	265	8.0	1	92	55	0.0007	0.057	0.00056	0.000013	0.000045	0.0003	0.00169	0.042	0.000053	0.00057	0.00055	0.00009	0.001
Max	223	444	8.1	20	140	92	0.0018	*0.500*	0.00097	0.00003	0.000066	0.0006	0.00287	*0.428*	0.000273	0.00133	0.00107	0.00011	0.0041
n	7	7	7	7	7	7	7	7	7	7		7	7	7	7	7	7	7	7
W2 - Brittania Creek ds from																			
Min	64	120	7.3	0.5	35	23	0.00025	0.011	0.00042	0.000008	0.000022	0.0001	0.00147	0.009	0.000009	0.00036	0.0005	0.00006	0.0006
Median	142	282	7.9	0.5	81	60	0.0008	0.037	0.00068	0.000015	0.000045	0.0003	0.00235	0.033	0.000088	0.00078	0.0010	0.00008	0.0013
Max	205	390	7.9	21	110	86	0.0015	*0.313*	0.00095	0.000041	0.000061	0.0004	*0.00465*	0.283	0.000283	0.00116	0.0027	0.0003	0.0021
n	7	7	7	7	7	7	7	7	7	7		7	7	7	7	7	7	7	7
W1 - Mouth of Canadian Creek																			
Min	74	150	7.4	0.5	41	27	0.00025	0.011	0.00042	0.000011	0.000025	0.0001	0.00147	0.006	0.000006	0.0004	0.00044	0.00009	0.0004
Median	182	372	7.8	0.5	100	84	0.00025	0.017	0.00047	0.000018	0.000055	0.0002	0.00182	0.017	0.000033	0.0010	0.00054	0.00011	0.0005
Max	224	421	8.1	10	110	110	0.0008	*0.236*	0.00077	0.000019	0.000066	0.0003	0.00361	0.215	0.000154	0.0011	0.00105	0.00015	0.0016
n	5	5	5	5	5	5	5	5	5	5		5	5	5	5	5	5	5	5

All units mg/L unless otherwise noted

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

b) 0.005 mg/L at pH < 6.5, [Ca^{2+}] < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, [Ca^{2+}] ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at [$CaCO_3$] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

0.231 result exceeds CCME Aquatic Life Guidelines

Table 15. Water Quality Summary Statistics, Yukon River Watershed, 2009

Station	Hardness (mg/L $CaCO_3$)	Conductivity (µS/cm)	pH	Total Suspended Solids	Total Alkalinity (as mg/L $CaCO_3$)	Sulfate	Total Cyanide	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Total Zinc
CCME[a]			**6.5-9.0**				**0.005**	**0.005-0.1[b]**	**0.005**	**0.000017[c]**	**0.001**	**0.002-0.004[d]**	**0.3**	**0.001-0.007[e]**	**0.073**	**0.025-0.15[f]**	**0.001**	**0.03**
W17 - Sunshine Creek																		
Min	128	266	7.7	0.5	91	41	0.00025	0.017	0.00052	0.000013	0.00005	0.00121	0.014	0.000225	0.00049	0.00045	0.00007	0.0004
Median	128	266	7.7	0.5	91	41	0.00025	0.017	0.00052	0.000013	0.00005	0.00121	0.014	0.000225	0.00049	0.00045	0.00007	0.0004
Max	128	266	7.7	0.5	91	41	0.00025	0.017	0.00052	0.000013	0.00005	0.00121	0.014	0.000225	0.00049	0.00045	0.00007	0.0004
n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W6b - Yukon River Upstream of Canadian Creek																		
Min	92	188	7.7	6	69	20	0.00025	0.073	0.00043	0.000029	0.0001	0.00068	0.124	0.00009	0.00082	0.00086	0.0003	0.0014
Median	99	191.5	7.9	11.5	75	25	0.00025	*0.122*	0.00054	*0.000055*	0.0003	0.00108	0.173	0.00015	0.00113	0.00189	0.00047	0.0052
Max	109	210	8.1	62	79	29	0.0007	*0.542*	0.00137	*0.000294*	0.0009	*0.00428*	*1.24*	0.00122	0.00122	0.00594	0.00056	0.0178
n	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
W6a - Yukon River downstream of Canadian Creek																		
Min	74	150	7.7	0.5	62	12	0.00025	0.027	0.0004	0.000017	0.0001	0.00054	0.031	0.000041	0.00085	0.0006	0.00023	0.0008
Median	80	162	8.0	6	67	15	0.00025	0.070	0.0004	0.000021	0.0002	0.00076	0.104	0.000086	0.00116	0.00096	0.00025	0.0013
Max	114	212	8.1	42	90	23	0.0011	*0.236*	0.0009	*0.000129*	0.0003	*0.00269*	*0.497*	0.000551	0.00128	0.00271	0.00036	0.0071
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
W15 - Island on Yukon River us from outflow of Excelsior Creek																		
Min	79	150	7.7	0.5	63	13	0.00025	0.027	0.00039	0.000017	0.0001	0.00065	0.034	0.000061	0.00087	0.00085	0.00026	0.0011
Median	90	176	7.9	8.5	71	18	0.00025	0.083	0.00048	0.000026	0.0003	0.00088	0.130	0.000115	0.00119	0.00105	0.00031	0.0024
Max	113	210	8.0	23	87	24	0.0015	*0.189*	0.00068	*0.000048*	0.0003	0.00172	0.293	0.000325	0.00130	0.00152	0.00036	0.0037
n	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

All units mg/L unless otherwise noted

a) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

0.231 result exceeds CCME Aquatic Life Guidelines

3.1.2 Exceedances of Water Quality Guidelines

Table 16 shows that CCME guidelines for protection of freshwater aquatic life were exceeded for pH, and six total metals: aluminum (Al), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb) and zinc (Zn) in 2009. CCME guidelines were exceeded for at least one parameter at all sites except R2 in 2009, which is the new reference site. The number of exceedances was highest for total cadmium, total copper and total aluminum and least for pH (Figure 5). Exceedances of total cadmium, total copper and total aluminum often occurred together at the same stations. Exceedances were most numerous in June (n = 64), similar between May (n = 31), August (n = 23), and September (n=17) and least numerous in October, November and December (n = 8, n = 6, n=3, respectively), indicating a seasonal trend related to hydrological factors such as snow melt and stream flow.

Table 16. Water Quality Parameters Exceeding CCME Guidelines, Casino Project, 2009

Site	May	June	August	September	October	November	December
W43	NS	Cd, Cu, Pb, Zn	Cd, Cu, Pb, Zn	NS	NS	NS	NS
W12	NS	pH, Al, Cd, Cu, Fe, Zn	pH, Al, Cd, Cu, Fe, Zn	pH, Al, Cd, Cu, Fe, Zn	NS	NS	NS
W8	NS	NS	Al, Cd, Cu, Fe	NS	NS	NS	NS
W13	NS	NS	-	Cd	NS	NS	NS
W11	Al, Cd, Cu	Al, Cd, Cu, Fe, Pb	Cu	Al, Cd, Cu, Fe	Al, Cd, Cu	Cd, Cu	Cu
W18	Al, Cd	Al, Cd, Cu, Fe	-	-	-	-	-
W4	Al, Cu	Al, Cd, Cu, Fe, Pb	-	Cu	Cu	-	-
W9	Al, Cd, Fe	Al, Cd, Cu, Fe, Pb	-	-	-	-	-
W5	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe, Pb	-	Cu	-	-	-
R2	NS	NS	-	-	-	-	-
W16	Al, Cu	Al, Cd, Cu, Fe, Pb	-	-	-	-	-
W20	NS	NS	NS	-	-	Fe	Fe
W21	NS	NS	NS	-	-	Fe	Fe
W7	NS	pH, Al, Cd, Cu	Al, Cd, Cu	Cd, Cu	Cd	NS	NS
W3	Cu	Al, Cd, Cu	Al, Cd, Cu, Fe	-	-	-	-
W14	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	-	-	-	-	-
W2	Al, Cu	Al, Cd, Cu	Al	-	-	-	-
W1	NS	Al, Cu	-	NS	-	-	-
W17	NS	NS	-	NS	NS	NS	NS
W6b	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	-	Al, Cd	Al, Cd	Cd	NS
W6a	Al, Cd, Cu, Fe	Al, Cd, Fe	-	-	Cd	-	-
W15	NS	Al, Cd	-	-	-	Cd	-

Dashes indicate no parameters exceeded CCME guidelines. NS = Not sampled.

Figure 5. Water Quality Exceedances of CCME Guidelines, Casino Project, 2009

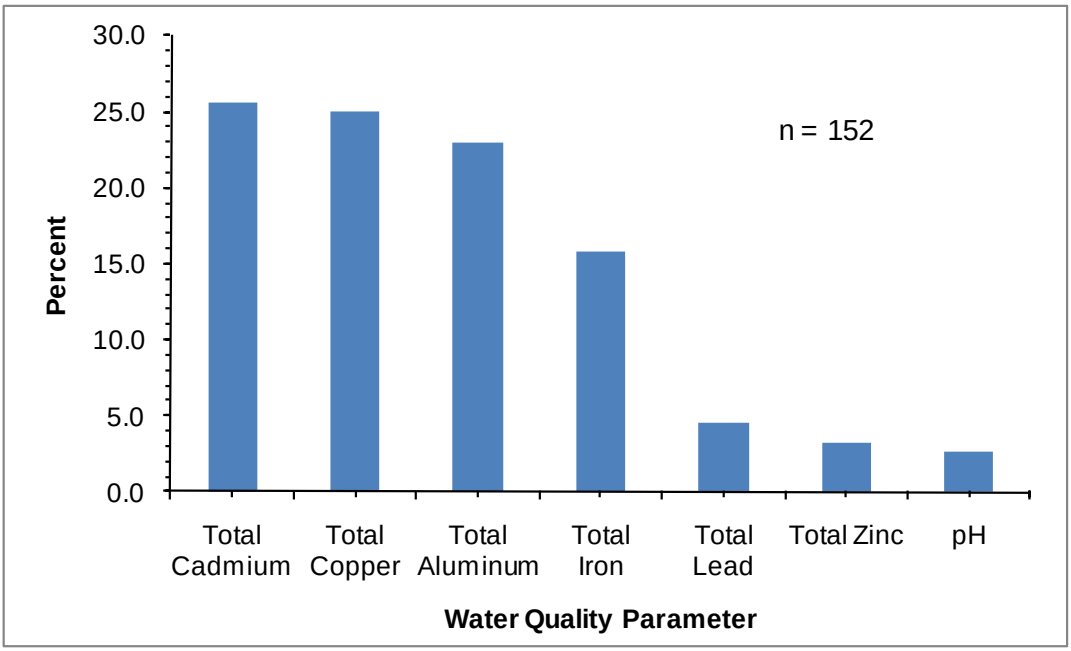


Figure 6 and Figure 7 show the spatial distribution of concentrations of total cadmium and total aluminum in the Casino Project area. These two spatial distributions represent the two types of patterns observed. Figure 6 shows that the highest concentrations of total cadmium were observed at the adit discharge, site W43. Second highest concentrations of total cadmium were observed at W12, the uppermost reach of Casino Creek. This decreasing trend appears to follow a downstream trend, indicating flow from the adit discharge flows through Casino Creek watershed. Concentrations of total cadmium in the Yukon River, Britannia Creek, Dip Creek and Klotassin River are generally uniformly low. This spatial distribution was very similar to concentrations of, total lead and total zinc and somewhat similar to concentrations of total copper, as shown in Figure 8.

Figure 7 shows that the lowest concentrations of total aluminum were observed at W43 and the highest at W12 (Proctor Gulch), and decreasing in a downstream trend in Casino Creek. Concentrations of total aluminum were generally uniformly low in the Yukon River, Britannia Creek, Dip Creek and Klotassin Creek, indicating that concentrations of total aluminum are representative of the geochemical signature of the surficial geology of Proctor Gulch. This spatial distribution pattern is very similar to total iron concentrations.

Figure 6. Median Concentration of Total Cadmium in Sampling Sites, Casino Project, 2009

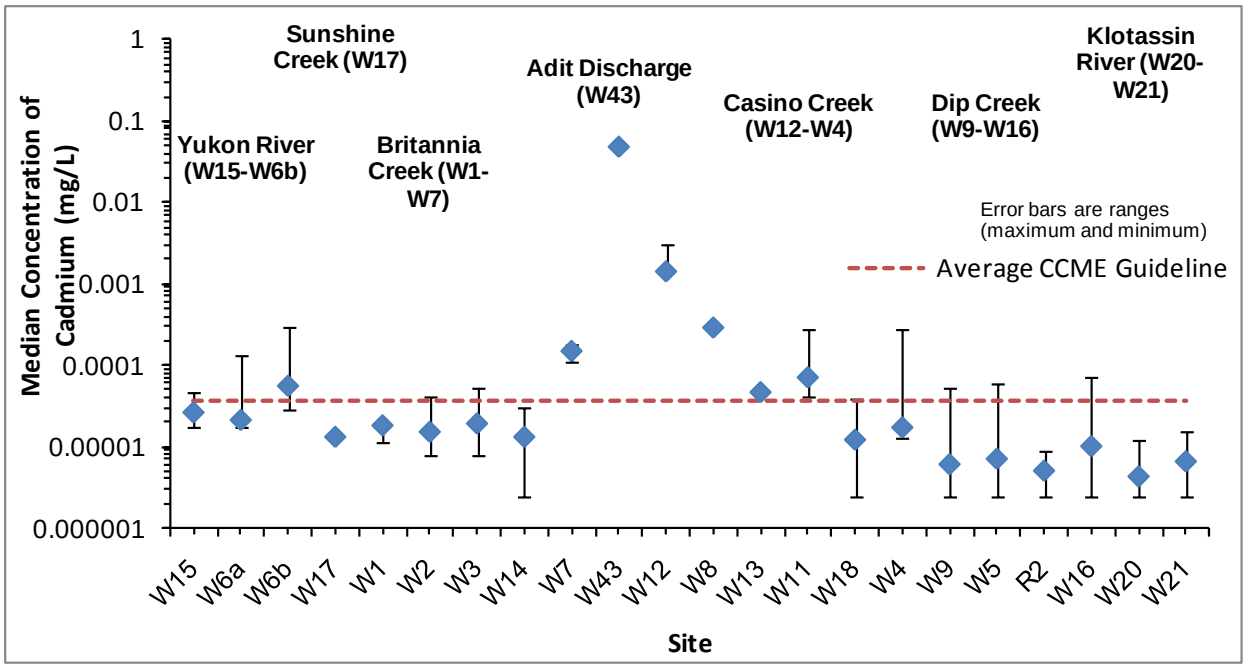


Figure 7. Median Concentration of Total Aluminum in Sampling Sites, Casino Project, 2009

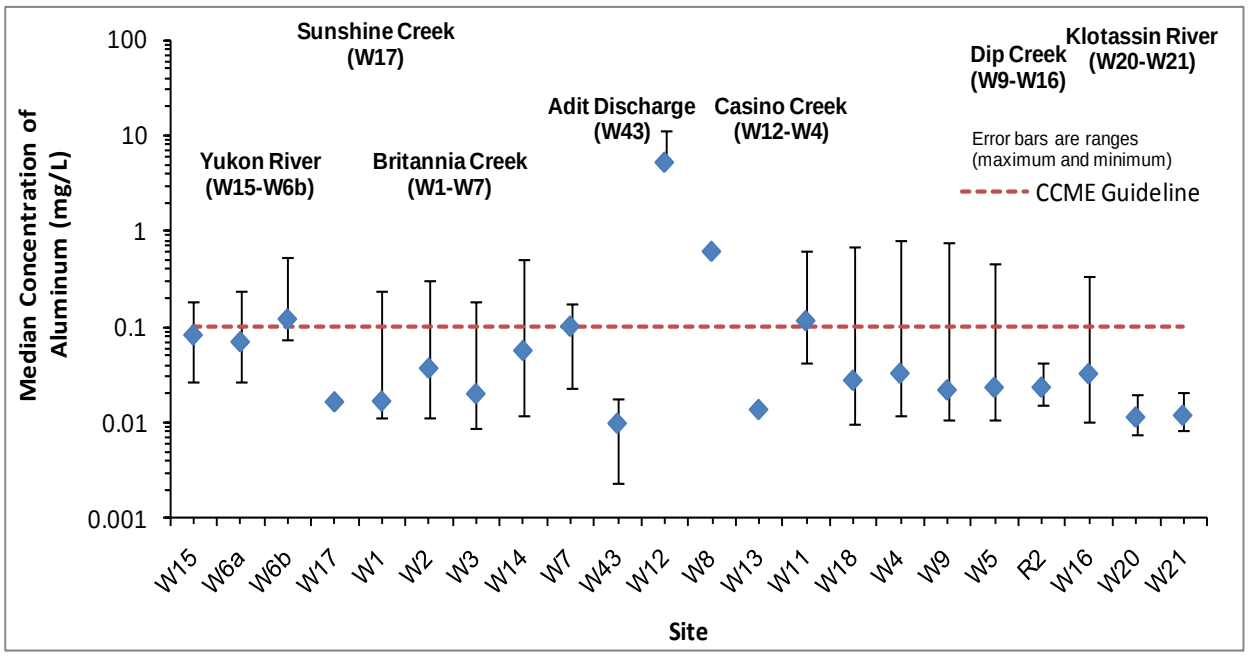
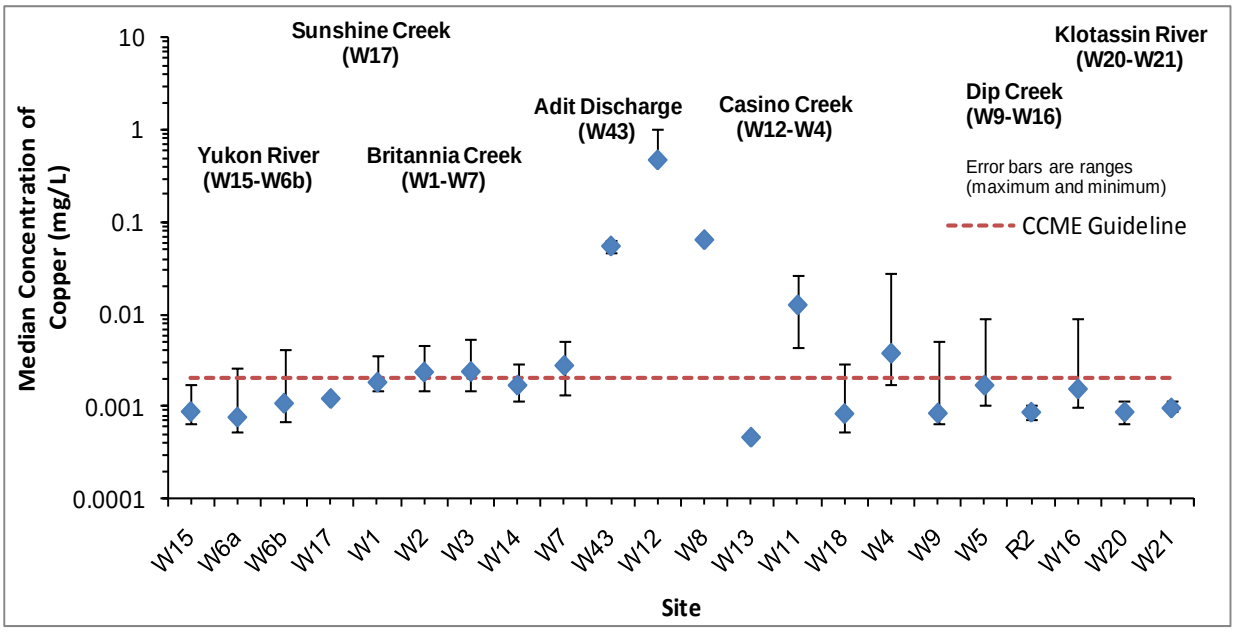


Figure 8. Median Concentration of Total Copper in Monitoring Stations, Casino Project, 2009



3.2 Sediment Quality

3.2.1 Exceedances of Sediment Quality Guidelines

Appendix B1 shows the sediment quality data. Table 17 shows the parameters exceeding the CCME sediment guidelines including the following five total metals: arsenic (As), cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn). All of those metals except arsenic were also observed to exceed CCME water quality guidelines at some stations on some dates in 2009.

Table 17. Sediment Quality Parameters Exceeding CCME Guidelines, Casino Project, 2009

Site	Interim Freshwater Sediment Quality Guideline (ISQG)	ISQG and Probable Effects Level (PEL)
R2	As	-
W12	Cd, Pb, Zn	As, Cu

Dashes indicate sample did not exceed CCME Guidelines.

3.3 Periphyton

Appendix C shows the densities (cells/cm^2) by taxa for each of the 40 samples of periphyton collected from the eight sampling sites in August 2009.

Figure 9 shows the mean densities of periphyton for each site. One-way ANOVA of the data transformed using natural logarithmic values showed there were highly significant differences in mean density among

sites ($F_{7,32}$ = 34.8, P<0.001). Post-hoc comparisons of means using the Bonferroni test showed that mean density at sites P1, P2, P4 and PR2 were significantly (P<0.05) higher than at other sites.

Figure 9. Mean Density of Periphyton by Site, Casino Project, 2009

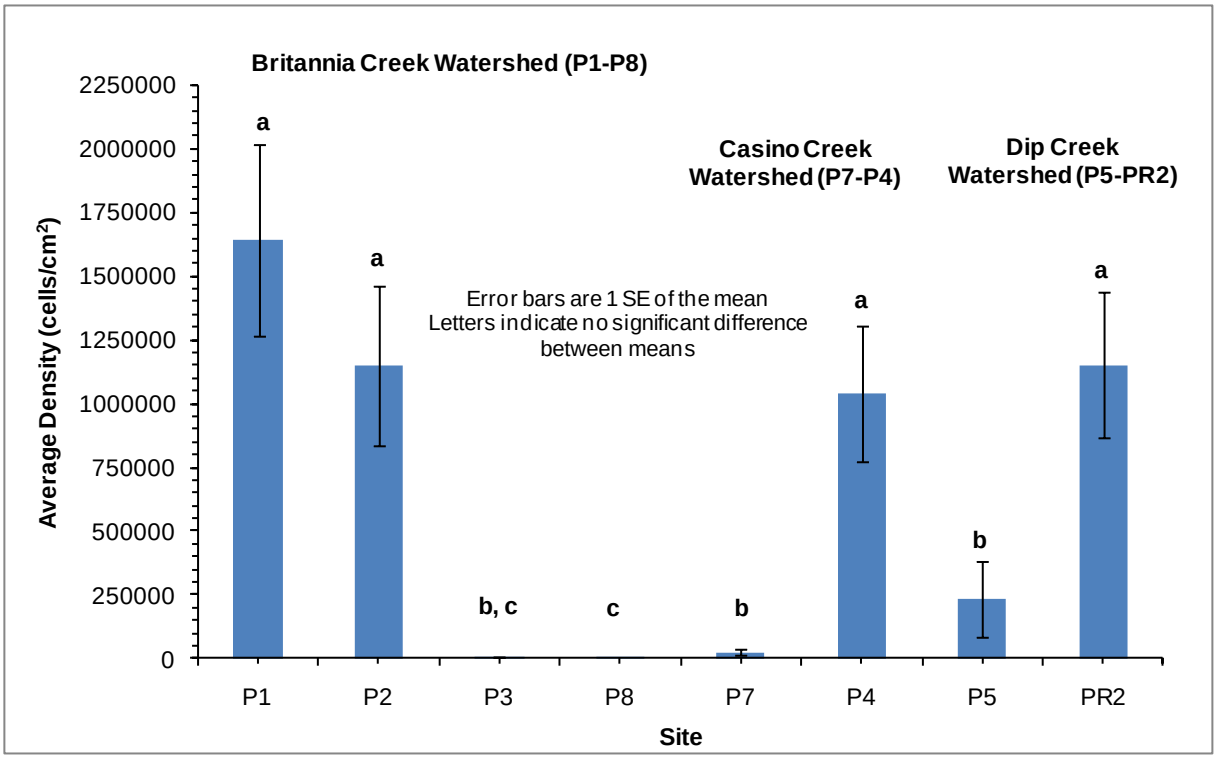


Table 18 shows the percentage composition of the periphyton community at each sampling site. Britannia Creek sites P1, P2, and P3 were dominated by diatoms, *Diatoma elongatum* and *Achnanthes minutissima,* whereas site P8 consisted of a variety of taxon that included diatoms, *Ceratoneis arcus* and *Synedra spp., and* blue-green algae, *Homoeothrix sp.* and red algae, unidentified unicellular. Casino Creek site P4 also consisted of a variety of taxon that included diatoms, *Diatoma elongatum* and *Synedra spp.* as well as blue-green algae, *Chamaesiphon spp. Homoeothrix sp.* and *Oscillatoria cf. agardhii*, whereas P7 was dominated by blue-green algae, *Clastidium setigerum,* followed by *Chamaesiphon spp.* Dip Creek site P5 was dominated by blue-green algae *Chamaesiphon spp,* followed by *Homoeothrix sp.* as well as diatom, *Diatoma elongatum*. Reference site PR2 was dominated by blue-green algae, *Oscillatoria cf. agardhii* followed by *Homoeothrix sp.* and diatom, *Diatoma elongatum.*

Table 18. Percentage Composition of Periphyton Communities, Casino Project, 2009

Taxon	Percentage of Mean Number of Cells/cm^2							
	P1	P2	P3	P8	P4	P7	P5	PR2
Cyclotella sp.	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00
Achnanthes flexella	0.00	0.10	0.04	0.00	0.00	0.00	0.00	0.00
Achnanthes lanceolata	0.00	0.00	0.00	9.09	0.00	0.00	0.00	0.00
Achnanthes minutissima	**15.44**	**23.97**	**21.35**	1.22	0.53	7.60	1.15	2.10
Achnanthes spp.	3.12	0.79	2.58	0.51	0.26	1.29	1.15	0.39
Amphipleura pellucida	0.00	0.14	1.53	0.00	0.00	0.00	0.00	0.00
Amphora spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anomoeoneis spp.	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00
Caloneis spp.	0.00	0.01	0.04	2.02	0.00	0.00	0.00	0.00
Ceratoneis arcus	0.43	0.22	0.85	**12.28**	3.27	0.10	9.98	1.57
Cocconeis placentula	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.00
Cymbella cf. cestaii	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Cymbella cistula	0.00	0.02	0.00	0.00	0.02	0.00	0.02	0.07
Cymbella microchepala	0.00	0.02	0.04	0.00	0.00	0.00	0.00	0.00
Cymbella minuta	0.37	0.64	0.11	0.18	0.07	0.04	0.22	0.18
Cymbella sinuata	0.01	0.03	0.24	0.30	0.02	0.03	0.22	0.02
Cymbella spp.	0.02	0.24	0.04	0.00	0.00	0.00	0.00	0.00
Denticula sp.	0.00	0.13	0.52	0.00	0.00	0.00	0.00	0.00
Diatoma elongatum	**65.64**	**44.06**	**32.38**	0.23	**15.94**	0.02	**18.39**	**17.28**
Diatoma mesodon	0.00	0.00	0.00	8.14	0.00	0.00	0.01	0.12
Diatoma moniliformis	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
Didymosphenia geminata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eunotia spp.	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00
Fragilaria capucina	0.00	0.00	0.00	1.16	0.03	0.00	0.47	0.00
Fragilaria construens	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fragilaria pinnata	0.00	0.15	0.05	0.00	0.00	0.00	0.00	0.00
Fragilaria vaucheriae	0.09	0.14	0.44	0.26	0.89	0.12	1.04	0.46
Fragilaria spp.	1.41	3.04	5.06	2.77	0.95	0.56	0.73	0.36
Frustulia sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Gomphonema acuminatum / parvulum	0.99	0.56	2.87	2.62	0.24	0.03	0.82	0.35
Gomphonema olivaceum	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00
Gomphonema olivaceum?	0.00	0.00	0.00	0.00	0.02	0.00	0.09	0.00
Gomphonema spp.	0.30	0.14	0.73	1.66	0.15	0.02	0.59	0.14
Meridion circulare	0.02	0.02	0.16	1.08	0.04	0.03	0.35	0.07
Navicula radiosa	0.00	0.02	0.23	0.00	0.01	0.00	0.00	0.00
Navicula spp.	0.02	0.03	0.30	0.00	0.01	0.00	0.07	0.00
Nitzschia dissipata	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00
Nitzschia spp.	0.06	2.48	1.80	2.21	0.03	0.12	0.23	0.02
Pinnularia spp.	0.00	0.01	0.09	2.43	0.00	0.03	0.00	0.00
Stauroneis spp.	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Synedra ulna	0.46	0.68	0.87	0.00	1.04	0.00	2.14	0.43
Synedra spp.	2.16	1.59	2.76	**11.11**	**16.29**	0.16	3.69	3.44
Tabellaria flocculosa	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.01
Deformed Diatoms	0.19	0.02	0.00	0.00	0.01	0.00	0.04	0.02
Chlorophyta								
Draparnaldia sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90
UID Chaetophorales	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Microspora sp.	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.00
Ulothrix spp.	0.00	0.16	0.00	0.00	0.17	0.00	0.47	0.11

Taxon	Percentage of Mean Number of Cells/cm^2							
	P1	P2	P3	P8	P4	P7	P5	PR2
Ulothrix zonata	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.16
Closterium spp.	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Mougeotia spp.	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.00
UID Chlorophyta flagellate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UID Chlorophyta unicellular	0.00	0.02	0.00	0.21	0.01	0.00	0.00	0.00
Chrysophyta								
Chromulina sp.	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00
Hydrurus sp.	0.00	1.48	0.00	0.00	0.00	0.00	0.00	0.00
UID Chrysophyta colonial	1.91	0.39	1.04	0.00	0.00	0.00	0.28	0.02
UID Chrysophyta cyst	0.04	0.01	0.24	1.15	0.01	0.03	0.02	0.02
UID Chrysophyta flagellate	0.00	0.01	0.00	0.20	0.00	0.00	0.00	0.00
UID Chrysophyta unicellular	0.01	0.55	2.56	2.77	0.02	0.00	0.02	0.02
Cyanophyta								
Chamaesiphon spp.	0.00	0.15	0.24	5.76	**18.91**	**23.56**	**31.64**	6.23
Clastidium setigerum	0.02	1.51	0.31	0.67	0.39	**58.16**	0.55	1.18
Aphanocapsa spp.	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Gomphosphaeria sp.	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00
Merismopedia spp.	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
UID Chrooccocales	0.00	0.42	2.09	0.00	0.17	0.00	0.06	0.00
Nostoc sp. / Anabaena sp.	0.00	0.00	0.04	2.26	0.00	0.00	0.00	0.00
Homoeothrix sp.	6.03	9.76	0.91	**11.46**	**17.72**	1.07	**18.46**	**18.75**
Oscillatoria cf. agardhii	0.00	0.00	0.00	0.00	**19.42**	0.00	0.03	**38.87**
Oscillatoria spp.	0.03	0.17	0.23	0.00	0.00	0.00	0.00	0.00
Pseudoanabaena spp.	0.05	3.32	5.38	0.00	0.02	0.97	0.41	0.07
Spirulina sp.	0.00	0.07	0.00	0.00	0.17	0.00	0.00	0.25
UID Oscillatoriales	0.03	0.82	0.00	0.74	0.05	0.00	0.41	0.74
Rhodophyta								
Audouinella sp.	0.00	0.03	0.00	0.00	2.88	0.00	4.14	4.04
UID flagellate	0.00	0.37	0.17	1.58	0.02	1.50	0.73	0.06
UID colonial	0.40	0.01	0.39	0.00	0.02	0.00	0.00	0.00
UID filamentous	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UID unicellular	0.73	0.96	11.25	**11.92**	0.19	4.53	1.12	0.56

**UID = unidentified.*

**Bold = dominant taxa.*

Figure 10 and Figure 11 show the mean taxonomic richness and Shannon-Wiener diversity index by site. There were significant differences among sites in taxonomic richness ($F_{7,32}$ = 9.99, P<0.001), as well as significant differences among sites in diversity ($F_{7,32}$ = 5.46, P < 0.001). Post-hoc tests using Bonferroni test for richness showed that mean richness at sites P2 and PR2 were significantly higher than the richness at all other sites except P4. Post-hoc comparisons of means using the Bonferroni tests showed that mean diversity at site P7 was significantly lower that the diversities at all other sites except for P1 and PR2.

Figure 10. Mean Taxonomic Richness of Periphyton Communities, Casino Project, 2009

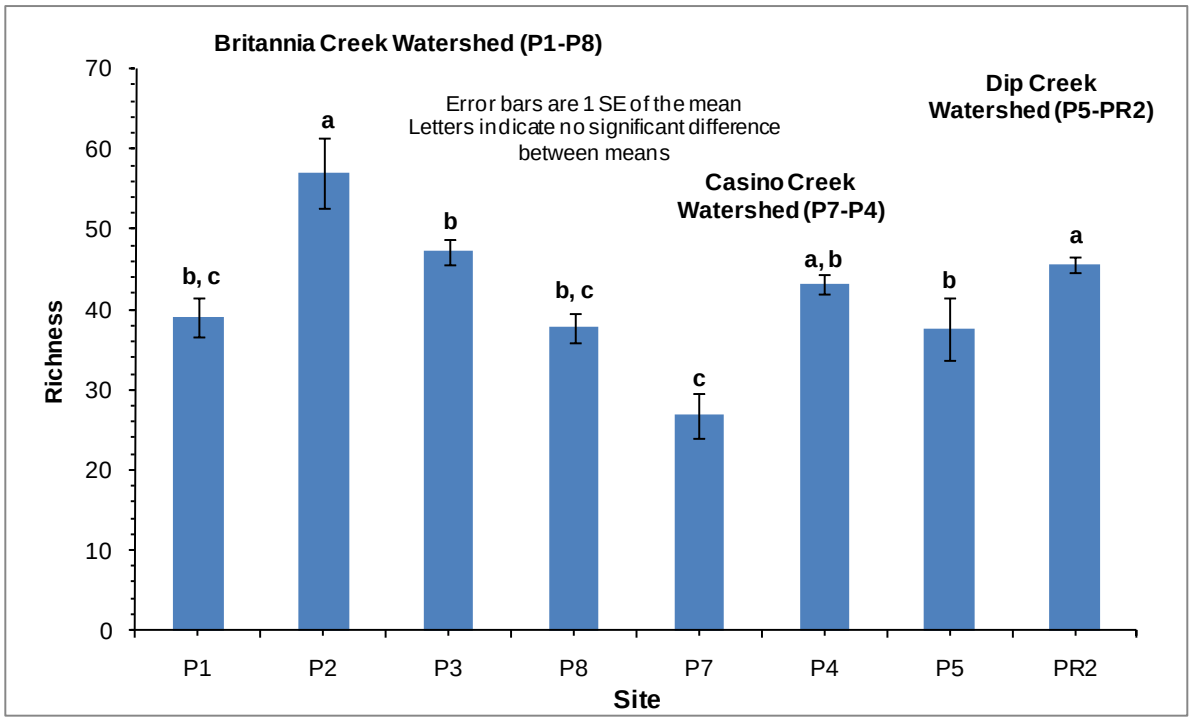
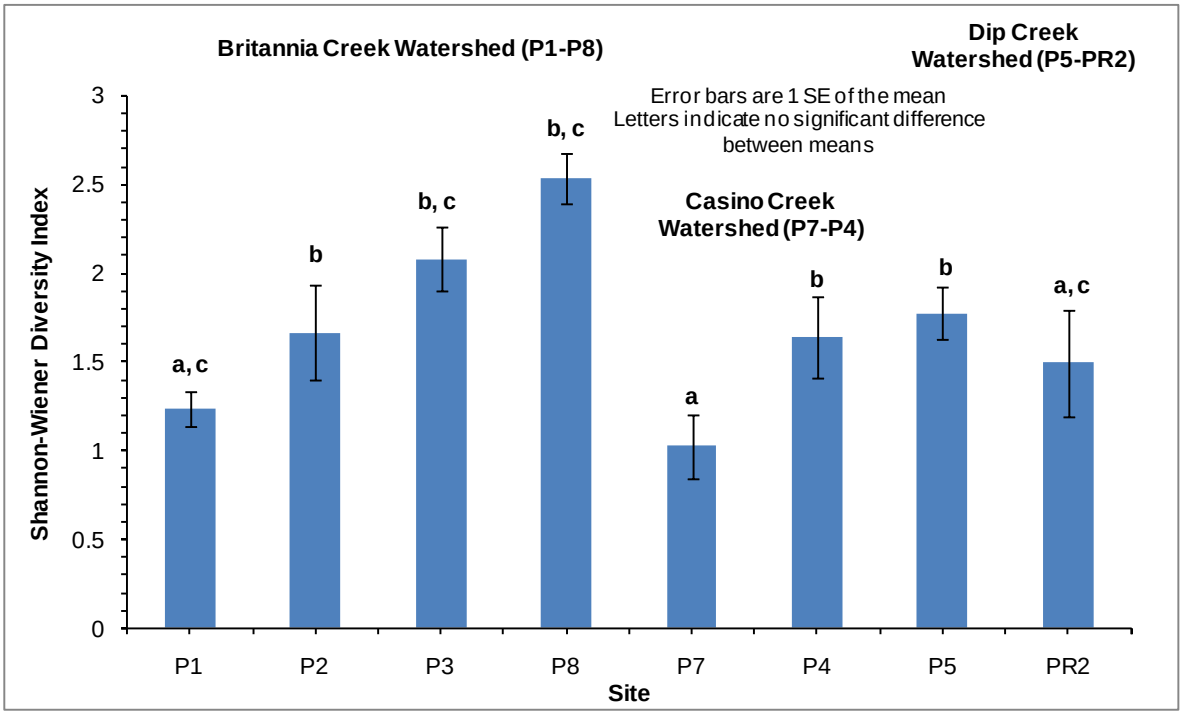


Figure 11. Mean Shannon-Wiener Diversity Index of Periphyton Communities, Casino Project, 2009



3.4 Benthic Invertebrates

Appendix D shows the number of organisms counted and identified to taxa in each of the 50 samples of benthos collected from the eight sampling sites in August 2009. Note that samples collected by the Surber sampler are denoted as B1S and B2S.

Figure 12 and Figure 13 show the mean densities of benthic invertebrates sampled with the kick net sampler and the Surber sampler, respectively, by site. One-way ANOVA of the ln-transformed densities showed there were highly significant differences in mean density among sites sampled with a kick net ($F_{7,32}$ = 21.998, P<0.001). Post-hoc comparisons of means using the Bonferroni test showed that mean density at site B7 was significantly lower than the densities at all other sites and that mean densities at site BR2 (reference site) was significantly higher than mean densities at sites in the Britannia Creek watershed (B1, B2, B3, and B8). One-way ANOVA of the ln-transformed densities showed there were no significant differences in mean density among the two sites sampled with a Surber sampler ($F_{1,8}$ = 0.11, P=0.75).

Table 19 shows the percentage composition of the benthic invertebrate community at each sampling site. Dipterans dominated the communities at all sites except for sites B5 and B8 where Ephemeropterans dominated. Over 95% of the organisms at each site belonged to six taxa: the insect Orders of Diptera, Plecoptera, Ephemeroptera, Trichoptera, plus the mite of Superorder Acariformes and the worm of Phylum Annelida.

Figure 12. Mean Density of Benthic Invertebrates by Site Using Kicknet, Casino Project, 2009

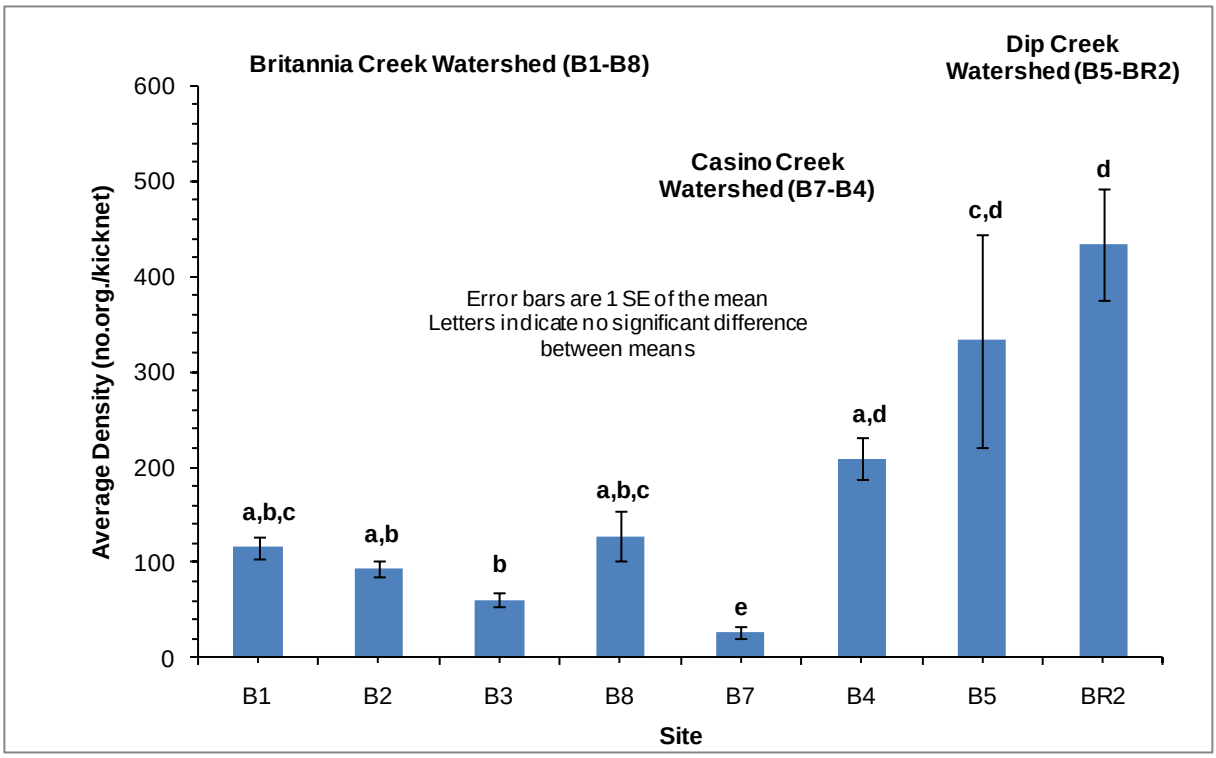


Figure 13. Mean Density of Benthic Invertebrates by Site Using Surber Sampler, Casino Project, 2009

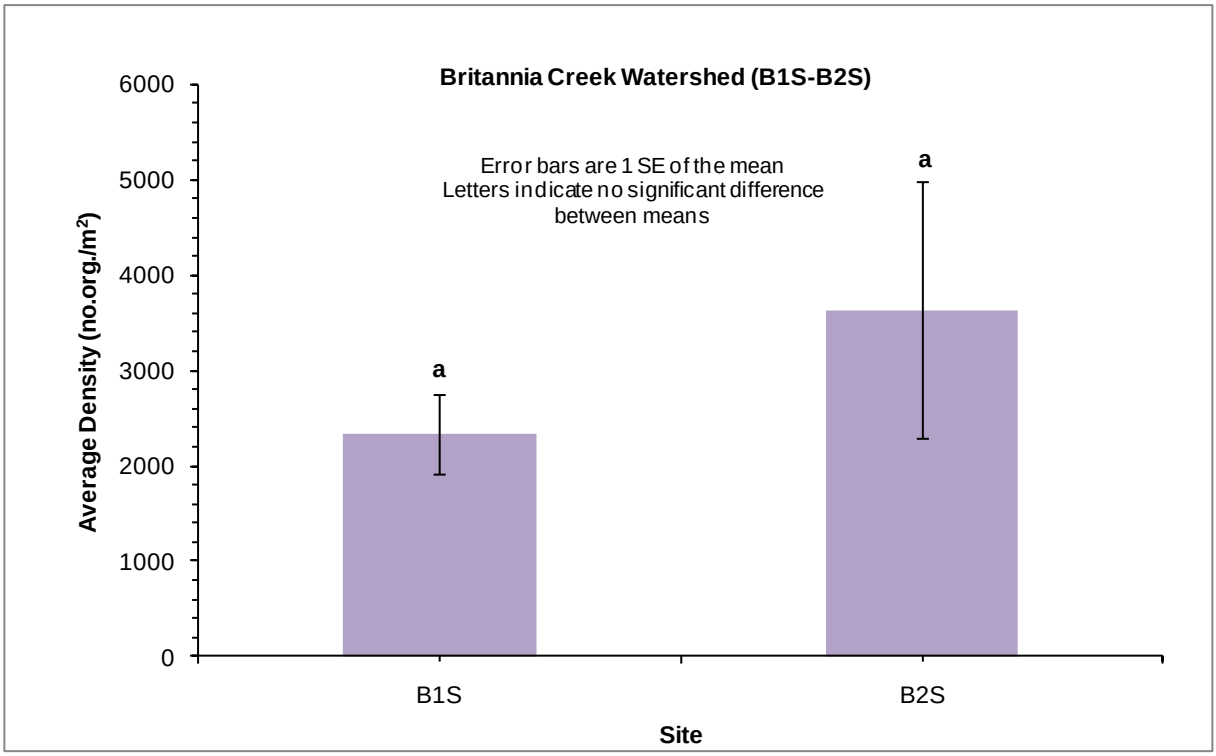


Table 19. Percentage Composition of Benthic Invertebrate Communities, Casino Project, 2009

Taxon	Percent of Total Number of Organisms									
	B1	B1S	B2	B2S	B3	B4	B5	B7	B8	BR2
Order Diptera	77.0	90.0	79.8	91.0	61.1	38.3	31.1	87.7	7.7	46.3
Order Ephemeroptera	13.1	4.9	15.5	3.2	26.5	37.1	54.7	6.9	50.9	45.3
Order Trichoptera	7.3	0.4	3.4	0.5	4.9	4.6	1.7	0.0	0.2	0.3
Order Plecoptera	2.2	4.0	1.3	4.4	4.6	5.7	9.1	3.1	12.9	5.1
Superorder Acariformes	0.3	0.1	0.0	0.1	0.0	1.1	1.4	0.0	0.3	0.1
Phylum Annelida	0.0	0.2	0.0	0.1	0.0	13.0	1.9	2.3	27.9	2.7
Order Collembola	0.0	0.2	0.0	0.5	1.3	0.0	0.0	0.0	0.2	0.0
Phylum Nemata	0.0	0.3	0.0	0.1	1.3	0.0	0.0	0.0	0.0	0.1
Order Lepidoptera	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0
Order Cladocera	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Order Isopoda	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Order Hemiptera	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Order Gastropoda	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0

Figure 14, Figure 15 and Figure 16 show the mean taxonomic richness, total EPT abundance and Shannon's index of diversity, respectively, by site. There were highly significant differences among sites in richness ($F_{9,40}$ = 12.23, P<0.001), total EPT ($F_{9,40}$ = 11.29, P<0.001) and in Shannon-Wiener diversity index ($F_{9,40}$ = 19.65, P<0.001). Post-hoc tests using the Bonferroni test showed that the main cause for variation in richness was low richness at site B7 compared to high richness at sites in the Dip Creek

watershed, B5 and BR2. Post-hoc tests using the Bonferroni test showed that the main cause for variation in total EPT was high total EPT at sites B5 and BR2 compared to low total EPT at all the other sites. Post-hoc tests using the Bonferroni test showed that the main cause for variation in Shannon-Wiener diversity index was lower diversity for site B7 compared to all other sites. Also, diversity was significantly higher for site B5 compared to sites B1, B2 and B7.

Figure 14. Mean Taxonomic Richness of Benthic Invertebrate Communities, Casino Project, 2009

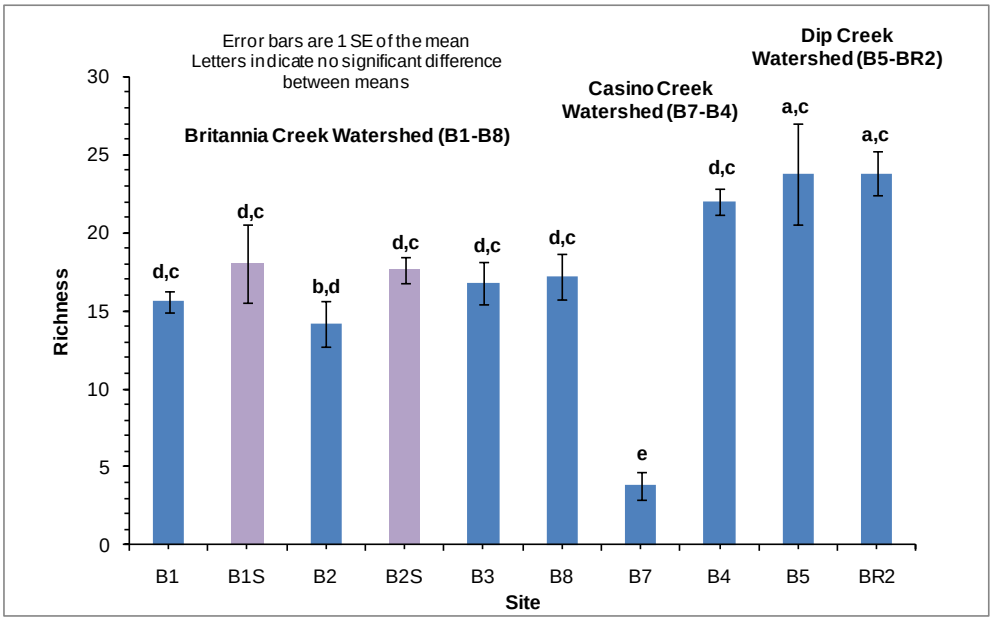


Figure 15. Mean Total EPT of Benthic Invertebrate Communities, Casino Project, 2009

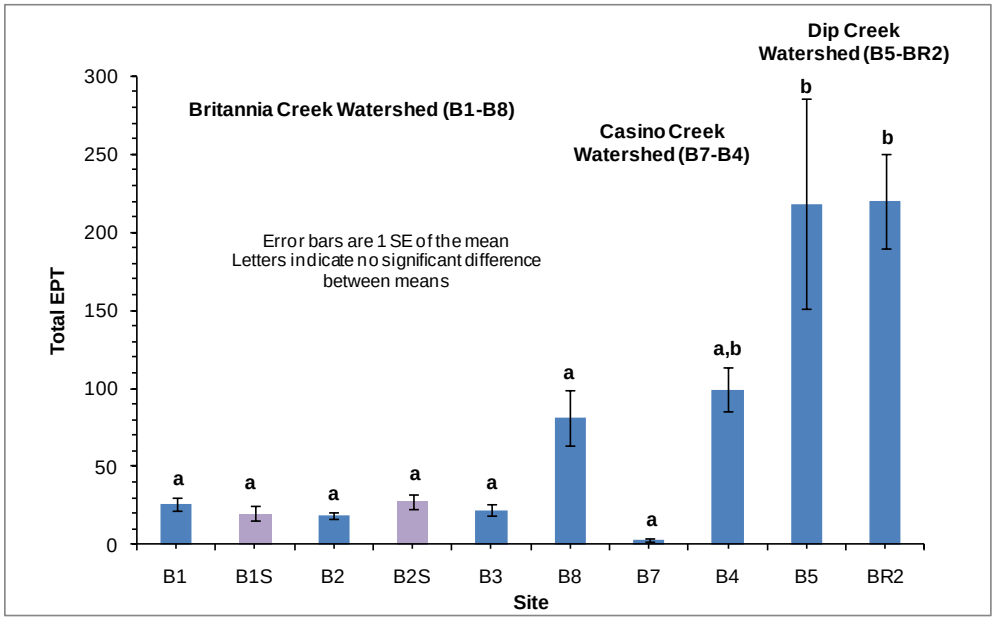
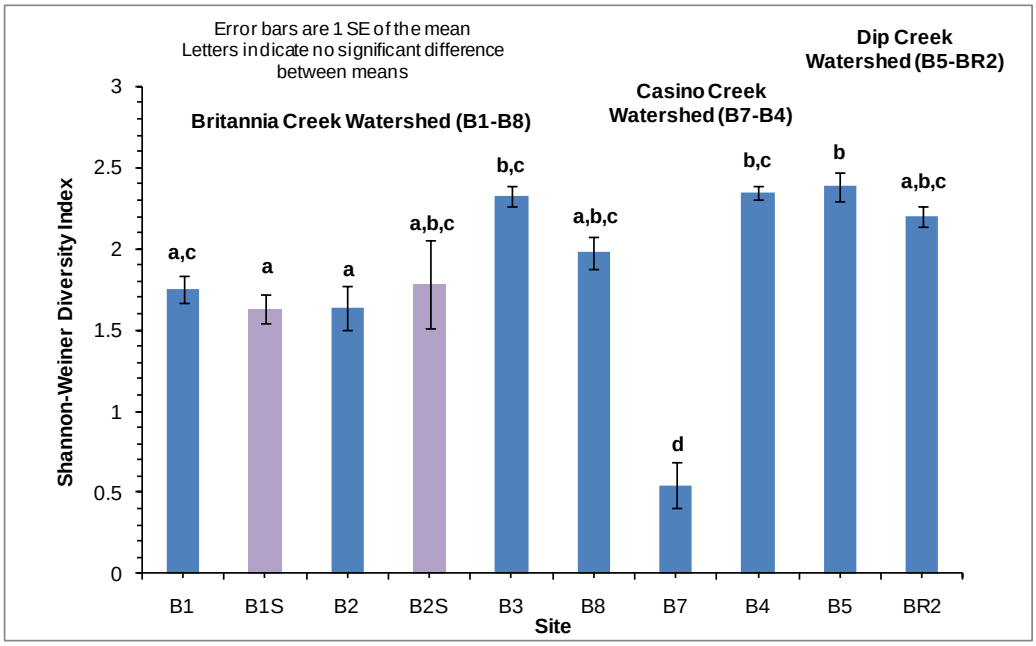


Figure 16. Mean Shannon-Weiner Index of Diversity of Benthic Invertebrate Communities, Casino Project, 2009



3.5 Periphyton and Benthic Invertebrate Summary

Periphyton and benthic invertebrate samples within each watershed generally appear to be similar. As a reference site, R2 in Dip Creek generally has the highest levels of biological density, diversity, and richness. P5/B5 is similar to R2 in benthic invertebrate communities but not with periphyton communities. The Britannia Creek watershed is generally comparable to R2, except with low total EPT and low benthic invertebrate densities. In the Casino Creek watershed, site P7/B7 appears to be mildly impacted as periphyton and benthic invertebrate communities generally have the lowest density, diversity and richness. This site is located at the head of Casino Creek just downstream of the confluence with Proctor Gulch. Proctor Gulch is a small alpine stream that intermittently flows underground and interacts with the mineralized zone such that the water re-emerging is highly acidic (e.g. a pH range of 3.2 to 3.9) and has elevated metal concentrations. This water appears to affect the periphyton and benthic invertebrate communities in upper Casino Creek. Further downstream Casino Creek at site P4/B4, biological communities show higher levels of density, diversity, and richness and is generally more comparable with R2.

3.6 Fish Community

3.6.1 Catch, Effort and CPUE

Appendix E1 shows the fish catch, effort and CPUE for electrofishing. A total of 152 fish from five species – Arctic grayling (*Thymallus arcticus*), slimy sculpin (*Cottus cognatus*), burbot (*Lota lota*), round whitefish (*Prosopium cylindraceum*), and chinook salmon (*Oncorhynchus tsawytscha*) – were captured from the Casino Project LSA in August 2009 (Table 20).

Table 20. Fish Data Electrofishing, Casino Project, 2009

Watershed	Arctic Grayling	Slimy Sculpin	Burbot	Round Whitefish	Chinook	Total
Britannia Creek Watershed	5	33	-	-	1	39
Casino Creek Watershed	20	35	1	-	-	56
Dip Creek Watershed	14	27	-	1	-	42
Reference site (R2)	3	12	-	-	-	15
Totals	40	107	1	1	1	152

Arctic grayling and slimy sculpin were found in all watersheds, Casino Creek, Britannia Creek, Dip Creek watersheds. Overall, slimy sculpin made up the majority of the total catch (70%) and comprised > 64% of the catch within each of watersheds.

A total of eleven sites were electrofished – six of the sites were fished in 2008 and five sites were new in 2009. Of the eleven sites sampled, two were fished using three-passes and nine were fished using a single pass. Effort ranged from 472 to 1,118 seconds with a mean of 805 seconds (n = 15, SE = 43).

Of the two three-pass surveys, both sites showed a decrease in catch of fish with successive passes. A decrease in the number of fish caught per pass (depletion) is required to estimate total fish number using standardized abundance estimation methods (e.g., Peterson *et al*. 2004). The low number of three-pass surveys meant that total fish number was not estimated using the three-pass algorithm. Instead, the CPUE of each survey was used as an index of population abundance.

Figure 17 and Figure 18 show the catch per unit effort for Arctic grayling and slimy sculpin. One each of chinook salmon, burbot and round whitefish were captured which, suggests that these species exist in the watershed, but are not abundant.

Figure 17. Electrofishing CPUE, Arctic Grayling, Casino Project, 2009

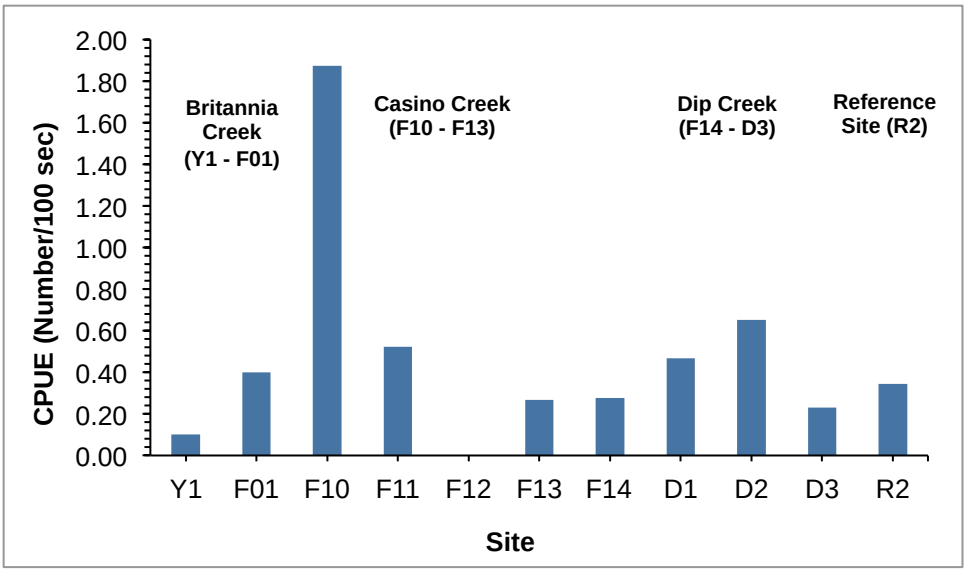


Figure 18. Electrofishing CPUE, Slimy Sculpin, Casino Project, 2009

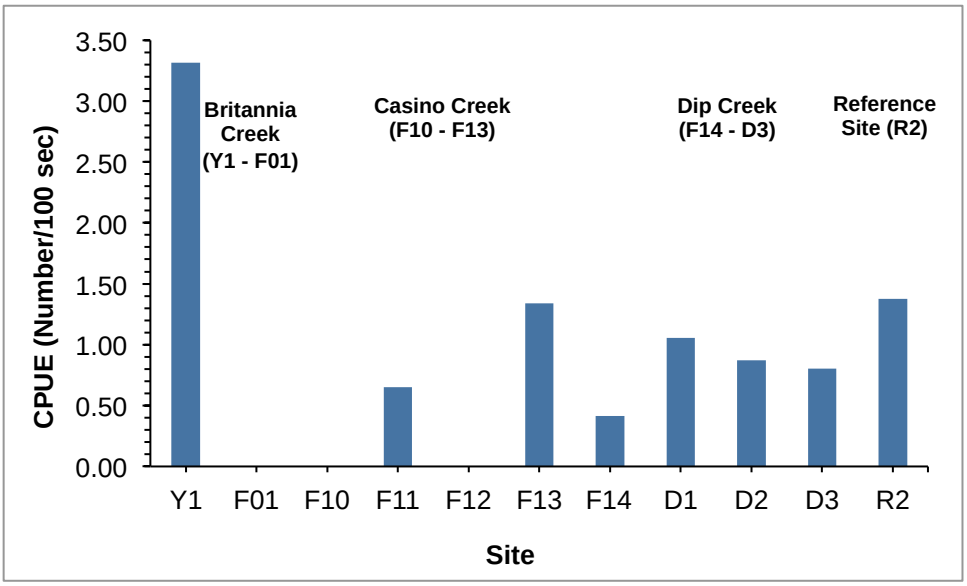


Table 21 summarizes the fish species caught in the aquatics LSA between 1993 and 2009. The presence of chinook salmon fry in lower Britannia Creek in June 1993 and August 2009 suggests the potential for salmon rearing habitat in Britannia Creek, but the absence of adult spawners in 1993, 1994, 2008 and 2009 indicates little spawning potential.

Table 21. Fish Species in the Aquatics Local Study Area, Casino Project, 1993 to 2009

Species	Life Stage	Britannia Creek Watershed				Casino/Dip Creek Watershed			
		1993*	1994*	2008	2009	1993*	1994*	2008	2009
Arctic grayling	juveniles/adults	Jun, Aug. Sep	Jun, Aug	Jul	Aug	Jun, Aug, Sep	Jun, Aug, Sep	Jul	Aug
	fry	Aug	-	-	Aug	-	Aug		Aug
Slimy sculpin	Juveniles/adults	Aug	Aug	-	Aug	Jun, Aug, Sep	Jun, Aug, Sep	Jul, Sep	Aug
Chinook salmon	juveniles	Aug	-	-	-	-	-	-	-
	fry	June	-	-	Aug	-	-	-	
Round whitefish	juveniles	Aug	-	-	-	-	-	-	Aug
Burbot	juveniles	Sep	-	-	-	-	-	-	Aug

** Hallam Knight Piésold (1997)*

3.6.1.1 Size, Age and Growth

Appendix E2 shows a summary of the fish biological characteristics including length, weight, age and Fulton Condition Factor, K. Length frequencies for Arctic grayling and slimy sculpin are show in Figure 19 and Figure 20, respectively. Age frequencies for Arctic grayling are shown in Figure 21.

Figure 19. Length Frequency for Arctic Grayling in Casino Creek, Dip Creek and Britannia Creek watersheds, Casino Project, 2009

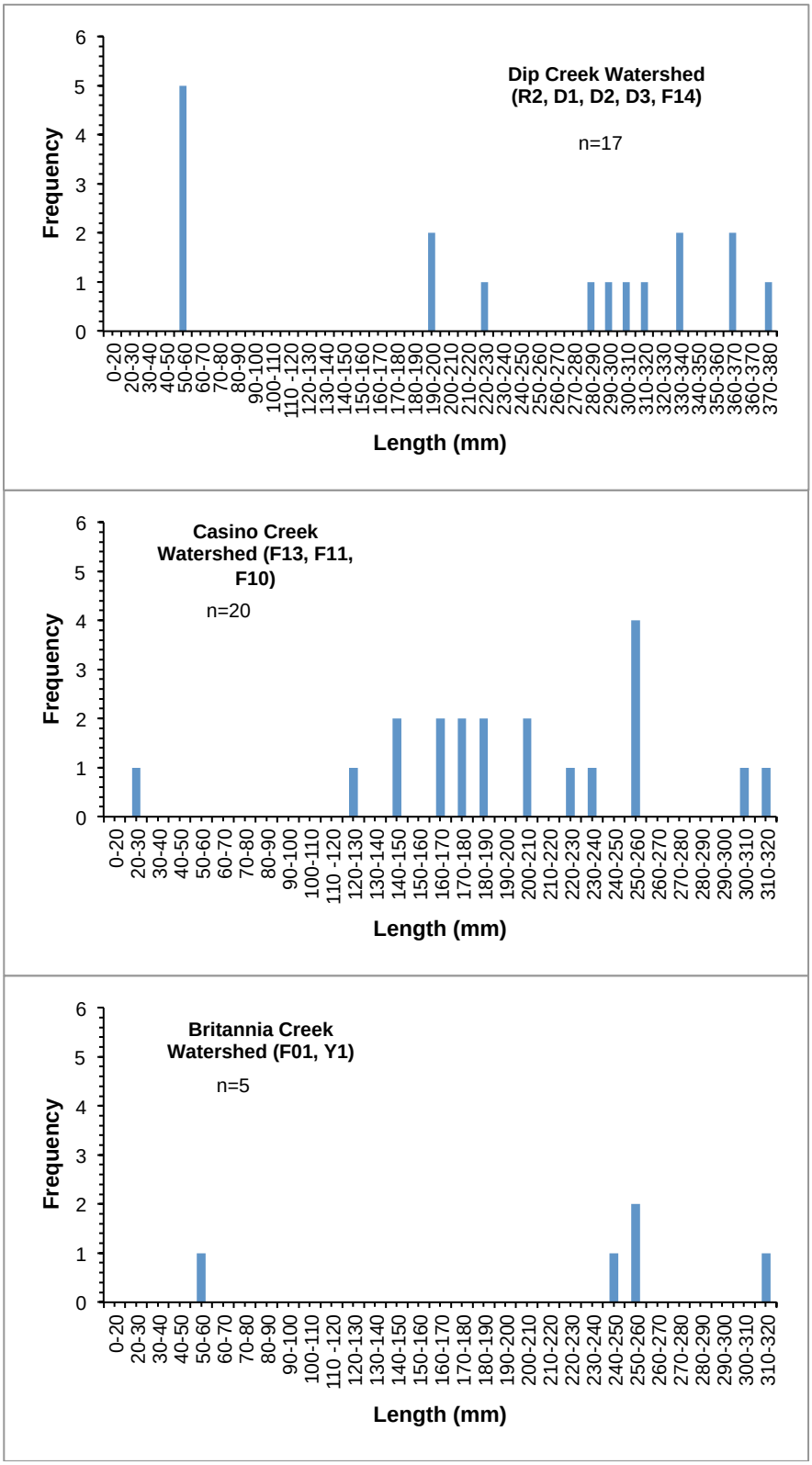


Figure 20. Length Frequency for Slimy Sculpin in Casino Creek, Dip Creek and Britannia Creek watersheds, Casino Project, 2009

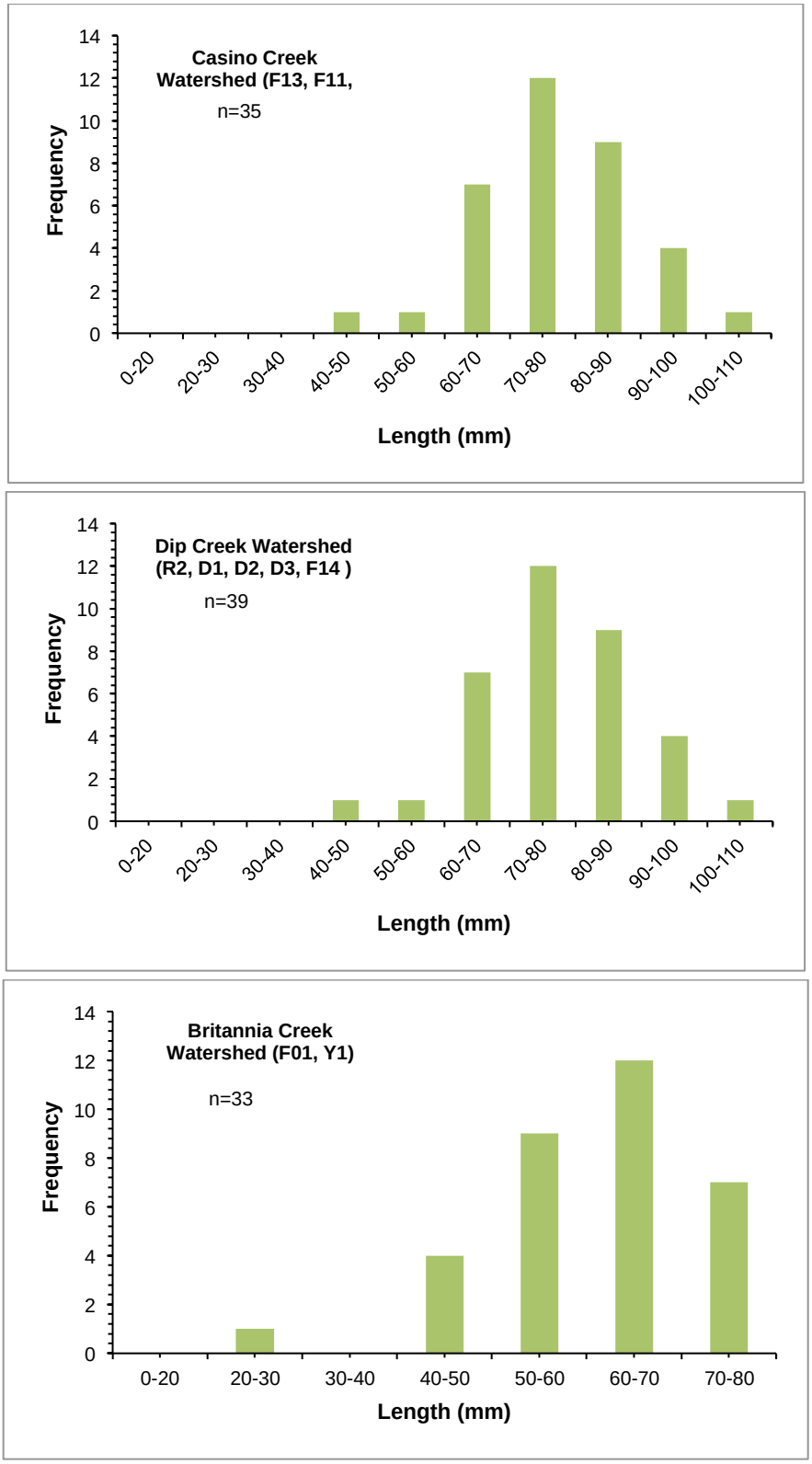
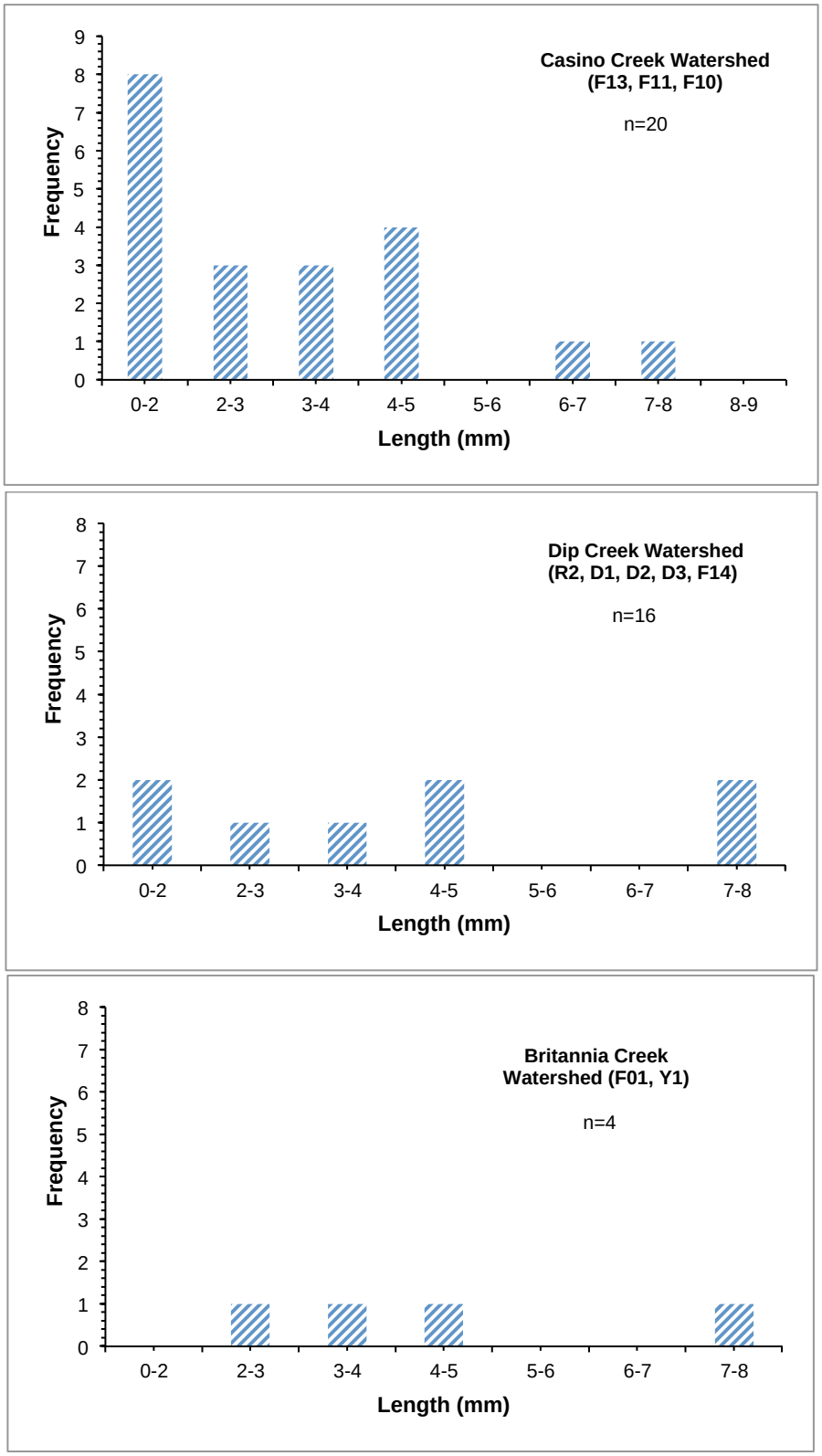


Figure 21. Age Frequency for Arctic Grayling in Casino Creek, Dip Creek and Britannia Creek watersheds, Casino Project, 2009



The length frequency distribution for Arctic grayling shows three modes: one at a length range of 1-49 mm that represent fry, one at a length range of 150-199 mm that are assumed to represent juveniles (2-3 years) and another mode at 250-299 mm that are assumed to represent adults (5+ years) (Figure 22). The length frequency distribution for slimy sculpin showed only one mode: one at a length range of 50-99 mm that is assumed to represent a mixture of juveniles and adults (Figure 23).

The condition factor represents and index of the "fatness" of the fish as measured by the weight of the fish relative to its length. Thus the heavier or fatter a fish is for a given length the higher the condition factor. Appendix E2 shows individual condition factors for Arctic grayling. Fish with condition factors close to 1.00 is indicative of their relatively good condition. Although most of the Arctic grayling caught in 2009 had relatively good condition factors, those caught in D2 (Dip Creek) had an average condition factor of 0.71.

Figure 22. Length Frequencies of Arctic Grayling, Casino Project, 2009

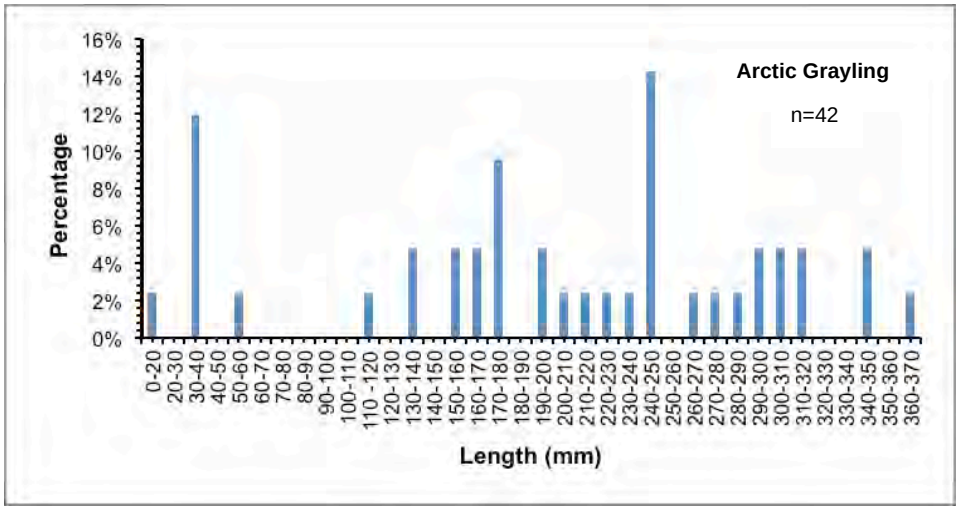
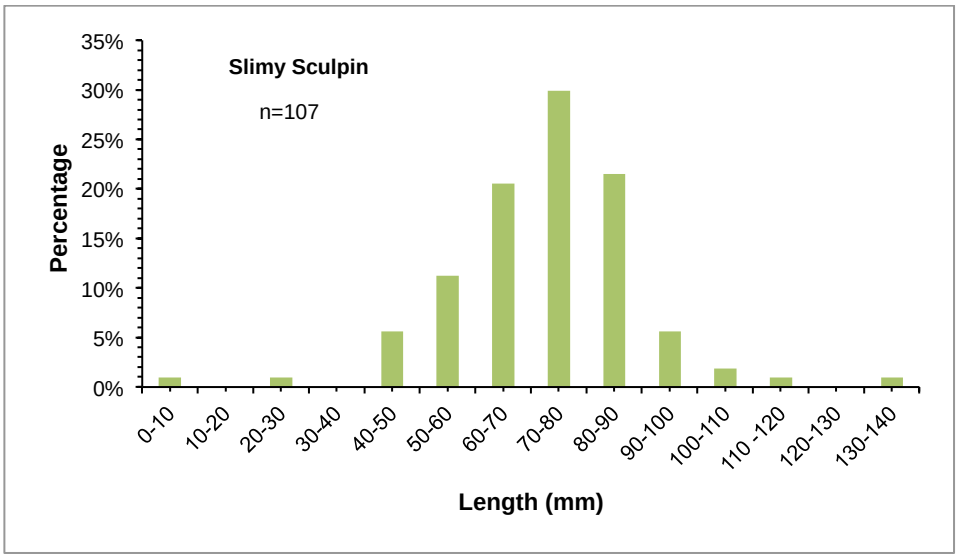


Figure 23. Length Frequencies of Slimy Sculpin, Casino Project, 2009



Linear regressions of weight on length were significant for both species (Figure 24 and Figure 25). The slopes of the regressions were both close to the value of 3.0, which indicates isometric growth (i.e., fish do not change shape as they increase in length).

The age frequency distribution for Arctic grayling shows is shown in Figure 26. A plot of mean length on age showed that growth rate is constant with increasing age (Figure 27).

Figure 24. Weight-length Regressions for Arctic Grayling, Casino Project, 2009

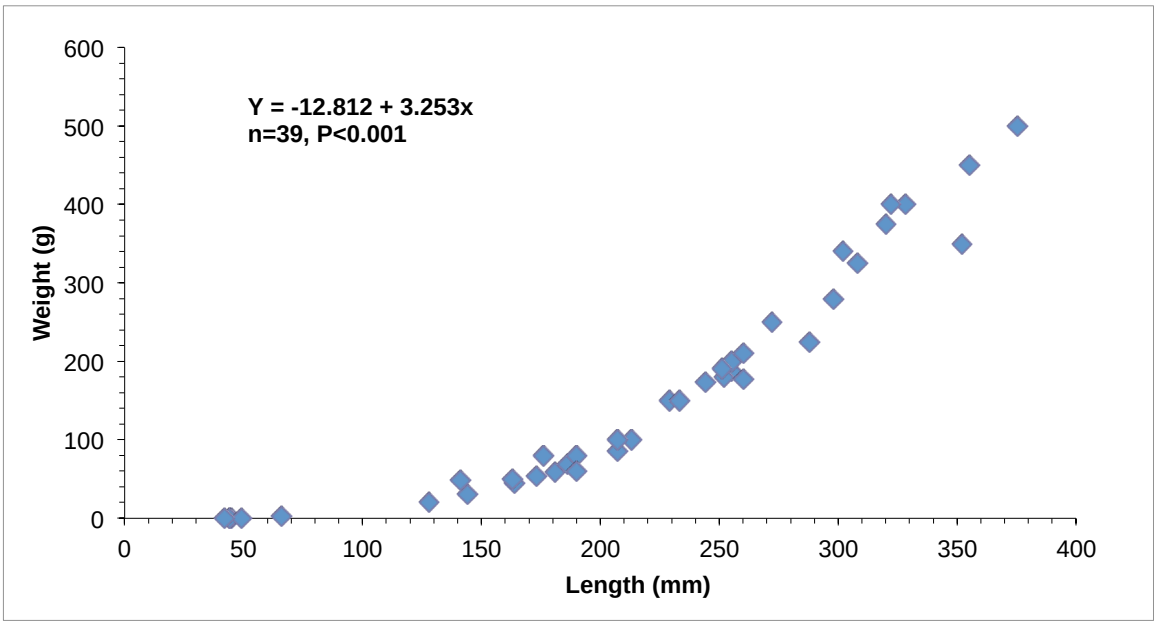


Figure 25. Weight-length Regressions for Slimy Sculpin, Casino Project, 2009

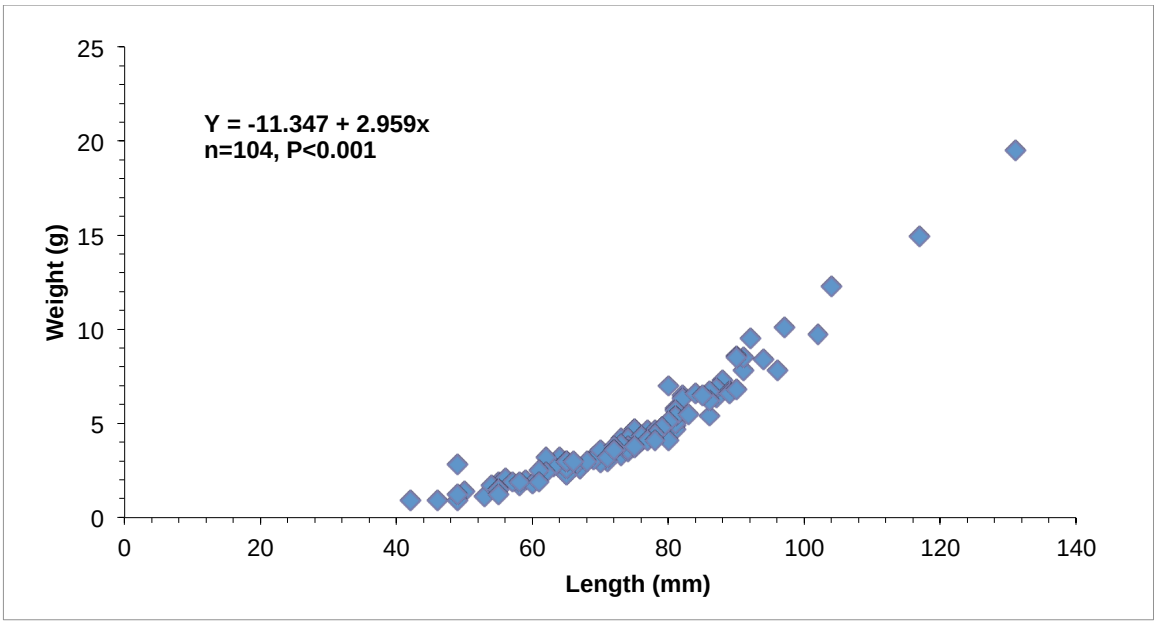


Figure 26. Age Frequency Distribution, Arctic Grayling, Casino Project, 2009

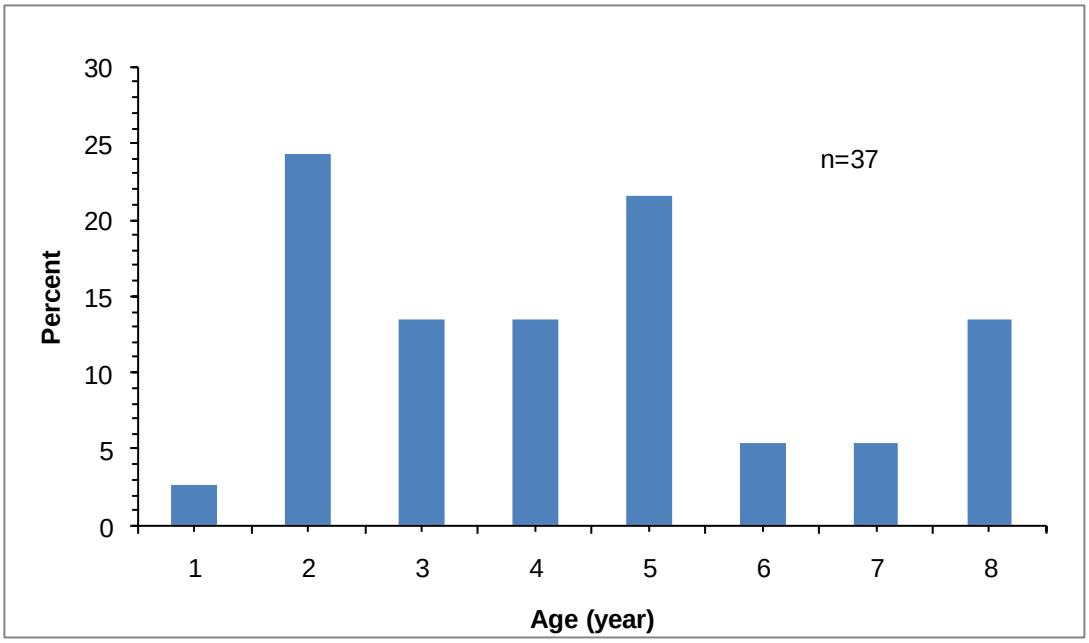
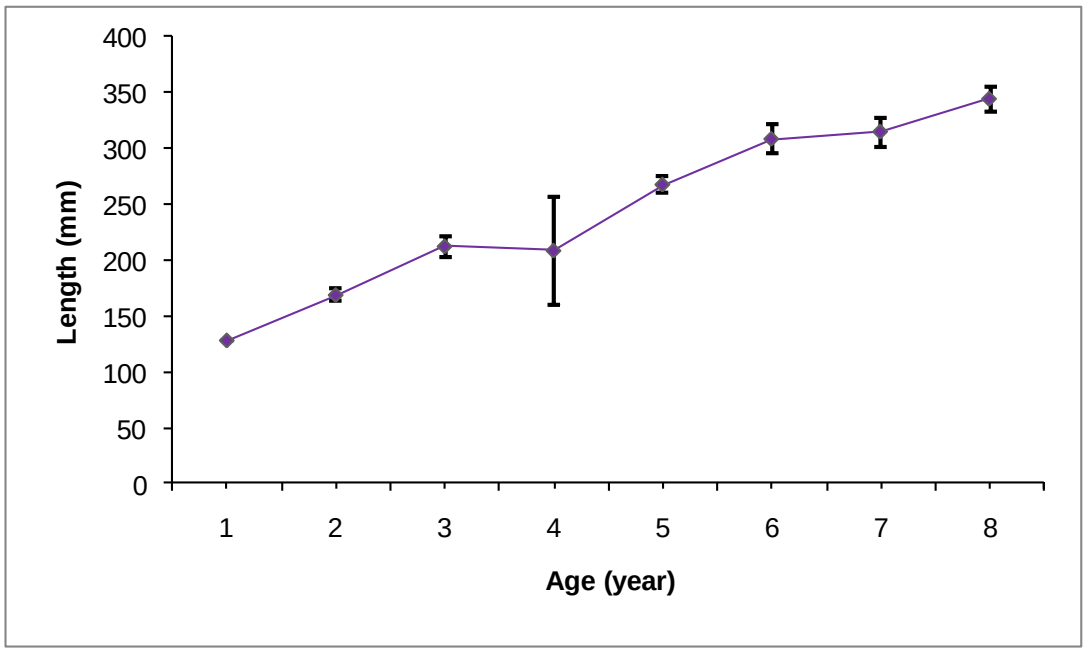


Figure 27. Length-at-Age Plot, Arctic Grayling, Casino Project, 2009



3.6.1.2 Tissue Metals Concentrations

Appendix E3 shows the concentrations of metals measured in whole-body samples of slimy sculpin collected from Casino, Dip and Britannia watersheds in August 2009. Of the 27 metals, ten (antimony, beryllium, bismuth, boron, chromium, molybdenum, silver, thallium, tin and vanadium) were excluded from analysis because all values were below detection limits. Also, cobalt was below detection limits for all fish except one and nickel was below detection limits for all except for the three fish sampled from site Y1. For the remaining fifteen metals, all values below detection limits were replaced by one-half the detection limit to allow statistical analysis. Table 22 shows the mean, standard error (SE), minimum and maximum values of metals concentrations

Table 22. Mean Whole-Body Metal Concentrations, Slimy Sculpin, Casino Project, 2009

Total Metal	Reference Site (R2)					Dip Creek Watershed				
	Mean	SE	Min	Max	n	Mean	SE	Min	Max	n
	Concentration (mg/kg wet weight)					Concentration (mg/kg wet weight)				
Aluminum (Al)	18.80	8.21	7.00	51.00	5	31.00	7.02	5.00	85.00	10
Arsenic (As)	0.08	0.01	0.06	0.09	5	0.10	0.01	0.06	0.13	10
Barium (Ba)	4.46	0.56	2.90	6.00	5	3.53	0.12	3.10	4.20	10
Cadmium (Cd)	0.02	0.00	0.01	0.02	5	0.04	0.00	0.02	0.06	10
Calcium (Ca)	11728.00	1413.70	8590.00	16000.00	5	11800.00	352.45	10100.00	13600.00	10
Copper (Cu)	0.70	0.03	0.60	0.80	5	0.83	0.04	0.60	1.00	10
Iron (Fe)	48.80	16.17	24.00	110.00	5	75.10	14.04	25.00	187.00	10
Lead (Pb)	0.02	0.00	0.01	0.03	5	0.03	0.01	0.01	0.08	10
Magnesium (Mg)	365.40	21.27	302.00	419.00	5	386.30	7.11	361.00	432.00	10
Manganese (Mn)	8.18	1.56	4.60	13.70	5	9.87	0.87	6.40	16.00	10
Mercury (Hg)	0.06	0.01	0.04	0.09	5	0.06	0.00	0.05	0.07	10
Nickel (Ni)	-	-	-	-	-	-	-	-	-	-
Phosphorus (P)	8602.00	783.02	6810.00	10900.00	5	8748.00	213.10	7810.00	9830.00	10
Potassium (K)	3002.00	83.51	2790.00	3280.00	5	3140.00	24.94	2960.00	3230.00	10
Selenium (Se)	0.96	0.15	0.52	1.44	5	0.85	0.07	0.59	1.32	10
Sodium (Na)	1142.00	73.03	1030.00	1400.00	5	1169.00	23.73	1080.00	1340.00	10
Strontium (Sr)	21.64	2.06	16.40	27.20	5	19.12	0.78	15.80	23.80	10
Titanium (Ti)	1.30	0.44	0.50	3.00	5	2.20	0.42	1.00	5.00	10
Uranium (U)	0.06	0.02	0.03	0.11	5	0.06	0.01	0.03	0.11	10
Zinc (Zn)	28.30	3.10	21.70	37.40	5	26.52	0.81	22.30	30.60	10

Table 23. Mean Whole-Body Metal Concentrations, Slimy Sculpin, Casino Project, 2009 (Continued)

Total Metal	Casino Creek Watershed					Britannia Creek Watershed				
	Mean	SE	Min	Max	n	Mean	SE	Min	Max	n
	Concentration (mg/kg wet weight)					Concentration (mg/kg wet weight)				
Aluminum (Al)	24.00	8.05	8.00	63.00	7	46.67	8.82	30.00	60.00	3
Arsenic (As)	0.13	0.02	0.08	0.21	7	0.14	0.01	0.11	0.16	3
Barium (Ba)	3.12	0.16	2.60	3.60	7	5.00	0.31	4.60	5.60	3
Cadmium (Cd)	0.08	0.01	0.06	0.09	7	0.52	0.07	0.38	0.63	3
Calcium (Ca)	11933.33	274.30	11200.00	13200.00	7	20266.67	1128.91	18100.00	21900.00	3
Copper (Cu)	1.18	0.17	0.90	2.10	7	0.87	0.07	0.80	1.00	3
Iron (Fe)	61.33	17.21	27.00	146.00	7	94.67	16.17	67.00	123.00	3
Lead (Pb)	0.13	0.07	0.03	0.52	7	0.05	0.01	0.04	0.06	3
Magnesium (Mg)	373.83	5.46	358.00	393.00	7	477.33	20.00	441.00	510.00	3
Manganese (Mn)	9.53	0.78	7.70	13.40	7	11.40	0.78	9.90	12.50	3
Mercury (Hg)	0.05	0.01	0.04	0.08	7	0.05	0.00	0.05	0.06	3
Nickel (Ni)	-	-	-	-	-	0.27	0.03	0.20	0.30	3
Phosphorus (P)	8825.00	83.69	8530.00	9070.00	7	12900.00	585.95	11800.00	13800.00	3
Potassium (K)	3205.00	53.76	2930.00	3340.00	7	2733.33	59.25	2620.00	2820.00	3
Selenium (Se)	1.03	0.07	0.76	1.29	7	1.76	0.17	1.58	2.10	3
Sodium (Na)	1205.00	16.86	1160.00	1270.00	7	1553.33	18.56	1530.00	1590.00	3
Strontium (Sr)	17.85	0.81	16.00	21.50	7	23.60	0.87	22.00	25.00	3
Titanium (Ti)	2.50	0.89	1.00	7.00	7	3.33	0.88	2.00	5.00	3
Uranium (U)	0.05	0.01	0.03	0.10	7	0.05	0.01	0.03	0.07	3
Zinc (Zn)	28.92	1.03	24.30	31.90	7	48.83	3.40	44.80	55.60	3

SE = Standard Error, Min = Minimum, Max = Maximum

Dashes indicates no data as all values are below detection limits

None of the slimy sculpins had mercury concentrations that exceeded the 0.5 mg/kg guideline established by Health Canada (http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/mercur/q12-q17-eng.php#q-15).

3.6.2 Fish Habitat Assessment

Appendix E4 shows the stream habitat record for Reference Tributary (R2). This site was selected in 2009 and was surveyed on August 5 (Photo 1). Morphology was riffle-pool habitat. At the time of survey, the stage was low, hence mean wetted width (3.6 m) was lower than mean bankfull width (5.8 m). Stream depth ranged from 0.31 m to 0.57 m with an average of 0.43 m. Gradient was 2%. Bed material was dominated by cobble and sub-dominated by fines. Cover suitable for fish in the stream consisted of small amounts of small woody debris, large woody debris, undercut banks, pools and a trace amount of overhanging vegetation. Crown closure was1-20%. The stream was unconfined and contained side bars.

Photograph 1: ***R2 - Reference site upstream of confluence of Casino and Dip creeks, August 5, 2009.***

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Appendix A1

Surface Water Quality Data, Casino Project, May 2009

Appendix A1. Surface Water Quality Analytical Results, Casino Project, May 2009

Station	Detection Limits	Water Quality Guidelines	W2 - Brittania Creek ds from confluence of Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino confluence	W6a - Yukon River downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W14 - Mouth of Britannia Creek	W16 - Lower Reach of Dip Creek	W18 - Brynelsen Creek
Date		**CCME [1]**	**19-May-09**	**19-May-09**	**19-May-09**	**19-May-09**	**19-May-09**	**19-May-09**	**19-May-09**	**19-May-09**	**19-May-09**	**19-May-09**	**19-May-09**
Physical Tests													
Temperature °C	-		3.80	7.2	2.2	1.8	8.6	-	0.6	5.1	0.9	3.0	4.9
Conductivity (Field) µS/cm	-		156	197	164	121	198	-	53	160	119	92	101
pH (Field)	-		7.56	7.7	7.6	7.6	8.2	-	7.4	7.6	7.5	7.4	7.5
Hardness $CaCO_3$	0.5		83.5	91.1	74.8	58.2	87.6	105	49.2	72.5	58.5	68.4	47.7
Conductivity	1		180	200	170	120	190	210	110	160	120	150	100
pH	-	6.5-9.0	7.8	7.9	7.9	7.8	8.1	8.1	7.8	7.8	7.7	7.9	7.8
Total Suspended Solids	1		11	2	1	15	42	62	24	2	20	5	2
Total Dissolved Solids	1		130	140	130	92	110	130	86	120	110	120	58
Turbidity	0.1		0.7	0.5	1.3	1.2	29.0	47.4	1.4	1.4	1.4	1.2	0.2
Dissolved Anions & Nutrients													
Ammonia as N	0.01	0.137[a]	0.04	0.05	0.03	0.03	0.02	0.03	0.04	0.07	0.05	0.04	0.03
Alkalinity, Total (as $CaCO_3$)	0.5		50	55	54	48	77	79	46	42	36	56	39
Acidity (pH 8.3) as $CaCO_3$	0.5		-	-	-	-	-	-	-	-	-	-	-
Bromide (Br)	0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride (Cl)	0.5		1.4	1.2	1.4	1.1	1.1	1.3	1.6	1.4	1.7	1.2	2.5
Fluoride (F)	0.01		0.07	0.08	0.06	0.05	0.10	0.10	0.05	0.07	0.05	0.05	0.04
Sulfate (SO_4)	0.5		36	49	29	15	22	29	3.2	40	24	28	18
Nitrate (as N)	0.002	2.9	0.088	0.103	0.080	0.076	0.049	0.044	0.051	0.076	0.058	0.063	0.069
Nitrite (as N)	0.002	0.06	0.003	0.002	<0.002	0.002	<0.002	<0.002	<0.002	0.002	0.003	0.002	0.004
Total Kjeldahl Nitrogen	0.02		0.99	0.31	0.46	0.34	0.23	0.22	0.33	0.45	0.59	0.48	0.52
Ortho Phosphate as P	0.001		0.037	0.046	0.048	0.002	0.046	0.045	0.002	0.042	0.026	0.002	0.042
Cyanide, Weak Acid Diss	0.0005		0.0008	0.0006	0.0006	0.0006	<0.0005	<0.0005	0.0006	0.0006	0.0007	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	0.0015	0.0012	0.092	0.0010	<0.0005	<0.0005	0.0005	<0.0005	0.0018	0.0011	<0.0005
Total Metals													
Aluminum	0.0002	0.005-0.1[b]	*0.186*	0.0989	*0.118*	*0.188*	*0.236*	*0.542*	*0.196*	*0.234*	*0.406*	*0.130*	*0.138*
Antimony	0.00002		0.00026	0.00030	0.00010	0.00009	0.00014	0.00022	0.00008	0.00012	0.00012	0.00009	0.00011
Arsenic	0.00002	0.005	0.00081	0.00083	0.00043	0.00052	0.00086	0.00137	0.00049	0.00056	0.00089	0.00046	0.00044
Barium	0.00002		0.0524	0.0463	0.0440	0.0443	0.0605	0.0975	0.0440	0.0429	0.0673	0.0448	0.0332
Beryllium	0.00001		0.00002	0.00001	0.00001	0.00002	0.00002	0.00004	0.00003	0.00003	0.00003	0.00001	0.00002
Bismuth	0.000005		0.000009	0.000008	0.000015	0.000005	0.000008	0.000016	0.000005	<0.000005	0.000005	0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000028	0.000028	0.000024	*0.000033*	*0.000129*	*0.000294*	*0.000031*	*0.000093*	*0.000030*	0.000022	*0.000020*
Calcium	0.05		21.1	23.2	19.7	15.0	24.0	28.1	12.4	19.8	14.4	16.9	12.8
Chromium	0.0001	0.001	0.0002	0.0002	<0.0001	0.0002	0.0003	0.0009	0.0002	<0.0001	0.0004	0.0002	<0.0001
Cobalt	0.000005		0.000140	0.000088	0.000064	0.000164	0.000355	0.000803	0.000165	0.000245	0.000284	0.000141	0.000057
Copper	0.00005	0.002-0.004[d]	*0.00465*	*0.00552*	*0.0114*	*0.00412*	*0.00269*	*0.00428*	0.00188	*0.0257*	*0.00250*	*0.00329*	0.00179
Iron	0.001	0.3	0.185	0.106	0.138	*0.305*	*0.497*	*1.24*	*0.331*	0.269	*0.396*	0.292	0.107
Lead	0.000005	0.001-0.007[e]	0.000088	0.000063	0.000137	0.000440	0.000551	0.00122	0.000551	0.000671	0.000258	0.000172	0.000040
Lithium	0.0005		0.0005	<0.0005	0.0009	0.0015	0.0017	0.0026	0.0017	0.0008	0.0006	0.0011	0.0005
Magnesium	0.05		7.52	8.05	6.21	5.04	6.75	8.40	4.43	5.62	5.49	6.36	3.79
Manganese	0.00005		0.0178	0.00602	0.00519	0.0271	0.0435	0.0785	0.0345	0.0179	0.0431	0.0237	0.00202
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	0.00001
Molybdenum	0.00005	0.073	0.00055	0.00073	0.00089	0.00057	0.00090	0.00082	0.00050	0.00044	0.00020	0.00064	0.00091
Nickel	0.00002	0.025-0.15[f]	0.00122	0.00129	0.00049	0.00071	0.00271	0.00594	0.00078	0.00069	0.00107	0.00083	0.00043
Phosphorous	0.002		0.012	0.008	0.007	0.016	0.056	0.094	0.024	0.011	0.026	0.010	0.009
Potassium	0.05		1.46	1.54	0.95	0.76	1.01	1.17	0.66	0.85	1.15	0.88	0.98
Selenium	0.00004	0.001	0.00006	0.00005	0.00008	0.00005	0.00032	0.00050	0.00007	0.00009	0.00004	0.00009	0.00006
Silicon	0.1		3.4	4.0	4.0	3.7	3.6	4.0	3.6	3.8	2.2	3.7	3.7
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000022	<0.000005	0.000008	<0.000005	<0.000005	<0.000005
Sodium	0.05		2.42	2.66	2.94	2.83	1.93	1.90	2.33	2.18	1.67	3.05	2.37
Strontium	0.00005		0.140	0.148	0.123	0.109	0.121	0.134	0.105	0.127	0.112	0.114	0.0707
Thallium	0.000002	0.0008	0.000004	0.000003	0.000003	0.000003	0.000007	0.000015	0.000003	0.000003	0.000004	<0.000002	0.000003
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0036	0.0020	0.0013	0.0046	0.0067	0.0171	0.0063	0.0017	0.0093	0.0032	0.0021

Appendix A2

Surface Water Quality Data, Casino Project, June-July 2009

Appendix A2. Surface Water Quality Analytical Results, Casino Project, June 2009

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from Confluence of Canadian Creek	W3 - Canadian Creek us of Confluence with Brittannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino Confluence	W6a - Yukon River Downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W7 - Upper Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W12 - Proctor Gulch before Confluence with Casino Creek	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from Outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek	W18 - Brynelsen Creek	W43 - Pipe Outflow of Portal near Lower Camp	Field Blank (WFB)
Date		CCME [1]	30-Jun-09	30-Jun-09	30-Jun-09	29-Jun-09	29-Jun-09	29-Jun-09	29-Jun-09	30-Jun-09	29-Jun-09	29-Jun-09	30-Jun-09	30-Jun-09	30-Jun-09	29-Jun-09	29-Jun-09	30-Jun-09	30-Jun-09
Physical Tests																			
Temperature °C	-		6.6	4.8	5.7	4.2	4.2	12.5	13.6	2.6	4.8	3.6	6.0	1.9	13.6	5.7	3.7	3.4	-
Conductivity (Field) µS/cm	-		138.6	46.5	135.5	98.7	106.1	151.0	94.3	74.3	106.8	84.7	613.0	102.0	152.7	40.1	63.1	223	-
pH (Field)	-		7.66	7.06	7.59	7.48	7.52	8.10	8.10	6.60	7.49	7.36	3.67	7.43	8.11	7.14	7.38	7.08	-
Hardness $CaCO_3$	0.5		73.6	63.8	70.7	52.8	56.3	76.5	91.7	28.2	58.4	45.1	164	53.6	81.2	64.8	36.3	105	<0.5
Conductivity	1		150	120	140	100	110	150	190	75	110	85	520	94	150	130	63	220	1
pH	-	6.5-9.0	7.4	7.3	7.5	7.3	7.4	7.7	7.7	6.4	7.4	7.2	3.9	7.3	7.7	7.4	7.2	6.9	6.0
Total Suspended Solids	1		10	11	7	130	96	35	38	5	160	53	19	20	23	37	46	<1	<1
Total Dissolved Solids	1		120	120	110	92	92	100	130	72	88	78	370	88	92	120	60	150	<1
Turbidity	0.1		1.4	1.9	0.8	51.0	6.8	14.0	16.6	1.7	29.0	22.5	9.7	2.8	9.7	12.6	3.6	0.8	0.1
Dissolved Anions & Nutrients																			
Ammonia as N	0.01	0.137[a]	0.07	0.02	0.02	0.03	0.02	0.03	0.01	0.01	0.03	0.04	0.05	0.02	0.02	0.03	0.04	<0.01	0.02
Alkalinity, Total (as $CaCO_3$)	0.5		41	35	38	33	41	62	69	3.5	45	25	<0.5	31	63	47	24	71	0.7
Acidity (pH 8.3) as $CaCO_3$	0.5		4.0	4.0	4.2	3.0	3.1	5.0	3.7	7.6	3.6	3.3	69.1	3.7	2.6	3.3	2.8	22.1	1.7
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		0.9	1.1	1.0	1.1	0.9	0.6	<0.5	0.7	1.1	1.0	0.5	1.3	0.6	1.0	1.0	<0.5	1.4
Fluoride (F)	0.01		0.08	0.07	0.07	0.05	0.06	0.09	0.10	0.04	0.05	0.06	0.15	0.06	0.11	0.06	0.04	0.09	0.01
Sulfate (SO_4)	0.5		27	23	32	10	8.1	12	24	25	3.7	9.3	190	8.8	13	15	<0.5	35	0.6
Nitrate (as N)	0.002	2.9	0.088	0.093	0.070	0.042	0.060	0.010	0.014	<0.002	0.049	0.035	0.024	0.118	0.010	0.056	0.090	0.162	<0.002
Nitrite (as N)	0.002	0.06	0.003	0.003	<0.002	0.002	0.002	<0.002	<0.002	<0.002	0.003	0.003	0.002	0.003	0.002	0.002	0.002	0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.50	0.69	0.31	0.41	0.48	0.12	0.13	0.39	0.38	0.31	0.40	0.49	0.16	0.36	0.38	0.06	0.10
Ortho Phosphate as P	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	0.002	<0.001	0.001	0.001	<0.001	0.001	0.063	<0.001
Cyanide, Weak Acid Diss	0.0005		0.0007	0.0009	0.0010	0.0009	0.0007	<0.0005	<0.0005	<0.0005	0.0007	0.0008	<0.0005	0.0009	<0.0005	0.0006	0.0009	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	0.0007	0.0011	0.0006	0.0007	0.0006	<0.0005	<0.0005	<0.0005	0.0006	0.0008	<0.0005	0.0015	<0.0005	0.0006	0.0009	<0.0005	<0.0005
Total Organic Carbon	0.5		17.7	16.5	13.2	19.8	16.0	3.0	3.8	9.5	15.2	19.9	12.3	22.8	4.4	13.0	21.8	1.0	1.3
Total Metals																			
Aluminum	0.0002	0.005-0.1[b]	0.236	0.313	0.161	0.821	0.469	0.182	0.213	0.173	0.777	0.630	5.30	0.500	0.189	0.342	0.709	0.0175	0.0005
Antimony	0.00002		0.00032	0.00033	0.00044	0.00046	0.00014	0.00010	0.00018	0.00011	0.00012	0.00039	0.00018	0.00025	0.00012	0.00016	0.00012	0.00366	<0.00002
Arsenic	0.00002	0.005	0.00077	0.00091	0.00094	0.00152	0.00087	0.00064	0.00080	0.00033	0.00141	0.00117	0.00043	0.00097	0.00068	0.00098	0.00066	0.00078	<0.00002
Barium	0.00002		0.0432	0.0464	0.0361	0.0747	0.0457	0.0451	0.0662	0.0335	0.0691	0.0564	0.0290	0.0584	0.0462	0.0482	0.0394	0.0462	0.00003
Beryllium	0.00001		0.00001	0.00002	0.00001	0.00007	0.00004	<0.00001	0.00003	0.00002	0.00007	0.00005	0.00027	0.00003	0.00001	0.00003	0.00003	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	0.000010	0.000017	0.000008	0.000005	0.000007	0.000006	0.000007	0.000031	0.000016	0.000020	<0.000005	0.000008	<0.000005	<0.000005	0.000016
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000018	0.00023	0.000042	0.000271	0.000061	0.000050	0.000170	0.000185	0.000054	0.000278	0.00137	0.000021	0.000048	0.000073	0.000038	0.0458	<0.000005
Calcium	0.05		17.9	15.7	17.5	14.3	15.0	21.0	24.8	8.44	15.0	12.7	48.2	13.2	22.3	16.6	9.97	28.6	<0.05
Chromium	0.0001	0.001	0.0003	0.0004	0.0002	0.0006	0.0007	0.0003	0.0003	<0.0001	0.0010	0.0005	0.0004	0.0006	0.0003	0.0005	0.0006	<0.0001	<0.0001
Cobalt	0.000005		0.000161	0.000212	0.000129	0.00124	0.000496	0.000237	0.000369	0.000148	0.000825	0.000973	0.0192	0.000264	0.000253	0.000391	0.000421	0.000162	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00361	0.00383	0.00498	0.0278	0.00929	0.00167	0.00229	0.00506	0.00526	0.0266	0.465	0.00287	0.00172	0.00892	0.00299	0.0635	<0.00005
Iron	0.001	0.3	0.215	0.283	0.146	1.08	0.784	0.303	0.498	0.146	1.44	0.698	12.9	0.428	0.293	0.676	0.617	0.049	<0.001
Lead	0.000005	0.001-0.007[e]	0.000154	0.000167	0.000166	0.119	0.00292	0.000342	0.000622	0.000654	0.00132	0.0748	0.00145	0.000273	0.000325	0.00301	0.000444	0.00985	0.000021
Lithium	0.0005		0.0005	<0.0005	<0.0005	0.0009	0.0015	0.0011	0.0020	0.0006	0.0021	0.0006	0.0028	0.0005	0.0012	0.0013	0.0007	0.0022	<0.0005
Magnesium	0.05		7.01	6.00	6.55	4.15	4.55	5.84	7.25	1.74	5.11	3.28	10.7	5.03	6.20	5.67	2.76	8.11	<0.05
Manganese	0.00005		0.00893	0.0122	0.00662	0.215	0.0408	0.0256	0.0403	0.0130	0.0694	0.134	0.563	0.0194	0.0258	0.0518	0.0330	0.269	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00044	0.00036	0.00050	0.00037	0.00049	0.00085	0.00093	0.00015	0.00034	0.00025	0.00011	0.00018	0.00087	0.00054	0.00045	<0.00005	<0.00005
Nickel	0.00002	0.025-0.150	0.00105	0.00108	0.00141	0.00146	0.00122	0.00162	0.00281	0.00115	0.00210	0.00123	0.00364	0.00106	0.00152	0.00125	0.00102	0.00039	<0.00002
Phosphorous	0.002		0.013	0.013	0.008	0.072	0.026	0.035	0.044	0.007	0.126	0.031	0.011	0.020	0.040	0.024	0.032	0.003	0.035
Potassium	0.05		1.12	0.94	1.03	0.59	0.57	0.70	0.71	0.34	0.51	0.50	1.08	0.80	0.75	0.64	0.64	1.29	<0.05
Selenium	0.00004	0.001	0.00009	0.00008	0.00008	0.00007	0.00006	0.00025	0.00056	0.00006	0.00006	0.00008	0.00016	0.00007	0.00026	0.00007	0.00006	<0.00004	<0.00004
Silicon	0.1		4.3	4.3	4.7	4.5	4.1	3.5	3.4	5.6	4.7	4.1	7.4	3.8	3.6	4.2	4.4	6.6	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	0.000012	<0.000005	<0.000005	0.000005	0.000008	0.000091	0.000021	<0.000005	<0.000005	0.000010	0.000007	0.000093	<0.000005
Sodium	0.05		2.29	2.10	2.29	1.82	2.28	1.54	1.52	2.22	2.41	1.52	3.32	1.74	1.62	2.67	1.64	3.28	<0.05
Strontium	0.00005		0.112	0.0990	0.102	0.0844	0.104	0.0889	0.114	0.0527	0.112	0.0728	0.134	0.0893	0.0911	0.109	0.0499	0.240	<0.00005
Thallium	0.000002	0.0008	0.000005	0.000004	0.000005	0.000030	0.000008	0.000005	0.000009	0.000003	0.000007	0.000022	0.000041	0.000007	0.000004	0.000006	0.000010	0.000022	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002
Titanium	0.0005		0.0048	0.0078	0.0029	0.0175	0.0136	0.0048	0.0043	0.0017	0.0216	0.0115	0.0014	0.0111	0.0053	0.0110	0.0158	0.0006	<0.0005
Uranium	0.000002		0.00350	0.00318	0.00376	0.00288	0.00234	0.000845	0.000872	0.000160	0.00312	0.00209	0.00686	0.00190	0.000861	0.00234	0.00144	0.00134	<0.000002
Vanadium	0.0002		0.0005	0.0008	0.0003	0.0034	0.0021	0.0008	0.0010	0.0003	0.0050	0.0016	0.0002	0.0012	0.0007	0.0020	0.0021	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0016	0.0018	0.0034	0.0238	0.0043	0.0036	0.0099	0.0205	0.0060	0.0211	0.101	0.0029	0.0037	0.0044	0.0040	2.40	<0.0001
Zirconium	0.0001		0.0004	0.0005	0.0003	0.0007	0.0005	0.0001	0.0002	0.0002	0.0008	0.0007	0.0003	0.0006	0.0001	0.0005	0.0006	<0.0001	<0.0001
Dissolved Metals																			
Aluminum	0.0002		0.168	0.190	0.104	0.194	0.355	0.0232	0.0469	0.162	0.102	0.247	5.72	0.299	0.0273	0.114	0.346	0.0062	0.0009
Antimony	0.00002		0.00031	0.00035	0.00042	0.00022	0.00012	0.00009	0.00015	0.00009	0.00012	0.00019	0.00016	0.00027	0.00011	0.00013	0.00021	0.00360	<0.00002
Arsenic	0.00002		0.00065	0.00071	0.00074	0.00075	0.00052	0.00041	0.00052	0.00025	0.00055	0.00075	0.00027	0.00059	0.00043	0.00050	0.00069	0.00034	<0.00002
Barium	0.00002		0.0427	0.0402	0.0329	0.0320	0.0408	0.0366	0.0454	0.0349	0.0374	0.0329	0.0280	0.0464	0.0371	0.0398	0.0270	0.0480	0.00012
Beryllium	0.00001		0.00001	0.00001	<0.00001	0.00001	0.00003	<0.00001	<0.00001	0.00003	0.00002	0.00003	0.00028	0.00002	<0.00001	<0.00001	0.00002	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	0.000005	0.000008	0.000006	<0.000005	0.000015	<0.000005	0.000009	<0.000005	<0.000005	<0.000005	0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000014	0.000014	0.000019	0.000039	0.000042	0.000022	0.000048	0.000164	<0.000005	0.000080	0.00134	0.000023	0.000028	0.000010	0.000045	0.0464	<0.000005
Calcium	0.05		19.4	14.4	16.0	14.4	15.1	22.4	28.5	9.23	14.1	12.5	50.9	12.0	22.3	18.0	9.71	31.9	<0.05
Chromium	0.0001		0.0002	0.0002	0.0001	0.0003	0.0003	<0.0001	<0.0001	<0.0001	0.0001	0.0003	0.0004	0.0003	<0.0001	0.0002	0.0004	<0.0001	<0.0001
Cobalt	0.000005		0.000084	0.000089	0.000073	0.000174	0.000362	0.000018	0.000056	0.000150	0.000104	0.000248	0.0204	0.000132	0.000026	0.000088	0.000080	0.000176	<0.000005
Copper	0.00005		0.00365	0.00357	0.00446	0.0147	0.00797	0.00090	0.00136	0.00485	0.00173	0.0173	0.486	0.00260	0.00097	0.00619	0.00231	0.0655	0.00013
Iron	0.001		0.121	0.158	0.093	0.181	0.581	0.023	0.059	0.104	0.192	0.212	12.4	0.246	0.029	0.182	0.192	0.030	0.001
Lead	0.000005		0.000030	0.000053	0.000039	0.0147	0.000760	0.000027	0.000062	0.000330	0.000065	0.00989	0.00131	0.000031	0.000321	0.000391	0.000399	0.000305	0.00400	0.000042
Lithium	0.0005		0.0005	<0.0005	<0.0005	0.0005	0.0015	0.0011	0.0019	0.0006	0.0018	<0.0005	0.0028	<0.0005	0.0011	0.0012	<0.0005	0.0022	<0.0005
Magnesium	0.05		7.38	5.49	5.93	4.14	4.94	6.16	8.55	1.91	4.80	3.23	11.2	4.53	6.31	6.60	2.59	8.61	<0.05
Manganese	0.00005		0.00302	0.00375	0.00274	0.0146	0.0320	0.00238	0.00581	0.0118	0.0119	0.0150	0.590	0.00500	0.00336	0.0126	0.00438	0.289	0.00048
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00049	0.00037	0.00050	0.00049	0.00048	0.00100	0.00101	0.00019	0.00050	0.00031	0.00011	0.00019	0.00101	0.00063	0.00052	0.00038	<0.00005
Nickel	0.00002		0.00106	0.00097	0.00116	0.00089	0.00083	0.00089	0.00174	0.00115	0.00073	0.00083	0.00394	0.00112	0.00086	0.00080	0.00076	0.00039	0.00002
Phosphorous	0.002		0.006	0.005	0.004	0.009	0.017	<0.002	0.008	0.005	0.007	0.005	0.007	0.007	0.003	0.007	0.025	0.005	<0.002
Potassium	0.05		1.24	0.85	0.93	0.59	0.68	0.75	0.78	0.40	0.51	0.45	1.14	0.72	0.78	0.70	0.63	1.37	<0.05
Selenium	0.00004		0.00008	0.00008	0.00007	0.00006	0.00006	0.00026	0.00052	0.00005	0.00006	0.00008	0.00014	0.00007	0.00026	0.00007	0.00005	<0.00004	<0.00004
Silicon	0.1		4.4	3.6	4.0	4.0	4.1	3.5	3.6	5.9	4.0	3.8	7.2	3.2	3.8	4.5	3.9	6.6	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	0.000028	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000013	0.000011	<0.000005	<0.000005	<0.000005	<0.000005	0.000019	<0.000005
Sodium	0.05		2.41	1.96	2.13	1.96	2.43	1.65	1.72	2.48	2.41	1.40	3.46	1.63	1.66	2.96	1.68	3.50	<0.05
Strontium	0.00005		0.117	0.106	0.108	0.0809	0.102	0.0913	0.115	0.0566	0.110	0.0721	0.143	0.0924	0.0914	0.112	0.0485	0.247	0.00013
Thallium	0.000002		0.000004	0.000004	0.000003	0.000005	0.000007	0.000003	0.000004	0.000003	<0.000002	0.000005	0.000041	0.000005	0.000003	0.000002	0.000005	0.000025	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	0.00003	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	<0.00001	0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0013	0.0021	0.0013	0.0023	0.0248	<0.0005	0.0035	<0.0005	0.0011	0.0021	0.0010	0.0026	0.0006	0.0016	0.0026	<0.0005	<0.0005
Uranium	0.000002		0.00352	0.00319	0.00372	0.00161	0.00225	0.000830	0.000847	0.000148	0.00229	0.00144	0.00681	0.00179	0.000842	0.00204	0.00102	0.00137	<0.000002
Vanadium	0.0002		0.0003	0.0004	0.0003	0.0004	0.0014	0.0003	0.0003	0.0002	0.0007	0.0003	<0.0002	0.0006	0.0002	0.0005	0.0006	<0.0002	<0.0002
Zinc	0.0001		0.0009	0.0016	0.0021	0.0041	0.0052	0.0007	0.0022	0.0155	0.0005	0.0048	0.104	0.0056	0.0008	0.0010	0.0027	2.57	0.0035
Zirconium	0.0001		0.0003	0.0004	0.0003	0.0005	0.0004	<0.0001	<0.0001	0.0002	0.0004	0.0005	0.0003	0.0005	<0.0001	0.0004	0.0005	<0.0001	<0.0001

Notes:

All units mg/L unless otherwise noted.

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment 2007.

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N.

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ <4 mg/L, DOC <2 mg/L; 0.1 mg/L at pH ≥6.5, $[Ca^{2+}]$ ≥4 mg/L, DOC ≥2 mg/L.

c) $10^{(0.86\log[hardness]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ =120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ >180 mg/L.

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ =60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ =120 -180 mg/L; 0.007 mg/L at $[CaCO_3]$ >180 mg/L.

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ =60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ =120 -180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L.

**Average of sample and replicate.*

0.231 *Results exceed CCME Aquatic Life Guidelines.*

Appendix A3. Surface Water Quality Analytical Results, Casino Project, August 2009

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from Confluence of Canadian Creek	W3 - Canadian Creek us of Confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino Confluence	W6a - Yukon River Downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W7 - Upper Canadian Creek	W8 - Upper Reach of Casino Creek us of Confluence with Meloy Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W12 - Proctor Gulch before Confluence with Casino Creek	W13 - Mouth of Meloy Creek	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from Outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek	W17 - Sunshine Creek	W18 - Brynelsen Creek	W43 - Pipe Outflow of Portal near Lower Camp	R2	Field Blank (WFB)
Date		CCME [1]	8-Aug-09	8-Aug-09	8-Aug-09	5-Aug-09	5-Aug-09	6-Aug-09	6-Aug-09	8-Aug-09	6-Aug-09	5-Aug-09	6-Aug-09	8-Aug-09	6-Aug-09	8-Aug-09	6-Aug-09	5-Aug-09	6-Aug-09	6-Aug-09	9-Aug-09	5-Aug-09	9-Aug-09
Physical Tests																							
Temperature °C	-		8.1	7.7	7.8	9.0	7.3	17.3	19.5	6.2	4.8	8.6	4.6	4.7	2.0	5.4	16.9	9.6	7.9	4.6	3.2	6.2	-
Conductivity (Field) µS/cm	-		372.2	296.7	234.1	295.1	230.8	123.8	186.3	112.2	338.2	203.6	341.9	592.7	274.6	445.7	180.3	233.1	258.8	215.4	276.9	143.3	-
pH (Field)	-		7.96	7.81	7.71	7.93	7.85	8.45	8.44	7.62	7.89	7.81	8.05	3.70	8.04	7.90	8.40	7.81	7.81	7.89	6.81	7.53	-
Hardness $CaCO_3$	0.5		182	142	112	141	108	73.8	92.0	39.9	154	95.5	169	185	149	223	93.0	109	128	102	125	75.5	<0.5
Conductivity	1		372	295	251	302	232	156	188	110	340	204	344	599	298	444	187	234	266	218	279	165	2
pH	-	6.5-9.0	7.8	7.7	7.4	7.9	8.0	7.8	8.0	6.8	7.6	7.9	8.0	3.6	8.1	8.0	8.0	7.9	7.7	8.0	7.2	7.7	6.3
Total Suspended Solids	1		<1	21	34	<1	<1	8	8	11	7	2	<1	54	<1	6	8	3	<1	<1	<1	<1	<1
Total Dissolved Solids	1		250	200	170	190	130	70	100	400	230	110	210	390	170	280	110	140	170	140	160	92	1500
Turbidity	0.1		0.1	2.5	2.2	0.3	0.3	1.6	4.1	4.9	10	0.4	0.6	59.6	0.4	0.8	3.9	0.4	0.2	0.4	0.4	0.4	0.5
Dissolved Anions & Nutrients																							
Ammonia as N	0.01	0.137[a]	0.01	0.05	0.04	0.10	<0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01	0.03	0.01	0.05	0.02	<0.01	0.01	<0.01	<0.01	<0.01	0.01
Alkalinity, Total (as $CaCO_3$)	0.5		100	81	62	100	93	67	75	7.2	46	89	99	<0.5	120	140	74	90	91	83	93	66	1.3
Acidity (pH 8.3) as $CaCO_3$	0.5		<0.5	1.2	0.7	0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	54.2	<0.5	3.7	<0.5	<0.5	1.2	<0.5	6.8	0.7	<0.5
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		1.1	0.8	0.8	0.5	0.8	0.7	0.5	<0.5	<0.5	0.7	0.7	0.7	0.8	1.0	0.7	0.6	1.1	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.01		0.11	0.09	0.08	0.07	0.06	0.11	0.11	0.07	0.11	0.06	0.09	0.16	0.07	0.15	0.12	0.06	0.08	0.04	0.09	0.06	<0.01
Sulfate (SO_4)	0.5		84	61	51	48	27	12	20	34	110	17	71	200	32	92	19	29	41	27	44	17	<0.5
Nitrate (as N)	0.002	2.9	0.071	0.205	0.255	0.052	0.027	0.002	0.012	0.004	0.055	0.019	0.135	0.055	0.284	0.162	0.002	<0.002	0.086	0.117	0.163	0.040	0.007
Nitrite (as N)	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.18	0.16	0.19	-	-	0.11	0.08	0.19	0.09	-	0.06	0.53	0.03	0.19	0.07	-	0.15	0.10	0.03	-	0.04
Ortho Phosphate as P	0.001		0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.002	0.001	0.001	<0.001	0.002	<0.001	0.002	0.001	<0.001	0.002	0.001	<0.001
Cyanide, Weak Acid Diss	0.0005		0.0007	0.0007	0.0018	<0.0005	<0.0005	0.0011	<0.0005	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	0.0005	0.0009	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	0.0008	0.0011	0.0011	0.0011	<0.0005	0.0011	0.0007	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	0.0006	0.0007	0.0015	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Total Organic Carbon	0.5		7.2	7.3	5.0	9.0	4.5	1.9	2.2	6.5	3.2	4.3	3.9	9.9	2.8	9.2	2.8	5.5	6.8	3.8	0.9	4.4	<0.5
Total Metals																							
Aluminum	0.0002	0.005-0.1[b]	0.0143	0.125	0.186	0.0168	0.0133	0.0704	0.0777	0.155	0.621	0.0144	0.0417	5.25	0.0132	0.0646	0.0813	0.0342	0.0166	0.0173	0.0023	0.0236	0.0010
Antimony	0.00002		0.00028	0.00032	0.00034	0.00015	0.00012	0.00009	0.00012	0.00008	0.00009	0.00009	0.00015	0.00035	0.00021	0.00020	0.00012	0.00010	0.00026	0.00017	0.00300	0.00004	<0.00002
Arsenic	0.00002	0.005	0.00047	0.00095	0.00119	0.00038	0.00031	0.00049	0.00053	0.00050	0.00023	0.00028	0.00061	0.00197	0.00137	0.00057	0.00054	0.00047	0.00052	0.00038	0.00043	0.00020	<0.00002
Barium	0.00002		0.0745	0.0686	0.0572	0.0725	0.0654	0.0385	0.0452	0.0434	0.0591	0.0608	0.0699	0.0346	0.0846	0.107	0.0457	0.0661	0.0843	0.0528	0.0475	0.0525	<0.00002
Beryllium	0.00001		<0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00003	<0.00001	<0.00001	0.00026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000016	<0.000005	<0.000005	<0.000005	0.000048	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000019	0.000041	0.000054	0.000017	0.000007	0.000018	0.000029	0.000152	0.000286	<0.000005	0.000041	0.00140	0.000045	0.000019	0.000030	0.000012	0.000013	0.000007	0.0492	0.000007	<0.000005
Calcium	0.05		45.5	35.7	28.9	37.6	28.4	20.9	25.5	11.9	46.2	24.9	45.6	54.6	40.5	52.5	25.9	27.5	31.3	27.5	35.0	18.2	<0.05
Chromium	0.0001	0.001	0.0001	0.0004	0.0005	<0.0001	<0.0001	0.0001	0.0001	0.0003	<0.0001	<0.0001	<0.0001	0.0008	<0.0001	0.0002	0.0002	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000029	0.000233	0.000301	0.000017	0.000029	0.000072	0.000084	0.000155	0.00273	0.000035	0.000045	0.0208	0.000018	0.000069	0.000082	0.000071	0.000023	0.000022	0.000179	0.000023	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00185	0.00297	0.00377	0.00231	0.00132	0.00079	0.00083	0.00345	0.0643	0.00084	0.00552	0.473	0.00055	0.00157	0.00089	0.00137	0.00121	0.00069	0.0463	0.00086	<0.00005
Iron	0.001	0.3	0.010	0.220	0.343	0.017	0.039	0.104	0.124	0.179	1.55	0.039	0.077	18.3	0.021	0.078	0.128	0.142	0.014	0.012	0.026	0.029	<0.001
Lead	0.000005	0.001-0.007[e]	0.000016	0.000283	0.000489	0.000044	0.000018	0.000085	0.000104	0.000352	0.00119	0.000018	0.000365	0.00164	0.00263	0.000263	0.000103	0.000121	0.000225	0.000253	0.00429	0.000023	0.000018
Lithium	0.0005		0.0009	0.0007	0.0005	0.0011	0.0021	0.0012	0.0018	0.0007	0.0011	0.0029	0.0015	0.0031	0.0017	0.0012	0.0018	0.0015	0.0008	0.0008	0.0028	0.0011	<0.0005
Magnesium	0.05		16.5	12.8	9.56	11.3	9.09	5.24	6.87	2.48	9.48	8.12	13.4	11.7	11.7	22.4	6.90	9.66	12.1	8.06	9.20	7.28	<0.05
Manganese	0.00005		0.00055	0.0287	0.0369	0.00381	0.0143	0.00964	0.0105	0.0106	0.0808	0.0148	0.0184	0.591	0.0120	0.00952	0.0109	0.0269	0.00162	0.00248	0.247	0.00393	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00110	0.00078	0.00068	0.00138	0.00099	0.00116	0.00122	0.00027	0.00027	0.00081	0.00089	0.00031	0.00072	0.00065	0.00121	0.00103	0.00049	0.00175	<0.00005	0.00086	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00054	0.00097	0.00113	0.00022	0.00025	0.00060	0.00086	0.00081	0.00083	0.00025	0.00024	0.00384	0.00016	0.00055	0.00085	0.00038	0.00045	0.00014	0.00048	0.00031	<0.00002
Phosphorous	0.002		0.002	0.017	0.024	<0.002	<0.002	0.011	0.009	0.010	<0.002	0.002	<0.002	0.074	0.002	0.009	0.010	0.004	0.003	<0.002	<0.002	<0.002	<0.002
Potassium	0.05		2.43	1.90	1.58	1.18	0.95	0.73	0.80	0.52	0.98	0.85	1.05	1.18	1.18	2.50	0.80	1.04	1.45	1.21	1.40	0.70	<0.05
Selenium	0.00004	0.001	0.00011	0.00008	0.00009	0.00006	0.00005	0.00023	0.00036	0.00006	0.00007	0.00004	0.00014	0.00022	0.00005	0.00010	0.00036	0.00006	0.00007	<0.00004	<0.00004	0.00006	<0.00004
Silicon	0.1		3.8	4.4	4.6	4.7	4.2	2.6	2.9	7.2	5.8	4.1	5.3	5.8	5.4	3.5	2.8	3.5	4.0	5.3	5.1	3.8	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000009	<0.000005	<0.000005	<0.000005	0.000019	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000045	<0.000005	<0.000005
Sodium	0.05		5.38	4.43	3.58	5.01	4.59	1.58	1.71	3.52	4.47	4.44	4.43	3.67	4.59	6.53	1.75	4.72	4.54	4.37	3.54	3.17	<0.05
Strontium	0.00005		0.295	0.252	0.187	0.241	0.213	0.0993	0.114	0.0849	0.288	0.211	0.275	0.176	0.242	0.441	0.115	0.198	0.197	0.149	0.318	0.165	<0.00005
Thallium	0.000002	0.0008	0.000003	0.000003	0.000005	<0.000002	<0.000002	0.000004	0.000005	0.000003	0.000006	<0.000002	0.000003	0.000046	<0.000002	0.000004	0.000004	<0.000002	<0.000002	0.000002	0.000024	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	0.0043	0.0067	<0.0005	<0.0005	0.0024	0.0028	0.0040	<0.0005	<0.0005	<0.0005	0.0069	<0.0005	0.0018	0.0035	0.0012	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0156	0.0109	0.00709	0.00993	0.00725	0.000856	0.000914	0.000131	0.00301	0.00664	0.0130	0.00705	0.0153	0.0165	0.00101	0.00482	0.00225	0.00587	0.00238	0.00175	0.000004
Vanadium	0.0002		<0.0002	0.0006	0.0008	0.0002	0.0003	0.0003	0.0004	0.0006	<0.0002	0.0003	<0.0002	0.0016	<0.0002	0.0005	0.0004	0.0004	0.0002	0.0003	<0.0002	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0007	0.0021	0.0034	0.0009	0.0003	0.0009	0.0014	0.0102	0.0224	0.0004	0.0018	0.105	0.0020	0.0015	0.0013	0.0007	0.0004	0.0003	2.59	0.0003	0.0002
Zirconium	0.0001		0.0002	0.0002	0.0002	<0.0001	0.0001	<0.0001	<0.0001	0.0003	<0.0001	0.0001	<0.0001	0.0005	<0.0001	0.0003	<0.0001	0.0002	0.0002	<0.0001	<0.0001	0.0001	<0.0001
Dissolved Metals																							
Aluminum	0.0002		0.107	0.0383	0.0395	0.0140	0.0118	0.0103	0.0108	0.0554	0.0510	0.0120	0.0168	4.97	0.0040	0.0260	0.0103	0.0097	0.0153	0.0166	0.0014	0.0161	0.0015
Antimony	0.00002		0.00039	0.00034	0.00034	0.00016	0.00012	0.00009	0.00011	0.00008	0.00009	0.00010	0.00014	0.00019	0.00020	0.00020	0.00011	0.00010	0.00026	0.00017	0.00283	0.00004	<0.00002
Arsenic	0.00002		0.00076	0.00071	0.00071	0.00036	0.00031	0.00041	0.00051	0.00025	0.00011	0.00031	0.00055	0.00031	0.00132	0.00049	0.00045	0.00047	0.00051	0.00036	0.00029	0.00020	<0.00002
Barium	0.00002		0.0796	0.0643	0.0501	0.0705	0.0641	0.0364	0.0422	0.0410	0.0586	0.0618	0.0691	0.0284	0.0866	0.106	0.0426	0.0680	0.0842	0.0520	0.0451	0.0540	0.00008
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00025	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.00004	0.000039	0.000026	0.000013	0.000010	0.000008	0.000011	0.000145	0.000212	0.000005	0.000023	0.00138	0.000026	0.000015	0.000010	0.000007	0.000007	<0.000005	0.0492	0.000006	<0.000005
Calcium	0.05		46.1	35.6	28.7	37.1	29.2	21.0	27.2	12.3	46.8	26.5	45.8	55.5	40.6	53.8	25.9	28.8	32.0	27.8	35.0	19.0	<0.05
Chromium	0.0001		0.0003	0.0001	0.0002	<0.0001	0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0001	<0.0001	0.0005	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001
Cobalt	0.000005		0.000167	0.000073	0.000053	0.000019	0.000038	0.000011	0.000009	0.000089	0.00268	0.000037	0.000033	0.0212	0.000011	0.000049	0.000006	0.000043	0.000026	0.000018	0.000172	0.000015	<0.000005
Copper	0.00005		0.00269	0.00301	0.00257	0.00226	0.00139	0.00063	0.00064	0.00308	0.0139	0.00083	0.00354	0.472	0.00040	0.00143	0.00060	0.00129	0.00113	0.00063	0.0447	0.00092	0.00009
Iron	0.001		0.174	0.068	0.050	0.011	0.035	0.009	0.008	0.046	0.190	0.032	0.016	15.6	0.008	0.021	0.006	0.083	0.011	0.012	0.020	0.017	0.003
Lead	0.000005		0.000564	0.000419	0.000059	0.000013	0.000016	0.000199	0.000009	0.000040	0.000712	0.000025	0.000114	0.000574	0.000102	0.000065	0.000058	0.000011	0.00226	0.000388	0.00222	<0.000005	0.000036
Lithium	0.0005		0.0009	0.0006	<0.0005	0.0012	0.0021	0.0011	0.0016	0.0006	0.0011	0.0030	0.0014	0.0030	0.0016	0.0011	0.0016	0.0015	0.0007	0.0007	0.0027	0.0011	<0.0005
Magnesium	0.05		16.4	12.8	9.35	11.3	9.23	5.16	7.01	2.51	9.64	8.33	12.8	12.0	11.4	22.8	6.75	9.78	11.9	7.77	9.14	7.47	<0.05
Manganese	0.00005		0.0106	0.00729	0.00593	0.00336	0.0142	0.00117	0.00101	0.00775	0.0817	0.0142	0.0166	0.600	0.00837	0.00505	0.00067	0.0164	0.00148	0.00228	0.249	0.00338	0.00008
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00106	0.00087	0.00079	0.00136	0.00099	0.00122	0.00124	0.00028	0.00026	0.00079	0.00088	0.00012	0.00076	0.00068	0.00121	0.00104	0.00047	0.00173	<0.00005	0.00089	<0.00005
Nickel	0.00002		0.00106	0.00063	0.00061	0.00019	0.00027	0.00043	0.00054	0.00080	0.00081	0.00028	0.00019	0.00380	0.00097	0.00053	0.00050	0.00034	0.00039	0.00013	0.00051	0.00033	0.00003
Phosphorous	0.002		0.009	0.004	0.003	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	0.002	<0.002	0.005	<0.002	0.003	<0.002	0.002	0.004	<0.002	<0.002	<0.002	<0.002
Potassium	0.05		2.48	1.91	1.56	1.17	0.98	0.73	0.85	0.53	1.00	0.91	1.07	1.21	1.18	2.59	0.81	1.08	1.48	1.24	1.43	0.73	<0.05
Selenium	0.00004		0.00010	0.00009	0.00008	0.00007	0.00005	0.00023	0.00037	0.00006	0.00007	0.00004	0.00013	0.00017	<0.00004	0.00009	0.00035	0.00004	0.00007	<0.00004	<0.00004	0.00005	<0.00004
Silicon	0.1		3.9	4.6	4.7	5.1	4.6	2.6	2.8	7.2	5.9	4.6	5.4	5.8	5.1	3.7	2.6	3.9	3.9	5.3	5.2	4.4	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000007	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000008	<0.000005	<0.000005
Sodium	0.05		5.47	4.65	3.54	4.97	4.72	1.55	1.76	3.61	4.58	4.58	4.22	3.71	4.44	7.21	1.74	4.85	4.48	4.22	3.48	3.23	<0.05
Strontium	0.00005		0.297	0.251	0.188	0.241	0.214	0.100	0.113	0.0848	0.294	0.209	0.275	0.177	0.241	0.443	0.111	0.197	0.194	0.145	0.313	0.162	<0.00005
Thallium	0.000002		0.000004	0.000003	0.000003	<0.000002	<0.000002	0.000003	0.000003	0.000002	0.000007	<0.000002	0.000004	0.000046	<0.000002	0.000002	0.000003	<0.000002	0.000003	0.000003	0.000021	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0041	0.0006	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0011	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005
Uranium	0.000002		0.0153	0.0106	0.00677	0.00984	0.00712	0.000842	0.000896	0.000106	0.00189	0.00665	0.0129	0.00641	0.0153	0.0166	0.00102	0.00483	0.00218	0.00571	0.00229	0.00175	<0.000002
Vanadium	0.0002		0.0006	0.0003	0.0002	0.0003	0.0003	0.0002	<0.0002	0.0003	<0.0002	0.0003	<0.0002	0.0002	<0.0002	0.0003	<0.0002	0.0003	0.0003	0.0002	<0.0002	0.0002	<0.0002
Zinc	0.0001		0.0041	0.0018	0.0010	0.0005	0.0006	0.0004	0.0003	0.0093	0.0130	0.0009	0.0013	0.107	0.0014	0.0007	0.0003	0.0004	0.0004	0.0003	2.60	0.0002	0.0003
Zirconium	0.0001		0.0002	0.0002	0.0002	<0.0001	0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0001	<0.0001	0.0003	<0.0001	0.0003	<0.0001	0.0001	0.0001	<0.0001	<0.0001	0.0001	<0.0001

Notes:
All units mg/L unless otherwise noted.
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment 2007.
a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N.
b) 0.005 mg/L at pH < 6.5, [Ca^{2+}] <4 mg/L, DOC <2 mg/L: 0.1 mg/L at pH >6.5, [Ca^{2+}] >4 mg/L, DOC >2 mg/L.
c) $10^{\{0.86[\log(hardness)]-3.2\}}$
d) 0.002 mg/L at [$CaCO_3$] = 0 - 120 mg/L; 0.003 mg/L at [$CaCO_3$] =120 - 180 mg/L; 0.004 mg/L at [$CaCO_3$] >180 mg/L.
e) 0.001 mg/L at [$CaCO_3$] = 0 - 60 mg/L; 0.002 mg/L at [$CaCO_3$] =60 - 120 mg/L; 0.004 mg/L at [$CaCO_3$] =120 -180 mg/L; 0.007 mg/L at [$CaCO_3$] >180 mg/L.
f) 0.025 mg/L at [$CaCO_3$] = 0 - 60 mg/L; 0.065 mg/L at [$CaCO_3$] =60 - 120 mg/L; 0.110 mg/L at [$CaCO_3$] =120 -180 mg/L; 0.150 mg/L at [$CaCO_3$] > 180 mg/L.
**Average of sample and replicate.*

0.231	*Results exceed CCME Aquatic Life Guidelines.*

Appendix A4

Surface Water Quality Data, Casino Project, September 2009

Appendix A4. Surface Water Quality Analytical Results, Casino Project, September 2009

Station	Detection Limits	Water Quality Guidelines	W2 - Brittania Creek ds from Confluence of Canadian Creek	W3 - Canadian Creek us of Confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino Confluence	W6a - Yukon River Downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W7 - Upper Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W12 - Proctor Gulch before Confluence with Casino Creek	W13 - Mouth of Meloy Creek	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek	W18 - Brynelsen Creek	W20 - Klotass in river us of Dip Creek	W21 - Klotass in River ds of Dip Creek	R2	Field Blank (W102)	Maxxam Travel Blank
Date		CCME [1]	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09
Physical Tests																						
Temperature °C	-		4.6	5.5	1.9	2.4	12.0	12.4	4.6	2.6	2.9	2.4	1.6	3.2	9.2	3.3	3.3	4.7	4.5	3.3	-	-
Conductivity (Field) µS/cm	-		257	259	264	202	101	198	148	176	296	1069	271	251	160	217	180	151	165	140	-	-
pH (Field)	-		7.70	7.72	7.77	7.70	8.19	8.25	7.37	7.64	7.84	3.33	7.76	7.82	8.07	7.70	7.72	7.46	7.64	7.56	-	-
Hardness (CaCO$_3$)	0.5		140	129	133	107	79.8	109	61.3	89.6	160	403	139	131	87.9	117	88.9	81.0	82.8	72.5	<0.5	<0.5
Conductivity	1		263	259	263	203	159	193	217	177	217	1100	271	249	162	221	180	157	169	139	1	1
pH	-	6.5-9.0	7.9	7.9	8.0	7.9	8.0	7.8	8.0	7.9	8.0	*3.3*	8.0	7.9	7.9	8.0	7.9	7.8	7.8	7.8	*6.2*	*6.1*
Total Suspended Solids	1		<1	<1	<1	<1	<1	4	6	2	<1	1	5	22	<1	6	1	<1	1	<1	<1	<1
Total Dissolved Solids	1		170	150	170	130	100	120	130	120	200	760	130	160	110	150	82	100	110	72	<10	<10
Turbidity	0.1		0.2	0.2	0.4	0.3	1.5	2.5	0.4	0.2	1.4	4.0	0.3	0.1	1.3	0.7	0.1	0.3	0.4	0.2	<0.1	<0.1
Dissolved Anions & Nutrients																						
Ammonia as N	0.01	0.137[a]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Alkalinity, Total (as CaCO$_3$)	0.5		76	70	90	82	67	72	7.8	77	83	<0.5	110	80	67	83	68	65	70	60	1.3	1.2
Acidity (pH 8.3) as CaCO$_3$	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		<0.5	<0.5	6.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.01		0.10	0.10	0.10	0.07	0.12	0.12	0.08	0.06	0.09	0.33	0.07	0.10	0.12	0.07	0.04	0.15	0.14	0.05	<0.01	<0.01
Sulfate (SO$_4$)	0.5		51	54	43	23	15	26	53	14	61	430	29	43	15	29	22	14	17	12	<0.5	<0.5
Nitrate (as N)	0.002	2.9	0.271	0.183	0.193	0.143	0.005	<0.002	<0.002	0.125	0.196	0.028	0.330	0.427	0.004	0.087	0.298	0.020	0.016	0.141	<0.002	<0.002
Nitrite (as N)	0.002	0.06	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.005	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.22	0.21	0.13	0.17	0.10	0.08	0.19	0.17	0.13	0.10	0.09	0.29	0.09	0.16	0.17	0.15	0.16	0.21	<0.02	0.03
Ortho Phosphate as P	0.001		<0.001	0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Cyanide, Weak Acid Diss	0.0005		0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	0.0008	0.0007	0.0009	0.0011	<0.0005	0.0006	<0.0005	0.0013	<0.0005	0.0005	<0.0005	0.0010	0.0007	0.0013	0.0006	0.0005	0.0006	<0.0005	<0.0005	0.0005
Total Organic Carbon	0.5		8.8	7.2	5.1	5.8	2.6	2.9	2.9	6.3	3.6	1.5	3.0	12.5	2.8	7.5	5.5	4.9	5.7	7.9	<0.5	<0.5
Total Metals																						
Aluminum	0.0002	0.005-0.1[b]	0.0373	0.0202	0.0376	0.0296	0.0668	*0.117*	0.0496	0.0278	*0.151*	*11.4*	0.0138	0.0571	0.0815	0.0327	0.0299	0.0201	0.0204	0.0358	0.0034	<0.0002
Antimony	0.00002		0.00043	0.00049	0.00014	0.00010	0.00009	0.00012	0.00007	0.00008	0.00016	0.00018	0.00022	0.00031	0.00010	0.00010	0.00017	0.00004	0.00004	0.00004	0.00009	<0.00002
Arsenic	0.00002	0.005	0.00068	0.00066	0.00038	0.00034	0.00041	0.00054	0.00024	0.00031	0.00064	0.00042	0.00113	0.00056	0.00049	0.00053	0.00036	0.00034	0.00039	0.00022	0.00004	<0.00002
Barium	0.00002		0.0576	0.0544	0.0545	0.0524	0.0331	0.0490	0.0527	0.0474	0.0641	0.00940	0.0904	0.0646	0.0394	0.0567	0.0469	0.0372	0.0377	0.0461	0.00039	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00001	<0.00001	0.00001	0.00060	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000012	0.000019	0.000015	0.000007	0.000021	*0.000048*	*0.000143*	0.000006	*0.000088*	*0.00315*	*0.000046*	<0.000005	0.000021	<0.000005	0.000013	0.000006	0.000005	0.000005	0.000005	<0.000005
Calcium	0.05		35.0	33.9	35.9	27.9	22.5	29.8	18.3	23.0	43.6	120	39.0	32.2	24.7	29.3	24.7	19.8	20.4	18.0	0.12	<0.05
Chromium	0.0001	0.001	0.0003	0.0001	<0.0001	<0.0001	0.0002	0.0002	0.0002	<0.0001	0.0002	0.0007	<0.0001	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0002	<0.0001	<0.0001
Cobalt	0.000005		0.000056	0.000043	0.000052	0.000044	0.000043	0.000105	0.000071	0.000043	0.000313	0.0472	0.000018	0.000053	0.000086	0.000090	0.000026	0.000070	0.000075	0.000036	0.000008	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00235	0.00238	*0.00870*	*0.00216*	0.00070	0.00101	*0.00299*	0.00110	*0.0165*	*1.02*	0.00046	0.00169	0.00086	0.00184	0.00086	0.00118	0.00114	0.00104	0.00062	<0.00005
Iron	0.001	0.3	0.032	0.022	0.078	0.071	0.073	0.141	0.046	0.061	*0.320*	*36.1*	0.022	0.042	0.118	0.197	0.019	0.194	0.226	0.044	0.004	<0.001
Lead	0.000005	0.001-0.007[e]	0.000011	0.000021	0.000388	0.000042	0.000055	0.000128	0.000073	0.000035	0.000307	0.00102	0.000755	0.000023	0.000108	0.000022	0.000016	0.000061	0.000017	0.000006	0.000162	<0.000005
Lithium	0.0005		0.0007	0.0006	0.0010	0.0020	0.0011	0.0019	0.0007	0.0023	0.0013	0.0062	0.0017	0.0009	0.0013	0.0014	0.0007	<0.0005	<0.0005	0.0013	<0.0005	<0.0005
Magnesium	0.05		12.8	10.8	10.7	9.09	5.76	8.37	3.81	7.81	12.4	25.0	10.2	12.4	6.39	10.7	6.57	7.68	7.72	6.69	25.0	<0.05
Manganese	0.00005		0.00387	0.00455	0.00820	0.0123	0.00769	0.0106	0.00356	0.0116	0.0376	1.22	0.0125	0.00311	0.00866	0.0277	0.00273	0.0275	0.0301	0.00486	0.00061	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00078	0.00091	0.00117	0.00092	0.00111	0.00120	0.00037	0.00074	0.00083	0.00025	0.00068	0.00054	0.00120	0.00097	0.00142	0.00063	0.00067	0.00095	<0.00005	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00067	0.00069	0.00043	0.00033	0.00070	0.00157	0.00076	0.00041	0.00050	0.00732	0.00020	0.00054	0.00092	0.00054	0.00025	0.00057	0.00054	0.00039	0.00019	<0.00002
Phosphorous	0.002		0.004	0.002	0.002	0.002	0.00400	0.003	0.004	0.004	<0.002	0.009	0.002	0.004	0.008	0.005	<0.002	0.005	0.004	0.003	0.003	<0.002
Potassium	0.05		1.86	1.77	1.09	0.88	0.76	0.86	0.68	0.74	1.05	2.18	1.16	1.65	0.84	1.02	1.12	0.78	0.79	0.61	0.05	<0.05
Selenium	0.00004	0.001	0.00008	0.00007	0.00008	0.00005	0.00023	0.00043	0.00007	<0.00004	0.00012	0.00027	<0.00004	0.00009	0.00027	0.00006	<0.00004	0.00010	0.00008	0.00005	<0.00004	<0.00004
Silicon	0.1		5.7	5.5	6.1	5.8	3.1	3.2	11.1	5.2	6.0	10.5	5.8	4.8	3.1	5.4	5.3	5.0	4.7	4.6	<0.1	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000008	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		4.45	3.83	4.79	4.53	1.79	1.95	5.27	4.14	4.38	7.40	4.09	4.07	1.87	5.16	3.63	4.01	4.06	2.78	0.19	<0.05
Strontium	0.00005		0.222	0.206	0.204	0.189	0.0979	0.128	0.111	0.176	0.254	0.309	0.238	0.252	0.106	0.187	0.120	0.153	0.148	0.144	0.00038	<0.00005
Thallium	0.000002	0.0008	0.000003	0.000002	<0.000002	<0.000002	0.000002	0.000004	0.000003	<0.000002	<0.000003	0.000088	0.000002	0.000002	0.000003	<0.000002	0.000003	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	0.0011	0.0022	0.0011	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	0.0030	0.0008	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	<0.0005
Uranium	0.000002		0.00927	0.00857	0.00726	0.00554	0.000847	0.00104	0.000067	0.00476	0.0105	0.0144	0.0138	0.00604	0.000950	0.00446	0.00382	0.000249	0.000806	0.00239	0.000004	0.000002
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0004	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	0.0003	0.0003	0.0004	0.0002	0.0003	0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0007	0.0013	0.0097	0.0006	0.0013	0.0040	0.0103	0.0007	0.0070	*0.221*	0.0025	0.0010	0.0020	0.0004	0.0007	0.0007	0.0003	0.0002	0.0035	0.0002
Zirconium	0.0001		0.0003	0.0002	0.0001	0.0002	0.0003	0.0001	<0.0001	0.0002	0.0001	<0.0001	<0.0001	0.0004	<0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	<0.0001	<0.0001
Dissolved Metals																						
Aluminum	0.0002		0.0345	0.0193	0.0210	0.0224	0.0134	0.0220	0.0252	0.0239	0.0332	11.3	0.0082	0.0615	0.0150	0.0220	0.0348	0.0122	0.0124	0.0369	0.0004	<0.0002
Antimony	0.00002		0.00041	0.00049	0.00015	0.00010	0.00010	0.00012	0.00006	0.00009	0.00015	0.00019	0.00021	0.00032	0.00010	0.00010	0.00018	0.00004	0.00005	0.00005	<0.00002	<0.00002
Arsenic	0.00002		0.00061	0.00071	0.00037	0.00033	0.00041	0.00039	0.00021	0.00031	0.00053	0.00045	0.00112	0.00059	0.00042	0.00045	0.00037	0.00027	0.00040	0.00023	<0.00002	<0.00002
Barium	0.00002		0.0568	0.0544	0.0615	0.0558	0.0380	0.0436	0.0513	0.0532	0.0641	0.00960	0.0889	0.0637	0.0374	0.0578	0.0477	0.0391	0.0422	0.0460	<0.00002	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00054	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000015	0.000021	0.000015	0.000006	0.000008	0.000018	0.000135	<0.000005	0.000071	0.00281	0.000035	0.000006	0.000011	<0.000005	0.000012	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Calcium	0.05		32.8	33.6	35.5	26.1	22.3	26.5	17.2	22.4	40.7	116	38.1	31.4	22.0	26.3	24.0	17.7	19.8	17.4	<0.05	<0.05
Chromium	0.0001		0.0002	0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0002	<0.0001	0.0001	0.0007	<0.0001	0.0003	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	0.0002	<0.0001	0.0001
Cobalt	0.000005		0.000046	0.000043	0.000042	0.000039	0.000009	0.000010	0.000046	0.000036	0.000308	0.0467	0.000012	0.000054	0.000012	0.000082	0.000028	0.000050	0.000060	0.000033	<0.000005	<0.000005
Copper	0.00005		0.00219	0.00252	0.00382	0.00178	0.00060	0.00069	0.00181	0.00108	0.00882	0.991	0.00052	0.00176	0.00072	0.00167	0.00093	0.00106	0.00112	0.00118	0.00006	<0.00005
Iron	0.001		0.027	0.015	0.028	0.042	0.009	0.013	0.012	0.041	0.057	34.5	0.011	0.038	0.013	0.137	0.021	0.134	0.180	0.038	<0.001	<0.001
Lead	0.000005		0.000006	0.000007	0.000006	<0.000005	<0.000005	<0.000005	0.000007	0.000003	0.000023	0.000883	0.000090	0.000012	0.000083	<0.000005	0.000038	<0.000005	<0.000005	0.000017	<0.000005	<0.000005
Lithium	0.0005		0.0007	0.0005	0.0010	0.0020	0.0012	0.0018	0.0009	0.0024	0.0013	0.0064	0.0015	0.0008	0.0012	0.0015	0.0006	<0.0005	0.0005	0.0011	<0.0005	<0.0005
Magnesium	0.05		11.8	11.1	10.6	8.46	5.70	7.36	3.39	7.59	11.7	23.9	10.6	12.5	5.70	9.49	6.79	6.87	7.50	6.80	<0.05	<0.05
Manganese	0.00005		0.00328	0.00391	0.00745	0.0110	0.00236	0.00143	0.00245	0.0109	0.0355	1.21	0.0106	0.00302	0.00155	0.0241	0.00255	0.0225	0.0288	0.00457	<0.00005	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00079	0.00086	0.00122	0.00092	0.00129	0.00127	0.00034	0.00082	0.00080	0.00026	0.00069	0.00054	0.00132	0.00100	0.00141	0.00064	0.00074	0.00095	<0.00005	<0.00005
Nickel	0.00002		0.00062	0.00073	0.00027	0.00035	0.00055	0.00108	0.00066	0.00037	0.00059	0.00735	0.00019	0.00055	0.00067	0.00050	0.00022	0.00052	0.00055	0.00041	0.00002	<0.00002
Phosphorous	0.002		0.002	0.003	0.002	0.003	<0.002	<0.002	<0.002	0.002	<0.002	0.009	<0.002	0.003	<0.002	0.00400	<0.002	0.003	0.002	0.004	<0.002	<0.002
Potassium	0.05		1.74	1.78	1.07	0.84	0.74	0.73	0.63	0.73	0.97	2.12	1.16	1.62	0.75	0.91	1.10	0.70	0.77	0.59	<0.05	<0.05
Selenium	0.00004		0.00009	0.00006	0.00008	0.00005	0.00024	0.00042	0.00005	0.00004	0.00012	0.00028	0.00004	0.00009	0.00025	0.00005	<0.00004	0.00009	0.00008	0.00006	<0.00004	<0.00004
Silicon	0.1		5.7	5.1	5.8	5.1	2.7	2.8	10.1	4.5	5.7	10.1	5.8	4.8	2.7	4.7	6.1	4.8	4.6	4.8	<0.1	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000016	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		4.27	4.14	4.84	4.30	1.77	1.79	4.75	4.06	4.37	7.29	4.49	4.29	1.74	4.68	3.92	3.65	4.04	2.98	<0.05	<0.05
Strontium	0.00005		0.219	0.198	0.210	0.190	0.106	0.123	0.109	0.184	0.248	0.308	0.229	0.244	0.105	0.186	0.118	0.153	0.151	0.141	<0.00005	<0.00005
Thallium	0.000002		0.000002	0.000002	<0.000002	<0.000002	0.000002	0.000003	0.000002	<0.000002	0.000003	0.000092	<0.000002	0.000003	<0.000002	<0.000002	0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.00962	0.00911	0.00838	0.00632	0.00103	0.00103	0.000044	0.00567	0.0107	0.0155	0.0143	0.00655	0.000991	0.00492	0.00406	0.000274	0.000938	0.00252	0.000002	<0.000002
Vanadium	0.0002		0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	0.0004	<0.0002	0.0004	<0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	<0.0002	<0.0002
Zinc	0.0001		0.0007	0.0008	0.0011	0.0005	0.0005	0.0010	0.0090	0.0003	0.0031	0.218	0.0020	0.0006	0.0046	0.0005	0.0006	0.0003	0.0002	0.0003	0.0002	0.0002
Zirconium	0.0001		0.0003	0.0002	0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.0004	<0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	<0.0001	<0.0001

Notes:

All units mg/L unless otherwise noted.

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment 2007.

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N.

b) 0.005 mg/L at pH < 6.5, [Ca^{2+}] <4 mg/L, DOC <2 mg/L; 0.1 mg/L at pH ≥6.5, [Ca^{2+}] ≥4 mg/L, DOC ≥2 mg/L.

c) $10^{(0.86\log[hardness]-3.3)}$

d) 0.002 mg/L at [CaCO$_3$] = 0 - 120 mg/L; 0.003 mg/L at [CaCO$_3$] =120 - 180 mg/L; 0.004 mg/L at [CaCO$_3$] >180 mg/L.

e) 0.001 mg/L at [CaCO$_3$] = 0 - 60 mg/L; 0.002 mg/L at [CaCO$_3$] =60 - 120 mg/L; 0.004 mg/L at [CaCO$_3$] =120 -180 mg/L; 0.007 mg/L at [CaCO$_3$] >180 mg/L.

f) 0.025 mg/L at [CaCO$_3$] = 0 - 60 mg/L; 0.065 mg/L at [CaCO$_3$] =60 - 120 mg/L; 0.110 mg/L at [CaCO$_3$] =120 -180 mg/L; 0.150 mg/L at [CaCO$_3$] > 180 mg/L.

**Average of sample and replicate.*

0.231	*Results exceed CCME Aquatic Life Guidelines.*

Appendix A5

Surface Water Quality Data, Casino Project, October 2009

Appendix A5. Surface Water Quality Analytical Results, Casino Project, October 2009

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from Confluence of Canadian Creek	W3 - Canadian Creek us of Confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino Confluence	W6a - Yukon River Downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W7 - Upper Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from Outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek	W18 - Brynelsen Creek	W20 - Klotass in River us of Dip Creek	W21 - Klotass in River ds of Dip Creek	R2	Field Blank (W102)	Maxxam Travel Blank
Date		CCME [1]	6-Oct-09	6-Oct-09	6-Oct-09	5-Oct-09	5-Oct-09	6-Oct-09	6-Oct-09	7-Oct-09	5-Oct-09	5-Oct-09	6-Oct-09	6-Oct-09	7-Oct-09	5-Oct-09	5-Oct-09	5-Oct-09	6-Oct-09	6-Oct-09	6-Oct-09
Physical Tests																					
Temperature °C	-		1.9	1.4	2.3	1.9	1.9	5.6	5.0	0.0	2.1	1.5	0.5	5.6	1.4	1.7	3.6	3.1	1.9	-	-
Conductivity (Field) µS/cm	-		324	296	285	272	209	162	200	159	183	312	301	163	222	190	160	174	146	-	-
pH (Field)	-		7.88	7.88	7.71	7.80	7.73	8.07	8.07	7.99	7.72	7.84	7.79	8.06	7.75	7.77	7.46	7.89	7.60	-	-
Hardness $CaCO_3$	0.5		151	142	130	132	98.5	80.2	97.8	55.7	87.9	149	142	78.8	101	86.1	75.3	81.8	68.7	<0.5	<0.5
Conductivity	1		324	282	285	273	211	162	193	158	183	312	265	165	220	191	160	174	147	1	1
pH	-	6.5-9.0	8.1	7.9	8.0	8.0	8.0	8.0	8.0	7.3	7.9	8.1	8.1	8.0	8.0	8.0	7.9	7.9	7.9	6.1	6.0
Total Suspended Solids	1		<1	<1	<1	<1	<1	6	15	1	<1	1	<1	9	<1	<1	<1	<1	2	<1	<1
Total Dissolved Solids	1		230	180	190	180	140	120	160	120	110	220	210	96	170	130	100	120	120	2	2
Turbidity	0.1		0.5	0.2	0.1	0.3	0.3	2.7	5.1	0.4	0.3	1.3	0.1	4.3	0.6	0.1	0.4	0.5	0.3	<0.1	<0.1
Dissolved Anions & Nutrients																					
Ammonia as N	0.01	0.137*	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Alkalinity, Total (as $CaCO_3$)	0.5		89	82	77	91	83	66	74	11	79	89	92	67	83	73	64	69	63	1.0	1.0
Acidity (pH 8.3) as $CaCO_3$	0.5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		0.7	0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.01		0.11	0.10	0.10	0.07	0.06	0.11	0.12	0.07	0.06	0.09	0.10	0.11	0.07	0.04	0.15	0.13	0.05	<0.01	<0.01
Sulfate (SO_4)	0.5		68	60	62	43	24	15	28	54	15	64	55	17	28	23	15	18	14	<0.5	<0.5
Nitrate (as N)	0.002	2.9	0.299	0.293	0.219	0.208	0.174	0.014	0.013	<0.002	0.166	0.222	0.437	0.022	0.140	0.333	0.040	0.043	0.199	<0.002	<0.002
Nitrite (as N)	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.24	0.20	0.15	0.17	0.12	0.07	0.07	0.07	0.16	0.14	0.23	0.06	0.15	0.12	0.12	0.14	0.16	0.02	<0.02
Ortho Phosphate as P	0.001		0.001	0.001	0.001	0.002	0.002	0.001	<0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.002	<0.001	<0.001
Cyanide, Weak Acid Diss	0.0005		0.0008	0.0008	0.0007	0.0006	0.0007	<0.0005	<0.0005	0.0005	0.0006	<0.0005	0.0008	<0.0005	0.0006	0.0006	<0.0005	0.0007	0.0006	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Total Organic Carbon	0.5		7.4	7.3	5.9	4.4	5.1	2.1	2.2	1.9	5.2	3.8	10.6	2.4	6.6	4.5	4.4	5.2	7.2	<0.5	<0.5
Total Metals																					
Aluminum	0.0002	0.005-0.1[b]	0.0187	0.022	0.0147	0.0330	0.0231	0.0801	0.127	0.0229	0.0221	0.117	0.0401	0.0866	0.0289	0.0279	0.0119	0.0129	0.0426	0.0053	0.0011
Antimony	0.00002		0.00030	0.0004	0.00040	0.00014	0.00010	0.00010	0.00012	0.00006	0.00009	0.00014	0.00027	0.00010	0.00009	0.00016	0.00004	0.00005	0.00004	<0.00002	<0.00002
Arsenic	0.00002	0.005	0.00049	0.0005	0.00054	0.00040	0.00035	0.00042	0.00049	0.00018	0.00030	0.00059	0.00056	0.00047	0.00048	0.00033	0.00033	0.00044	0.00025	<0.00002	<0.00002
Barium	0.00002		0.0606	0.0628	0.0553	0.0596	0.0557	0.0375	0.0472	0.0528	0.0504	0.0621	0.0679	0.0393	0.0560	0.0450	0.0371	0.0418	0.0429	0.00005	<0.00002
Beryllium	0.00001		<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.00003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000011	<0.00003	0.000010	0.000016	0.000006	0.000036	0.000062	0.000113	<0.000005	0.000067	<0.000005	0.000022	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Calcium	0.05		38.2	35.9	34.1	35.8	26.2	22.4	26.8	16.8	23.0	41.0	34.6	22.0	25.5	23.7	18.4	20.2	16.6	<0.05	<0.05
Chromium	0.0001	0.001	0.0002	<0.0005	0.0002	0.0002	0.0002	0.0002	0.0003	<0.0001	0.0002	0.0002	0.0003	0.0003	0.0002	0.0002	0.0003	0.0002	0.0003	<0.0001	0.0001
Cobalt	0.000005		0.000046	0.00005	0.000032	0.000037	0.000048	0.000081	0.000162	0.000033	0.000043	0.000194	0.000052	0.000091	0.000086	0.000022	0.000064	0.000083	0.000050	<0.000005	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00182	0.0021	0.00194	0.00376	0.00169	0.00076	0.00114	0.00133	0.00082	0.0126	0.00154	0.00089	0.00154	0.00083	0.00087	0.00102	0.00101	<0.00005	<0.00005
Iron	0.001	0.3	0.017	0.033	0.020	0.068	0.059	0.108	0.205	0.027	0.059	0.251	0.035	0.132	0.168	0.020	0.150	0.261	0.063	<0.001	<0.001
Lead	0.000005	0.001-0.007[e]	0.000006	0.00006	0.000012	0.000041	0.000026	0.000086	0.000176	0.000060	0.000018	0.000158	0.000009	0.000122	0.000033	0.000007	0.000009	0.000019	0.000029	0.000025	<0.000005
Lithium	0.0005		0.0008	<0.003	0.0005	0.0012	0.0020	0.0014	0.0019	0.0008	0.0025	0.0014	0.0008	0.0012	0.0014	0.0007	<0.0005	0.0006	0.0010	<0.0005	<0.0005
Magnesium	0.05		13.5	12.8	10.8	10.5	8.05	5.93	7.50	3.34	7.43	11.4	13.6	5.80	9.11	6.51	7.11	7.59	6.59	<0.05	<0.05
Manganese	0.00005		0.0094	0.0034	0.00410	0.00912	0.0131	0.00959	0.0175	0.00149	0.0127	0.0311	0.00225	0.0112	0.0302	0.00271	0.0266	0.0375	0.00512	0.00006	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00005	<0.00001	0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00082	0.0006	0.00091	0.00118	0.00088	0.00116	0.00108	0.00027	0.00072	0.00071	0.00057	0.00109	0.00089	0.00141	0.00058	0.00072	0.00090	<0.00005	<0.00005
Nickel	0.00002	0.025-0.15[c]	0.00061	0.0027	0.00064	0.00023	0.00025	0.00107	0.00220	0.00065	0.00032	0.00035	0.00048	0.00124	0.00047	0.00023	0.00052	0.00050	0.00036	0.00003	0.00003
Phosphorous	0.002		<0.002	<0.01	<0.002	<0.002	0.003	0.010	0.017	0.006	0.004	<0.002	0.003	0.011	0.003	0.002	0.003	0.003	0.004	<0.002	<0.002
Potassium	0.05		1.97	1.90	1.76	1.05	0.83	0.72	0.72	0.58	0.71	0.95	1.75	0.72	0.86	1.04	0.73	0.77	0.55	<0.05	<0.05
Selenium	0.00004	0.001	0.00011	0.0003	0.00007	0.00008	0.00005	0.00028	0.00050	0.00007	0.00005	0.00015	0.00011	0.00028	0.00005	0.00006	0.00011	0.00010	0.00008	<0.00004	<0.00004
Silicon	0.1		5.0	5.2	5.4	5.6	5.3	2.8	3.2	10.8	5.3	5.7	5.2	2.9	4.9	5.9	4.7	4.6	4.9	<0.1	<0.1
Silver	0.000005	0.0001	<0.000005	<0.00003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		4.41	4.43	4.12	4.83	4.22	1.69	1.70	4.83	4.07	4.13	4.53	1.62	4.35	3.86	3.69	4.04	2.78	<0.05	<0.05
Strontium	0.00005		0.237	0.244	0.208	0.201	0.184	0.0971	0.113	0.109	0.173	0.242	0.275	0.0991	0.173	0.116	0.141	0.144	0.133	<0.00005	<0.00005
Thallium	0.000002	0.0008	<0.000002	<0.00001	0.000002	<0.000002	<0.000002	0.000002	0.000003	0.000002	<0.000002	<0.000002	0.000002	0.000003	<0.000002	0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0013	0.0023	<0.0005	<0.0005	<0.0005	0.0007	0.0022	0.0006	<0.0005	<0.0005	0.0006	0.0008	<0.0005	<0.0005
Uranium	0.000002		0.0122	0.0118	0.0102	0.00849	0.00656	0.000904	0.000962	0.000065	0.00593	0.0109	0.00850	0.000933	0.00504	0.00416	0.000227	0.00105	0.00253	0.000026	0.000008
Vanadium	0.0002		<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0005	0.0013	0.0008	0.0009	0.0004	0.0027	0.0063	0.0106	0.0003	0.0038	0.0003	0.0031	0.0005	0.0002	0.0002	0.0005	0.0006	0.0004	0.0001
Zirconium	0.0001		0.0002	<0.0005	0.0001	0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0004	<0.0001	0.0002	0.0001	0.0001	0.0002	0.0002	<0.0001	<0.0001
Dissolved Metals																					
Aluminum	0.0002		0.0169	0.0208	0.0124	0.0176	0.0166	0.0146	0.0213	0.0129	0.0177	0.0258	0.0384	0.0172	0.0224	0.0265	0.0099	0.0265	0.0314	0.0020	<0.0002
Antimony	0.00002		0.00031	0.00035	0.00039	0.00013	0.00010	0.00009	0.00012	0.00006	0.00008	0.00014	0.00026	0.00009	0.00009	0.00016	0.00004	0.00017	0.00004	<0.00002	<0.00002
Arsenic	0.00002		0.00052	0.00056	0.00058	0.00038	0.00033	0.00039	0.00034	0.00018	0.00031	0.00050	0.00052	0.00035	0.00045	0.00034	0.00029	0.00035	0.00022	<0.00002	<0.00002
Barium	0.00002		0.0589	0.0601	0.0544	0.0589	0.0561	0.0347	0.0409	0.0530	0.0500	0.0631	0.0688	0.0366	0.0558	0.0471	0.0376	0.0474	0.0428	<0.00002	<0.00002
Beryllium	0.00001		<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		<0.000005	0.000005	0.000018	0.000015	<0.000005	0.000011	0.000018	0.000139	<0.000005	0.000060	<0.000005	<0.000005	<0.000005	<0.000005	0.000009	<0.000005	<0.000005	<0.000005	<0.000005
Calcium	0.05		37.7	34.9	32.8	33.9	26.1	21.4	25.6	16.9	21.9	39.3	35.2	22.2	26.1	23.8	17.8	23.7	16.6	0.06	<0.05
Chromium	0.0001		0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	<0.0001	0.0002	0.0001	0.0003	0.0001	0.0001	0.0002	0.0002	<0.0001	0.0002	<0.0001	<0.0001
Cobalt	0.000005		0.000041	0.000044	0.000054	0.000027	0.000038	0.000013	0.000025	0.000030	0.000036	0.000191	0.000039	0.000013	0.000081	0.000021	0.000056	0.000027	0.000040	<0.000005	<0.000005
Copper	0.00005		0.00178	0.00186	0.00229	0.00306	0.00154	0.00051	0.00069	0.00134	0.00078	0.00655	0.00151	0.00057	0.00143	0.00080	0.00090	0.00076	0.00098	<0.00005	<0.00005
Iron	0.001		0.017	0.020	0.016	0.028	0.041	0.016	0.023	0.007	0.043	0.055	0.034	0.018	0.160	0.018	0.125	0.017	0.040	<0.001	<0.001
Lead	0.000005		<0.000005	0.000006	0.000022	0.000022	0.000008	0.000010	0.000013	0.000009	0.000005	0.000031	0.000012	0.000060	0.000012	0.000007	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Lithium	0.0005		0.0008	0.0007	0.0006	0.0011	0.0020	0.0012	0.0018	0.0008	0.0025	0.0013	0.0008	0.0013	0.0014	0.0007	<0.0005	0.0007	0.0010	<0.0005	<0.0005
Magnesium	0.05		13.2	12.3	10.8	10.0	8.32	5.47	7.30	3.42	7.14	10.9	14.1	5.54	9.27	6.66	6.93	6.48	6.53	<0.05	<0.05
Manganese	0.00005		0.00078	0.00295	0.00386	0.00771	0.0121	0.00152	0.00202	0.00079	0.0116	0.0301	0.00200	0.00158	0.0293	0.00274	0.0259	0.00252	0.00468	<0.00005	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00084	0.00081	0.0009	0.00120	0.00091	0.00113	0.00109	0.00027	0.00077	0.00071	0.00052	0.00117	0.00091	0.00143	0.00056	0.00144	0.00087	<0.00005	<0.00005
Nickel	0.00002		0.00054	0.00058	0.00066	0.00019	0.00026	0.00085	0.00158	0.00059	0.00026	0.00034	0.00049	0.00094	0.00043	0.00022	0.00046	0.00021	0.00041	<0.00002	<0.00002
Phosphorous	0.002		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002
Potassium	0.05		1.93	1.82	1.75	1.03	0.83	0.70	0.69	0.59	0.69	0.94	1.78	0.72	0.88	1.09	0.73	1.08	0.57	<0.05	<0.05
Selenium	0.00004		0.00013	0.00009	0.00008	0.00007	0.00005	0.00026	0.00047	0.00007	<0.00004	0.00013	0.00011	0.00028	0.00007	0.00004	0.00010	<0.00004	0.00006	<0.00004	<0.00004
Silicon	0.1		5.7	5.0	5.3	5.8	5.1	2.8	3.0	10.2	5.2	5.7	5.1	2.8	5.4	5.5	4.6	5.7	5.3	<0.1	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		4.44	4.47	4.06	4.66	4.27	1.61	1.65	5.00	3.89	4.00	4.73	1.63	4.40	3.96	3.56	3.87	2.82	<0.05	<0.05
Strontium	0.00005		0.233	0.236	0.203	0.201	0.187	0.0960	0.113	0.111	0.173	0.239	0.272	0.101	0.174	0.121	0.142	0.121	0.134	<0.00005	<0.00005
Thallium	0.000002		0.000002	0.000002	0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000004	0.000002	<0.000002	0.000002	<0.000002	0.000003	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0006	0.0006	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0120	0.0116	0.0100	0.00858	0.00661	0.000870	0.000946	0.000037	0.00588	0.0104	0.00844	0.000914	0.00507	0.00425	0.000230	0.00425	0.00255	<0.000002	<0.000002
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	0.0002	<0.0002	0.0003	<0.0002	<0.0002	<0.0002
Zinc	0.0001		0.0003	0.0005	0.0009	0.0008	0.0004	0.0007	0.0014	0.0102	0.0001	0.0026	0.0005	0.0011	0.0004	0.0005	0.0002	0.0002	0.0002	0.0002	<0.0001
Zirconium	0.0001		0.0002	0.0002	0.0001	0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0004	<0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	<0.0001	<0.0001

Notes:
All units mg/L unless otherwise noted.
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment 2007.
a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N.
b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ <4 mg/L, DOC <2 mg/L; 0.1 mg/L at pH ≥6.5, $[Ca^{2+}]$ ≥4 mg/L, DOC ≥2 mg/L.
c) $10^{0.86[\log(hardness)]-3.2}$.
d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ =120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ >180 mg/L.
e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ =60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ =120 -180 mg/L; 0.007 mg/L at $[CaCO_3]$ >180 mg/L.
f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ =60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ =120 -180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L.
**Average of sample and replicate.*

0.231	Results exceed CCME Aquatic Life Guidelines.

Appendix A3

Surface Water Quality Data, Casino Project, November 2009

Appendix A6. Surface Water Quality Analytical Results, Casino Project, November 2009

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from Confluence of Canadian Creek	W3 - Canadian Creek us of Confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino Confluence	W6a - Yukon River Downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from Outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek	W18 - Brynelsen Creek	W20 - Klotass in River us of Dip Creek	W21 - Klotass in River ds of Dip Creek	R2	Maxxam Travel Blank
Date		CCME [1]	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09	4-Nov-09
Physical Tests																			
Temperature °C	-		0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.1	0.0	0.0	-
Conductivity (Field) µS/cm	-		376	343	313	14.1*	74.5*	160	126	15.6*	350	406	124	37*	217	160	179	4.3*	-
pH (Field)	-		7.86	7.70	7.70	7.54	7.58	8.21	8.18	7.58	7.55	7.77	8.05	7.44	7.86	7.49	7.63	7.66	-
Hardness $CaCO_3$	0.5		194	182	157	156	126	88.5	100	109	189	218	102	124	108	81.2	89.3	84.6	<0.5
Conductivity	1		385	342	320	315	249	174	190	218	358	416	200	251	225	170	185	174	1
pH	-	6.5-9.0	7.9	7.9	7.8	7.8	7.7	7.9	7.8	7.8	7.9	8.0	7.8	7.9	7.8	7.7	7.7	7.7	5.4
Total Suspended Solids	1		<1	<1	<1	<1	<1	2	7	<1	<1	1	19	<1	<1	<1	<1	1	<1
Total Dissolved Solids	1		240	210	180	190	140	68	80	110	210	250	110	160	110	76	100	84	<10
Turbidity	0.1		0.2	0.1	0.2	0.2	0.2	1.3	1.7	0.4	0.9	0.3	2.1	0.3	0.2	0.5	1.2	0.1	<0.1
Dissolved Anions & Nutrients																			
Ammonia as N	0.01	0.137[a]	<0.01	0.01	0.01	0.01	0.02	<0.01	<0.01	0.02	<0.01	0.03	0.02	0.02	0.01	0.03	0.03	0.02	<0.01
Alkalinity, Total (as $CaCO_3$)	0.5		100	95	86	100	96	75	77	96	110	120	80	97	84	69	73	71	<0.5
Acidity (pH 8.3) as $CaCO_3$	0.5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		7.4	<0.5	0.8	1.7	0.7	<0.5	<0.5	<0.5	<0.5	0.6	1.6	5.0	0.7	0.5	15	<0.5	<0.5
Fluoride (F)	0.01		0.12	0.12	0.11	0.07	0.06	0.12	0.13	0.06	0.09	0.11	0.13	0.07	0.05	0.14	0.13	0.06	<0.01
Sulfate (SO_4)	0.5		85	76	71	58	33	16	20	18	78	86	24	35	36	17	23	17	<0.5
Nitrate (as N)	0.002	2.9	0.319	0.280	0.252	0.240	0.227	0.033	0.031	0.225	0.241	0.351	0.056	0.202	0.305	0.079	0.081	0.291	<0.002
Nitrite (as N)	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.18	0.16	0.14	0.12	0.14	0.10	0.06	0.14	0.14	0.19	0.07	0.16	0.25	0.15	0.16	0.17	0.06
Ortho Phosphate as P	0.001		0.002	0.001	0.002	0.001	0.002	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.002	0.001	0.002	0.001	<0.001
Cyanide, Weak Acid Diss	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0009
Cyanide, Total	0.0005	0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Total Organic Carbon	0.5		7.5	6.6	5.5	1.8	2.9	2.1	1.8	4.8	2.9	7.0	2.3	3.6	3.7	4.0	4.7	6.1	<0.5
Total Metals																			
Aluminum	0.0002	0.005-0.1[b]	0.0169	0.0153	0.0127	0.0169	0.0235	0.0415	0.0733	0.0160	0.0777	0.0314	0.0847	0.0120	0.0152	0.0111	0.0111	0.0210	0.0003
Antimony	0.00002		0.00025	0.00029	0.00032	0.00014	0.00011	0.00009	0.00010	0.00009	0.00015	0.00023	0.00011	0.00009	0.00016	0.00004	0.00005	0.00004	<0.00002
Arsenic	0.00002	0.005	0.00042	0.00046	0.00049	0.00029	0.00032	0.00040	0.00043	0.00023	0.00059	0.00047	0.00040	0.00036	0.00033	0.00053	0.00053	0.00020	<0.00002
Barium	0.00002		0.0692	0.0708	0.0629	0.0738	0.0665	0.0388	0.0463	0.0647	0.0737	0.0945	0.0560	0.0704	0.0539	0.0443	0.0507	0.0506	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000018	0.000015	0.000018	0.000017	0.000011	0.000020	0.000037	0.000015	0.000070	0.000009	0.000042	0.000010	0.000012	0.000012	0.000015	0.000009	<0.000005
Calcium	0.05		49.5	46.5	41.7	42.2	33.6	25.1	28.3	28.8	51.7	52.6	28.4	31.9	29.5	20.0	22.4	20.6	<0.05
Chromium	0.0001	0.001	0.0002	0.0002	0.0002	<0.0001	0.0001	0.0002	0.0002	<0.0001	0.0001	0.0002	0.0003	<0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000046	0.000034	0.000031	0.000026	0.000047	0.000043	0.000072	0.000042	0.000098	0.000039	0.000112	0.000073	0.000014	0.000123	0.000156	0.000029	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00152	0.00147	0.00164	0.00207	0.00124	0.00054	0.00068	0.00073	0.00751	0.00119	0.00076	0.00101	0.00058	0.00086	0.00089	0.00073	<0.00005
Iron	0.001	0.3	0.017	0.015	0.014	0.033	0.051	0.066	0.129	0.043	0.155	0.027	0.163	0.099	0.013	0.361	0.393	0.025	<0.001
Lead	0.000005	0.001-0.007[e]	0.000033	0.000009	0.000010	0.000030	0.000034	0.000041	0.000089	0.000020	0.000171	0.000016	0.000135	0.000015	<0.000005	0.000016	0.000040	0.000007	<0.000005
Lithium	0.0005		0.0008	0.0008	0.0005	0.0011	0.0020	0.0012	0.0015	0.0028	0.0015	0.0011	0.0016	0.0013	0.0008	<0.0005	<0.0005	0.0010	<0.0005
Magnesium	0.05		17.2	15.9	12.9	12.3	10.3	6.24	7.22	9.02	14.5	21.0	7.45	10.7	8.27	7.60	8.08	8.08	<0.05
Manganese	0.00005		0.00112	0.00179	0.00260	0.00760	0.0212	0.00670	0.00939	0.0203	0.0290	0.00167	0.00995	0.0392	0.00223	0.0785	0.106	0.00481	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00104	0.00101	0.00107	0.00132	0.00091	0.00119	0.00117	0.00071	0.00080	0.00073	0.00117	0.00104	0.00173	0.00062	0.00070	0.00092	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00044	0.00053	0.00055	0.00017	0.00024	0.00075	0.00114	0.00028	0.00024	0.00052	0.00113	0.00032	0.00016	0.00053	0.00055	0.00026	<0.00002
Phosphorous	0.002		0.004	0.003	0.003	0.003	0.003	0.003	0.011	0.004	0.003	0.005	0.017	0.003	0.002	0.007	0.009	0.003	<0.002
Potassium	0.05		2.32	2.28	2.15	1.20	1.01	0.81	0.85	0.87	1.16	2.39	0.83	1.08	1.24	0.84	0.93	0.66	<0.05
Selenium	0.00004	0.001	0.00012	0.00010	0.00007	0.00007	0.00005	0.00024	0.00030	<0.00004	0.00016	0.00009	0.00035	0.00004	0.00004	0.00008	0.00008	0.00005	<0.00004
Silicon	0.1		4.3	4.5	4.4	5.4	5.1	2.7	2.8	5.0	5.4	4.0	3.0	4.7	5.4	4.4	4.5	4.4	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		5.21	5.51	4.78	5.30	4.91	1.80	1.87	4.74	4.83	6.50	1.88	5.04	4.35	3.80	4.21	3.27	<0.05
Strontium	0.00005		0.286	0.281	0.238	0.243	0.221	0.106	0.117	0.221	0.288	0.389	0.119	0.206	0.146	0.151	0.156	0.164	<0.00005
Thallium	0.000002	0.0008	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000003	<0.000002	<0.000002	<0.000002	0.000003	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0006	0.0008	<0.0005	0.0007	<0.0005	0.0011	0.0035	0.0005	<0.0005	0.0009	0.0033	<0.0005	<0.0005	<0.0005	<0.0005	0.0006	<0.0005
Uranium	0.000002		0.0199	0.0183	0.0139	0.0117	0.00919	0.00101	0.00108	0.00861	0.0143	0.0184	0.00121	0.00630	0.00556	0.000179	0.000818	0.00274	<0.000002
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0003	0.0004	0.0002	<0.0002	0.0003	0.0004	0.0002	0.0003	0.0003	0.0003	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0005	0.0006	0.0005	0.0009	0.0007	0.0008	0.0021	0.0004	0.0044	0.0003	0.0028	0.0005	0.0003	0.0005	0.0014	0.0006	0.0002
Zirconium	0.0001		0.0001	0.0001	0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0003	<0.0001	0.0001	<0.0001	0.0001	0.0002	0.0001	<0.0001
Dissolved Metals																			
Aluminum	0.0002		0.0109	0.0102	0.0087	0.0095	0.0090	0.0066	0.0067	0.0087	0.0147	0.0191	0.0056	0.0085	0.0106	0.0073	0.0080	0.0235	0.0006
Antimony	0.00002		0.00028	0.00029	0.00032	0.00015	0.00011	0.00009	0.00010	0.00008	0.00015	0.00023	0.00011	0.00010	0.00018	0.00005	0.00006	0.00004	<0.00002
Arsenic	0.00002		0.00046	0.00049	0.00048	0.00032	0.00029	0.00035	0.00039	0.00026	0.00051	0.00047	0.00031	0.00038	0.00035	0.00052	0.00058	0.00020	<0.00002
Barium	0.00002		0.0667	0.0680	0.0610	0.0724	0.0679	0.0362	0.0389	0.0630	0.0724	0.0904	0.0457	0.0673	0.0524	0.0434	0.0504	0.0495	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000014	0.000010	0.000016	0.000015	0.000015	0.000005	0.000018	0.000007	0.000067	0.000006	0.000021	0.000017	0.000011	0.000008	0.000008	0.000007	<0.000005
Calcium	0.05		46.9	41.7	39.4	40.3	31.5	22.0	22.9	25.3	27.2	45.8	49.0	26.5	30.3	27.8	18.9	21.5	19.4
Chromium	0.0001		<0.0001	0.0002	0.0002	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0001	0.0002	0.0001	0.0003	0.0001	0.0002	0.0003	<0.0001	<0.0001
Cobalt	0.000005		0.000031	0.000026	0.000028	0.000018	0.000041	0.000013	0.000016	0.000034	0.000096	0.000037	0.000010	0.000058	0.000021	0.000119	0.000162	0.000030	<0.000005
Copper	0.00005		0.00154	0.00146	0.00162	0.00197	0.00111	0.00049	0.00052	0.00071	0.00482	0.00120	0.00051	0.00110	0.00065	0.00090	0.00090	0.00079	0.00166
Iron	0.001		0.007	0.010	0.009	0.013	0.028	0.010	0.011	0.030	0.020	0.014	0.011	0.081	0.010	0.341	0.333	0.034	<0.001
Lead	0.000005		0.000007	0.000011	0.000005	0.000011	<0.000005	0.000011	0.000045	<0.000005	0.000020	0.000009	0.000013	0.000011	0.000012	0.000020	0.000015	0.000020	0.000166
Lithium	0.0005		0.0008	0.0008	0.0005	0.0011	0.0020	0.0012	0.0015	0.0028	0.0016	0.0011	0.0015	0.0013	0.0007	<0.0005	<0.0005	0.0010	<0.0005
Magnesium	0.05		16.6	14.7	12.4	12.3	9.77	5.78	6.69	8.52	13.4	19.7	7.05	10.3	7.97	7.26	7.91	7.77	<0.05
Manganese	0.00005		0.00042	0.00145	0.00197	0.00644	0.0195	0.00278	0.00210	0.0188	0.0253	0.00074	0.00219	0.0387	0.00186	0.0783	0.106	0.00491	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00100	0.00101	0.00108	0.00129	0.00094	0.00117	0.00121	0.00075	0.00085	0.00075	0.00123	0.00103	0.00170	0.00062	0.00069	0.00088	<0.00005
Nickel	0.00002		0.00051	0.00051	0.00054	0.00019	0.00024	0.00065	0.00096	0.00028	0.00026	0.00045	0.00092	0.00035	0.00016	0.00061	0.00057	0.00032	0.00005
Phosphorous	0.002		<0.002	<0.002	<0.002	0.003	0.002	<0.002	<0.002	0.002	<0.002	0.003	<0.002	0.002	<0.002	0.007	0.006	<0.002	<0.002
Potassium	0.05		2.15	2.06	1.98	1.15	0.93	0.73	0.74	0.81	1.01	2.19	0.75	1.03	1.16	0.79	0.88	0.62	<0.05
Selenium	0.00004		0.00013	0.00010	0.00008	0.00009	0.00004	0.00026	0.00035	<0.00004	0.00017	0.00011	0.00037	0.00006	<0.00004	0.00011	0.00009	0.00005	<0.00004
Silicon	0.1		4.5	4.8	4.8	5.8	5.6	2.8	2.9	5.1	5.7	4.6	2.9	5.3	5.8	5.0	5.0	4.8	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		5.07	5.09	4.63	5.10	4.66	1.68	1.77	4.54	4.50	6.13	1.80	4.82	4.28	3.59	4.05	3.17	<0.05
Strontium	0.00005		0.279	0.277	0.236	0.251	0.227	0.103	0.111	0.213	0.284	0.381	0.114	0.209	0.143	0.152	0.161	0.164	<0.00005
Thallium	0.000002		<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0010	<0.0005
Uranium	0.000002		0.0197	0.0181	0.0134	0.0118	0.00917	0.000979	0.00104	0.00843	0.0148	0.0182	0.00119	0.00629	0.00547	0.000168	0.000833	0.00268	<0.000002
Vanadium	0.0002		0.0002	<0.0002	<0.0002	0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	0.0003	0.0002	0.0003	0.0003	<0.0002	<0.0002
Zinc	0.0001		0.0005	0.0008	0.0006	0.0009	0.0004	0.0005	0.0008	0.0002	0.0033	0.0005	0.0009	0.0005	0.0003	0.0005	0.0007	0.0004	0.0021
Zirconium	0.0001		0.0002	0.0002	0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0003	<0.0001	0.0002	<0.0001	0.0002	0.0002	0.0001	<0.0001

Notes:
All units mg/L unless otherwise noted.
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment 2007.
a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N.
b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ <4 mg/L; DOC <2 mg/L. 0.1 mg/L at pH ≥6.5, $[Ca^{2+}]$ ≥4 mg/L, DOC ≥2 mg/L.
c) $10^{0.86(\log(hardness))-3.2}$
d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ =120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ >180 mg/L.
e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ =60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ =120 -180 mg/L; 0.007 mg/L at $[CaCO_3]$ >180 mg/L.
f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ =60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ =120 -180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L.
**Average of sample and replicate.*

0.231	*Results exceed CCME Aquatic Life Guidelines.*

Appendix A7

Surface Water Quality Data, Casino Project, December 2009

Appendix A7. Surface Water Quality Analytical Results, Casino Project, December 2009

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from Confluence of Canadian Creek	W3 - Canadian Creek us of Confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino Confluence	W6a - Yukon River Downstream of Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from Outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek*	W18 - Brynelsen Creek	W20 - Klotass in River us of Dip Creek	W21 - Klotass in River ds of Dip Creek	R2	Field Blank	Maxxam Travel Blank
Date		CCME [1]	2-Dec-09	1-Dec-09	1-Dec-09	1-Dec-09	1-Dec-09	2-Dec-09	1-Dec-09	1-Dec-09	1-Dec-09	2-Dec-09	1-Dec-09	1-Dec-09	1-Dec-09	1-Dec-09	1-Dec-09	2-Dec-09	2-Dec-09
Physical Tests																			
Temperature °C	-		1.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	-	-
Conductivity (Field) µS/cm	-		389	375	280	327	252	204	222	365	470	186	260	238	152	169	177	-	-
pH (Field)	-		8.26	7.76	7.81	7.55	7.50	8.89	7.64	7.73	7.60	8.69	8.89	7.71*	7.55	7.73	7.66*	-	-
Hardness $CaCO_3$	0.5		224	205	179	176	135	114	116	203	271	113	140.5	124	83.0	91.2	94.2	<0.5	<0.5
Conductivity	1		421	390	346	320	262	212	227	380	482	210	269.5	244	167	174	173	1	2
pH	-	6.5-9.0	7.8	7.9	7.9	8	7.9	8	7.8	7.9	7.9	7.9	7.8	7.9	7.6	7.8	7.9	6	6
Total Suspended Solids	1		2	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	1	<1	<1	<1	<1
Total Dissolved Solids	1		290	250	210	210	120	130	130	210	310	130	175	130	130	110	120	<10	<10
Turbidity	0.1		0.2	0.1	0.1	0.3	0.2	0.8	0.3	0.5	0.1	1.2	0.4	0.2	2.9	2	0.1	0.1	0.2
Dissolved Anions & Nutrients																			
Ammonia as N	0.01	0.137[a]	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.02	<0.01	0.02	<0.01	0.03	<0.01	0.03	0.03	<0.01	<0.01	<0.01
Alkalinity, Total (as $CaCO_3$)	0.5		110	110	94	110	100	90	99	120	140	87	110	92	68	73	73	0.6	0.5
Acidity (pH 8.3) as $CaCO_3$	0.5		2.8	1.1	0.8	2.5	3.4	<0.5	2.4	1.6	2.3	1.1	2.5	1.2	1.1	2	1.4	<0.5	<0.5
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		5.4	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	0.7	<0.5	1.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.01		0.11	0.11	0.11	0.07	0.06	0.11	0.05	0.09	0.1	0.12	0.06	0.04	0.12	0.11	0.05	<0.01	<0.01
Sulfate (SO_4)	0.5		110	86	79	56	31	23	19	79	110	22	32.5	35	18	21	19	0.6	<0.5
Nitrate (as N)	0.002	2.9	0.371	0.293	0.296	0.240	0.245	0.042	0.304	0.252	0.341	0.061	0.2385	0.291	0.094	0.135	0.309	0.002	0.036
Nitrite (as N)	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	0.019	<0.002	<0.002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.1	0.1	0.09	0.03	0.02	0.06	0.04	0.06	0.05	<0.02	0.03	<0.02	0.04	0.07	0.02	0.04	<0.02
Ortho Phosphate as P	0.001		0.014	0.001	0.001	0.001	0.002	0.002	0.002	0.002	<0.001	0.009	0.002	0.001	0.001	0.002	0.002	0.001	0.001
Cyanide, Weak Acid Diss	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Cyanide, Total	0.0005	0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Total Organic Carbon	0.5		6.5	5.2	5	3.2	3.8	2.3	3.7	2.1	8.6	2.5	4.55	2.7	3.8	4.5	3.9	<0.5	<0.5
Total Metals																			
Aluminum	0.0002	0.005-0.1[b]	0.0112	0.0114	0.0086	0.012	0.0107	0.0271	0.0106	0.0535	0.0189	0.027	0.0102	0.0099	0.0074	0.0085	0.0155	0.0009	<0.0002
Antimony	0.00002		0.00026	0.00027	0.0003	0.00014	0.00011	0.00011	0.00008	0.00014	0.00021	0.00011	0.00009	0.00018	0.00004	0.00004	0.00004	<0.00002	<0.00002
Arsenic	0.00002	0.005	0.00042	0.00042	0.00041	0.00034	0.00026	0.00040	0.0002	0.00055	0.00044	0.00039	0.00031	0.0003	0.00106	0.0005	0.00015	<0.00002	<0.00002
Barium	0.00002		0.0802	0.0823	0.0709	0.083	0.0764	0.0466	0.0716	0.0816	0.115	0.0483	0.0797	0.0604	0.05	0.0542	0.0576	0.00003	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000014	0.000008	0.000008	0.000013	<0.000005	0.000017	<0.000005	0.000049	<0.000005	0.000017	0.000009	0.000006	<0.000005	0.000008	<0.000005	<0.000005	<0.000005
Calcium	0.05		56.5	52.3	47.4	47.2	35.3	32.1	30.5	54.6	65.1	31.5	36.2	34	20.3	22.7	23	54.6	<0.05
Chromium	0.0001	0.001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	<0.0001	0.0002	0.0002	0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000026	0.000023	0.000028	0.00002	0.000045	0.000018	0.000052	0.000047	0.000028	0.000022	0.000073	0.000012	0.000145	0.000147	0.000021	<0.000005	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00147	0.00147	0.00153	0.00176	0.00104	0.00062	0.00065	*0.00441*	0.00118	0.00065	0.00108	0.00054	0.00066	0.00089	0.00075	0.00011	<0.00005
Iron	0.001	0.3	0.006	0.009	0.006	0.011	0.041	0.031	0.044	0.035	0.011	0.034	0.078	0.005	*0.815*	*0.307*	0.011	<0.001	<0.001
Lead	0.000005	0.001-0.007[e]	0.000082	0.000097	0.000025	0.000053	0.000123	0.000139	0.000093	0.000258	0.00002	0.000061	0.0000975	0.000029	0.000091	0.000128	0.000124	0.000118	<0.000005
Lithium	0.0005		0.0007	0.001	0.0006	0.0012	0.0021	0.0016	0.0029	0.0017	0.0013	0.0017	0.00145	0.0009	<0.0005	<0.0005	0.0010	<0.0005	<0.0005
Magnesium	0.05		20.2	18.1	14.7	14.1	11	8.34	9.75	16.1	26.4	8.34	12.15	9.59	7.85	8.4	8.97	<0.05	<0.05
Manganese	0.00005		0.00033	0.00083	0.00072	0.00545	0.0281	0.00243	0.0326	0.0291	0.00052	0.00292	0.04155	0.00153	0.103	0.0994	0.00316	<0.00005	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00105	0.00116	0.00143	0.00133	0.00089	0.00128	0.00068	0.00089	0.00085	0.0013	0.00096	0.00205	0.00062	0.00062	0.00081	<0.00005	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00052	0.00046	0.00051	0.00016	0.00023	0.00096	0.00024	0.00027	0.00045	0.00096	0.000325	0.00013	0.00044	0.00051	0.00026	<0.00002	<0.00002
Phosphorous	0.002		0.002	0.002	<0.002	0.004	<0.002	<0.002	0.002	<0.002	0.003	<0.002	0.0035	0.002	0.012	0.005	0.003	<0.002	<0.002
Potassium	0.05		2.47	2.46	2.34	1.30	1.04	0.95	0.89	1.2	2.75	0.96	1.155	1.36	0.85	0.94	0.74	<0.05	<0.05
Selenium	0.00004	0.001	0.00015	0.00010	0.00008	0.00008	0.00005	0.00036	<0.00004	0.00018	0.00012	0.00034	0.00005	0.00004	0.00009	0.00009	0.00006	<0.00004	<0.00004
Silicon	0.1		4.8	4.9	4.9	5.3	5.5	3.4	5.4	5.9	4.8	3.4	5.35	5.8	5.1	5.2	5	<0.1	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		5.8	6.12	5.32	5.87	5.16	2.23	4.93	5.11	7.74	2.23	5.595	5.02	3.82	4.16	3.55	<0.05	<0.05
Strontium	0.00005		0.318	0.334	0.275	0.273	0.244	0.134	0.237	0.32	0.484	0.136	0.239	0.174	0.153	0.166	0.18	0.00006	<0.00005
Thallium	0.000002	0.0008	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000002	<0.000002	0.000003	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005	0.0013	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0237	0.0256	0.0162	0.0139	0.01	0.00116	0.00894	0.0175	0.0281	0.00122	0.007475	0.0068	0.000152	0.000472	0.00228	0.000013	<0.000002
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.0002	0.0002	<0.0002	0.0003	0.0002	0.0002	0.0003	0.0003	0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0004	0.0006	0.0007	0.0009	0.0007	0.0011	0.0004	0.0034	0.0004	0.0011	0.0008	0.0005	0.0003	0.0004	0.0005	0.0004	0.0002
Zirconium	0.0001		0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0002	<0.0001	0.0001	<0.0001	0.0001	0.0002	0.0001	<0.0001	<0.0001
Dissolved Metals																			
Aluminum	0.0002		0.0087	0.0077	0.0056	0.0067	0.0072	0.003	0.007	0.0112	0.0127	0.0031	0.0071	0.007	0.005	0.0059	0.0119	0.0004	<0.0002
Antimony	0.00002		0.00024	0.00027	0.00029	0.00013	0.00008	0.00009	0.00008	0.00014	0.00019	0.00009	0.00008	0.00016	0.00002	0.00003	0.00002	<0.00002	<0.00002
Arsenic	0.00002		0.00041	0.00045	0.0004	0.00032	0.00026	0.00034	0.00025	0.0005	0.00043	0.00038	0.000295	0.00032	0.00097	0.00044	0.00017	<0.00002	<0.00002
Barium	0.00002		0.0763	0.0788	0.0685	0.0803	0.0731	0.0453	0.0714	0.0801	0.115	0.0459	0.0748	0.0594	0.0484	0.0507	0.0545	<0.00002	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		<0.000005	0.000009	0.000008	0.000006	<0.000005	0.000014	<0.000005	0.000056	<0.000005	0.000008	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Calcium	0.05		51.4	48.5	43.5	42.9	33.4	28.9	29.3	51	59.4	29.1	33.05	31.2	19	20.6	20.8	<0.05	<0.05
Chromium	0.0001		0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001	0.0002	0.0002	0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000029	0.000022	0.000023	0.000014	0.000041	0.000008	0.000049	0.000038	0.000029	0.000010	0.0000755	0.000011	0.000145	0.000138	0.000020	<0.000005	<0.000005
Copper	0.00005		0.00143	0.00126	0.00134	0.00163	0.00105	0.0006	0.00066	0.00336	0.00101	0.00059	0.001005	0.00049	0.00070	0.00079	0.00075	0.00007	<0.00005
Iron	0.001		0.006	0.006	0.005	0.007	0.039	0.008	0.035	0.006	0.009	0.009	0.063	0.004	0.666	0.192	0.012	<0.001	<0.001
Lead	0.000005		0.000076	0.000086	0.000023	0.000021	0.000093	0.00005	0.000083	0.000084	0.000019	0.000023	0.000068	0.00003	0.000082	0.000082	0.000102	0.000025	<0.000005
Lithium	0.0005		0.0007	0.001	0.0006	0.0012	0.0020	0.0016	0.0028	0.0017	0.0013	0.0016	0.00135	0.0008	<0.0005	<0.0005	0.0009	<0.0005	<0.0005
Magnesium	0.05		17.9	14.8	12	12.8	10.4	7.52	8.2	13.2	21	7.58	11	7.85	7.28	7.57	8.03	<0.05	<0.05
Manganese	0.00005		0.00031	0.00075	0.00067	0.00519	0.0284	0.00144	0.0324	0.0278	0.0005	0.00199	0.0408	0.0015	0.103	0.0985	0.0032	<0.00005	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00102	0.00109	0.00107	0.00129	0.00088	0.00122	0.00066	0.00084	0.00081	0.00127	0.00092	0.00194	0.00061	0.00058	0.00078	<0.00005	<0.00005
Nickel	0.00002		0.00047	0.00047	0.00047	0.00015	0.00025	0.00086	0.00023	0.00021	0.00044	0.00094	0.00033	0.00014	0.00047	0.00051	0.00026	<0.00002	<0.00002
Phosphorous	0.002		0.003	0.004	0.003	<0.002	<0.002	<0.002	0.003	<0.002	0.003	<0.002	0.003	0.002	0.01	0.005	<0.002	<0.002	<0.002
Potassium	0.05		2.22	2.24	2.13	1.17	0.97	0.87	0.84	1.08	2.44	0.88	1.045	1.23	0.8	0.84	0.67	<0.05	<0.05
Selenium	0.00004		0.00012	0.00011	0.00008	0.00008	0.00004	0.00033	<0.00004	0.00018	0.0001	0.00032	0.00004	0.00004	0.00008	0.00007	0.00005	<0.00004	<0.00004
Silicon	0.1		4.5	4.2	4.3	5.4	5.5	3.2	4.7	4.9	4.1	3.2	5.1	4.8	5.0	5.1	5.7	<0.1	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		5.21	4.75	4.21	5.38	4.91	1.99	4.02	4.01	6.02	2.03	5.11	3.92	3.58	3.79	3.23	<0.05	<0.05
Strontium	0.00005		0.308	0.314	0.26	0.264	0.238	0.131	0.231	0.305	0.461	0.13	0.234	0.169	0.154	0.162	0.178	0.00008	<0.00005
Thallium	0.000002		<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.023	0.0228	0.0147	0.0134	0.00956	0.00111	0.00802	0.0153	0.0251	0.00111	0.00703	0.00618	0.00015	0.000445	0.00219	<0.000002	<0.000002
Vanadium	0.0002		<0.0002	0.0002	<0.0002	<0.0002	0.0002	0.0002	0.0002	<0.0002	0.0003	0.0002	0.0002	0.0003	0.0003	0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0001		0.0006	0.0005	0.0005	0.0009	0.0006	0.0011	0.0005	0.0028	0.0004	0.0011	0.00045	0.0006	0.0004	0.0003	0.0002	<0.0001	<0.0001
Zirconium	0.0001		0.0001	0.0001	0.0001	<0.0001	0.0001	<0.0001	0.0001	<0.0001	0.0002	<0.0001	0.0001	<0.0001	0.0001	0.0002	0.0001	<0.0001	<0.0001

Notes:

All units mg/L unless otherwise noted.

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment 2007.

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N.

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ <4 mg/L, DOC <2 mg/L: 0.1 mg/L at pH ≥6.5, $[Ca^{2+}]$ ≥4 mg/L, DOC ≥2 mg/L.

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ =120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ >180 mg/L.

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ =60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ =120 -180 mg/L; 0.007 mg/L at $[CaCO_3]$ >180 mg/L.

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ =60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ =120 -180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L.

**Average of sample and replicate.*

0.231 *Results exceed CCME Aquatic Life Guidelines.*

Appendix A8

Surface Water Quality Replicate Data, Casino Project, 2009

Appendix A8. QA/QC: Field Replicates, May 2009

Surface Water Analysis Results (mg/L)

Station	W2		RPD	Station	W2		RPD
Date	**19-May-09**		**%**	**Date**	**19-May-09**		**%**
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	83.5	79.2	5.3%	Ammonia as Nitrogen	0.04	0.08	**66.7%**
Conductivity	180	180	0.0%	Total Alkalinity (mg/L CaCO3)	50	49	2.0%
pH	7.8	7.8	0.0%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	11	10	9.5%	Bromide	<0.1	<0.1	n/c
TDS	130	150	14.3%	Chloride	1.4	1.5	6.9%
Turbidity	0.7	0.7	0.0%	Fluoride	0.07	0.07	0.0%
Dissolved Ortho Phosphate as P	0.037	0.036	2.7%	Sulphate SO4	36	36	0.0%
Weak Acid Dissociable Cyanide	0.0008	0.0009	11.8%	Nitrate (as Nitrogen)	0.088	0.083	5.8%
Strong Acid Dissociable Cyanide	0.0015	0.0012	22.2%	Nitrite (as Nitrogen)	0.003	0.003	0.0%
Total Organic Carbon	-	-	n/c	Total Kjeldahl Nitrogen	0.99	1.91	**63.4%**
Average			7.3%	Average			18%
Total Metals				**Dissolved Metals**			
Aluminum	0.186	0.207	10.7%	Aluminum	0.138	0.137	0.7%
Antimony	0.00026	0.00023	12.2%	Antimony	0.00024	0.00023	4.3%
Arsenic	0.00081	0.00084	3.6%	Arsenic	0.00071	0.00070	1.4%
Barium	0.0524	0.0537	2.5%	Barium	0.0490	0.0498	1.6%
Beryllium	0.00002	0.00002	0.0%	Beryllium	0.00001	0.00002	**66.7%**
Bismuth	0.000009	<0.000005	n/c	Bismuth	<0.000005	0.000009	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000028	0.000027	3.6%	Cadmium	0.000021	0.000024	13.3%
Calcium	21.1	20.0	5.4%	Calcium	21.6	22.1	2.3%
Chromium	0.0002	0.0003	**40.0%**	Chromium	0.0002	0.0002	0.0%
Cobalt	0.000140	0.000168	18.2%	Cobalt	0.000099	0.000111	11.4%
Copper	0.00465	0.00432	7.4%	Copper	0.00471	0.00470	0.2%
Iron	0.185	0.213	14.1%	Iron	0.120	0.117	2.5%
Lead	0.000088	0.000128	**37.0%**	Lead	0.000040	0.000035	13.3%
Lithium	0.0005	<0.0005	n/c	Lithium	0.0005	0.0005	0.0%
Magnesium	7.52	7.10	5.7%	Magnesium	7.83	7.79	0.5%
Manganese	0.0178	0.0209	16.0%	Manganese	0.0131	0.0133	1.5%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00055	0.00052	5.6%	Molybdenum	0.00058	0.00056	3.5%
Nickel	0.00122	0.00115	5.9%	Nickel	0.00110	0.00116	5.3%
Phosphorous	0.012	0.014	15.4%	Phosphorous	0.007	0.008	13.3%
Potassium	1.46	1.40	4.2%	Potassium	1.48	1.53	3.3%
Selenium	0.00006	0.00004	**40.0%**	Selenium	0.00008	0.00009	11.8%
Silicon	3.4	3.3	3.0%	Silicon	3.5	3.4	2.9%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	0.000006	n/c
Sodium	2.42	2.28	6.0%	Sodium	2.55	2.57	0.8%
Strontium	0.140	0.134	4.4%	Strontium	0.138	0.139	0.7%
Thallium	0.000004	0.000004	0.0%	Thallium	0.000003	0.000004	**28.6%**
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0036	0.0050	**32.6%**	Titanium	0.0015	0.0015	0.0%
Uranium	0.00677	0.00634	6.6%	Uranium	0.00691	0.00678	1.9%
Vanadium	0.0008	0.0006	**28.6%**	Vanadium	0.0004	0.0004	0.0%
Zinc	0.0020	0.0017	16.2%	Zinc	0.0014	0.0018	**25.0%**
Zirconium	0.0003	0.0003	0.0%	Zirconium	0.0003	0.0003	0.0%
Average			12.3%	Average			7.5%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, June 2009 (1 of 2)

Surface Water Analysis Results (mg/L)

Station	W2		RPD	Station	W2		RPD
Date	30-Jun-09		%	Date	30-Jun-09		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	63.8	61.3	4.0%	Ammonia as Nitrogen	0.02	0.02	0.0%
Conductivity	120	120	0.0%	Total Alkalinity (mg/L CaCO3)	35	35	0.0%
pH	7.3	7.3	0.0%	Acidity (pH 8.3) (mg/L CaCO3)	4.0	3.9	2.5%
TSS	11	12	8.7%	Bromide	<0.4	<0.4	n/c
TDS	120	110	8.7%	Chloride	1.1	1.0	9.5%
Turbidity	1.9	2.5	**27.3%**	Fluoride	0.07	0.07	0.0%
Dissolved Ortho Phosphate as P	<0.001	<0.001	n/c	Sulphate SO4	23	21	9.1%
Weak Acid Dissociable Cyanide	0.0009	0.0008	11.8%	Nitrate (as Nitrogen)	0.093	0.089	4.4%
Strong Acid Dissociable Cyanide	0.0011	0.0009	20.0%	Nitrite (as Nitrogen)	0.003	0.004	**28.6%**
Total Organic Carbon	16.5	19.7	17.7%	Total Kjeldahl Nitrogen	0.69	0.43	**46.4%**
Average			10.9%	Average			11%
Total Metals				**Dissolved Metals**			
Aluminum	0.313	0.303	3.2%	Aluminum	0.190	0.186	2.1%
Antimony	0.00033	0.00034	3.0%	Antimony	0.00035	0.00037	5.6%
Arsenic	0.00091	0.00087	4.5%	Arsenic	0.00071	0.00066	7.3%
Barium	0.0464	0.0457	1.5%	Barium	0.0402	0.0409	1.7%
Beryllium	0.00002	0.00001	**66.7%**	Beryllium	0.00001	0.00001	0.0%
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000023	0.000023	0.0%	Cadmium	0.000014	0.000018	**25.0%**
Calcium	15.7	15.0	4.6%	Calcium	14.4	15.3	6.1%
Chromium	0.0004	0.0003	**28.6%**	Chromium	0.0002	0.0003	**40.0%**
Cobalt	0.000212	0.000159	**28.6%**	Cobalt	0.000089	0.000092	3.3%
Copper	0.00383	0.00369	3.7%	Copper	0.00357	0.00375	4.9%
Iron	0.283	0.269	5.1%	Iron	0.158	0.165	4.3%
Lead	0.000167	0.000191	13.4%	Lead	0.000053	0.000102	**63.2%**
Lithium	<0.0005	<0.0005	n/c	Lithium	<0.0005	<0.0005	n/c
Magnesium	6.00	5.77	3.9%	Magnesium	5.49	5.60	2.0%
Manganese	0.0122	0.0111	9.4%	Manganese	0.00375	0.00421	11.6%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00036	0.00034	5.7%	Molybdenum	0.00037	0.00037	0.0%
Nickel	0.00108	0.00115	6.3%	Nickel	0.00097	0.00095	2.1%
Phosphorous	0.013	0.014	7.4%	Phosphorous	0.005	0.005	0.0%
Potassium	0.94	0.89	5.5%	Potassium	0.85	0.89	4.6%
Selenium	0.00008	0.00007	13.3%	Selenium	0.00008	0.00008	0.0%
Silicon	4.3	4.4	2.3%	Silicon	3.6	3.9	8.0%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	2.10	2.06	1.9%	Sodium	1.96	2.06	5.0%
Strontium	0.0990	0.0972	1.8%	Strontium	0.106	0.105	0.9%
Thallium	0.000004	0.000005	22.2%	Thallium	0.000004	0.000004	0.0%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	0.00001	n/c
Titanium	0.0078	0.0068	13.7%	Titanium	0.0021	0.0015	**33.3%**
Uranium	0.00318	0.00311	2.2%	Uranium	0.00319	0.00316	0.9%
Vanadium	0.0008	0.0007	13.3%	Vanadium	0.0004	0.0005	22.2%
Zinc	0.0018	0.0026	**36.4%**	Zinc	0.0016	0.0036	**76.9%**
Zirconium	0.0005	0.0005	0.0%	Zirconium	0.0004	0.0004	0.0%
Average			11.0%	Average			11.8%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, June 2009 (2 of 2)
Surface Water Analysis Results (mg/L)

Station	W15		RPD	Station	W15		RPD
Date	29-Jun-09		%	Date	29-Jun-09		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	81.2	80.7	0.6%	Ammonia as Nitrogen	0.02	<0.01	n/c
Conductivity	150	160	6.5%	Total Alkalinity (mg/L CaCO3)	63	64	1.6%
pH	7.7	7.8	1.3%	Acidity (pH 8.3) (mg/L CaCO3)	2.6	2.1	21.3%
TSS	23	30	**26.4%**	Bromide	<0.4	<0.4	n/c
TDS	92	88	4.4%	Chloride	0.6	0.6	0.0%
Turbidity	9.7	9.2	5.3%	Fluoride	0.11	0.11	0.0%
Dissolved Ortho Phosphate as P	0.001	0.001	0.0%	Sulphate SO4	13	13	0.0%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.010	0.010	0.0%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	0.002	0.002	0.0%
Total Organic Carbon	4.4	4.6	4.4%	Total Kjeldahl Nitrogen	0.16	0.16	0.0%
Average			6.1%	Average			3%
Total Metals				**Dissolved Metals**			
Aluminum	0.189	0.191	1.1%	Aluminum	0.0273	0.0256	6.4%
Antimony	0.00012	0.00011	8.7%	Antimony	0.00011	0.00010	9.5%
Arsenic	0.00068	0.00065	4.5%	Arsenic	0.00043	0.00041	4.8%
Barium	0.0462	0.0458	0.9%	Barium	0.0371	0.0367	1.1%
Beryllium	0.00001	0.00001	0.0%	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	0.000006	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000048	0.000032	**40.0%**	Cadmium	0.000028	0.000010	**94.7%**
Calcium	22.3	22.0	1.4%	Calcium	22.3	22.3	0.0%
Chromium	0.0003	0.0003	0.0%	Chromium	<0.0001	<0.0001	n/c
Cobalt	0.000253	0.000241	4.9%	Cobalt	0.000026	0.000021	21.3%
Copper	0.00172	0.00166	3.6%	Copper	0.00097	0.00093	4.2%
Iron	0.293	0.296	1.0%	Iron	0.029	0.024	18.9%
Lead	0.000325	0.000305	6.3%	Lead	0.000031	0.000021	**38.5%**
Lithium	0.0012	0.0013	8.0%	Lithium	0.0011	0.0011	0.0%
Magnesium	6.20	6.23	0.5%	Magnesium	6.31	6.21	1.6%
Manganese	0.0258	0.0250	3.1%	Manganese	0.00306	0.00296	3.3%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00087	0.00090	3.4%	Molybdenum	0.00101	0.00097	4.0%
Nickel	0.00152	0.00151	0.7%	Nickel	0.00086	0.00080	7.2%
Phosphorous	0.040	0.036	10.5%	Phosphorous	0.003	<0.002	n/c
Potassium	0.75	0.76	1.3%	Potassium	0.78	0.78	0.0%
Selenium	0.00026	0.00027	3.8%	Selenium	0.00026	0.00025	3.9%
Silicon	3.6	3.7	2.7%	Silicon	3.8	3.5	8.2%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	1.62	1.62	0.0%	Sodium	1.66	1.65	0.6%
Strontium	0.0911	0.0901	1.1%	Strontium	0.0914	0.0919	0.5%
Thallium	0.000004	0.000006	**40.0%**	Thallium	0.000003	0.000002	**40.0%**
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0053	0.0049	7.8%	Titanium	0.0006	<0.0005	n/c
Uranium	0.000861	0.000872	1.3%	Uranium	0.000842	0.000834	1.0%
Vanadium	0.0007	0.0007	0.0%	Vanadium	0.0002	0.0002	0.0%
Zinc	0.0037	0.0035	5.6%	Zinc	0.0006	0.0005	18.2%
Zirconium	0.0001	0.0001	0.0%	Zirconium	<0.0001	<0.0001	n/c
Average			5.6%	Average			12.0%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, August 2009 (1 of 2)

Surface Water Analysis Results (mg/L)

Station	W3		RPD	Station	W3		RPD
Date	8-Aug-09		%	Date	8-Aug-09		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	112	111	0.9%	Ammonia as Nitrogen	0.04	0.05	22.2%
Conductivity	251	239	4.9%	Total Alkalinity (mg/L CaCO3)	62	60	3.3%
pH	7.4	7.3	1.4%	Acidity (pH 8.3) (mg/L CaCO3)	0.7	1.6	**78.3%**
TSS	34	30	12.5%	Bromide	<0.4	<0.4	n/c
TDS	170	170	0.0%	Chloride	0.8	0.9	11.8%
Turbidity	2.2	2.8	24.0%	Fluoride	0.08	0.08	0.0%
Dissolved Ortho Phosphate as P	0.001	0.002	**66.7%**	Sulphate SO4	51	49	4.0%
Weak Acid Dissociable Cyanide	0.0018	<0.0005	n/c	Nitrate (as Nitrogen)	0.255	0.255	0.0%
Strong Acid Dissociable Cyanide	0.0011	0.0016	**37.0%**	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	5.0	7.3	**37.4%**	Total Kjeldahl Nitrogen	0.19	0.19	0.0%
Average			20.5%	Average			15%
Total Metals				**Dissolved Metals**			
Aluminum	0.186	0.182	2.2%	Aluminum	0.0395	0.0350	12.1%
Antimony	0.00034	0.00034	0.0%	Antimony	0.00034	0.00034	0.0%
Arsenic	0.00119	0.00112	6.1%	Arsenic	0.00071	0.00073	2.8%
Barium	0.0572	0.0568	0.7%	Barium	0.0501	0.0506	1.0%
Beryllium	0.00001	0.00001	0.0%	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000054	0.000047	13.9%	Cadmium	0.000026	0.000021	21.3%
Calcium	28.9	29.0	0.3%	Calcium	28.7	28.8	0.3%
Chromium	0.0005	0.0005	0.0%	Chromium	0.0002	0.0002	0.0%
Cobalt	0.000301	0.000303	0.7%	Cobalt	0.000053	0.000057	7.3%
Copper	0.00377	0.00371	1.6%	Copper	0.00257	0.00269	4.6%
Iron	0.343	0.318	7.6%	Iron	0.050	0.044	12.8%
Lead	0.000489	0.000395	21.3%	Lead	0.000059	0.000247	**122.9%**
Lithium	0.0005	<0.0005	n/c	Lithium	<0.0005	<0.0005	n/c
Magnesium	9.56	9.49	0.7%	Magnesium	9.35	9.38	0.3%
Manganese	0.0369	0.0370	0.3%	Manganese	0.00593	0.00593	0.0%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00068	0.00070	2.9%	Molybdenum	0.00079	0.00079	0.0%
Nickel	0.00113	0.00116	2.6%	Nickel	0.00061	0.00068	10.9%
Phosphorous	0.024	0.026	8.0%	Phosphorous	0.003	<0.002	n/c
Potassium	1.58	1.58	0.0%	Potassium	1.56	1.58	1.3%
Selenium	0.00009	0.00008	11.8%	Selenium	0.00008	0.00008	0.0%
Silicon	4.6	4.4	4.4%	Silicon	4.7	4.5	4.3%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	3.58	3.58	0.0%	Sodium	3.54	3.55	0.3%
Strontium	0.187	0.188	0.5%	Strontium	0.188	0.190	1.1%
Thallium	0.000005	0.000004	22.2%	Thallium	0.000003	0.000003	0.0%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0067	0.0061	9.4%	Titanium	0.0005	<0.0005	n/c
Uranium	0.00709	0.00713	0.6%	Uranium	0.00677	0.00667	1.5%
Vanadium	0.0008	0.0007	13.3%	Vanadium	0.0002	0.0002	0.0%
Zinc	0.0034	0.0029	15.9%	Zinc	0.0010	0.0012	18.2%
Zirconium	0.0002	0.0002	0.0%	Zirconium	0.0002	0.0002	0.0%
Average			5.2%	Average			8.9%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, August 2009 (2 of 2)

Surface Water Analysis Results (mg/L)

Station	W43		RPD	Station	W43		RPD
Date	9-Aug-09		%	Date	9-Aug-09		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	125	127	1.6%	Ammonia as Nitrogen	<0.01	<0.01	n/c
Conductivity	279	279	0.0%	Total Alkalinity (mg/L CaCO3)	93	94	1.1%
pH	7.2	7.3	1.4%	Acidity (pH 8.3) (mg/L CaCO3)	6.8	7.0	2.9%
TSS	<1	<1	n/c	Bromide	<0.4	<0.4	n/c
TDS	160	170	6.1%	Chloride	<0.5	<0.5	n/c
Turbidity	0.4	0.6	**40.0%**	Fluoride	0.09	0.10	10.5%
Dissolved Ortho Phosphate as P	0.002	0.002	0.0%	Sulphate SO4	44	46	4.4%
Weak Acid Dissociable Cyanide	<0.0005	0.0010	n/c	Nitrate (as Nitrogen)	0.163	0.154	5.7%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	0.9	1.4	**43.5%**	Total Kjeldahl Nitrogen	0.03	<0.02	n/c
Average			13.2%	Average			5%
Total Metals				**Dissolved Metals**			
Aluminum	0.0023	0.0024	4.3%	Aluminum	0.0014	0.0016	13.3%
Antimony	0.00300	0.00289	3.7%	Antimony	0.00283	0.00286	1.1%
Arsenic	0.00043	0.00045	4.5%	Arsenic	0.00029	0.00029	0.0%
Barium	0.0475	0.0457	3.9%	Barium	0.0451	0.0456	1.1%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.0492	0.0490	0.4%	Cadmium	0.0492	0.0498	1.2%
Calcium	35.0	35.3	0.9%	Calcium	35.0	35.8	2.3%
Chromium	<0.0001	<0.0001	n/c	Chromium	<0.0001	<0.0001	n/c
Cobalt	0.000179	0.000185	3.3%	Cobalt	0.000172	0.000172	0.0%
Copper	0.0463	0.0468	1.1%	Copper	0.0447	0.0453	1.3%
Iron	0.026	0.026	0.0%	Iron	0.020	0.020	0.0%
Lead	0.00429	0.00427	0.5%	Lead	0.00222	0.00222	0.0%
Lithium	0.0028	0.0028	0.0%	Lithium	0.0027	0.0027	0.0%
Magnesium	9.20	9.41	2.3%	Magnesium	9.14	9.38	2.6%
Manganese	0.247	0.248	0.4%	Manganese	0.249	0.253	1.6%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	<0.00005	<0.00005	n/c	Molybdenum	<0.00005	<0.00005	n/c
Nickel	0.00048	0.00043	11.0%	Nickel	0.00051	0.00050	2.0%
Phosphorous	<0.002	<0.002	n/c	Phosphorous	<0.002	<0.002	n/c
Potassium	1.40	1.41	0.7%	Potassium	1.43	1.45	1.4%
Selenium	<0.00004	<0.00004	n/c	Selenium	<0.00004	<0.00004	n/c
Silicon	5.1	5.0	2.0%	Silicon	5.2	5.3	1.9%
Silver	0.000045	0.000046	2.2%	Silver	0.000008	0.000009	11.8%
Sodium	3.54	3.60	1.7%	Sodium	3.48	3.58	2.8%
Strontium	0.318	0.312	1.9%	Strontium	0.313	0.317	1.3%
Thallium	0.000024	0.000024	0.0%	Thallium	0.000021	0.000024	13.3%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00238	0.00231	3.0%	Uranium	0.00229	0.00233	1.7%
Vanadium	<0.0002	<0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	2.59	2.60	0.4%	Zinc	2.60	2.65	1.9%
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c
Average			2.2%	Average			2.8%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, September 2009 (1 of 2)

Surface Water Analysis Results (mg/L)

Station	W7		RPD	Station	W7		RPD
Date	22-Sep-09		%	Date	22-Sep-09		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	61.3	59.7	2.6%	Ammonia as Nitrogen	<0.01	0.01	n/c
Conductivity	217	147	**38.5%**	Total Alkalinity (mg/L CaCO3)	7.8	8.8	12.0%
pH	8.0	7.1	11.9%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	2	1	**66.7%**	Bromide	<0.4	<0.4	n/c
TDS	130	110	16.7%	Chloride	<0.5	<0.5	n/c
Turbidity	0.4	0.4	0.0%	Fluoride	0.08	0.08	0.0%
Dissolved Ortho Phosphate as P	<0.001	<0.001	n/c	Sulphate SO4	53	49	7.8%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	<0.002	<0.002	n/c
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	2.9	3.2	9.8%	Total Kjeldahl Nitrogen	0.19	0.11	**53.3%**
Average			20.9%	Average			18%
Total Metals				**Dissolved Metals**			
Aluminum	0.0496	0.0556	11.4%	Aluminum	0.0252	0.0283	11.6%
Antimony	0.00007	0.00007	0.0%	Antimony	0.00006	0.00007	15.4%
Arsenic	0.00024	0.00024	0.0%	Arsenic	0.00021	0.00019	10.0%
Barium	0.0527	0.0528	0.2%	Barium	0.0513	0.0532	3.6%
Beryllium	0.00001	0.00001	0.0%	Beryllium	<0.00001	0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000143	0.000155	8.1%	Cadmium	0.000135	0.000129	4.5%
Calcium	18.3	17.7	3.3%	Calcium	17.2	17.0	1.2%
Chromium	0.0002	0.0002	0.0%	Chromium	0.0002	0.0001	**66.7%**
Cobalt	0.000071	0.000083	15.6%	Cobalt	0.000046	0.000053	14.1%
Copper	0.00209	0.00205	1.9%	Copper	0.00181	0.00190	4.9%
Iron	0.046	0.050	8.3%	Iron	0.012	0.012	0.0%
Lead	0.000073	0.000074	1.4%	Lead	0.000007	0.000015	**72.7%**
Lithium	0.0007	0.0008	13.3%	Lithium	0.0009	0.0008	11.8%
Magnesium	3.81	3.74	1.9%	Magnesium	3.39	3.52	3.8%
Manganese	0.00356	0.00338	5.2%	Manganese	0.00245	0.00253	3.2%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00037	0.00036	2.7%	Molybdenum	0.00034	0.00036	5.7%
Nickel	0.00076	0.00079	3.9%	Nickel	0.00066	0.00075	12.8%
Phosphorous	0.004	0.004	0.0%	Phosphorous	<0.002	0.003	n/c
Potassium	0.68	0.67	1.5%	Potassium	0.63	0.63	0.0%
Selenium	0.00007	0.00007	0.0%	Selenium	0.00005	0.00006	18.2%
Silicon	11.1	10.9	1.8%	Silicon	10.1	9.9	2.0%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	5.27	5.18	1.7%	Sodium	4.75	5.05	6.1%
Strontium	0.111	0.112	0.9%	Strontium	0.109	0.110	0.9%
Thallium	0.000003	0.000003	0.0%	Thallium	0.000002	0.000002	0.0%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0011	0.0024	**74.3%**	Titanium	<0.0005	<0.0005	n/c
Uranium	0.000067	0.000072	7.2%	Uranium	0.000044	0.000064	**37.0%**
Vanadium	<0.0002	<0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0103	0.0100	3.0%	Zinc	0.0090	0.0096	6.5%
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c
Average			6.2%	Average			13.0%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, September 2009 (2 of 2)

Surface Water Analysis Results (mg/L)

Station	W15		RPD	Station	W15		RPD
Date	22-Sep-09		%	Date	22-Sep-09		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	87.9	88.0	0.1%	Ammonia as Nitrogen	<0.01	0.02	n/c
Conductivity	162	162	0.0%	Total Alkalinity (mg/L CaCO3)	67	65	3.0%
pH	7.9	8.0	1.3%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	6	6	0.0%	Bromide	<0.4	<0.4	n/c
TDS	110	100	9.5%	Chloride	0.6	<0.5	n/c
Turbidity	1.3	1.6	20.7%	Fluoride	0.12	0.12	0.0%
Dissolved Ortho Phosphate as P	0.001	<0.001	n/c	Sulphate SO4	15	15	0.0%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.004	0.004	0.0%
Strong Acid Dissociable Cyanide	0.0006	0.0006	0.0%	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	2.8	2.7	3.6%	Total Kjeldahl Nitrogen	0.09	0.09	0.0%
Average			4.4%	Average			0.6%
Total Metals				**Dissolved Metals**			
Aluminum	0.0815	0.0869	6.4%	Aluminum	0.0150	0.0133	12.0%
Antimony	0.00010	0.00010	0.0%	Antimony	0.00010	0.00009	10.5%
Arsenic	0.00049	0.00046	6.3%	Arsenic	0.00042	0.00040	4.9%
Barium	0.0394	0.0395	0.3%	Barium	0.0374	0.0368	1.6%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000021	0.000024	13.3%	Cadmium	0.000011	0.000012	8.7%
Calcium	24.7	24.8	0.4%	Calcium	22.0	22.0	0.0%
Chromium	0.0002	0.0003	**40.0%**	Chromium	<0.0001	<0.0001	n/c
Cobalt	0.000086	0.000073	16.4%	Cobalt	0.000012	0.000011	8.7%
Copper	0.00086	0.00085	1.2%	Copper	0.00072	0.00062	14.9%
Iron	0.118	0.113	4.3%	Iron	0.013	0.009	**36.4%**
Lead	0.000108	0.000082	**27.4%**	Lead	0.000083	0.000014	**142.3%**
Lithium	0.0013	0.0013	0.0%	Lithium	0.0012	0.0012	0.0%
Magnesium	6.39	6.32	1.1%	Magnesium	5.70	5.80	1.7%
Manganese	0.00866	0.00858	0.9%	Manganese	0.00155	0.00150	3.3%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00120	0.00119	0.8%	Molybdenum	0.00132	0.00126	4.7%
Nickel	0.00092	0.00093	1.1%	Nickel	0.00067	0.00061	9.4%
Phosphorous	<0.002	<0.002	n/c	Phosphorous	0.008	0.008	0.0%
Potassium	0.84	0.84	0.0%	Potassium	0.75	0.73	2.7%
Selenium	0.00027	0.00025	7.7%	Selenium	0.00025	0.00023	8.3%
Silicon	3.1	3.0	3.3%	Silicon	2.7	2.7	0.0%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	1.87	1.87	0.0%	Sodium	1.74	1.73	0.6%
Strontium	0.106	0.106	0.0%	Strontium	0.105	0.104	1.0%
Thallium	0.000003	0.000003	0.0%	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0030	0.0027	10.5%	Titanium	<0.0005	<0.0005	n/c
Uranium	0.000950	0.000946	0.4%	Uranium	0.000991	0.000985	0.6%
Vanadium	0.0003	0.0003	0.0%	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0020	0.0017	16.2%	Zinc	0.0046	0.0006	**153.8%**
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c
Average			6.1%	Average			18.5%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, October 2009 (1 of 2)

Surface Water Analysis Results (mg/L)

Station	W1		RPD	Station	W1		RPD
Date	6-Oct-09		%	Date	6-Oct-09		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	151	148	2.0%	Ammonia as Nitrogen	<0.01	<0.01	n/c
Conductivity	324	324	0.0%	Total Alkalinity (mg/L CaCO3)	89	88	1.1%
pH	8.1	8.0	1.2%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	<1	<1	n/c	Bromide	<0.4	<0.4	n/c
TDS	230	210	9.1%	Chloride	0.7	<0.5	n/c
Turbidity	0.5	0.2	**85.7%**	Fluoride	0.11	0.11	0.0%
Dissolved Ortho Phosphate as P	0.001	0.002	**66.7%**	Sulphate SO4	68	62	9.2%
Weak Acid Dissociable Cyanide	0.0008	0.0008	0.0%	Nitrate (as Nitrogen)	0.299	0.295	1.3%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	7.4	7.3	1.4%	Total Kjeldahl Nitrogen	0.24	0.17	**34.1%**
Average			20.8%	Average			9.2%
Total Metals				**Dissolved Metals**			
Aluminum	0.0187	0.0177	5.5%	Aluminum	0.0169	0.0168	0.6%
Antimony	0.00030	0.00031	3.3%	Antimony	0.00031	0.00029	6.7%
Arsenic	0.00049	0.00049	0.0%	Arsenic	0.00052	0.00049	5.9%
Barium	0.0606	0.0579	4.6%	Barium	0.0589	0.0618	4.8%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000011	0.000007	**44.4%**	Cadmium	<0.000005	0.000006	n/c
Calcium	38.2	37.2	2.7%	Calcium	37.7	39.3	4.2%
Chromium	0.0002	0.0002	0.0%	Chromium	0.0002	0.0002	0.0%
Cobalt	0.000046	0.000033	**32.9%**	Cobalt	0.000041	0.000044	n/c
Copper	0.00182	0.00174	4.5%	Copper	0.00178	0.00190	6.5%
Iron	0.017	0.018	5.7%	Iron	0.017	0.016	6.1%
Lead	0.000006	0.000015	**85.7%**	Lead	<0.000005	<0.000005	n/c
Lithium	0.0008	0.0009	11.8%	Lithium	0.0008	0.0008	0.0%
Magnesium	13.5	13.4	0.7%	Magnesium	13.2	14.0	5.9%
Manganese	0.00094	0.00095	1.1%	Manganese	0.00078	0.00082	5.0%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00082	0.00085	3.6%	Molybdenum	0.00084	0.00086	2.4%
Nickel	0.00061	0.00063	3.2%	Nickel	0.00054	0.00058	7.1%
Phosphorous	0.003	<0.002	n/c	Phosphorous	<0.002	<0.002	n/c
Potassium	1.97	1.87	5.2%	Potassium	1.93	2.07	7.0%
Selenium	0.00011	0.00013	16.7%	Selenium	0.00013	0.00012	8.0%
Silicon	5.0	5.0	0.0%	Silicon	5.7	4.9	15.1%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	4.41	4.30	2.5%	Sodium	4.44	4.60	3.5%
Strontium	0.237	0.231	2.6%	Strontium	0.233	0.244	4.6%
Thallium	<0.000002	0.000003	n/c	Thallium	0.000002	0.000002	0.0%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.0122	0.0121	0.8%	Uranium	0.0120	0.0124	3.3%
Vanadium	<0.0002	<0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0005	0.0007	**33.3%**	Zinc	0.0003	0.0003	0.0%
Zirconium	0.0002	0.0002	0.0%	Zirconium	0.0002	0.0002	0.0%
Average			11.3%	Average			4.4%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, October 2009 (2 of 2)

Surface Water Analysis Results (mg/L)

Station	R2		RPD	Station	R2		RPD
Date	7-Oct-09		%	Date	7-Oct-09		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	68.7	71.3	3.7%	Ammonia as Nitrogen	<0.01	<0.01	n/c
Conductivity	147	146	0.7%	Total Alkalinity (mg/L CaCO3)	63	63	0.0%
pH	7.9	7.9	0.0%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	2	2	0.0%	Bromide	<0.4	<0.4	n/c
TDS	120	100	18.2%	Chloride	<0.5	<0.5	n/c
Turbidity	0.3	0.2	**40.0%**	Fluoride	0.05	0.05	0.0%
Dissolved Ortho Phosphate as P	0.002	0.002	0.0%	Sulphate SO4	14	13	7.4%
Weak Acid Dissociable Cyanide	0.0006	0.0007	15.4%	Nitrate (as Nitrogen)	0.199	0.192	3.6%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	7.2	7.2	0.0%	Total Kjeldahl Nitrogen	0.16	0.15	6.5%
Average			8.7%	Average			3.5%
Total Metals				**Dissolved Metals**			
Aluminum	0.0426	0.0417	2.1%	Aluminum	0.0314	0.0311	1.0%
Antimony	0.00004	0.00004	0.0%	Antimony	0.00004	0.00004	0.0%
Arsenic	0.00025	0.00024	4.1%	Arsenic	0.00022	0.00024	8.7%
Barium	0.0429	0.0427	0.5%	Barium	0.0428	0.0431	0.7%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	<0.000005	0.000006	n/c	Cadmium	<0.000005	<0.000005	n/c
Calcium	16.6	17.2	3.6%	Calcium	16.6	16.6	0.0%
Chromium	0.0003	0.0003	0.0%	Chromium	0.0002	0.0002	0.0%
Cobalt	0.000050	0.000050	0.0%	Cobalt	0.000040	0.000030	**28.6%**
Copper	0.00101	0.00102	1.0%	Copper	0.00098	0.00096	2.1%
Iron	0.063	0.061	3.2%	Iron	0.040	0.036	10.5%
Lead	0.000029	0.000023	23.1%	Lead	<0.000005	<0.000005	n/c
Lithium	0.0010	0.0011	9.5%	Lithium	0.0010	0.0011	9.5%
Magnesium	6.59	6.90	4.6%	Magnesium	6.53	6.54	0.2%
Manganese	0.00512	0.00556	8.2%	Manganese	0.00468	0.00452	3.5%
Mercury	0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00090	0.00084	6.9%	Molybdenum	0.00087	0.00088	1.1%
Nickel	0.00036	0.00048	**28.6%**	Nickel	0.00041	0.00039	5.0%
Phosphorous	0.004	0.004	0.0%	Phosphorous	<0.002	<0.002	n/c
Potassium	0.55	0.57	3.6%	Potassium	0.57	0.54	5.4%
Selenium	0.00008	0.00007	13.3%	Selenium	0.00006	0.00006	0.0%
Silicon	4.9	4.9	0.0%	Silicon	5.3	4.9	7.8%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	2.78	2.92	4.9%	Sodium	2.82	2.76	2.2%
Strontium	0.133	0.131	1.5%	Strontium	0.134	0.133	0.7%
Thallium	<0.000002	<0.000002	n/c	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0008	0.0007	13.3%	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00253	0.00248	2.0%	Uranium	0.00255	0.00248	2.8%
Vanadium	<0.0002	<0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0006	0.0003	**66.7%**	Zinc	0.0002	0.0002	0.0%
Zirconium	0.0002	0.0002	0.0%	Zirconium	0.0002	0.0002	0.0%
Average			8.0%	Average			4.1%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, November 2009 (1 of 2)

Surface Water Analysis Results (mg/L)

Station	W6b		RPD	Station	W6b		RPD
Date	4-Nov-09		%	Date	4-Nov-09		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	100	98.7	1.3%	Ammonia as Nitrogen	<0.01	<0.01	n/c
Conductivity	190	189	0.5%	Total Alkalinity (mg/L CaCO3)	77	77	0.0%
pH	7.8	7.8	0.0%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	7	9	**25.0%**	Bromide	<0.4	<0.4	n/c
TDS	80	96	18.2%	Chloride	<0.5	<0.5	n/c
Turbidity	1.7	2.7	**45.5%**	Fluoride	0.13	0.12	8.0%
Dissolved Ortho Phosphate as P	0.001	0.001	0.0%	Sulphate SO4	20	21	4.9%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.031	0.034	9.2%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	1.8	1.6	11.8%	Total Kjeldahl Nitrogen	0.06	0.08	**28.6%**
Average			12.8%	Average			10.1%
Total Metals				**Dissolved Metals**			
Aluminum	0.0733	0.0782	6.5%	Aluminum	0.0067	0.0057	16.1%
Antimony	0.00010	0.00010	0.0%	Antimony	0.00010	0.00010	0.0%
Arsenic	0.00043	0.00046	6.7%	Arsenic	0.00039	0.00036	8.0%
Barium	0.0463	0.0453	2.2%	Barium	0.0389	0.0382	1.8%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000037	0.000035	5.6%	Cadmium	0.000018	0.000014	**25.0%**
Calcium	28.3	27.8	1.8%	Calcium	25.3	25.2	0.4%
Chromium	0.0002	0.0002	0.0%	Chromium	0.0001	<0.0001	n/c
Cobalt	0.000072	0.000097	**29.6%**	Cobalt	0.000016	0.000015	6.5%
Copper	0.00068	0.00070	2.9%	Copper	0.00052	0.00048	8.0%
Iron	0.129	0.146	12.4%	Iron	0.011	0.011	0.0%
Lead	0.000089	0.000107	18.4%	Lead	0.000045	<0.000005	n/c
Lithium	0.0015	0.0015	0.0%	Lithium	0.0015	0.0015	0.0%
Magnesium	7.22	7.11	1.5%	Magnesium	6.69	6.67	0.3%
Manganese	0.00939	0.0108	14.0%	Manganese	0.00210	0.00186	12.1%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00117	0.00121	3.4%	Molybdenum	0.00121	0.00126	4.0%
Nickel	0.00114	0.00117	2.6%	Nickel	0.00096	0.00094	2.1%
Phosphorous	0.011	0.015	**30.8%**	Phosphorous	<0.002	<0.002	n/c
Potassium	0.85	0.85	0.0%	Potassium	0.74	0.74	0.0%
Selenium	0.00030	0.00031	3.3%	Selenium	0.00035	0.00033	5.9%
Silicon	2.8	2.8	0.0%	Silicon	2.9	2.8	3.5%
Silver	0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	1.87	1.87	0.0%	Sodium	1.77	1.76	0.6%
Strontium	0.117	0.115	1.7%	Strontium	0.111	0.111	0.0%
Thallium	0.000003	0.000003	0.0%	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0035	0.0035	0.0%	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00108	0.00108	0.0%	Uranium	0.00104	0.00102	1.9%
Vanadium	0.0004	0.0004	0.0%	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0021	0.0023	9.1%	Zinc	0.0008	0.0007	13.3%
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c
Average			5.6%	Average			5.2%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, November 2009 (2 of 2)

Surface Water Analysis Results (mg/L)

Station	W20		RPD	Station	W20		RPD
Date	4-Nov-09		%	Date	4-Nov-09		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	81.2	81.0	0.2%	Ammonia as Nitrogen	0.03	0.04	**28.6%**
Conductivity	170	168	1.2%	Total Alkalinity (mg/L CaCO3)	69	68	1.5%
pH	7.7	7.7	0.0%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	<1	<1	n/c	Bromide	<0.4	<0.4	n/c
TDS	76	100	**27.3%**	Chloride	0.5	<0.5	n/c
Turbidity	0.5	0.6	18.2%	Fluoride	0.14	0.14	0.0%
Dissolved Ortho Phosphate as P	0.001	0.002	**66.7%**	Sulphate SO4	17	18	5.7%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.079	0.077	2.6%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	4.0	3.2	22.2%	Total Kjeldahl Nitrogen	0.15	0.11	**30.8%**
Average			19.4%	Average			11.5%
Total Metals				**Dissolved Metals**			
Aluminum	0.0111	0.0128	14.2%	Aluminum	0.0073	0.0071	2.8%
Antimony	0.00004	0.00004	0.0%	Antimony	0.00005	0.00005	0.0%
Arsenic	0.00053	0.00050	5.8%	Arsenic	0.00052	0.00051	1.9%
Barium	0.0443	0.0421	5.1%	Barium	0.0434	0.0428	1.4%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000012	0.000010	18.2%	Cadmium	0.000008	0.000009	11.8%
Calcium	20.0	19.9	0.5%	Calcium	18.9	18.5	2.1%
Chromium	0.0001	0.0002	**66.7%**	Chromium	0.0002	0.0002	0.0%
Cobalt	0.000123	0.000118	4.1%	Cobalt	0.000119	0.000119	0.0%
Copper	0.00086	0.00085	1.2%	Copper	0.00090	0.00082	9.3%
Iron	0.361	0.349	3.4%	Iron	0.341	0.291	15.8%
Lead	0.000016	0.000011	**37.0%**	Lead	0.000020	0.000005	**120.0%**
Lithium	<0.0005	<0.0005	n/c	Lithium	<0.0005	<0.0005	n/c
Magnesium	7.60	7.57	0.4%	Magnesium	7.26	7.28	0.3%
Manganese	0.0785	0.0789	0.5%	Manganese	0.0763	0.0750	1.7%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00062	0.00060	3.3%	Molybdenum	0.00062	0.00059	5.0%
Nickel	0.00053	0.00047	12.0%	Nickel	0.00061	0.00050	19.8%
Phosphorous	0.007	0.007	0.0%	Phosphorous	0.007	0.005	**33.3%**
Potassium	0.84	0.84	0.0%	Potassium	0.79	0.78	1.3%
Selenium	0.00008	0.00009	11.8%	Selenium	0.00011	0.00010	9.5%
Silicon	4.4	4.3	2.3%	Silicon	5.0	4.9	2.0%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	3.80	3.74	1.6%	Sodium	3.59	3.60	0.3%
Strontium	0.151	0.149	1.3%	Strontium	0.152	0.153	0.7%
Thallium	<0.000002	<0.000002	n/c	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.000179	0.000192	7.0%	Uranium	0.000168	0.000196	15.4%
Vanadium	0.0003	0.0004	**28.6%**	Vanadium	0.0003	0.0003	0.0%
Zinc	0.0005	0.0004	22.2%	Zinc	0.0005	0.0003	**50.0%**
Zirconium	0.0001	0.0001	0.0%	Zirconium	0.0002	0.0002	0.0%
Average			9.9%	Average			12.2%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix A8. QA/QC: Field Replicates, December 2009
Surface Water Analysis Results (mg/L)

Station	W16		RPD	Station	W16		RPD
Date	1-Dec-09		%	Date	1-Dec-09		%
Physical Tests				**Dissolved Anions**			
Hardness	140	141	0.7%	Ammonia as Nitrogen	<0.01	0.03	n/c
Conductivity	270	269	0.4%	Total Alkalinity (mg/L CaCO3)	110	110	0.0%
pH	7.8	7.8	0.0%	Acidity (pH 8.3) (mg/L CaCO3)	2.4	2.6	8.0%
TSS	<1	<1	n/c	Bromide	<0.4	<0.4	n/c
TDS	170	180	5.7%	Chloride	<0.5	1.7	n/c
Turbidity	0.4	0.4	0.0%	Fluoride	0.06	0.06	0.0%
Dissolved Ortho Phosphate	0.002	0.002	0.0%	Sulphate SO4	33	32	3.1%
Weak Acid Dissociable	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.236	0.241	2.1%
Strong Acid Dissociable	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	4.4	4.7	6.6%	Total Kjeldahl Nitrogen	0.03	<0.02	n/c
Average			1.9%	Average			2.6%
Total Metals				**Dissolved Metals**			
Aluminum	0.0102	0.0102	0.0%	Aluminum	0.0071	0.0071	0.0%
Antimony	0.00009	0.00009	0.0%	Antimony	0.00008	0.00008	0.0%
Arsenic	0.00031	0.00031	0.0%	Arsenic	0.00029	0.0003	3.4%
Barium	0.0787	0.0807	2.5%	Barium	0.0755	0.0741	1.9%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	<0.000005	0.000009	n/c	Cadmium	<0.000005	<0.000005	n/c
Calcium	36.1	36.3	0.6%	Calcium	33.2	32.9	0.9%
Chromium	0.0001	0.0001	0.0%	Chromium	0.0001	0.0001	0.0%
Cobalt	0.000073	0.000073	0.0%	Cobalt	0.00008	0.000071	11.9%
Copper	0.00116	0.00100	14.8%	Copper	0.00098	0.00103	5.0%
Iron	0.078	0.078	0.0%	Iron	0.063	0.063	0.0%
Lead	0.000051	0.000144	**95.4%**	Lead	0.000032	0.000104	**105.9%**
Lithium	0.0014	0.0015	6.9%	Lithium	0.0014	0.0013	7.4%
Magnesium	12.1	12.2	0.8%	Magnesium	11	11	0.0%
Manganese	0.0414	0.0417	0.7%	Manganese	0.04120	0.0404	2.0%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00095	0.00097	2.1%	Molybdenum	0.00092	0.00092	0.0%
Nickel	0.00031	0.00034	9.2%	Nickel	0.00034	0.00032	6.1%
Phosphorous	0.003	0.004	**28.6%**	Phosphorous	0.003	0.003	0.0%
Potassium	1.16	1.15	0.9%	Potassium	1.05	1.04	1.0%
Selenium	0.00005	0.00005	0.0%	Selenium	<0.00004	0.00004	n/c
Silicon	5.3	5.4	1.9%	Silicon	5	5.2	3.9%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	5.55	5.64	1.6%	Sodium	5.11	5.11	0.0%
Strontium	0.235	0.243	3.3%	Strontium	0.234	0.234	0.0%
Thallium	<0.000002	<0.000002	n/c	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00736	0.00759	3.1%	Uranium	0.00706	0.007	0.9%
Vanadium	<0.0002	0.0002	n/c	Vanadium	0.0002	0.0002	0.0%
Zinc	0.0009	0.0007	25.0%	Zinc	0.0005	0.0004	22.2%
Zirconium	0.0001	0.0001	0.0%	Zirconium	0.0001	0.0001	0.0%
Average			8.2%	Average			7.2%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 3x the DL.*
"<"	*Less than detection limit.*

Appendix B1

Sediment Quality Data, Casino Project, August 2009

Appendix B1. Laboratory Sediment Results For Casino Property, August 2009

Station	Detection Limits	CCME Sediment Quality Guidelines for the Protection of Aquatic Life[a]		R2-1	R2-2	W12-1	W12-2
Date		**ISQG[b]**	**PEL[c]**	**5-Aug-09**	**5-Aug-09**	**8-Aug-09**	**8-Aug-09**
Physical Tests							
Moisture %	0.3			19	22	45	58
pH	0.01			7.40	7.30	3.20	2.78
Total Metals							
Aluminum	100			4570	4580	12400	3470
Antimony	0.1			0.2	0.2	2.9	3.0
Arsenic	0.2	5.9	17	5.8	*8.4*	***45.5***	***22.9***
Barium	0.1			96.8	128	187	73.1
Beryllium	0.1			0.1	0.2	0.4	<0.1
Bismuth	0.1			<0.1	<0.1	1.0	0.8
Cadmium	0.05	0.6	3.5	0.09	0.11	*0.64*	0.09
Calcium	100			1370	1440	1170	415
Chromium	1	37.3	90	4	4	14	6
Cobalt	0.3			4.8	5.0	10.3	1.8
Copper	0.5	35.7	197	7.1	5.5	***265***	*145*
Iron	100			14000	13900	220000	287000
Lead	0.1	35	91.3	3.0	3.5	*74.8*	26.4
Magnesium	100			2160	2170	2740	1040
Manganese	0.2			433	488	526	94.9
Mercury	0.05	0.17	0.486	<0.05	<0.05	0.06	<0.05
Molybdenum	0.1			0.9	0.8	5.1	5.7
Nickel	0.8			4.9	5.5	8.0	2.1
Phosphorous	10			320	327	524	435
Potassium	100			548	724	818	392
Selenium	0.5			<0.5	<0.5	1.1	1.2
Silver	0.05			<0.05	<0.05	0.74	0.56
Sodium	100			<100	<100	<100	<100
Strontium	0.1			10.6	11.9	10.9	4.7
Thallium	0.05			0.07	0.08	0.18	0.09
Tin	0.1			0.3	0.3	0.4	0.2
Titanium	1			234	304	427	184
Vanadium	2			20	21	39	23
Zinc	1	123	315	33	32	*143*	37
Zirconium	0.5			0.7	0.7	1.5	1.9

Notes:

All units mg/kg unless otherwise noted.

a) Canadian Sediment quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2002.

b)ISQG: Interim Freshwater Sediment Quality Guidelines.

c)PEL: Probable Effects Levels.

Italic	*Results exceed ISQG.*
Italic	*Results exceed ISQG & PEL.*

Appendix B2

Sediment Quality Replicate Data, Casino Project, 2009

Appendix B2. QA/QC: Field Replicates, August 2009
Sediment Quality Analysis Results (mg/L)

Station	R2		RPD	Station	W12		RPD
Date	5-Aug-09		%	Date	8-Aug-09		%
Physical Tests				**Physical Tests**			
Moisture %	19	22	14.6%	Moisture %	45	58	25.2%
pH	7.40	7.30	1.4%	pH	3.20	2.78	14.0%
Average			8.0%	Average			19.6%
Total Metals				**Total Metals**			
Aluminum	4570	4580	0.2%	Aluminum	12400	3470	**112.5%**
Antimony	0.2	0.2	0.0%	Antimony	2.9	3.0	3.4%
Arsenic	5.8	8.4	36.6%	Arsenic	45.5	22.9	**66.1%**
Barium	96.8	128	27.8%	Barium	187	73.1	**87.6%**
Beryllium	0.1	0.2	**66.7%**	Beryllium	0.4	<0.1	n/c
Bismuth	<0.1	<0.1	n/c	Bismuth	1.0	0.8	22.2%
Cadmium	0.09	0.11	20.0%	Cadmium	0.64	0.09	**150.7%**
Calcium	1370	1440	5.0%	Calcium	1170	415	**95.3%**
Chromium	4	4	0.0%	Chromium	14	6	**80.0%**
Cobalt	4.8	5.0	4.1%	Cobalt	10.3	1.8	**140.5%**
Copper	7.1	5.5	25.4%	Copper	265	145	**58.5%**
Iron	14000	13900	0.7%	Iron	220000	287000	26.4%
Lead	3.0	3.5	15.4%	Lead	74.8	26.4	**95.7%**
Magnesium	2160	2170	0.5%	Magnesium	2740	1040	**89.9%**
Manganese	433	488	11.9%	Manganese	526	94.9	**138.9%**
Mercury	<0.05	<0.05	n/c	Mercury	0.06	<0.05	n/c
Molybdenum	0.9	0.8	11.8%	Molybdenum	5.1	5.7	11.1%
Nickel	4.9	5.5	11.5%	Nickel	8.0	2.1	**116.8%**
Phosphorous	320	327	2.2%	Phosphorous	524	435	18.6%
Potassium	548	724	27.7%	Potassium	818	392	**70.4%**
Selenium	<0.5	<0.5	n/c	Selenium	1.1	1.2	8.7%
Silver	<0.05	<0.05	n/c	Silver	0.74	0.56	27.7%
Sodium	<100	<100	n/c	Sodium	<100	<100	n/c
Strontium	10.6	11.9	11.6%	Strontium	10.9	4.7	**79.5%**
Thallium	0.07	0.08	13.3%	Thallium	0.18	0.09	**66.7%**
Tin	0.3	0.3	0.0%	Tin	0.4	0.2	**66.7%**
Titanium	234	304	26.0%	Titanium	427	184	**79.5%**
Vanadium	20	21	4.9%	Vanadium	39	23	**51.6%**
Zinc	33	32	3.1%	Zinc	143	37	**117.8%**
Zirconium	0.7	0.7	0.0%	Zirconium	1.5	1.9	23.5%
Average			13.0%	Average			70.6%

Notes:

Bold	*Exceeds Data Quality objective of 50%.*
Bold	*Exceeds Data Quality objective of 50%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated, because one or both values not precisely known, or within 5x the DL.*
"<"	*Less than detection limit.*

Appendix C

Periphyton Taxonomy, Casino Project, August 2009

Appendix C. Periphyton Taxonomy, Casino Project, 2009

Waterbody			Britannia Creek near Yukon River					Confluence of Britannia and Canadian Creeks					Lowe	
FES Sample Number			**090283**	**090284**	**090285**	**090286**	**090287**	**090293**	**090294**	**090295**	**090296**	**090297**	**090308**	**090309**
Sample Site			**P1-1**	**P1-2**	**P1-3**	**P1-4**	**P1-5**	**P2-1**	**P2-2**	**P2-3**	**P2-4**	**P2-5**	**P3-1**	**P3-2**
Sampling Date			**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**07-Aug-09**	**07-Aug-09**	**07-Aug-09**	**07-Aug-09**	**07-Aug-09**	**08-Aug-09**	**08-Aug-09**
Phylum	**Order**	**Genera and Species**												
		Cyclotella sp.	-	-	-	-	-	21.0	3,267.0	3,080.0	47.8	1,666.5	<3.7	<1.3
		Melosira sp.	-	-	-	-	-	-	-	-	-	-	-	-
	Pennales	*Achnanthes flexella*	20.9	8.5	39.8	59.2	<28.3	84.0	1,815.0	1,320.0	23.9	606.0	3.7	<1.3
		Achnanthes lanceolata	41.8	-	-	-	<28.3	-	-	-	-	-	-	-
		Achnanthes minutissima	304,707.2	54,463.0	405,851.4	342,177.2	207,476.4	304,916.4	296,121.6	242,070.4	37,799.6	144,559.2	662.4	144.2
		Achnanthes spp.	59,942.4	12,216.0	83,069.0	70,552.0	38,796.4	1,882.2	8,380.8	6,771.2	7,132.0	8,160.6	114.8	51.5
		Amphipleura pellucida	-	<8.5	-	-	<28.3	-	2,541.0	2,420.0	<23.9	606.0	22.2	51.5
		Amphora spp.	-	-	-	-	-	-	23.4	56.8	-	<19.5	-	<1.3
		Anomoeoneis spp.	-	-	-	-	-	-	46.8	440.0	-	151.5	-	<1.3
		Caloneis spp.	<20.9	<8.5	-	-	<28.3	<21.0	93.6	113.6	<23.9	117.0	<3.7	1.3
		Ceratoneis arcus	7,492.8	991.5	14,240.4	9,700.9	6,137.6	1,304.0	1,815.0	4,180.0	926.5	1,212.0	22.2	41.2
		Cocconeis placentula	20.9	8.5	<39.8	<29.6	28.3	21.0	140.4	170.4	23.9	78.0	-	<1.3
		Cymatopleura solea	-	-	-	-	-	-	<23.4	<28.4	-	<19.5	-	-
		Cymbella cf. cestaii	83.6	<8.5	<39.8	<29.6	<28.3	-	93.6	113.6	-	19.5	-	<1.3
		Cymbella cistula	<20.9	8.5	<39.8	29.6	<28.3	<21.0	374.4	340.8	<23.9	117.0	<3.7	<1.3
		Cymbella microchepala	-	-	-	-	-	42.0		440.0	-	303.0	-	2.6
		Cymbella minuta	2,272.2	330.5	20,173.9	7,937.1	6,747.2	652.0	6,984.0	9,310.4	741.2	5,829.0	<3.7	5.2
		Cymbella sinuata	83.6	34.0	-	118.4	169.8	84.0	363.0	440.0	47.8	151.5		2.6
		Cymbella spp.	811.5	68.0	398.0	177.6	-	126.0	1,815.0	7,260.0	<23.9	909.0	<3.7	<1.3
		Denticula sp.	<20.9	<8.5	<39.8	<29.6	-	42.0	2,178.0	1,760.0	23.9	909.0	7.4	10.4
		Diatoma elongatum	1,141,403.2	374,624.0	1,960,428.4	888,955.2	1,025,574.4	427,886.8	241,646.4	262,384.0	1,966,527.0	198,186.0	993.6	635.2
		Diatoma mesodon	-	-	<39.8	-	-	<21.0	-	-	-	<19.5	<3.7	-
		Diatoma moniliformis	-	-	-	-	-	<21.0	-	-	47.8	-	<3.7	-
		Diatomella sp.	-	-	-	-	-	-	-	-	-	-	-	-
		Didymosphenia geminata		<8.5	<39.8	<29.6	-	-	23.4	28.4	-	<19.5	-	<1.3
		Diploneis spp.	-	-	-	-	-	<21.0	-	<28.4	-	-	-	-
		Epithemia spp.	-	-	-	-	-	-	-		-	-	<3.7	-
		Eunotia spp.	-	-	-	-	-	-	<23.4	<28.4	-	<19.5	<3.7	-
		Fragilaria capucina	-	-	<39.8	<29.6	-	-	-		-	-	-	-
		Fragilaria construens	125.4	132.2	-	916.8	-	-	-	170.4	-	-	-	-
		Fragilaria leptostauron	-	-	-	-	-	-	-	<28.4	-	-	-	-
		Fragilaria montana	-	-	<39.8	<29.6	<28.3	-	-	<28.4	-	-	-	-
		Fragilaria pinnata	-	-	-	-	-	<21.0	2,359.5	2,200.0	-	1,131.0	<3.7	
		Fragilaria vaucheriae	1,623.0	793.2	1,233.6	1,833.6	876.8	326.0	1,089.0	1,980.0	555.9	1,363.5	7.4	7.8
		Fragilaria spp.	9,366.0	6,617.0	32,040.9	49,386.4	17,711.4	4,890.0	33,523.2	44,012.8	9,271.6	25,647.6	258.3	82.4
		Frustulia sp.	-	-	-	-	-	-	-	-	-	-	<3.7	-
		Gomphonema acuminatum / parvulum	29,971.2	2,799.5	16,613.8	20,283.7	11,807.6	4,075.0	6,285.6	5,924.8	1,297.1	4,663.2	37.0	82.4
		Gomphonema olivaceum	-	-	-	-	-	-	-	-	-	-	-	-
		Gomphonema olivaceum?	-	-	-	-	-	-	-	-	-	-	-	-
		Gomphonema spp.	3,746.4	1,018.0	9,493.6	6,173.3	5,903.8	1,793.0	1,396.8	1,692.8	555.9	909.0	7.4	10.3
		Meridion circulare	627.0	68.0	79.6	414.4	226.4	126.0	514.8	284.0		78.0	7.4	5.2
		Navicula radiosa	<20.9	8.5	<39.8	<29.6	<28.3	<21.0	374.4	397.6	<23.9	156.0	14.8	5.2
		Navicula spp.	324.6	85.0	159.2	687.6	-	84.0	140.4	660.0	47.8	273.0	7.4	2.6
		Neidium spp.	-	-	-	-	-	-	-	-	-	-	-	-
		Nitzschia dissipata	-	-	-	-	-	-	-	-	-	-	-	-
		Nitzschia spp.	3,746.4	66.1	925.2	229.2	438.4	815.0	39,110.4	42,320.0	<23.9	13,406.7	37.0	61.8
		Pinnularia spp.	<20.9	<8.5	-	<29.6	<28.3	-	140.4	227.2	<23.9	78.0	3.7	1.3
		Stauroneis spp.	-	-	<39.8	-	<28.3	-	93.6	85.2	-	78.0	<3.7	<1.3
		Surirella spp.	<20.9	-	-	-	-	-	-	-	-	-	-	-
		Synedra ulna	6,244.0	2,545.0	14,240.4	6,173.3	8,434.0	10,038.4	7,682.4	5,078.4	11,411.2	2,727.0	29.6	36.4
		Synedra spp.	6,868.4	13,234.0	42,721.2	38,803.6	60,724.8	2,771.0	27,936.0	17,774.4	4,992.4	9,909.3	44.4	72.1
		Tabellaria fenestrata	-	-	-	-	-	-	<23.4	-	-	-	-	-
		Tabellaria flocculosa	-	-	-	-	-	-	<23.4	<28.4	<23.9	<19.5	-	-
		UID girdle view	<20.9	<8.5	-	-	<28.3	-	-	-	-	-	-	<1.3
		Deformed Diatoms	10,614.8	528.8	1,542.0	888.0	1,753.6	326.0	140.4	-	370.6	117.0	-	-
Chlorophyta	Chaetophorales	*Draparnaldia sp.*	-	-	-	-	-	-	-	-	-	-	-	-
		Stigeoclonium sp.	-	-	-	-	-	-	-	<28.4	<23.9	-	-	-
		Stigeoclonium sp. ?	-	-	-	-	-	-	-	-	-	-	-	-
		UID Chaetophorales	-	-	-	-	-	<21.0	-	227.2	-	<19.5	-	-

Waterbody			Britannia Creek near Yukon River					Confluence of Britannia and Canadian Creeks					Lowe	
FES Sample Number			**090283**	**090284**	**090285**	**090286**	**090287**	**090293**	**090294**	**090295**	**090296**	**090297**	**090308**	**090309**
Sample Site			**P1-1**	**P1-2**	**P1-3**	**P1-4**	**P1-5**	**P2-1**	**P2-2**	**P2-3**	**P2-4**	**P2-5**	**P3-1**	**P3-2**
Sampling Date			**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**07-Aug-09**	**07-Aug-09**	**07-Aug-09**	**07-Aug-09**	**07-Aug-09**	**08-Aug-09**	**08-Aug-09**
Phylum	**Order**	**Genera and Species**												
	Chlorococcales	*Selenastrum sp.*	-	-	-	-	-	-	-	<28.4	-		-	-
	Ulothricales	*Geminella sp.*	-	-	-	-	-	-	-	<28.4	-	<19.5	-	-
		Microspora sp.	-	-	-	-	-	<21.0	842.4	340.8	-	<19.5	-	<1.3
		Ulothrix spp.	-		<39.8	118.4	<28.3	126.0	2,199.6	2,499.2	<23.9	1,131.0	-	<1.3
		Ulothrix zonata	-	<8.5	318.4	236.8	<28.3	168.0	-	<28.4	-	-	-	<1.3
	Volvocales	*Chlamydomonas sp ?*	-	-	-	-	-	-	-	-	-	-	-	-
	Zygnematales	*Closterium spp.*	-	-	-	-	-	-	23.4	-	<23.9	<19.5	<3.7	<1.3
		Cosmarium spp.	-	-	-	-	-	-	<23.4	<28.4	-	<19.5	-	-
		Cylindrocystis spp.	-	-	-	-	-	-	-	-	-	-	-	-
		Mougeotia spp.	-	-	-	-	-	-	<23.4	<28.4	-	-	<3.7	-
		Spirogyra sp.	-	-	-	-	-	-	-	-	-	-	-	-
		Staurastrum sp.	-	-	-	-	-	-	<23.4	<28.4	<23.9	-	-	-
Chlorophyta		UID Chlorophyta colonial	-	-	-	-	-	-	-	<28.4	-	-	-	-
		UID Chlorophyta filamentous	-	-	-	-	-	-	-	-	-	-	-	-
		UID Chlorophyta flagellate	-	-	-	-	-	<21.0	-	56.8	-	-	-	-
		UID Chlorophyta unicellular	162.3	-	-	-	-		-	56.8	185.3	303.0	-	-
Chrysophyta	Chromulinales	*Chromulina sp.*	-	-	-	-	-	326.0	-	-	-	-	-	2.6
		Hydrurus sp.	-	-	-	-	226.4	2,730.0	544.5	56.8	163,322.8	-	-	-
	Tribonematales	*Tribonema spp.*		-	-	-	-		-	-	-	-	-	-
Chrysophyta		UID Chrysophyta colonial	8,115.0	12,470.5	54,588.2	52,914.0	26,145.4	6,274.0	1,633.5	2,860.0	21,396.0	-	<3.7	-
		UID Chrysophyta cyst	324.6	396.6	616.8	687.6	657.6		-	113.6	185.3	39.0	-	2.6
		UID Chrysophyta flagellate			-	-	-		363.0	-	-	-	-	-
		UID Chrysophyta unicellular	162.3	132.2	-	229.2	-	8,156.2	2,095.2	3,385.6	10,698.0	4,663.2	57.4	79.4
Cryptophyta	Cryptomonadales	UID	-	-	-	-	-		-	<28.4	-	-	-	-
Cyanophyta	Chamaesiphonales	*Chamaesiphon spp.*	-	132.2	-	-	-	5,646.6	-	1,100.0	-	909.0	37.0	-
		Clastidium setigerum	-	-	-	1,375.2	-	46,427.6	2,095.2	12,696.0	4,992.4	9,326.4	28.7	10.3
	Chroococcales	*Aphanocapsa spp.*	-	-	-	-	-	-	421.2	454.4	-	-	-	-
		Aphanothece sp.	-	-	-	-	-	-	-	-	-	-	-	-
		Gomphosphaeria sp.	-	-	<39.8	-	-	-	3,931.2	1,363.2	<23.9	1,248.0	-	-
		Merismopedia spp.	-	-		-	-	-	187.2	113.6	-	312.0	<3.7	-
		UID Chrooccocales	-	-	<39.8	<29.6	-	2,509.6	363.0	5,078.4	4,992.4	5,246.1	-	79.4
	Nostocales	*Anabaena sp. ?*	-	-	-	-	-	-	-	-	-	-	-	-
		Calothrix sp. ?	-	-	-	-	-	-	-	-	-	-	-	-
		Nostoc sp. / Anabaena sp.	-	-	-	-	-	-	-	-	-	-	<3.7	<1.3
		Nostoc spp.	-	-	-	-	-	-	-	-	-	-	-	-
		UID Nostocales	-	<8.5	-	-	-	<21.0	<23.4	-	-	-	-	-
	Oscillatoriales	*Lyngbya spp.*	-	<8.5	-	-	-			-	-	-	-	-
		Homoeothrix sp.	7,141.2	80,167.5	237,340.0	126,111.7	<28.3	399,026.4	16,698.0	98,182.4	27,980.3	14,089.5	74.0	20.8
		Oscillatoria cf. agardhii	-	<8.5	-	-	-	-	-	<28.4	-	-	-	-
		Oscillatoria spp.	1,298.4	391.0	398.0	-	<28.3	<21.0	1,544.4	5,060.0	573.6	351.0	<3.7	<1.3
		Pseudoanabaena spp.	-	1,322.0	<39.8	-	-	1,467.0	45,012.0	79,561.6	6,485.5	8,938.5	<3.7	46.8
		Spirulina sp.	-		-	-	-	-	-	<28.4	2,408.9	1,060.5	-	-
		UID Oscillatoriales	1,947.6	204.0	-	<29.6	-	<21.0	9,982.5	25,392.0	2,223.6		-	<1.3
Euglenophyta	Euglenales	UID	-		-	-	-		<23.4	-	-	-	-	-
Rhodophyta	Nemalionales	*Audouinella sp.*	-	<8.5	-	-	<28.3	1,218.0	374.4	170.4		<19.5	-	<1.3
		Batrachospermum sp.	-		-	-	-		-	-	-	-	-	-
		UID flagellate	-	66.1	-	-	-	489.0	5,587.2	8,464.0	2,852.8	303.0	-	10.3
		UID colonial	973.8	1,272.5	-	29,102.7	-	<21.0	544.5	-	-	-	-	<1.3
		UID filamentous	-	<8.5	159.2	-	-		-	-	-	-	-	-
		UID unicellular	16,234.4	2,545.0	21,360.6	19,401.8	4,217.0	16,312.4	13,968.0	6,771.2	6,418.8	3,497.4	552.0	198.5

Diatoma mesodon = Diatoma hiemale var. mesodon

Area = 100 cm^2 per sample

Appendix C. Periphyton Taxonomy, Casino Project, 2009

Waterbody			er Canadian Creek			Lower Casino Creek					Dip Creek			
FES Sample Number			**090310**	**090311**	**090312**	**090278**	**090279**	**090280**	**090281**	**090282**	**090298**	**090299**	**090300**	**090301**
Sample Site			**P3-3**	**P3-4**	**P3-5**	**P4-1**	**P4-2**	**P4-3**	**P4-4**	**P4-5**	**P5-1**	**P5-2**	**P5-3**	**P5-4**
Sampling Date			**08-Aug-09**	**08-Aug-09**	**08-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**
Phylum	**Order**	**Genera and Species**												
		Cyclotella sp.	<2.2	<2.3	<0.5	-	-	-	-	-	-	-	-	-
		Melosira sp.	-	<2.3	-	-	-	-		-	-	-	-	<33.6
	Pennales	*Achnanthes flexella*	<2.2	2.3	0.5	<9.2	-	-	<17.0	-	-	-	-	<33.6
		Achnanthes lanceolata	-	-	-	-	<28.3	<21.6	-	-	-	-	-	-
		Achnanthes minutissima	3,411.90	558.4	880.0	2,201.6	6,747.2	3,870.6	395.4	5,942.4	126.2	8.5	4,390.0	12,038.4
		Achnanthes spp.	200.7	139.6	48.0	357.5	4,217.0	2,580.4	659.0	3,714.0	189.3	17.0	702.4	12,038.4
		Amphipleura pellucida	13.2	181.0	25.2	-	-	-	-	-	-	-	-	-
		Amphora spp.	<2.2	<2.3	<0.5	-	<28.3	-	-	-	-	-	-	<33.6
		Anomoeoneis spp.	<2.2	2.3	<0.5	-	-	-	-	-	-	-	-	-
		Caloneis spp.	<2.2	4.6	1.0	<9.2	<28.3	<28.3	<17.0	<24.9	-	-	-	<33.6
		Ceratoneis arcus	13.2	23.0	21.0	16,787.2	26,145.4	28,384.4	7,098.0	47,539.2	1,262.0	161.5	12,292.0	64,204.8
		Cocconeis placentula	<2.2	-	<0.5	36.8	28.3	43.2	17.0	49.8	<8.1	<1.1	59.0	521.4
		Cymatopleura solea	-	-	-	-	-	-	-	-	-	-	-	-
		Cymbella cf. cestaii	<2.2	-	-	-	-	-	-	-	-	-	-	-
		Cymbella cistula	<2.2	<2.3	<0.5	55.2	283.0	129.6	102.0	149.4	8.1	<1.1	<5.9	33.6
		Cymbella microchepala	-	4.6	-	-	-	-	-	-	-	-	-	-
		Cymbella minuta	4.4	9.2	2.0	286.0	657.6	1,005.6	340.0	249.0	48.6	2.2	35.4	2,346.3
		Cymbella sinuata	17.6	36.2	8.4	71.5	438.4	-	<17.0	99.6	32.4	4.4	228.0	1,042.8
		Cymbella spp.	2.2	9.2	1.0	9.2	28.3	<28.3	34.0	49.8	<8.1		<5.9	67.2
		Denticula sp.	13.2	90.5	3.0	-	-	-	-	-	-	-	-	-
		Diatoma elongatum	3,478.8	633.5	1,344.0	54,489.6	172,053.6	154,824.0	74,022.0	222,840.0	3,155.1	391.2	15,804.0	102,326.4
		Diatoma mesodon	<2.2	<2.3	-	<9.2	<28.3	-	-	-	-	-	11.8	201.6
		Diatoma moniliformis	<2.2	9.2	4.2	-	-	-	-	-	-	-	-	-
		Diatomella sp.	-	-	-	-	-	-	-	-	-	-	-	-
		Didymosphenia geminata	<2.2	<2.3	-	<9.2	113.2	<28.3	<17.0	<24.9	-	-	-	33.6
		Diploneis spp.	-	<2.3	-	<9.2	-	-	-	-	-	-	<5.9	-
		Epithemia spp.	-		-	-	-	-	-	-	-	-	-	-
		Eunotia spp.	-	<2.3	-	-	<28.3	-	-	-	-	-	-	<33.6
		Fragilaria capucina	-	<2.3	-	128.8	339.6	172.8	-	199.2	64.8	13.2	531.0	3,024.0
		Fragilaria construens	-	-	-	-	-	<28.3	<17.0	-	-	-	-	-
		Fragilaria leptostauron	-	-	-	-	-	-	-	-	-	-	-	-
		Fragilaria montana	-	-	-	-	-	-	-	<24.9	-	-	-	-
		Fragilaria pinnata	8.8	9.2	<0.5	-	-	-	-	-	-	-	-	-
		Fragilaria vaucheriae	4.4	72.4	8.4	1,501.5	12,651.0	10,966.7	5,070.0	10,399.2	97.2	13.2	1,053.6	18,057.6
		Fragilaria spp.	174.0	362.0	128.0	5,504.0	6,747.2	9,676.5	3,042.0	8,170.8	48.6	4.4	702.4	18,057.6
		Frustulia sp.	-	-	-	-	-	-	-	-	-	-	-	336.0
		Gomphonema acuminatum / parvulum	401.4	144.8	42.0	572.0	3,068.8	3,184.4	263.6	3,281.0	129.6	6.6	2,985.2	3,910.5
		Gomphonema olivaceum	-	-	-	-	-	-	-	-	-	-	-	1,042.8
		Gomphonema olivaceum?	-	-	-	-	438.4	167.6	131.8	-	32.4	-	45.6	-
		Gomphonema spp.	87.0	36.2	37.8	357.5	2,411.2	1,340.8	659.0	965.0	81.0	4.4	878.0	4,431.9
		Meridion circulare	4.4	9.2	1.0	294.4	283.0	345.6	136.0	348.6	64.8	4.4	141.6	3,389.1
		Navicula radiosa	2.2	13.8	3.0	18.4	113.2	<28.3	17.0	24.9	<8.1	-	-	67.2
		Navicula spp.	<2.2	27.6	21.0	55.2	56.6	86.4	170.0	<24.9	8.1	<1.1	11.8	1,564.2
		Neidium spp.	-	<2.3	-	-	-	-	-	-	-	-	-	-
		Nitzschia dissipata	-	-	-	-	-	-	-	-	-	-	<5.9	5,016.0
		Nitzschia spp.	52.2	162.9	29.4	71.5	438.4	335.2	170.0	579.0	8.1	<1.1	23.6	6,019.2
		Pinnularia spp.	<2.2	13.8	1.0	<9.2	28.3	<28.3	34.0	49.8	-	-	-	134.4
		Stauroneis spp.	<2.2	<2.3	<0.5	-	-	-	<17.0	<24.9	-	-	-	<33.6
		Surirella spp.	-	-	-	-	<28.3	-	-	<24.9	-	-	-	<33.6
		Synedra ulna	14.0	46.0	12.0	6,329.6	11,807.6	4,515.7	748.0	6,685.2	226.8	93.5	1,053.6	4,692.6
		Synedra spp.	104.4	181.0	128.0	62,195.2	172,053.6	176,757.4	77,064.0	164,901.6	441.7	102.0	3,863.2	25,080.0
		Tabellaria fenestrata	-	-	-	<9.2	<28.3	<28.3	<17.0	-	-	-	-	-
		Tabellaria flocculosa	-	-	<0.5	-	-	-	<17.0	-	-	-	<5.9	<33.6
		UID girdle view	-	-	<0.5	-	-	<28.3	-	-	-	-	-	-
		Deformed Diatoms	-	<2.3	-		169.8	<28.3	-	<24.9	8.1	-	23.6	521.4
Chlorophyta	Chaetophorales	*Draparnaldia sp.*	-	-	-	-	-	-	-	-	-	-	-	-
		Stigeoclonium sp.	-	-	-	-	-	-	-	-	-	-	-	-
		Stigeoclonium sp. ?	-	-	-	-	-	-	-	-	-	-	-	-
		UID Chaetophorales	-	-	-	-	-	-	-	<24.9	-	-	<5.9	-

Waterbody			er Canadian Creek			Lower Casino Creek					Dip Creek			
FES Sample Number			**090310**	**090311**	**090312**	**090278**	**090279**	**090280**	**090281**	**090282**	**090298**	**090299**	**090300**	**090301**
Sample Site			**P3-3**	**P3-4**	**P3-5**	**P4-1**	**P4-2**	**P4-3**	**P4-4**	**P4-5**	**P5-1**	**P5-2**	**P5-3**	**P5-4**
Sampling Date			**08-Aug-09**	**08-Aug-09**	**08-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**	**05-Aug-09**
Phylum	**Order**	**Genera and Species**												
	Chlorococcales	*Selenastrum sp.*	-	-	-	-	-	-	-	-	-	-	-	-
	Ulothricales	*Geminella sp.*	-	-	-	-	-	-	-	-	-	-	-	-
		Microspora sp.	<2.2	<2.3		-	-	-	-	-	-	-	-	1,276.8
		Ulothrix spp.	<2.2	-	<0.5	404.8	3,507.2	691.2	-	1,394.4	145.8	<1.1	660.8	1,478.4
		Ulothrix zonata	-	-	-	-	-	-	-	-	-	<1.1	365.8	336.0
	Volvocales	*Chlamydomonas sp ?*	-	-	-	-	-	<28.3	-	-	-	-	-	-
	Zygnematales	*Closterium spp.*	<2.2	<2.3	-	36.8	113.2	129.6	17.0	99.6	-	-	<5.9	33.6
		Cosmarium spp.	-	-	-	<9.2	-	-	-	-	-	-	-	-
		Cylindrocystis spp.	-	-	-	-	-	-	<17.0	-	-	-	-	<33.6
		Mougeotia spp.	-	<2.3	-	-	-	-	-	-	-	-	-	-
		Spirogyra sp.	-	-	-	-	-	-	-	-	-	-	-	<33.6
		Staurastrum sp.	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyta		UID Chlorophyta colonial	-	-	-	-	-	-	-	-	-	-	-	-
		UID Chlorophyta filamentous	-	-	-	-	-	-	-	-	-	-	-	-
		UID Chlorophyta flagellate	-	-	-	-	-	43.2	-	-	-	-	-	-
		UID Chlorophyta unicellular	-	-	-	71.5	56.6	21.6	-	-	-	-	-	-
Chrysophyta	Chromulinales	*Chromulina sp.*	-	-	-	-	-	-	-	-	-	-	-	-
		Hydrurus sp.	-	-	-	-	-	-	-	-	-	-	-	-
	Tribonematales	*Tribonema spp.*	-	-	-	-	-	-	-	-	-	-	-	-
Chrysophyta		UID Chrysophyta colonial	-	162.9	79.8	-	-	-	-	-	-	-	-	-
		UID Chrysophyta cyst	-	54.3	4.2	<9.2	-	-	263.6	193.0	<8.1	<1.1	5.9	782.1
		UID Chrysophyta flagellate	-	-	-	-	-	-	131.8	-	-	-	-	-
		UID Chrysophyta unicellular	34.8	209.4	80.0	143.0	219.2	335.2	-	-	-	-	91.2	260.7
Cryptophyta	Cryptomonadales	UID	-	-	-	-	-	-	-	-	-	-	-	-
Cyanophyta	Chamaesiphonales	*Chamaesiphon spp.*	-	-	-	32,473.6	156,029.0	349,644.2	61,854.0	411,511.2	1,213.5	586.8	100,794.4	71,227.2
		Clastidium setigerum	-	-	-	214.5	1,315.2	18,062.8	922.6	2,228.4	-	-	526.8	17,054.4
	Chroococcales	*Aphanocapsa spp.*	-	-	-	-	-	-	-	-	-	-	-	-
		Aphanothece sp.	-	-	-	-	-	-	-	-	-	-	-	-
		Gomphosphaeria sp.	<2.2	-	-	-	-	<28.3	<17.0	-	-	-	-	-
		Merismopedia spp.	-	<2.3	-	-	-	-	-	-	-	-	-	-
		UID Chrooccocales	104.4	279.2	-	825.6	3,373.6	-	-	-	-	4.4	-	-
	Nostocales	*Anabaena sp. ?*	-	-	<0.5	-	-	-	-	-	-	-	-	-
		Calothrix sp. ?	-	-	-	-	-	-	-	-	-	-	-	-
		Nostoc sp. / Anabaena sp.	-	<2.3	6.0	-	-	-	-	-	-	-	-	-
		Nostoc spp.	-	-	-	-	-	-	-	-	-	-	-	-
		UID Nostocales	-	-	-	-	-	-	-	-	-	-	-	-
	Oscillatoriales	*Lyngbya spp.*	-	-	-	-	-	-	-	-	-	-	-	-
		Homoeothrix sp.	70.4	-	4.0	56,416.0	16,659.2	420,605.2	204.0	502,132.8	<8.1	<1.1	158,391.2	327,043.2
		Oscillatoria cf. agardhii	-	-	-	220.8	<28.3	2,160.0	1,137,708.0	249,580.8	-	-	-	1,142.4
		Oscillatoria spp.	<2.2	<2.3	38.0	-	-	-	-	-	-	-	-	-
		Pseudoanabaena spp.	61.6	1,267.0	71.4	55.2	-	<28.3	170.0	946.2	-	-	-	15,902.7
		Spirulina sp.	-	-	-	715.0	2,411.2	502.8	2,108.8	<24.9	-	-	<5.9	-
		UID Oscillatoriales	<2.2	<2.3	<0.5	<9.2			3,690.4	<24.9	<8.1	<1.1	-	15,642.0
Euglenophyta	Euglenales	UID	-	-	-	-	-	-	-	-	-	-	-	-
Rhodophyta	Nemalionales	*Audouinella sp.*	<2.2	-	-	8,937.5	27,180.8	25,475.2	1,224.0	75,765.6	243.0	<1.1	40,563.6	21,116.7
		Batrachospermum sp.	-	-	-	-	-	-	-	-	-	-	-	-
		UID flagellate	17.4	4.6	-	143.0	219.2	-	131.8	193.0	-	51.0	182.4	-
		UID colonial	<2.2	<2.3	63.0	276.0	-	-	-	-	-	-	-	-
		UID filamentous	-	-	-	-	-	-	-	-	-	-	-	-
		UID unicellular	200.7	1,186.6	144.0	550.4	843.4	1,935.3	3,042.0	3,714.0	16.2	65.2	878.0	4,012.8

Diatoma mesodon = Diatoma hiemale var. mesodon

Area = 100 cm^2 per sample

Appendix C. Periphyton Taxonomy, Casino Project, 2009

Waterbody				Upper Casino Creek						Upper Canadian Creek				
FES Sample Number			**090302**	**090288**	**090289**	**090290**	**090291**	**090292**		**090303**	**090304**	**090305**	**090306**	**090307**
Sample Site			**P5-5**	**P7-1**	**P7-2**	**P7-3**	**P7-4**	**P7-5**		**P8-1**	**P8-2**	**P8-3**	**P8-4**	**P8-5**
Sampling Date			**05-Aug-09**	**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**06-Aug-09**		**08-Aug-09**	**08-Aug-09**	**08-Aug-09**	**08-Aug-09**	**08-Aug-09**
Phylum	**Order**	**Genera and Species**												
		Cyclotella sp.	-	-	-	-	-	-		-	-	-	-	-
		Melosira sp.	-	-	-	-	-	-		-	-	-	-	-
	Pennales	*Achnanthes flexella*	-	<3.2	<12.7	-	-	<2.0		-	-	-	-	-
		Achnanthes lanceolata	<2.3	<3.2	<12.7	-	-	-		28.8	19.8	41.8	123.0	34.2
		Achnanthes minutissima	265.5	516.6	5,682.0	962.0	4.3	252.8		3.2	4.4	7.6	5.2	4.2
		Achnanthes spp.	141.6	319.8	1,515.2	38.4	-	79.0		<1.6	2.2	3.8	2.6	1.4
		Amphipleura pellucida	-	-	-	-	-	-		-	-	-	-	-
		Amphora spp.	-	-	-	-	-	-		-	-	-	-	-
		Anomoeoneis spp.	-	-	-	-	-	-		-	-	-	-	-
		Caloneis spp.	<2.3	<3.2	12.7	<12.7	-	<2.0		9.6	2.2	19.0	20.8	0.7
		Ceratoneis arcus	4,086.0	12.8	127.0	10.0	<4.3	2.0		25.6	37.4	11.4	57.2	119.7
		Cocconeis placentula	4.6	-	-	-	-	-		-	-	-	-	-
		Cymatopleura solea	-	-	-	-	-	-		-	-	-	-	-
		Cymbella cf. cestaii	-	-	-	-	-	-		-	-	-	-	-
		Cymbella cistula	<2.3	<3.2	<12.7	-	-	<2.0		-	-	-	-	-
		Cymbella microchepala	-	-	-	-	-			-	-	-	-	-
		Cymbella minuta	9.2	3.2	50.8	2.5	-	2.0		<1.6	<1.1	<1.9	10.4	<0.7
		Cymbella sinuata	70.8	12.8	76.2	<12.7	-	<2.0		-	1.1	3.8	-	<0.7
		Cymbella spp.	-	-	-	-	-	-		-	-	<1.9	<2.6	-
		Denticula sp.	-	-	-	-	-	-		-	-	-	-	-
		Diatoma elongatum	2,724.0	12.8	<12.7	5.0	-	<2.0		<1.6	<1.1	1.9	2.6	1.4
		Diatoma mesodon	-	<3.2	<12.7	<12.7	-	-		97.6	11.0	34.2	78.0	5.6
		Diatoma moniliformis	-	-	-	-	-	-		-	-	-	-	-
		Diatomella sp.	-	<3.2	-	-	-	-		-	-	-	-	-
		Didymosphenia geminata	<2.3	-	-	-	-	-		-	-	-	-	-
		Diploneis spp.	-	-	-	-	-	-		-	-	-	-	-
		Epithemia spp.	-	-	-	-	-	-		-	-	-	-	-
		Eunotia spp.	-	<3.2	<12.7	<12.7	-	<2.0		1.6	1.1	3.8	10.4	4.2
		Fragilaria capucina	41.4	-	<12.7	<12.7	-	-		<1.6	<1.1	5.7	33.8	4.2
		Fragilaria construens	-	-	-	-	-	-		-	-	-	-	-
		Fragilaria leptostauron	-	-	-	-	-	-		-	-	-	-	-
		Fragilaria montana	-	-	-	-	-	-		-	-	-	-	-
		Fragilaria pinnata	-	-	-	-	-	-		-	-	-	-	-
		Fragilaria vaucheriae	159.3	38.4	254.0	5.0	<4.3	<2.0		-	-	-	10.4	1.4
		Fragilaria spp.	70.8	70.4	457.2	55.0	8.6	20.0		12.8	15.4	7.6	20.8	5.6
		Frustulia sp.	<2.3	-	-	-	-	-		-	-	-	-	-
		Gomphonema acuminatum / parvulum	230.1	19.2	76.2	-	-	-		4.8	13.2	11.4	31.2	4.2
		Gomphonema olivaceum	17.7	-	-	-	-	-		-	-	-	-	-
		Gomphonema olivaceum?	-	-	-	-	-	-		-	-	-	-	-
		Gomphonema spp.	283.2	6.4	25.4	2.5	-	<2.0		6.4	4.4	11.4	15.6	2.8
		Meridion circulare	50.6	12.8	76.2	<12.7	-	<2.0		3.2	4.4	3.8	5.2	5.6
		Navicula radiosa	<2.3	-	-	-	-	-						
		Navicula spp.	9.2	<3.2	-	-	-	-		<1.6		<1.9	<2.6	<0.7
		Neidium spp.	-	-	<12.7	-	-	-		<1.6	<1.1		<2.6	-
		Nitzschia dissipata	-	-		-	-	-		-	-	-	-	-
		Nitzschia spp.	88.5	3.2	152.4	10.0	-	4.0		3.2	6.6	11.4	26.0	8.4
		Pinnularia spp.	<2.3	<3.2	38.1	<12.7	<4.3	2.0		16.0	4.4	15.2	31.2	1.4
		Stauroneis spp.	-	-	-	-	-	-		-	-	-	<2.6	-
		Surirella spp.	-	-	-	-	-	-		-	-	-	-	-
		Synedra ulna	265.5	<3.2	<12.7	<12.7	-	<2.0		-	-	-	-	-
		Synedra spp.	612.9	25.6	127.0	20.0	<4.3	4.0		12.8	28.6	41.8	123.0	68.4
		Tabellaria fenestrata	-	-	-	-	-	-		<1.6	-	<1.9	<2.6	<0.7
		Tabellaria flocculosa	<2.3	-	<12.7	-	-	-		1.6	<1.1	3.8	7.8	2.8
		UID girdle view	-	-	-	-	-	<2.0		<1.6	-	<1.9	-	-
		Deformed Diatoms	4.6	-	-	-	-	-		-	-	-	-	-
Chlorophyta	Chaetophorales	*Draparnaldia sp.*	-	-	-	-	-	-		-	-	-	-	-
		Stigeoclonium sp.	-	-	-	-	-	-		-	-	-	-	-
		Stigeoclonium sp. ?	-	-	-	-	-	-		-	-	-	-	-
		UID Chaetophorales	-	-	-	-	-	-		-	<1.1	-	-	<0.7

Waterbody				Upper Casino Creek					Upper Canadian Creek				
FES Sample Number			**090302**	**090288**	**090289**	**090290**	**090291**	**090292**	**090303**	**090304**	**090305**	**090306**	**090307**
Sample Site			**P5-5**	**P7-1**	**P7-2**	**P7-3**	**P7-4**	**P7-5**	**P8-1**	**P8-2**	**P8-3**	**P8-4**	**P8-5**
Sampling Date			**05-Aug-09**	**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**06-Aug-09**	**08-Aug-09**	**08-Aug-09**	**08-Aug-09**	**08-Aug-09**	**08-Aug-09**
Phylum	**Order**	**Genera and Species**											
	Chlorococcales	*Selenastrum sp.*	-	-	-	-	-	-	-	-	-	-	-
	Ulothricales	*Geminella sp.*	-	-	-	-	-	-	-	-	-	-	-
		Microspora sp.	<2.3	<3.2	<12.7	-	-	-	<1.6	-	-	-	<0.7
		Ulothrix spp.	23.0	-	-	-	-	-	-	-	-	-	-
		Ulothrix zonata	<2.3	-	-	-	-	-	-	-	-	-	-
	Volvocales	*Chlamydomonas sp ?*	-	-	-	-	-	-	-	-	-	-	-
	Zygnematales	*Closterium spp.*	<2.3	-	-	-	-	-	<1.6	<1.1	<1.9	<2.6	<0.7
		Cosmarium spp.	-	-	-	-	-	-	<1.6		<1.9	<2.6	-
		Cylindrocystis spp.	-	-	-	-	-	-	<1.6		<1.9		<0.7
		Mougeotia spp.	-	-	<12.7	-	-	-	<1.6	<1.1	<1.9	10.4	8.4
		Spirogyra sp.	<2.3	-	-	-	-	-	-	-	-	-	-
		Staurastrum sp.	-	-	-	-	-	-	-	-	-	-	-
Chlorophyta		UID Chlorophyta colonial	-	-	-	-	-	-	-	-	-	-	-
		UID Chlorophyta filamentous	-	-	-	-	-	<2.0	<1.6	-	-	-	-
		UID Chlorophyta flagellate	-	-	-	-	-	-	-	-	-	-	-
		UID Chlorophyta unicellular	2.3	-	-	-	-	-	-	-	-	2.6	2.8
Chrysophyta	Chromulinales	*Chromulina sp.*	-	-	-	-	-	-	-	-	-	-	-
		Hydrurus sp.	-	-	-	-	-	-	-	-	-	-	-
	Tribonematales	*Tribonema spp.*	-	-	-	-	-	-	-	<1.1	<1.9	-	-
Chrysophyta		UID Chrysophyta colonial	531.0	-	-	-	-	-	-	-	-	-	<0.7
		UID Chrysophyta cyst	-	12.8	25.4	5.0	-	-	12.2	2.2	7.6	5.2	<0.7
		UID Chrysophyta flagellate	-	-	-	-	-	-	3.2				1.4
		UID Chrysophyta unicellular	17.7	-	-	-	-	-	-	8.8	29.6	5.2	5.6
Cryptophyta	Cryptomonadales	UID	-	-	-	-	-	-	-	-	-	-	-
Cyanophyta	Chamaesiphonales	*Chamaesiphon spp.*	24,516.0	33,902.6	25,758.4	592.0	-	47.4	-	52.8	3.8	78.0	2.8
		Clastidium setigerum	136.2	21,023.4	19,697.6	2,812.0	5,092.0	2,367.3	<1.6	8.8	-	-	-
	Chroococcales	*Aphanocapsa spp.*	-	-	-	-	-	-	-	-	-	-	-
		Aphanothece sp.	-	-	-	-	-	-	-	-	-	-	-
		Gomphosphaeria sp.	-	-	-	-	-	-	-	-	-	-	-
		Merismopedia spp.	-	-	-	-	-	-	-	-	-	<2.6	-
		UID Chrooccocales	-	-	-	-	-	-	-	-	-	-	-
	Nostocales	*Anabaena sp. ?*	-	-	-	-	-	-	-	-	-	-	-
		Calothrix sp. ?	-	-	-	-	-	-	<1.6	-	-	<2.6	-
		Nostoc sp. / Anabaena sp.	-	-	-	-	<4.3	-	8.0	<1.1	9.5	62.4	5.6
		Nostoc spp.	-	-	-	-	-	-	<1.6	-	-	-	<0.7
		UID Nostocales	-	-	-	-	-	-	-	-	-	-	-
	Oscillatoriales	*Lyngbya spp.*	-	-	-	-	-	-	<1.6	-	-	-	-
		Homoeothrix sp.	1,522.2	1,132.8	<12.7	<12.7	-	112.0	131.2	<1.1	38.0	166.4	25.2
		Oscillatoria cf. agardhii	<2.3	-	-	-	-	-	-	-	-	-	-
		Oscillatoria spp.	-		<12.7	-	-	<2.0	-	<1.1	-	<2.6	-
		Pseudoanabaena spp.	-	103.4	254.0	120.0	<4.3	60.0	-	-	-	-	<0.7
		Spirulina sp.	<2.3	-	-	-	-	-	-	-	-	-	-
		UID Oscillatoriales	-	<3.2	<12.7	<12.7	<4.3	-	-	<1.1	-	41.6	<0.7
Euglenophyta	Euglenales	UID	-	-	-	-	-	-	-	-	-	-	-
Rhodophyta	Nemalionales	*Audouinella sp.*	1,150.5	-	-	-	-	-	-	-	<1.9	<2.6	-
		Batrachospermum sp.	-	-	-	-	-	-	-	-	-	-	-
		UID flagellate	106.2	123.0	196.8	19.2	231.7	79.0	12.2	<1.1	7.6	20.5	5.7
		UID colonial	-	-	-	<12.7	-	-	-	-	-	<2.6	-
		UID filamentous	-	-	-	<12.7	-	-	-	-	-	-	-
		UID unicellular	136.2	757.6	1,136.4	370.0	254.6	242.8	140.4	35.2	14.8	123.0	17.1

Diatoma mesodon = Diatoma hiemale var. mesodon

Area = 100 cm^2 per sample

Appendix D

Benthic Invertebrate Taxonomy, Casino Project, August 2009

		Kicknet Sampler																																								Surber Sampler									
	Sample ID:	**B1-1**	**B1-2**	**B1-3**	**B1-4**	**B1-5**	**B2-1**	**B2-2**	**B2-3**	**B2-4**	**B2-5**	**B7-1**	**B7-2**	**B7-3**	**B7-4**	**B7-5**	**BR-1**	**BR-2**	**BR-3**	**BR-4**	**BR-5**	**B5-1**	**B5-2**	**B5-3**	**B5-4**	**B5-5**	**B4-1**	**B4-2**	**B4-3**	**B4-4**	**B4-5**	**B3-1**	**B3-2**	**B3-3**	**B3-4**	**B3-5**	**B8-1**	**B8-2**	**B8-3**	**B8-4**	**B8-5**	**B1-1S**	**B1-2S**	**B1-3S**	**B1-4S**	**B1-5S**	**B2-1S**	**B2-2S**	**B2-3S**	**B2-4S**	**B2-5S**
Order: Ephemeroptera	adult																				1												1			1	1			1											
Order: Ephemeroptera	nymph (juv./dam.)																								5																										
Family: Ameletidae																																																			
Ameletus sp.	nymph						4		6	10			3	1		1											3		1		3	12	1	1		1			1			2				1	1		2	1	2
Family: Baetidae																																																			
Acentrella sp.	nymph	8	5	3	1	4				1	2						26	34	16	19	31	7	15	30	21	10	2	10	2	10	1		1	1		1						5	10	1	3	3	2	2			
Baetis sp.	nymph		1														2	15	4	10	4		1	1	1	4				2					1		2	3	5	2	3										1
Baetis bicaudatus	nymph								1			1					24	34	7	20	27		2	10	2	1		5		5	2						43	57	39	20	37		1					1			
Baetis tricaudatus	nymph		1				1				1													1																		1									
Family: Ephemerellidae	nymph (juv./dam.)		3																	2								4								1							2				1	1		1	
Drunella coloradensis	nymph		2	1	1		1			1	1						1			1													1			1						1			1						
Drunella doddsi	nymph	3	1		1	3	1		2		2						2		3		1		3	2	4	5	1			1		1	1		3	2						2			2	5	7	1			
Ephemerella sp.	nymph																2	9	12		8	17	46	184	265	17	3		6	9	6																				
Serratella sp.	nymph				1		1																												1	1															
Family: Heptageniidae	nymph (juv./dam.)						1										1			4	4			6	7	5	2		2		3		1				1	6	5		1					1		1	1	3	1
Cinygmula sp.	nymph	9	2	4	14	7	4	6	3		6			2		1	53	159	99	103	103	26	48	32	15	27	33	17	28	32	45	7	13	6	2	7	8	27	15	3	19	3	3	1	1	2	1	1	6	5	3
Epeorus sp.	nymph					1	6	2	4	3	2						11	33	25	39	34	12	21	18	13	27	15	47	13	51	24		1	1		10	5	6	1		13		1			1	1		2	6	
Order: Plecoptera	nymph (juv./dam.)				1					1									1					2	1										1	1						2						3	2	2	
Family: Capniidae	nymph (juv./dam.)		1																		2		1										1	1			1	18	8		5	2	5	2	2	5	3		20	16	9
Capnia sp.	nymph																						1																		1										
Family: Chloroperlidae																																																			
Suwallia sp.	nymph	1		1	7	2	1	2		1			2	1			7	15	4	14	7	3	7	6	7	4	1	4	3	1	2	2	2	2	1	2						4	4	3		2	8	4	1	1	2
Sweltsa sp.	nymph																										1		1																						
Family: Nemouridae	nymph (juv./dam.)																																																		2
Podmosta sp.	nymph																																					14	7	3	2										
Zapada sp.	nymph																2	6	7	12	8	2		3	38												3														
Zapada oregonensis group	nymph								1								2						4	8		1	6	8	6	13	6																				
Family: Perlodidae	nymph (juv./dam.)												1				2	6		5	2	1	5	22	29	3		1		2					1				1	1	1		5	1	2	4	1	1			
Isoperla sp.	nymph																	3	1	1	2			2				2																							
Megarcys sp.	nymph																											1	1								1	3	1		1										
Skwala sp.	nymph																	1			1		1							1								4	1	1	5										
Order: Trichoptera	larvae (juv./dam.)																																						1												
Family: Apataniidae																																																			
Apatania sp.	larvae																							1					1	1																					
Family: Brachycentridae																																																			
Brachycentrus sp.	larvae																								1																										
Family: Glossosomatidae																																																			
Glossosoma sp.	larvae			1							1													1			1	1		1	2				1	1															
Family: Limnephilidae	larvae (juv./dam.)	12	2	5	8	4	2	2	2	3	3									1	3				4					2					1	2							1			2	1				
Ecclisomyia sp.	larvae	2	1	2	3	2	2	1											3			3	9	8	2		8	1	5	18	7	1	6	2	1											1	1		6		1
Order: Diptera UID	larvae (juv./dam.)					2					1																									2			1												
Family: Ceratopogonidae																																																			
Monohelea sp.	larvae								1		1												2																												
Family: Chironomidae	larvae																																																		
Subfamily : Orthocladiinae																																																			
Corynoneura sp.																							17																								6		3	3	8
Cricotopus/Orthocladius sp.				3	1	7	4	5	11	9	3						3	17	24	14	11	11	21	14	35	6	27	6	9	17	6	4	7	7	1	5		3	3		1	13	20	30	12	33	45	65	36	41	15
Diplocladius sp.		1					3																																							1					
Epoicladius sp.																				1																															
Eukiefferiella sp.		18	15	16	6	16	6	4	3	5	6							3	7	12	3	3	8	7	38	7	2	8		4			5	9	12	15						37	34	20	15	50	67	175	27	30	4
Heterotrissocladius sp.				1																	1												2	1												5					
Hydrobaenus sp.				4	6	5			5	10	9																						2	3	7	9						23	28	5	2	10			30	6	2
Krenosmittia sp.																																									1										
Parasmittia sp.																																																			
Metriocnemus sp.																																																			
Propsilocerus sp.																							1																												
Rheocricotopus sp.																																										2				2		20	12		
Synorthocladius sp.			5	1			1		1	2	1						1							1	1																	4	2	1	1	5					
Tvetenia sp.		2	4		1												47	167	125	43	97	19	4	20	44	6	38	52	41	78	32	4																			
Subfamily : Diamesinae																																																			
Diamesa sp.											1	11	29	36	9	23					5		12					2					1		2				1		1						7				
Pseudodiamesa sp.											3																										4	1													
Pagastia sp.		97	51	54	61	46	34	55	46	57	79					3			5		10	8	20	23	155	4	9			4	1	6	8	18	12	22						125	186	78	61	141	353	460	55	43	
Potthastia longimana																																															2				
Subfamily : Chironominae																																																			
Tribelos sp.																																																			
Micropsectra sp.								2	1																		2		3	2	2							2			1				1	2					
Subfamily : Tanypodinae																																																			
Subfamily : Podonominae																																																				
Trichotanypus sp.																																																			
Family: Empididae	larvae (juv./dam.)																																									1									
Chelifera/Metachela sp.	larvae	1			6	1	1			1									1		1	1	1		1		5	5	13	5	12	1		2		1				1		4	2		4				6		3
Clinocera sp.	larvae	2			3	3																																				4	1			2					
Oreogeton sp.	larvae												1		1						2																														
Family: Ephydridae	larvae (juv./dam.)																1	1		1													1																		
Family: Psychodidae UID	larvae									1																	1					5	9	3								3	2		3	1		3	4	2	
Pericoma sp.	larvae	1		1																																				1											
Family: Simuliidae	pupae																			20																	1	1													
Cnephia sp.	larvae																	3	1	2	1																														
Prosimulium sp.	larvae																80	108	10	152	11	2	1	5	9	3		7									3	1			3							1			
Simulium sp.	larvae																1	5	1	4				3	2			1																							
Family: Tipulidae	larvae (juv./dam.)												1																																	1					
Dicranota sp.	larvae	1	1	1																					1									1				2	2	1	1					1					1
Hesperoconopa sp.	larvae																																																1		1
Tipula sp.	larvae		1		1													1			1				2		1	1	1	3	1						1	7	5									1			

Appendix D. Benthic Invertebrate Taxonomy, Casino Project, 2009

		Kicknet Sampler																								
	Sample ID:	B1-1	B1-2	B1-3	B1-4	B1-5	B2-1	B2-2	B2-3	B2-4	B2-5	B7-1	B7-2	B7-3	B7-4	B7-5	BR-1	BR-2	BR-3	BR-4	BR-5	B5-1	B5-2	B5-3	B5-4	B5-5
Order: Hemiptera																										
Family: Corixidae																										
Order: Lepidoptera	larvae																									
Order: Collembola																										
Family: Poduridae	larvae																									
Class: Crustacea																										
Order: Cladocera																										
Order: Isopoda																										
Cyclopoida																										
Super-Order: Acariformes	deutonymph																							1		
Family: Feltriidae																										
Feltria sp.	adult																								2	
Family: Hydryphantidae																										
Wandesia sp.	adult																									
Family: Hygrobatidae																										
Hygrobates sp.	adult																									
Family: Lebertidae																										
Lebertia sp.	adult																	2					3	3	9	
Family: Sperchontidae																										
Sperchon sp.	adult	1			1														1				2	4		
Family: Hydrozetidae	adult																									
Phylum: Mollusca																										
Order: Gastropoda																										
Family: Valvatidae																										
Phylum: Annelida																										
Class: Oligochaeta																										
Family: Lumbriculidae													3				18	6	2	6	19	7	11	4	5	2
Rhynchelmis sp.																	3				3		1			
Sub-Family: Tubificinae																			1						1	
Phylum: Nemata																	1			1						
TOTAL NUMBER		**159**	**96**	**98**	**123**	**103**	**73**	**79**	**87**	**105**	**122**	**12**	**40**	**40**	**10**	**28**	**290**	**628**	**360**	**487**	**403**	**122**	**268**	**422**	**720**	**132**

		Kicknet Sampler															Surber Sampler									
	Sample ID:	B4-1	B4-2	B4-3	B4-4	B4-5	B3-1	B3-2	B3-3	B3-4	B3-5	B8-1	B8-2	B8-3	B8-4	B8-5	B1-1S	B1-2S	B1-3S	B1-4S	B1-5S	B2-1S	B2-2S	B2-3S	B2-4S	B2-5S
Order: Hemiptera																										
Family: Corixidae																	1									
Order: Lepidoptera	larvae										1												1			
Order: Collembola																										
Family: Poduridae	larvae						1		3				1				1			1			1	3	5	
Class: Crustacea																										
Order: Cladocera																								1		
Order: Isopoda																										
Cyclopoida																									1	
Super-Order: Acariformes	deutonymph	1																								
Family: Feltriidae																										
Feltria sp.	adult																									
Family: Hydryphantidae																										
Wandesia sp.	adult																					1				
Family: Hygrobatidae																										
Hygrobates sp.	adult			1																						
Family: Lebertidae																										
Lebertia sp.	adult	1		1	4	1																				
Family: Sperchontidae																										
Sperchon sp.	adult	2		1								1														
Family: Hydrozetidae	adult													1			1									
Phylum: Mollusca																										
Order: Gastropoda																										
Family: Valvatidae						1																				
Phylum: Annelida																										
Class: Oligochaeta																										
Family: Lumbriculidae		24	9	19	25	59						13	52	58	28	15										
Rhynchelmis sp.												2	3	4	2	1										
Sub-Family: Tubificinae																		2							1	
Phylum: Nemata							1		2	1								3						1		
TOTAL NUMBER		**189**	**192**	**158**	**291**	**216**	**45**	**64**	**63**	**48**	**86**	**90**	**211**	**160**	**64**	**112**	**241**	**312**	**142**	**111**	**281**	**508**	**742**	**219**	**167**	**55**

Notes:
juv. = juvenile.
dam. = damaged.

Appendix E1

Electrofishing Effort, Catch and CPUE, 2009

Appendix E1. Electrofishing Effort, Catch and CPUE, Casino Project, 2009

				Effort	Catch						CPUE (number/100 sec)					
Date	Site	Pass	Voltage	(sec)	AG	CCG	CH	BB	RW	Total	AG	CCG	CH	BB	RW	Total
6-Aug-10	F11	1	310	765	4	5	0	0	0	**9**	0.52	0.65	0.00	0.00	0.00	**1.18**
6-Aug-10	F11	2	310	743	0	5	0	0	0	**5**	0.00	0.67	0.00	0.00	0.00	**0.67**
6-Aug-10	F11	3	310	629	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	**0.00**
6-Aug-10	F11	total		2,137	4	10	0	0	0	**14**	0.19	0.47	0.00	0.00	0.00	**0.66**
6-Aug-10	F10	1	350	641	12	0	0	0	0	**12**	1.87	0.00	0.00	0.00	0.00	**1.87**
5-Aug-10	R2	1	350-500	872	3	12	0	0	0	**15**	0.34	1.38	0.00	0.00	0.00	**1.72**
5-Aug-10	D3	1	400	872	2	7	0	0	0	**9**	0.23	0.80	0.00	0.00	0.00	**1.03**
6-Aug-10	F12	1	250	472	0	0	0	0	0	**0**	0.00	0.00	0.00	0.00	0.00	**0.00**
6-Aug-10	F13	1	350	1118	3	15	0	1	0	**19**	0.27	1.34	0.00	0.09	0.00	**1.70**
6-Aug-10	F13	2	350	683	1	8	0	0	0	**9**	0.15	1.17	0.00	0.00	0.00	**1.32**
6-Aug-10	F13	3	350	786	0	2	0	0	0	**2**	0.00	0.25	0.00	0.00	0.00	**0.25**
6-Aug-10	F13	total		2,587	4	25	0	1	0	**30**	0.15	0.97	0.00	0.04	0.00	**1.16**
7-Aug-10	F01	1	350	1,001	4	0	0	0	0	**4**	0.40	0.00	0.00	0.00	0.00	**0.40**
7-Aug-10	Y1	1	360	995	1	33	1	0	0	**35**	0.10	3.32	0.10	0.00	0.00	**3.52**
5-Aug-10	F14	1	350	727	2	3	0	0	0	**5**	0.28	0.41	0.00	0.00	0.00	**0.69**
5-Aug-10	D1	1	400	854	4	9	0	0	0	**13**	0.47	1.05	0.00	0.00	0.00	**1.52**
5-Aug-10	D2	1	400	919	6	8	0	0	1	**15**	0.65	0.87	0.00	0.00	0.11	**1.63**

Notes:

AG: Arctic grayling.

CCG: Slimy sculpin.

RW: Round whitefish.

CH: Chinook.

Appendix E2

Fish Biological Characteristics, Casino Project, 2009

Appendix E2. Fish Biological Characteristics, Casino Project, 2009

Date	Watershed	Site	Method	Pass	Number	Species	Length (mm)	Weight (g)	Age (year)	Fulton Condition Factor, K
05-Aug-09	Unnamed Trib	R2	EF	1	1	AG	355	450.0	8	1.01
05-Aug-09	Unnamed Trib	R2	EF	1	2	CCG	82	6.5	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	3	CCG	81	5.8	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	4	CCG	73	3.3	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	5	CCG	75	4.5	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	6	AG	288	225.0	5	0.94
05-Aug-09	Unnamed Trib	R2	EF	1	7	AG	181	58.9	2	0.99
05-Aug-09	Unnamed Trib	R2	EF	1	8	CCG	117	14.9	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	9	CCG	88	7.3	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	10	CCG	86	5.4	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	11	CCG	87	6.4	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	12	CCG	87	6.9	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	13	CCG	102	9.7	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	14	CCG	80	7.0	-	-
05-Aug-09	Unnamed Trib	R2	EF	1	15	CCG	80	4.7	-	-
05-Aug-09	Dip	D1	EF	1	1	AG	352	350.0	8	0.80
05-Aug-09	Dip	D1	EF	1	2	AG	308	325.0	5	1.11
05-Aug-09	Dip	D1	EF	1	3	AG	298	280.0	4	1.06
05-Aug-09	Dip	D1	EF	1	4	AG	213	100.0	3	1.03
05-Aug-09	Dip	D1	EF	1	5	CCG	5	1.2	-	-
05-Aug-09	Dip	D1	EF	1	6	CCG	67	2.6	-	-
05-Aug-09	Dip	D1	EF	1	7	CCG	72	3.6	-	-
05-Aug-09	Dip	D1	EF	1	8	CCG	82	6.3	-	-
05-Aug-09	Dip	D1	EF	1	9	CCG	71	3.0	-	-
05-Aug-09	Dip	D1	EF	1	10	CCG	89	6.7	-	-
05-Aug-09	Dip	D1	EF	1	11	CCG	86	6.7	-	-
05-Aug-09	Dip	D1	EF	1	12	CCG	65	2.3	-	-
05-Aug-09	Dip	D1	EF	1	13	CCG	53	1.1	-	-
05-Aug-09	Dip	D2	EF	1	1	RW	295	300.0	6	-
05-Aug-09	Dip	D2	EF	1	2	AG	186	69.5	2	1.08
05-Aug-09	Dip	D2	EF	1	3	AG	45	0.7	-	0.77
05-Aug-09	Dip	D2	EF	1	4	AG	44	0.5	-	0.59
05-Aug-09	Dip	D2	EF	1	5	AG	44	0.5	-	0.59
05-Aug-09	Dip	D2	EF	1	6	CCG	89	6.6	-	-
05-Aug-09	Dip	D2	EF	1	7	CCG	75	4.7	-	-
05-Aug-09	Dip	D2	EF	1	8	CCG	67	2.6	-	-
05-Aug-09	Dip	D2	EF	1	9	CCG	91	7.8	-	-
05-Aug-09	Dip	D2	EF	1	10	CCG	90	6.8	-	-
05-Aug-09	Dip	D2	EF	1	11	CCG	73	4.2	-	-
05-Aug-09	Dip	D2	EF	1	12	CCG	75	4.7	-	-
05-Aug-09	Dip	D2	EF	1	13	CCG	74	4.2	-	-
05-Aug-09	Dip	D2	EF	1	14	AG	49	0.8	-	0.68
05-Aug-09	Dip	D2	EF	1	15	AG	42	0.4	-	0.54
05-Aug-09	Dip	D3	EF	1	1	AG	328	400.0	7	1.13
05-Aug-09	Dip	D3	EF	1	2	AG	272	250.0	5	1.24
05-Aug-09	Dip	D3	EF	1	3	CCG	131	19.5	-	-
05-Aug-09	Dip	D3	EF	1	4	CCG	81	4.9	-	-
05-Aug-09	Dip	D3	EF	1	5	CCG	74	3.8	-	-
05-Aug-09	Dip	D3	EF	1	6	CCG	81	4.7	-	-
05-Aug-09	Dip	D3	EF	1	7	CCG	80	4.1	-	-
05-Aug-09	Dip	D3	EF	1	8	CCG	75	3.7	-	-
05-Aug-09	Dip	D3	EF	1	9	CCG	42	0.9	-	-
05-Aug-09	Dip	F14	EF	1	1	AG	375	500.0	8	0.95
05-Aug-09	Dip	F14	EF	1	2	AG	322	400.0	6	1.20
05-Aug-09	Dip	F14	EF	1	3	CCG	91	8.5	-	-
05-Aug-09	Dip	F14	EF	1	4	CCG	84	6.6	-	-
05-Aug-09	Dip	F14	EF	1	5	CCG	55	1.9	-	-
06-Aug-10	Casino	F13	EF	1	1	BB	244	74.0	-	-
06-Aug-10	Casino	F13	EF	1	2	AG	255	187.6	5	1.13
06-Aug-10	Casino	F13	EF	1	3	AG	144	31.1	2	1.04
06-Aug-10	Casino	F13	EF	1	4	AG	302	340.0	7	1.23
06-Aug-10	Casino	F13	EF	1	5	CCG	86	6.2	-	-
06-Aug-10	Casino	F13	EF	1	6	CCG	81	5.0	-	-
06-Aug-10	Casino	F13	EF	1	7	CCG	72	3.6	-	-
06-Aug-10	Casino	F13	EF	1	8	CCG	81	5.7	-	-
06-Aug-10	Casino	F13	EF	1	9	CCG	81	5.4	-	-
06-Aug-10	Casino	F13	EF	1	10	CCG	79	4.8	-	-
06-Aug-10	Casino	F13	EF	1	11	CCG	81	5.4	-	-
06-Aug-10	Casino	F13	EF	1	12	CCG	77	4.6	-	-
06-Aug-10	Casino	F13	EF	1	13	CCG	76	4.1	-	-
06-Aug-10	Casino	F13	EF	1	14	CCG	69	3.2	-	-
06-Aug-10	Casino	F13	EF	1	15	CCG	70	3.3	-	-
06-Aug-10	Casino	F13	EF	1	16	CCG	66	2.7	-	-
06-Aug-10	Casino	F13	EF	1	17	CCG	70	2.9	-	-
06-Aug-10	Casino	F13	EF	1	18	CCG	65	2.3	-	-
06-Aug-10	Casino	F13	EF	1	19	CCG	46	0.9	-	-
06-Aug-10	Casino	F13	EF	2	1	AG	128	20.1	1	0.96
06-Aug-10	Casino	F13	EF	2	2	CCG	74	3.5	-	-
06-Aug-10	Casino	F13	EF	2	3	CCG	78	4.6	-	-
06-Aug-10	Casino	F13	EF	2	4	CCG	83	5.5	-	-
06-Aug-10	Casino	F13	EF	2	5	CCG	65	2.6	-	-
06-Aug-10	Casino	F13	EF	2	6	CCG	76	4.3	-	-
06-Aug-10	Casino	F13	EF	2	7	CCG	74	3.6	-	-
06-Aug-10	Casino	F13	EF	2	8	CCG	69	3.1	-	-
06-Aug-10	Casino	F13	EF	2	9	CCG	58	1.7	-	-
06-Aug-10	Casino	F13	EF	3	1	CCG	80	5.1	-	-
06-Aug-10	Casino	F13	EF	3	2	CCG	73	3.9	-	-
06-Aug-10	Casino	F12	EF	1	NFC				-	-
06-Aug-10	Casino	F11	EF	1	1	AG	173	53.4	2	1.03
06-Aug-10	Casino	F11	EF	1	2	AG	207	85.8	3	0.97

Appendix E2. Fish Biological Characteristics, Casino Project, 2009

Date	Watershed	Site	Method	Pass	Number	Species	Length (mm)	Weight (g)	Age (year)	Fulton Condition Factor, K
06-Aug-10	Casino	F11	EF	1	3	AG	141	48.8	2	1.74
06-Aug-10	Casino	F11	EF	1	4	CCG	104	12.3	-	-
06-Aug-10	Casino	F11	EF	1	5	CCG	96	7.8	-	-
06-Aug-10	Casino	F11	EF	1	6	CCG	90	8.6	-	-
06-Aug-10	Casino	F11	EF	1	7	CCG	90	8.5	-	-
06-Aug-10	Casino	F11	EF	1	8	CCG	79	4.8	-	-
06-Aug-10	Casino	F11	EF	1	9	AG	164	45.1	2	1.02
06-Aug-10	Casino	F11	EF	2	1	CCG	97	10.1	-	-
06-Aug-10	Casino	F11	EF	2	2	CCG	94	8.4	-	-
06-Aug-10	Casino	F11	EF	2	3	CCG	92	9.5	-	-
06-Aug-10	Casino	F11	EF	2	4	CCG	85	6.5	-	-
06-Aug-10	Casino	F11	EF	2	5	CCG	78	4.4	-	-
06-Aug-10	Casino	F11	EF	3	NFC				-	-
06-Aug-10	Casino	F10	EF	1	1	AG	320	375.0	8	1.14
06-Aug-10	Casino	F10	EF	1	2	AG	229	150.0	4	1.25
06-Aug-10	Casino	F10	EF	1	3	AG	255	200.0	5	1.21
06-Aug-10	Casino	F10	EF	1	4	AG	252	180.0	5	1.12
06-Aug-10	Casino	F10	EF	1	5	AG	22	110.0	4	-
06-Aug-10	Casino	F10	EF	1	6	AG	190	80.0	3	1.17
06-Aug-10	Casino	F10	EF	1	7	AG	233	150.0	4	1.19
06-Aug-10	Casino	F10	EF	1	8	AG	260	210.0	5	1.19
06-Aug-10	Casino	F10	EF	1	9	AG	207	100.0	3	1.13
06-Aug-10	Casino	F10	EF	1	10	AG	176	80.0	2	1.47
06-Aug-10	Casino	F10	EF	1	11	AG	190	60.0	2	0.87
06-Aug-10	Casino	F10	EF	1	12	AG	163	50.5	2	1.17
07-Aug-10	Britannia	Y1	EF	1	1	CH	59	2.2	-	-
07-Aug-10	Britannia	Y1	EF	1	2	AG	66	2.6	-	0.90
07-Aug-10	Britannia	Y1	EF	1	3	CCG	68	3.0	-	-
07-Aug-10	Britannia	Y1	EF	1	4	CCG	56	2.1	-	-
07-Aug-10	Britannia	Y1	EF	1	5	CCG	59	2.0	-	-
07-Aug-10	Britannia	Y1	EF	1	6	CCG	70	3.6	-	-
07-Aug-10	Britannia	Y1	EF	1	7	CCG	72	3.8	-	-
07-Aug-10	Britannia	Y1	EF	1	8	CCG	72	3.6	-	-
07-Aug-10	Britannia	Y1	EF	1	9	CCG	49	2.8	-	-
07-Aug-10	Britannia	Y1	EF	1	10	CCG	54	1.7	-	-
07-Aug-10	Britannia	Y1	EF	1	11	CCG	63	2.8	-	-
07-Aug-10	Britannia	Y1	EF	1	12	CCG	71	3.2	-	-
07-Aug-10	Britannia	Y1	EF	1	13	CCG	77	4.1	-	-
07-Aug-10	Britannia	Y1	EF	1	14	CCG	64	3.2	-	-
07-Aug-10	Britannia	Y1	EF	1	15	CCG	63	2.7	-	-
07-Aug-10	Britannia	Y1	EF	1	16	CCG	72	3.6	-	-
07-Aug-10	Britannia	Y1	EF	1	17	CCG	62	3.2	-	-
07-Aug-10	Britannia	Y1	EF	1	18	CCG	60	1.8	-	-
07-Aug-10	Britannia	Y1	EF	1	19	CCG	75	3.8	-	-
07-Aug-10	Britannia	Y1	EF	1	20	CCG	57	1.9	-	-
07-Aug-10	Britannia	Y1	EF	1	21	CCG	65	3.0	-	-
07-Aug-10	Britannia	Y1	EF	1	22	CCG	65	3.0	-	-
07-Aug-10	Britannia	Y1	EF	1	23	CCG	78	4.1	-	-
07-Aug-10	Britannia	Y1	EF	1	24	CCG	62	2.4	-	-
07-Aug-10	Britannia	Y1	EF	1	25	CCG	61	2.5	-	-
07-Aug-10	Britannia	Y1	EF	1	26	CCG	55	1.5	-	-
07-Aug-10	Britannia	Y1	EF	1	27	CCG	58	1.9	-	-
07-Aug-10	Britannia	Y1	EF	1	28	CCG	50	1.4	-	-
07-Aug-10	Britannia	Y1	EF	1	29	CCG	61	1.9	-	-
07-Aug-10	Britannia	Y1	EF	1	30	CCG	55	1.5	-	-
07-Aug-10	Britannia	Y1	EF	1	31	CCG	55	1.2	-	-
07-Aug-10	Britannia	Y1	EF	1	32	CCG	49	0.9	-	-
07-Aug-10	Britannia	Y1	EF	1	33	CCG	66	3.0	-	-
07-Aug-10	Britannia	Y1	EF	1	34	CCG	49	1.2	-	-
07-Aug-10	Britannia	Y1	EF	1	35	CCG	24	<0.1	-	-
07-Aug-10	Britannia	F01	EF	1	1	AG	320	>300	8	-
07-Aug-10	Britannia	F01	EF	1	2	AG	244	173.2	3	1.19
07-Aug-10	Britannia	F01	EF	1	3	AG	251	191.0	5	1.21
07-Aug-10	Britannia	F01	EF	1	4	AG	260	177.9	4	1.01

Notes:

AG = Arctic Grayling.
CH = Chinook.
RW = Round Whitefish.
CCG = Slimy Sculpin.
BB = Burbot.
NFC = No Fish Caught.

Appendix E3

Fish Tissue Metal Concentrations, Casino Project, 2009

Your Project #: 111071 CASINO
Your C.O.C. #: F109263

Attention: Jennifer Sarchuk
AECOM
275 - 3001 WAYBURNE DRIVE
BURNABY, BC
Canada V5G 4W3

Report Date: 2009/08/18

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: A942258
Received: 2009/08/11, 13:40

Sample Matrix: Tissue
Samples Received: 24

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Elements by CRC ICPMS (total) - Tissue	4	2009/08/13	2009/08/15	BRN SOP-00206 R7.0	Based on EPA 200.8
Elements by CRC ICPMS (total) - Tissue	20	2009/08/13	2009/08/17	BRN SOP-00206 R7.0	Based on EPA 200.8

* Results relate only to the items tested.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

ROB MACARTHUR, BBY Customer Service
Email: rob.macarthur@maxxamanalytics.com
Phone# (604) 444-4808 Ext:253

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. SCC and CALA have approved this reporting process and electronic report format.

Total cover pages: 1

Maxxam Job #: A942258
Report Date: 2009/08/18

AECOM
Client Project #: 111071 CASINO

ELEMENTS BY ATOMIC SPECTROSCOPY (TISSUE)

Maxxam ID		Q19378	Q19379	Q19380	Q19381	Q19382	Q19383	Q19384	Q19385	Q19386	Q19387		
Sampling Date		2009/08/05	2009/08/05	2009/08/05	2009/08/05	2009/08/05	2009/08/05	2009/08/05	2009/08/05	2009/08/05	2009/08/05		
	Units	**REF 1 CCG# 3**	**REF 1 CCG# 5**	**REF 1 CCG# 12**	**REF 1 CCG# 13**	**REF 1 CCG# 15**	**D1 CCG# 8**	**D1 CCG# 9**	**D1 CCG# 10**	**D1 CCG# 11**	**D2 CCG# 6**	**RDL**	**QC Batch**
Total Metals by ICPMS													
Total Aluminum (Al)	mg/kg	51	7	8	16	12	28	5	33	10	23	1	3346489
Total Antimony (Sb)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Arsenic (As)	mg/kg	0.09	0.08	0.06	0.09	0.07	0.10	0.06	0.10	0.07	0.12	0.01	3346489
Total Barium (Ba)	mg/kg	6.0	2.9	3.5	5.0	4.9	3.2	3.1	3.3	3.6	3.6	0.1	3346489
Total Beryllium (Be)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Boron (B)	mg/kg	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	3346489
Total Cadmium (Cd)	mg/kg	0.02	0.02	0.01	0.02	0.02	0.04	0.02	0.03	0.03	0.06	0.01	3346489
Total Calcium (Ca)	mg/kg	10200	9750	8590	16000	14100	11600	10700	11200	13300	13600	10	3346489
Total Chromium (Cr)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	3346489
Total Cobalt (Co)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Copper (Cu)	mg/kg	0.7	0.8	0.6	0.7	0.7	0.7	0.6	0.8	0.7	0.9	0.5	3346489
Total Iron (Fe)	mg/kg	110	24	25	53	32	60	25	81	35	77	10	3346489
Total Lead (Pb)	mg/kg	0.03	0.01	<0.01	0.02	0.02	0.02	<0.01	0.04	0.02	0.04	0.01	3346489
Total Magnesium (Mg)	mg/kg	354	346	302	406	419	388	376	369	432	380	10	3346489
Total Manganese (Mn)	mg/kg	6.7	9.2	4.6	13.7	6.7	7.6	6.4	9.7	8.4	10.7	0.1	3346489
Total Mercury (Hg)	mg/kg	0.06	0.04	0.04	0.09	0.06	0.05	0.05	0.05	0.05	0.05	0.01	3346489
Total Molybdenum (Mo)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Nickel (Ni)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Phosphorus (P)	mg/kg	7610	7690	6810	10900	10000	8500	8010	8500	9830	9790	10	3346489
Total Potassium (K)	mg/kg	2880	3050	2790	3010	3280	3090	3130	3100	3170	3160	10	3346489
Total Selenium (Se)	mg/kg	1.07	0.89	1.44	0.52	0.89	0.78	1.14	0.89	0.66	0.87	0.01	3346489
Total Silver (Ag)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	3346489
Total Sodium (Na)	mg/kg	1040	1030	1030	1400	1210	1180	1110	1150	1180	1340	10	3346489
Total Strontium (Sr)	mg/kg	20.8	18.3	16.4	27.2	25.5	17.9	17.8	16.7	23.8	22.5	0.1	3346489
Total Thallium (Tl)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	3346489
Total Tin (Sn)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Titanium (Ti)	mg/kg	3	1	<1	1	1	2	1	3	1	1	1	3346489
Total Uranium (U)	mg/kg	0.09	<0.05	<0.05	0.11	0.06	<0.05	<0.05	0.06	0.06	0.06	0.05	3346489
Total Vanadium (V)	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	2	3346489
Total Zinc (Zn)	mg/kg	24.3	21.7	24.1	37.4	34.0	23.4	27.8	26.8	26.3	29.4	0.1	3346489

RDL = Reportable Detection Limit

Maxxam Job #: A942258
Report Date: 2009/08/18

AECOM
Client Project #: 111071 CASINO

ELEMENTS BY ATOMIC SPECTROSCOPY (TISSUE)

Maxxam ID		Q19388	Q19389	Q19403	Q19404	Q19405	Q19406	Q19407	Q19408	Q19409		
Sampling Date		2009/08/05	2009/08/05	2009/08/05	2009/08/05	2009/08/05	2009/08/06	2009/08/06	2009/08/06	2009/08/06		
	Units	**D2 CCG# 7**	**D2 CCG# 9**	**D2 CCG# 10**	**D3 CCG# 4**	**D3 CCG# 6**	**F13 PASS 1 CCG# 5**	**F13 PASS 1 CCG# 11**	**F13 PASS 2 CCG# 4**	**F13 PASS 3 CCG# 1**	**RDL**	**QC Batch**
Total Metals by ICPMS												
Total Aluminum (Al)	mg/kg	18	29	85	37	42	8	9	11	63	1	3346489
Total Antimony (Sb)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Arsenic (As)	mg/kg	0.09	0.10	0.13	0.09	0.13	0.10	0.08	0.11	0.15	0.01	3346489
Total Barium (Ba)	mg/kg	3.2	3.5	4.2	3.5	4.1	2.6	3.3	2.7	3.6	0.1	3346489
Total Beryllium (Be)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Boron (B)	mg/kg	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	3346489
Total Cadmium (Cd)	mg/kg	0.03	0.05	0.03	0.03	0.05	0.06	0.06	0.09	0.09	0.01	3346489
Total Calcium (Ca)	mg/kg	10100	11300	12700	12000	11500	11700	12300	11400	13200	10	3346489
Total Chromium (Cr)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	3346489
Total Cobalt (Co)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	3346489
Total Copper (Cu)	mg/kg	1.0	1.0	0.8	0.8	1.0	0.9	0.9	1.1	2.1	0.5	3346489
Total Iron (Fe)	mg/kg	48	74	187	82	82	27	28	37	146	10	3346489
Total Lead (Pb)	mg/kg	0.02	0.03	0.08	0.04	0.05	0.04	0.04	0.09	0.52	0.01	3346489
Total Magnesium (Mg)	mg/kg	361	372	420	382	383	372	373	359	393	10	3346489
Total Manganese (Mn)	mg/kg	7.6	9.7	16.0	12.0	10.6	7.9	8.9	9.7	13.4	0.1	3346489
Total Mercury (Hg)	mg/kg	0.06	0.07	0.07	0.05	0.06	0.05	0.04	0.04	0.05	0.01	3346489
Total Molybdenum (Mo)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Nickel (Ni)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Phosphorus (P)	mg/kg	7810	8560	9200	8740	8540	8780	9070	8610	9010	10	3346489
Total Potassium (K)	mg/kg	3200	3140	2960	3220	3230	3240	3260	3340	2930	10	3346489
Total Selenium (Se)	mg/kg	1.32	0.89	0.59	0.67	0.73	0.91	1.16	1.04	0.76	0.01	3346489
Total Silver (Ag)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	3346489
Total Sodium (Na)	mg/kg	1080	1200	1120	1220	1110	1170	1230	1170	1270	10	3346489
Total Strontium (Sr)	mg/kg	15.8	19.2	19.7	18.4	19.4	16.4	19.3	16.0	17.2	0.1	3346489
Total Thallium (Tl)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	3346489
Total Tin (Sn)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	3346489
Total Titanium (Ti)	mg/kg	1	2	5	3	3	1	1	1	7	1	3346489
Total Uranium (U)	mg/kg	<0.05	0.08	0.11	0.06	0.06	<0.05	<0.05	0.06	0.10	0.05	3346489
Total Vanadium (V)	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	2	3346489
Total Zinc (Zn)	mg/kg	22.3	26.2	30.6	27.7	24.7	28.7	27.8	31.9	31.2	0.1	3346489

RDL = Reportable Detection Limit

Maxxam Job #: A942258
Report Date: 2009/08/18

AECOM
Client Project #: 111071 CASINO

ELEMENTS BY ATOMIC SPECTROSCOPY (TISSUE)

Maxxam ID		Q19411		Q19412	Q19413	Q19414	Q19415		
Sampling Date		2009/08/06		2009/08/06	2009/08/07	2009/08/07	2009/08/07		
	Units	**F11 PASS 1 CCG# 5**	**QC Batch**	**F11 PASS 1 CCG# 8**	**Y1 CCG# 13**	**Y1 CCG# 19**	**Y1 CCG# 23**	**RDL**	**QC Batch**
Total Metals by ICPMS									
Total Aluminum (Al)	mg/kg	20	3346489	33	50	60	30	1	3346494
Total Antimony (Sb)	mg/kg	<0.1	3346489	<0.1	<0.1	<0.1	<0.1	0.1	3346494
Total Arsenic (As)	mg/kg	0.12	3346489	0.21	0.14	0.16	0.11	0.01	3346494
Total Barium (Ba)	mg/kg	3.0	3346489	3.5	4.8	5.6	4.6	0.1	3346494
Total Beryllium (Be)	mg/kg	<0.1	3346489	<0.1	<0.1	<0.1	<0.1	0.1	3346494
Total Bismuth (Bi)	mg/kg	<0.1	3346489	<0.1	<0.1	<0.1	<0.1	0.1	3346494
Total Boron (B)	mg/kg	<5	3346489	<5	<5	<5	<5	5	3346494
Total Cadmium (Cd)	mg/kg	0.09	3346489	0.06	0.63	0.55	0.38	0.01	3346494
Total Calcium (Ca)	mg/kg	11200	3346489	11800	21900	20800	18100	10	3346494
Total Chromium (Cr)	mg/kg	<0.5	3346489	<0.5	<0.5	<0.5	<0.5	0.5	3346494
Total Cobalt (Co)	mg/kg	<0.1	3346489	<0.1	<0.1	<0.1	<0.1	0.1	3346494
Total Copper (Cu)	mg/kg	1.1	3346489	1.0	1.0	0.8	0.8	0.5	3346494
Total Iron (Fe)	mg/kg	53	3346489	77	94	123	67	10	3346494
Total Lead (Pb)	mg/kg	0.03	3346489	0.03	0.06	0.06	0.04	0.01	3346494
Total Magnesium (Mg)	mg/kg	358	3346489	388	481	510	441	10	3346494
Total Manganese (Mn)	mg/kg	7.7	3346489	9.6	11.8	9.9	12.5	0.1	3346494
Total Mercury (Hg)	mg/kg	0.08	3346489	0.06	0.05	0.06	0.05	0.01	3346494
Total Molybdenum (Mo)	mg/kg	<0.1	3346489	<0.1	<0.1	<0.1	<0.1	0.1	3346494
Total Nickel (Ni)	mg/kg	<0.1	3346489	<0.1	0.3	0.3	0.2	0.1	3346494
Total Phosphorus (P)	mg/kg	8530	3346489	8950	13800	13100	11800	10	3346494
Total Potassium (K)	mg/kg	3200	3346489	3260	2620	2760	2820	10	3346494
Total Selenium (Se)	mg/kg	1.00	3346489	1.29	2.10	1.59	1.58	0.01	3346494
Total Silver (Ag)	mg/kg	<0.05	3346489	<0.05	<0.05	<0.05	<0.05	0.05	3346494
Total Sodium (Na)	mg/kg	1230	3346489	1160	1540	1590	1530	10	3346494
Total Strontium (Sr)	mg/kg	16.7	3346489	21.5	25.0	23.8	22.0	0.1	3346494
Total Thallium (Tl)	mg/kg	<0.05	3346489	<0.05	<0.05	<0.05	<0.05	0.05	3346494
Total Tin (Sn)	mg/kg	<0.1	3346489	<0.1	<0.1	<0.1	<0.1	0.1	3346494
Total Titanium (Ti)	mg/kg	2	3346489	3	3	5	2	1	3346494
Total Uranium (U)	mg/kg	0.08	3346489	<0.05	0.07	<0.05	0.06	0.05	3346494
Total Vanadium (V)	mg/kg	<2	3346489	<2	<2	<2	<2	2	3346494
Total Zinc (Zn)	mg/kg	24.3	3346489	29.6	55.6	46.1	44.8	0.1	3346494

RDL = Reportable Detection Limit

Maxxam Job #: A942258
Report Date: 2009/08/18

AECOM
Client Project #: 111071 CASINO

General Comments

Sample Q19378-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19379-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19380-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19381-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19382-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19383-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19384-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19385-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19386-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19387-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19388-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19389-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19403-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19404-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19405-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19406-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19407-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19408-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19409-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Sample Q19411-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Maxxam Job #: A942258
Report Date: 2009/08/18

AECOM
Client Project #: 111071 CASINO

Sample	Q19412-: Metals in tissue are reported on wet weight basis unless noted otherwise.
Sample	Q19413-: Metals in tissue are reported on wet weight basis unless noted otherwise.
Sample	Q19414-: Metals in tissue are reported on wet weight basis unless noted otherwise.
Sample	Q19415-: Metals in tissue are reported on wet weight basis unless noted otherwise.

Maxxam Job #: A942258
Report Date: 2009/08/18

AECOM
Client Project #: 111071 CASINO

QUALITY ASSURANCE REPORT

			Spiked Blank		Method Blank		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	Value	Units	% Recovery	QC Limits
3346489	Total Arsenic (As)	2009/08/17	93	75 - 125	<0.01	mg/kg	86	75 - 125
3346489	Total Cadmium (Cd)	2009/08/17	99	75 - 125	<0.01	mg/kg	104	75 - 125
3346489	Total Copper (Cu)	2009/08/17	88	75 - 125	<0.5	mg/kg	89	75 - 125
3346489	Total Iron (Fe)	2009/08/17			<10	mg/kg	96	75 - 125
3346489	Total Mercury (Hg)	2009/08/17	96	75 - 125	<0.01	mg/kg	100	75 - 125
3346489	Total Nickel (Ni)	2009/08/17	88	75 - 125	<0.1	mg/kg	95	75 - 125
3346489	Total Zinc (Zn)	2009/08/17	95	75 - 125	<0.1	mg/kg	96	75 - 125
3346489	Total Beryllium (Be)	2009/08/17	90	75 - 125	<0.1	mg/kg		
3346489	Total Chromium (Cr)	2009/08/17	91	75 - 125	<0.5	mg/kg		
3346489	Total Cobalt (Co)	2009/08/17	88	75 - 125	<0.1	mg/kg		
3346489	Total Lead (Pb)	2009/08/17	94	75 - 125	<0.01	mg/kg		
3346489	Total Selenium (Se)	2009/08/17	107	75 - 125	<0.01	mg/kg		
3346489	Total Uranium (U)	2009/08/17	93	75 - 125	<0.05	mg/kg		
3346489	Total Vanadium (V)	2009/08/17	91	75 - 125	<2	mg/kg		
3346489	Total Aluminum (Al)	2009/08/17			<1	mg/kg		
3346489	Total Antimony (Sb)	2009/08/17			<0.1	mg/kg		
3346489	Total Barium (Ba)	2009/08/17			<0.1	mg/kg		
3346489	Total Bismuth (Bi)	2009/08/17			<0.1	mg/kg		
3346489	Total Boron (B)	2009/08/17			<5	mg/kg		
3346489	Total Calcium (Ca)	2009/08/17			<10	mg/kg		
3346489	Total Magnesium (Mg)	2009/08/17			<10	mg/kg		
3346489	Total Manganese (Mn)	2009/08/17			<0.1	mg/kg		
3346489	Total Molybdenum (Mo)	2009/08/17			<0.1	mg/kg		
3346489	Total Phosphorus (P)	2009/08/17			<10	mg/kg		
3346489	Total Potassium (K)	2009/08/17			<10	mg/kg		
3346489	Total Silver (Ag)	2009/08/17			<0.05	mg/kg		
3346489	Total Sodium (Na)	2009/08/17			<10	mg/kg		
3346489	Total Strontium (Sr)	2009/08/17			<0.1	mg/kg		
3346489	Total Thallium (Tl)	2009/08/17			<0.05	mg/kg		
3346489	Total Tin (Sn)	2009/08/17			<0.1	mg/kg		
3346489	Total Titanium (Ti)	2009/08/17			<1	mg/kg		
3346494	Total Arsenic (As)	2009/08/15	101	75 - 125	<0.01	mg/kg	88	75 - 125
3346494	Total Cadmium (Cd)	2009/08/15	105	75 - 125	<0.01	mg/kg	109	75 - 125
3346494	Total Copper (Cu)	2009/08/15	99	75 - 125	<0.5	mg/kg	95	75 - 125
3346494	Total Iron (Fe)	2009/08/15			<10	mg/kg	94	75 - 125
3346494	Total Mercury (Hg)	2009/08/15	104	75 - 125	<0.01	mg/kg	105	75 - 125
3346494	Total Nickel (Ni)	2009/08/15	98	75 - 125	<0.1	mg/kg	94	75 - 125
3346494	Total Zinc (Zn)	2009/08/15	106	75 - 125	<0.1	mg/kg	98	75 - 125
3346494	Total Beryllium (Be)	2009/08/15	99	75 - 125	<0.1	mg/kg		
3346494	Total Chromium (Cr)	2009/08/15	99	75 - 125	<0.5	mg/kg		

Maxxam Job #: A942258
Report Date: 2009/08/18

AECOM
Client Project #: 111071 CASINO

QUALITY ASSURANCE REPORT

			Spiked Blank		Method Blank		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	Value	Units	% Recovery	QC Limits
3346494	Total Cobalt (Co)	2009/08/15	98	75 - 125	<0.1	mg/kg		
3346494	Total Lead (Pb)	2009/08/15	101	75 - 125	<0.01	mg/kg		
3346494	Total Selenium (Se)	2009/08/15	104	75 - 125	<0.01	mg/kg		
3346494	Total Uranium (U)	2009/08/15	101	75 - 125	<0.05	mg/kg		
3346494	Total Vanadium (V)	2009/08/15	99	75 - 125	<2	mg/kg		
3346494	Total Aluminum (Al)	2009/08/15			<1	mg/kg		
3346494	Total Antimony (Sb)	2009/08/15			<0.1	mg/kg		
3346494	Total Barium (Ba)	2009/08/15			<0.1	mg/kg		
3346494	Total Bismuth (Bi)	2009/08/15			<0.1	mg/kg		
3346494	Total Boron (B)	2009/08/15			<5	mg/kg		
3346494	Total Calcium (Ca)	2009/08/15			<10	mg/kg		
3346494	Total Magnesium (Mg)	2009/08/15			<10	mg/kg		
3346494	Total Manganese (Mn)	2009/08/15			<0.1	mg/kg		
3346494	Total Molybdenum (Mo)	2009/08/15			<0.1	mg/kg		
3346494	Total Phosphorus (P)	2009/08/15			<10	mg/kg		
3346494	Total Potassium (K)	2009/08/15			<10	mg/kg		
3346494	Total Silver (Ag)	2009/08/15			<0.05	mg/kg		
3346494	Total Sodium (Na)	2009/08/15			<10	mg/kg		
3346494	Total Strontium (Sr)	2009/08/15			<0.1	mg/kg		
3346494	Total Thallium (Tl)	2009/08/15			<0.05	mg/kg		
3346494	Total Tin (Sn)	2009/08/15			<0.1	mg/kg		
3346494	Total Titanium (Ti)	2009/08/15			<1	mg/kg		

N/A = Not Applicable
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Maxxam Analytics Inc

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CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

PAGE 1 OF 2

A942258 . ANALYSIS REQUEST F109263

COMPANY NAME: AECOM	PH. #: 604 412 3521 E-mail: jennifer.sarchuk@aecom.com FAX #:
COMPANY ADDRESS: 275-3001 Wayburne Drive Burnaby, BC V5G 4W3	CLIENT PROJECT ID: (#) 111071 casino
SAMPLER NAME (PRINT): Jen Sarchuk, Scott Seward.	PROJECT MANAGER: Greg Bull

LAB USE ONLY

FIELD SAMPLE ID	MAXXAM LAB # (Lab Use Only)	MATRIX: GROUND WATER	SURFACE WATER	SOIL	OTHER (Fish Tissue)	# CONTAINERS	SAMPLING: DATE DD/MM/YY	TIME	HEADSPACE VAPOUR	Metals (fish tissue)
1 Ref1 CCG#3					X		05/08/09			
2 Ref1 CCG#5										
3 Ref1 CCG#12										
4 Ref1 CCG#13										
5 Ref1 CCG#15										
6 D1 CCG#8										
7 D1 CCG#9										
8 D1 CCG#10										
9 D1 CCG#11										
10 D2 CCG#6										
11 D2 CCG#7										
12 D2 CCG#9										

TAT (Turnaround Time)

<5 DAY TAT MUST HAVE PRIOR APPROVAL

*some exceptions apply please contact lab.

STANDARD 5 BUSINESS DAYS ☐
RUSH 3 BUSINESS DAYS ☐
RUSH 2 BUSINESS DAYS ☐
URGENT 1 BUSINESS DAY ☐

OTHER BUSINESS DAYS _____

CUSTODY RECORD

P.O. NUMBER / QUOTE NUMBER:

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:

☐ CCME
☐ CSR
☐ ALBERTA TIER 1
☐ OTHER

ACCOUNTING CONTACT:

SPECIAL REPORTING OR BILLING INSTRUCTIONS:

JARS USED:

LAB USE ONLY

ARRIVAL TEMPERATURE °C: 7, 7, 8 cs intact

DUE DATE:

LOG IN CHECK:

RELINQUISHED BY SAMPLER:	DATE DD/MM/YY 10/08/09	TIME: 17:00	RECEIVED BY:
RELINQUISHED BY:	DATE DD/MM/YY	TIME:	RECEIVED BY:
RELINQUISHED BY:	DATE DD/MM/YY 11/08/09	TIME: 1340	RECEIVED BY LABORATORY:

COCFORM - BC - 06/06

ORIGINAL - MAXXAM YELLOW - MAXXAM PINK - CLIENT

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CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

A942258

ANALYSIS REQUEST F 109266

COMPANY NAME: AECOM

PH. #: 604.412.3521
E-mail: jennifer.sarchuk@aecom.com
FAX #:

COMPANY ADDRESS: 275-3001 Wayburne Drive Burnaby, BC V5G 4W3

CLIENT PROJECT ID: (#) 111071 Cosino

SAMPLER NAME (PRINT): Jen Sarchuk, Scott Seward

PROJECT MANAGER: Greg Bull

	FIELD SAMPLE ID	MAXXAM LAB # (Lab Use Only)	MATRIX: GROUND WATER	SURFACE WATER	SOIL	OTHER (FISH)	# CONTAINERS	SAMPLING: DATE DD/MM/YY	TIME	HEADSPACE VAPOUR	Fish tissue metals
1	D2 CCG#10					X		05/08/09			X
2	D3 CCG#4										
3	D3 CCG#6										
4	F13 Pass 1 CCG#5							06/08/09			
5	F13 Pass 1 CCG#11										
6	F13 Pass 2 CCG#4										
7	F13 Pass 3 CCG#1										
8	F11 Pass 1 CCG#5										
9	F11 Pass 1 CCG#8										
10	Y1 CCG#13							07/08/09			
11	Y1 CCG#19										
12	Y1 CCG#23										

TAT (Turnaround Time)

<5 DAY TAT MUST HAVE PRIOR APPROVAL

*some exceptions apply please contact lab

STANDARD 5 BUSINESS DAYS ☐
RUSH 3 BUSINESS DAYS ☐
RUSH 2 BUSINESS DAYS ☐
URGENT 1 BUSINESS DAY ☐

OTHER BUSINESS DAYS _____

CUSTODY RECORD

P.O. NUMBER / QUOTE NUMBER:

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:

☐ CCME
☐ CSR
☐ ALBERTA TIER 1
☐ OTHER

ARRIVAL TEMPERATURE °C: 7, 7, 8 CS intact

DUE DATE:

LOG IN CHECK:

ACCOUNTING CONTACT:

SPECIAL REPORTING OR BILLING INSTRUCTIONS:

JARS USED:

RELINQUISHED BY SAMPLER:	DATE: DD/MM/YY	TIME:	RECEIVED BY:
Jen Sarchuk	10/08/09	17:00	
RELINQUISHED BY:	DATE: DD/MM/YY	TIME:	RECEIVED BY:
RELINQUISHED BY:	DATE: DD/MM/YY	TIME:	RECEIVED BY LABORATORY:
	11/08/09	13:40	

COCFORM - BC - 06/06

ORIGINAL - MAXXAM YELLOW - MAXXAM PINK - CLIENT

Appendix E4

Fish Habitat Data, Casino Project, August 2009

Appendix E4. Fish Habitat Data, Casino Property, August 2009

Site	Date	Stream Characteristics					Stream Morphology	Channel Pattern	Bed Material		D95 (cm)		Cover Type (N,T,M,A)							Banks				Islands (N, O, I, F, S, AN)	Bars (N, Side, Diag, Mid, Span, Br)	Coupling (DC, PC, CO)	Confinement (EN, CO, FC, OC, UC, N/A)	Comments
		Stage (H/M/L)	Gradient (Degrees)	Wetted Width (m)	Bankfull Width (m)	Depths (m)			Dominant	Subdominant		Crown Closure (%)	Small Woody Debris (%)	Large Woody Debris (%)	Boulder (%)	Undercut Bank (%)	Deep Pool (%)	Overhanging Veg (%)	Instream Veg (%)	Shape (U, V, S, O)	Texture (F, G, C, B, R, A)	Rip. Veg. (N, G, S, C, D, W)	Stage (INIT, SHR, PS, YF, MF, NA)					
R2	05-Aug-09	L	2	4.4 2.9 3.7	7.0 3.9 6.5	0.40 0.57 0.31	Riffle-Pool	Irregular, wandering	Cobble	Fines	15.9	1-20	5	7	N/A	5	5	Trace	N/A	V, S	F,C	S, C	MF	N	Side	DC	UN	Some deep pools

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Casino Project:

2010 Aquatic Studies Report

draft for discussion

Prepared for

Western Copper and Gold Corporation

December 2011

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

1199 West Hastings Street, Suite 800, Vancouver, BC V6E 375
t: 604-629-9075 f: 604-687-3141

December 30, 2011

Jesse Duke Project Director
Western Copper and Gold Corporation
2050-1111 West Georgia Street
Vancouver, BC V6E 4M3

Dear Mr. Duke,

Re: Casino Project: 2010 Aquatic Studies Report

Palmer Environmental Consulting Group Inc. is pleased to submit the attached draft report describing the studies conducted in 2010 on the aquatic environment of the Casino Project area. If there are any questions or comments on this report, then please contact the undersigned.

Thank you for the opportunity to work with you on this project.

Yours truly,

Palmer Environmental Consulting Group Inc.

R. Palmer

Rick Palmer, M.Sc. R.P. Bio
President, Senior Fisheries Biologist

RP:mq

Distribution List

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Revision #	Revised By	Date	Issue / Revision Description
1			
2			
3			

Signatures

Report Prepared By: _____

May Quach, M.Sc.
Palmer Environmental Consulting Group
Aquatic Ecologist

Report Reviewed By:

_____

Rick Palmer, M.Sc., R.P. Bio
Palmer Environmental Consulting Group
President, Senior Fisheries Biologist

Executive Summary

This report describes the studies conducted in 2010 on the aquatic environment of the Casino Project area. Western Copper and Gold Corporation, formerly Western Copper Corporation, has 100% ownership of the Casino property. The Casino Project is a proposed porphyry copper-gold-molybdenum mine located at 611379E 6956218N in west-central Yukon, approximately 380 km northwest of the territorial capital of Whitehorse.

Surveys of the aquatic environment in 2010 were completed on January 6, February 24, March 23-25, April 21, May 8-10, June 14-16, July 7-9, August 8-12, September 14-15 and October 15. The objectives were to sample water quality, stream sediment quality, periphyton communities, benthic invertebrate communities and fish communities.

A total of 22 sites were chosen for water quality sampling. Water samples were collected from each site in January to October and analyzed for the full suite of physical parameters, anions, nutrients and total and dissolved metals. Exceedances of the Canadian Council of Ministers of the Environment (CCME) guidelines for protection of freshwater aquatic life were observed for seven parameters. The number of exceedances was highest for copper, aluminum, iron and cadmium and least for mercury. Exceedances were most numerous in May to August and least in September and October, indicating a seasonal trend most likely directly related to hydrological factors such as snow melt and stream flow.

Sediment samples were collected from five stream sites in August and pH and total metal concentrations were measured. Exceedances of CCME sediment guidelines were identified for three metals: arsenic, cadmium, and zinc.

Fish communities at three stream sites were sampled in August with an electrofisher and minnow traps. Two assessments on Dip Creek resulted in 1 burbot captured. No fish were captured on Canadian Creek above a potential cascade barrier. In addition, a chinook spawning assessment was conducted on August 10 in the Klotassin River and the lower reach of Dip Creek (none were observed).

Acknowledgements

The studies described in this report were carried out by the following staff:

- Project Management:
  - Rick Palmer, M.Sc., R.P. Bio., Senior Fisheries Biologist
- Report Preparation/editing:
  - May Quach, M.Sc., Aquatic Ecologist
- Senior Review:
  - Neil Hutchinson, Ph.D.
  - Rick Palmer, M.Sc., R.P. Bio., Senior Fisheries Biologist
- Field Studies:
  - Kai Woloshyn, B.Sc., Environmental Scientist (AECOM)
  - Eric Cleveland, D.Tech., Environmental Technician
  - Jennifer Sarchuk, B.Sc., Aquatic Biologist (AECOM)
  - May Quach, M.Sc., Aquatic Ecologist

In 2010, the Aquatic program described in this report was transferred from AECOM to Palmer Environmental Consulting Group Ltd. (PECG). Field studies were carried out by AECOM and the development of this report was carried out by PECG.

Acronyms and Abbreviations

ARD	Acid Rock Drainage
BC MOE	British Columbia Ministry of Environment
CCME	Canadian Council of Ministers of the Environment
CPUE	Catch-per-unit-effort
DFO	Fisheries and Oceans Canada
DIAND	Department of Indian Affairs and Northern Development
DOC	Dissolved Organic Carbon
EEM	Environmental Effects Monitoring
FISS	Fisheries Information Summary System
GPS	Global Positioning System
HKP	Hallam Knight Piésold Ltd.
INAC	Indian and Northern Affairs Canada
ISQG	Interim Sediment Quality Guideline
LSA	Local Study Area
MMER	Metal Mining Effluent Regulations
µS	micro-Siemens
NA	Not applicable
NAN	Not a Number
NS	Not sampled
NTU	Nephelometric unit
PEL	Probable Effects Level
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
RDL	Reported Detection Limit
RPD	Relative Percent Difference
RSA	Regional Study Area
SE	Standard error
TDS	Total Dissolved Solids
TIA	Tailings Impoundment Area
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TSS	Total Suspended Solids
U.S. EPA	United States Environmental Protection Agency
YESAB	Yukon Environmental and Socio-Economic Assessment Board

Table of Contents

Letter
Executive Summary
Acknowledgements
Acronyms and Abbreviations

1 Introduction 1
1.1 Overview 1
1.2 Study Areas 4
1.3 Study Objectives 6

2 Methods 7
2.1 Dates and Locations of Sampling Surveying 7
2.1.1 General 7
2.1.2 Water Quality 7
2.1.3 Sediment Quality 9
2.1.4 Fish Assessment 9
2.2 Sample Collection 10
2.2.1 Water Quality 10
2.2.2 Sediment Quality 11
2.2.3 Fish Assessment and Spawning Survey 12
2.3 QA/QC 13
2.3.1 Water Quality 13
2.3.2 Sediment Quality 15
2.3.3 Fish Assessment 15
2.4 Data Analysis 15
2.4.1 Water Quality 15
2.4.2 Sediment Quality 16
2.4.3 Fish Assessment 16

3 Results and Discussion 16
3.1 Water Quality 16
3.1.1 Statistical Summary 16
3.1.2 Exceedances of Water Quality Guidelines 21
3.2 Sediment Quality 24
3.3 Fish Assessment 25

4 Summary 27

5 References 27

List of Figures

Figure 1. Aquatic Regional Study Area in Relation to the Yukon River 2
Figure 2. Proposed Casino Mine Site Layout 3
Figure 3. Aquatic Regional Study Area with Sampling Sites on the Klotassin River 5
Figure 4. Water Quality Exceedances of CCME Guidelines, Casino Project, 2010 22
Figure 5. Median Concentration of Total Copper in Sampling Sites, Casino Project, 2010 23
Figure 6. Median Concentration of Total Iron in Sampling Sites, Casino Project, 2010 23
Figure 7. Median Concentration of Total Lead in Monitoring Stations, Casino Project, 2010 24

List of Tables

Table 1. Sampling Trips, Aquatic Environment, Casino Project, 2010 7
Table 2. Summary of Water Quality Sampling Sites, Casino Project, 2010 8
Table 3. Summary of Fish Assessments and Spawning Surveys Casino Project, 2010 10
Table 4. Water Quality Parameters and Detection Limits 10
Table 5. Sediment Quality Parameters and Detection Limits 11
Table 6. RPD Analysis of Replicate Water Quality Samples, Casino Project, 2010 13
Table 7. RPD Analysis of Replicate Sediment Quality Samples, Casino Project, 2010 15
Table 8. Water Quality Summary Statistics, Casino Creek Watershed, 2010 17
Table 9. Water Quality Summary Statistics, Dip Creek Watershed, 2010 18
Table 10. Water Quality Summary Statistics, Britannia Creek Watershed, 2010 19
Table 11. Water Quality Summary Statistics, Yukon River Watershed, 2010 20
Table 12. Water Quality Parameters Exceeding CCME Guidelines, Casino Project, 2010 21
Table 13. Sediment Quality Parameters Exceeding CCME Guidelines, Casino Project, 2010 24
Table 14. Fish Sampling Effort on Canadian Creek, August 2010 25

List of Appendices

A1. Surface Water Quality Data, Casino Project, January 2010
A2. Surface Water Quality Data, Casino Project, February 2010
A3. Surface Water Quality Data, Casino Project, March 2010
A4. Surface Water Quality Data, Casino Project, April 2010
A5. Surface Water Quality Data, Casino Project, May 2010
A6. Surface Water Quality Data, Casino Project, June 2010
A7. Surface Water Quality Data, Casino Project, July 2010
A8. Surface Water Quality Data, Casino Project, August 2010
A9. Surface Water Quality Data, Casino Project, September 2010
A10. Surface Water Quality Data, Casino Project, October 2010
A11. Surface Water Quality Replicate Data, Casino Project, 2010
B1. Sediment Quality Data, Casino Project, August 2010
B2. Sediment Quality Replicate Data, Casino Project, 2010
C. Fish Assessment Details, Casino Project, 2010

1 Introduction

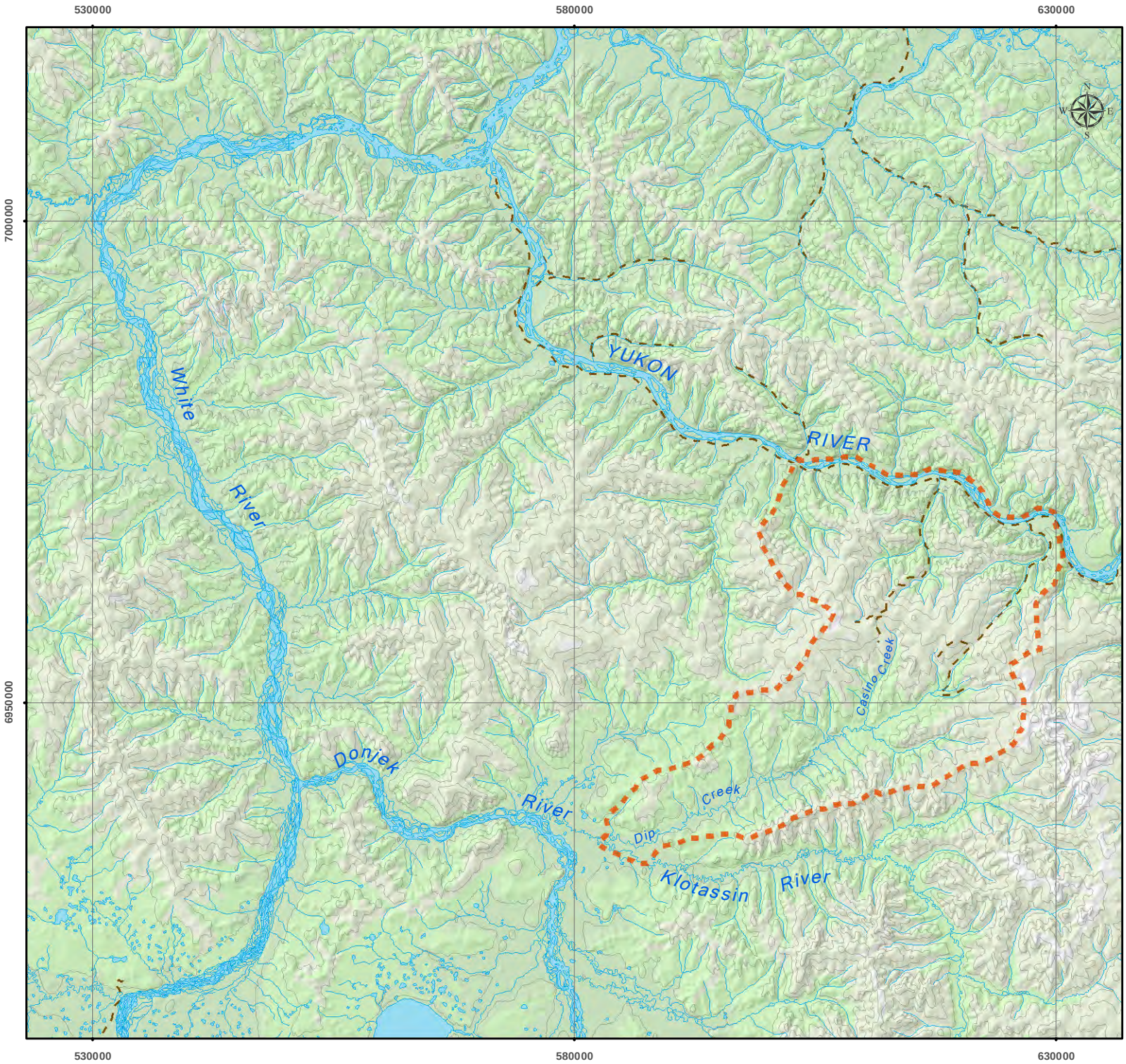
1.1 Overview

This report describes the studies conducted in 2010 on the aquatic environments of the Casino Project (Casino), which specifically includes water quality, sediment quality and fish and fish habitat. Studies conducted in 2010 on hydrology, climate and meteorology, hydrogeology and geochemistry are reported separately. The purpose of these studies was to characterize the pre-development environment in support of the permitting process for the Casino Project.

The Casino Project is owned by the Western Copper and Gold (WCG). It is a proposed porphyry copper-gold-molybdenum mine located at in west-central Yukon, 611379E 6956218N, approximately 380 km northwest of the territorial capital of Whitehorse. Figure 1 shows the location of the Casino Project, surrounded by the aquatic Regional Study Area (RSA), in relation to the Yukon River – to which all of the streams in the Casino Project area eventually discharge.

In August 2008, a pre-feasibility study of the Casino Project was completed (M3 Engineering, 2008). It envisioned a conventional truck-shovel, open pit mine. Heap leach, ore stockpile and oxide waste will be stored in the interior of the impoundment (Figure 2). Tailings, process water, treated sewage effluent, leachate from the waste rock dumps and surface runoff from the mine site will be directed to the Tailings Impoundment Area (TIA) located in the headwaters of Casino Creek. Historical studies on the aquatic ecosystem of the Casino property were conducted from 1993 to 1995 (Hallam Knight Piésold 1997). In 1994, Fisheries and Oceans Canada (DFO) and Indian and Northern Affairs Canada (INAC), then known as Department of Indian Affairs and Northern Development (DIAND), conducted an overview investigation of waters that may be affected by the Casino project (DFO, 1994). This included the Klotassin River, Dip Creek, Britannia Creek, Selwyn River and Hayes Creek. In 1998, White River First Nation commissioned a study to identify areas of the Lower Donjek River drainage utilized by chinook salmon (Otto, 1998). This was conducted in order to serve as a pilot study to develop a strategic plan for future chinook salmon restoration and enhancement work in the lower Donjek. Otherwise, there are limited data available on the aquatic environment of the Casino area. DFO has conducted surveys of fish and fish habitat in watersheds in the area, including the reaches of the Yukon River adjacent to the Casino property and the lower reaches of Dip Creek and the Klotassin, Donjek and White rivers. These were conducted for the purposes of managing Pacific salmon fisheries in the Yukon River, and for classifying fish habitat in support of the Yukon Placer Authorization (Government of Canada, 2000). The results of the DFO surveys are reported in Appendix B10 of AECOM (2009).

Recent studies of the aquatic ecosystem of the RSA began in 2008 with sampling trips in May, July, September and October. Study components included stream flows, water quality, sediment quality, periphyton, benthic invertebrates, fish and fish habitat. The results of those surveys were reported in "*Casino Project: 2008 Environmental Studies Report*" (AECOM, 2009). The continuation of these studies was carried out in 2009 with monthly water quality sampling between May and December and sediment quality, periphyton, benthic invertebrates, fish and fish habitat sampling in August. The results of these surveys are reported in "*Casino Project: 2009 Aquatic Studies Report*" (PECG, 2011). The studies conducted in 2010 and reported here and are a continuation of the 2008 program.



Legend

- Regional Study Area
- Access Road
- Contours
- Watercourse
- Waterbody

0 2.5 5 10 15 km

Map scale 1:500,000 (printed at 8.5x11)

Figure 1. Aquatic Regional Study Area

Drawn By:	L. Grieve
Checked By:	M. Power / M. Kearns
Date:	16 December 2011
Projection:	North American Datum

1:250,000 Topographic Spatial Data: Canvec; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Digital Elevation Model provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

This document is not an official land survey and the spatial data presented is subject to change without any notice.

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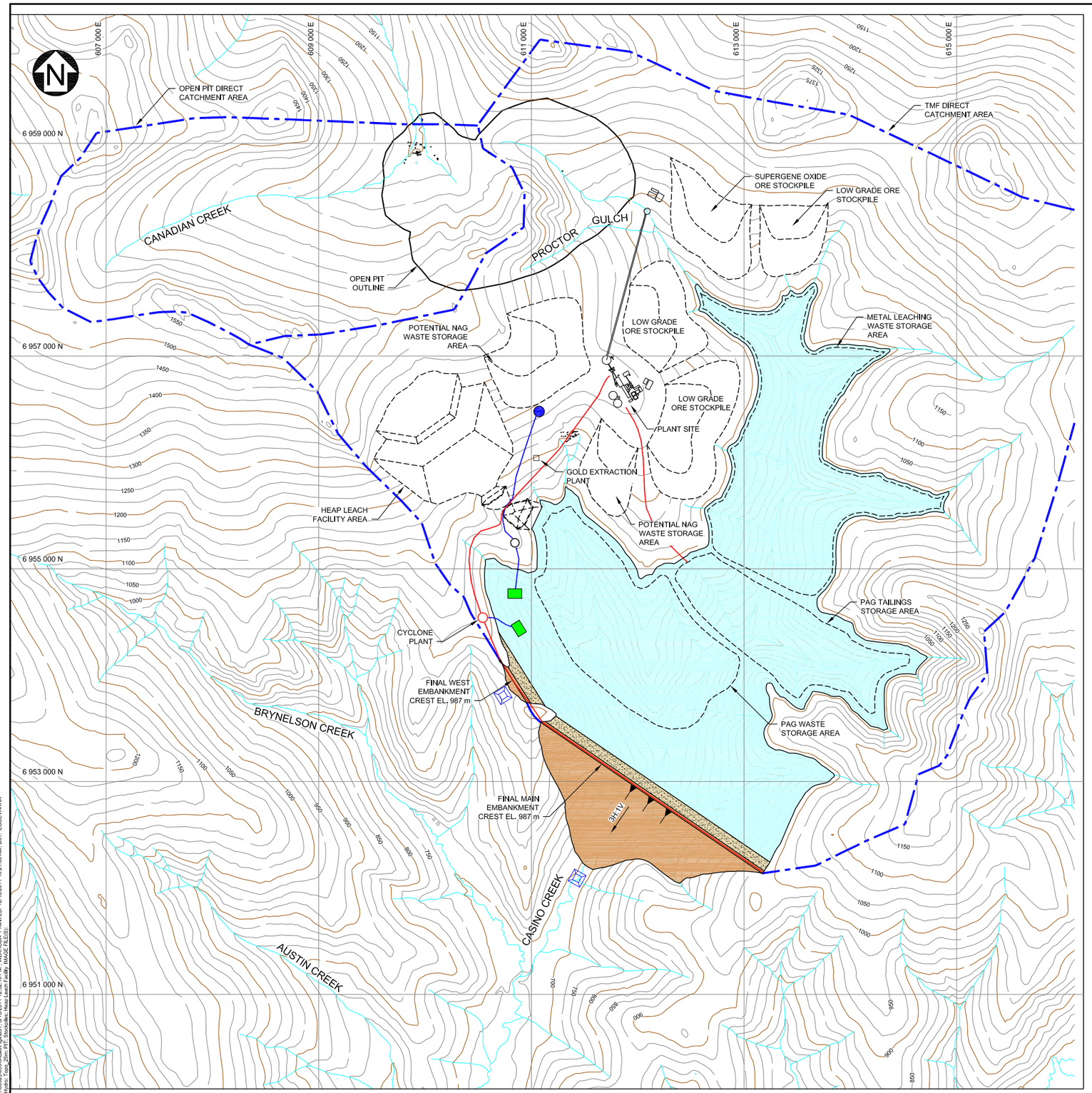

NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3ENGINEERING AND TECHNOLOGY CORPORATION (APRIL 9, 2008).
5. ORE STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE DURING OPERATIONS.

LEGEND:

- TAILINGS PIPELINES
- RECLAIM PIPELINES
- SUPERNATANT POND
- TAILINGS BEACH
- RECLAIM BOOSTER PUMP STATION
- RECLAIM WATER HEAD TANK
- RECLAIM BARGE
- SEDIMENT AND SEEPAGE COLLECTION PONDS

SCALE A 400 200 0 400 800 1200 1600 2000 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	07JUN'11	ISSUED WITH REPORT	AG	ELG	GRG	KJB

WESTERN COPPER CORPORATION

CASINO COPPER-GOLD PROJECT

PROJECT GENERAL ARRANGEMENT

Knight Piésold CONSULTING

P/A NO. VA101-325/3

REF NO. 5

FIGURE 2

REV 0

SAVED: M:\101\00325\03\A\Acad\Figs\B31, 01/5/2011 12:42:10 PM , VILAHUDA , PRINTED: 12/16/2011 10:21:33 AM , B31 , EQUEVIARRA
XREF FILE(S): Hydro; Topo_25m; PIT; Stockpiles; Heap Leach Facility; IMAGE FILE(S):

1.2 Study Areas

In 2008, the Local Study Area (LSA) for the aquatic ecosystems of the Casino project was defined by the boundaries of the two watersheds surrounding the Casino deposit: the Britannia Creek Watershed to the north and the Casino Creek Watershed to the south. This area includes the direct footprint of the proposed Casino mine and near-field effects. The boundaries of the LSA are shown as dotted line within the RSA in Figure 3.

Most of the proposed mine infrastructure will be in the Casino Creek Watershed, but some (e.g., the northern corner of the open pit) will be in the Britannia Creek Watershed. The northern part of the LSA is drained by Britannia Creek and one of its tributaries, Canadian Creek. Britannia Creek flows into the Yukon River. The northern edge of the LSA includes a 2 km-long reach of the Yukon River. The southern part of the property is drained by Casino Creek which flows south to Dip Creek and thence to the Yukon River via the Klotassin, Donjek and White rivers. The southern edge of the LSA includes a 2 km-long reach of Dip Creek.

In 2008, the aquatics Regional Study Area (RSA) was defined as the LSA plus four adjacent areas:

- ***Dip Creek Watershed***. The headwaters of Dip Creek are not expected to be affected by Project activities, but the reaches of Dip Creek downstream of the confluence of Dip and Casino creeks may be affected by a reduction in flows from Casino Creek caused by the impoundment of its headwaters. The effects of those flow reductions may decrease with downstream distance from the confluence of Dip and Casino creeks. One water quality site (W16) was placed approximately 11 km downstream of the confluence to monitor far-field effects.
- **Sunshine Creek Watershed**. This watershed, located to the east of the Britannia Creek Watershed, is not expected to be affected by Project activities. For that reason a reference water quality station – site W17 – was located on Sunshine Creek upstream of its confluence with the Yukon River.
- ***Excelsior Creek Watershed***. This watershed, located to the west of Britannia Creek Watershed, is also not expected to be affected by Project activities. It was originally intended to be the site of a reference water quality site, but that site (W17) was eventually moved to Sunshine Creek for logistical reasons. This watershed may serve as a location for a reference site in the future.
- ***Yukon River***. This river will be the receiving environment for flows from Britannia Creek. Therefore, water quality sampling stations were placed upstream (W6b – a reference site) and downstream (W6a and W15) of the confluence of Britannia Creek and the Yukon River.

In September 2009, the RSA was extended in a south-western direction to the confluence of Dip Creek and the Klotassin River (Figure 3). The RSA includes waterbodies not directly impacted but are either indirectly affected or suitable for providing references sites (mid-to-far field effects). Two water sampling stations (W20 and W21) were established in the Klotassin River: W20 downstream of the Dip Creek confluence and W21 upstream of the confluence. In addition to W20 and W21, another reference site, R2, was established on a tributary to Dip Creek in August 2009 for water quality sampling, benthos, periphyton and fish communities.

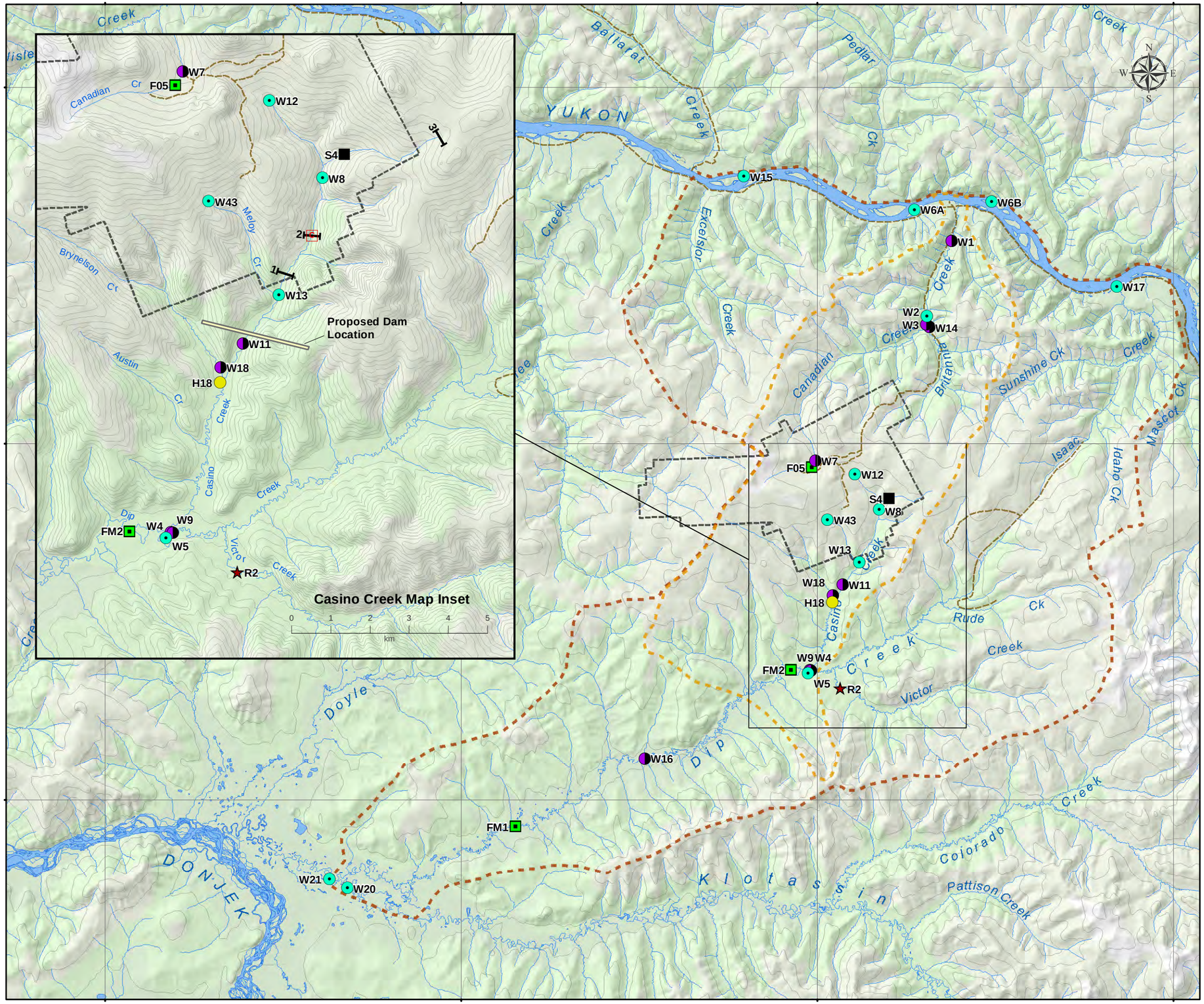

Figure 3. 2010 Casino Aquatic Sampling Sites

Drawn By: L. Grieve / M. Power
Checked By: M. Power
Date: 25 October 2011
Projection: North American Datum 1983 UTM Zone 7

1:50,000 Topographic Spatial Data: Canvec; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Digital Elevation Model provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

This document is not an official land survey and the spatial data presented is subject to change without any notice.

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EDI Environmental Dynamics Inc.

1.3 Study Objectives

As in 2008 and 2009, the overall objective of the 2010 aquatic studies was to collect information that will be used to characterize the pre-development aquatic environment of the Casino Project area. The sampling strategy was to use, as much as was possible, the same sampling sites or areas and methods that were monitored by Hallam Knight Piésold Ltd. from 1993 to 1995 in order to develop further a multi-year database that will allow assessment of natural inter-annual variability.

The specific objectives for the 2010 aquatic studies were the following:

- Continue to sample stream water quality at all sites in the LSA and RSA on a monthly basis from January through to October in order to complete a one-year continuous monthly prior to submission of the Casino Project Proposal to the Yukon Environmental and Socio-Economic Assessment Board (YESAB). Monthly water quality sampling began September 2009.
- Sample stream sediment quality at sites in the LSA and RSA that were not sampled in 2008-2009.
- Determine extent of fish presence/absence in upper Canadian Creek within the conceptual footprint of the open pit.
- Conduct a salmonid spawning assessment of the lower reaches of Dip Creek and Klottassin River near the confluence of Dip Creek.

2 Methods

2.1 Dates and Locations of Sampling Surveying

2.1.1 General

The study design for the 2010 aquatics work was similar to the study design used in 2008-2009. The same sampling locations were used and the same sampling techniques were employed. Ten sampling trips were made from January to October (Table 1). For each trip during the spring, summer and fall, a fixed-wing aircraft was chartered from Alkan Air to fly from Whitehorse to the Casino property. In the winter months, access to the site was by helicopter, while based in the town of Carmacks. While on the property, aquatic biologists travelled to sampling sites by helicopter, by all-terrain vehicles or by foot, depending on weather and trail conditions.

Table 1. Sampling Trips, Aquatic Environment, Casino Project, 2010

Date	Water Quality	Sediment Quality	Fish Assessment
January 26	X	-	-
February 24	X	-	-
March 23-25	X	-	-
April 21	X	-	-
May 8-10	X	-	-
June 14-16	X	-	-
July 7-9	X	-	-
August 8-12	X	X	X
September 14-15	X	-	-
October 15	X	-	-

Dashes indicate no data were collected.

2.1.2 Water Quality

A total of 22 sites were chosen for water quality sampling (Table 2). Seven sites were in the Casino Creek Watershed:

- W12 in Proctor Gulch, a tributary to reach 2 of Casino Creek;
- W8 in the upper reach of Casino Creek, upstream of the confluence of Meloy Creek;
- W43 on the adit discharge pipe of the lower camp (which discharges to surface about 1 km from upper Meloy Creek);
- W13 on Meloy Creek upstream of its confluence with Casino Creek;
- W11 in reach 1 of Casino Creek outside of the southern edge of the proposed TIA;
- W18 on Brynelsen Creek upstream of its confluence with reach 1 of Casino Creek; and
- W4 on reach 1 of Casino Creek upstream of its confluence with Dip Creek.

Table 2. Summary of Water Quality Sampling Sites, Casino Project, 2010

Watershed	Creek/River	Site	UTM Co-ordinates	
			Easting	Northing
Casino Creek	Procter Gulch (Casino Tributary)	W12	612,163	6,958,175
	Casino (Reach 3)	W8	613,398	6,956,258
	Casino (Reach 1)	W11	611,557	6,952,289
	Casino (Reach 1)	W4	609,833	6,947,575
	Adit	W43	610,823	6,955,906
	Meloy	W13	612,275	6,953,326
	Brynelson	W18	610,893	6,951,180
Dip Creek	Dip	W9*	610,018	6,947,352
	Dip	W5	609,219	6,947,348
	Dip	W16	600,423	6,942,454
	Victor	R2*	611,102	6,946,387
Britannia Creek	Britannia	W1	617,439	6,971,241
	Britannia	W2	616,158	6,967,156
	Britannia	W14	616,205	6,966,952
	Canadian	W3	616,141	6,966,789
	Canadian	W7	609,913	6,959,158
Yukon River	Yukon	W6a	615,375	6,973,129
	Yukon	W6b*	619,781	6,973,576
	Yukon	W15	605,721	6,975,108
Sunshine Creek	Sunshine	W17*	626,775	6,968,802
Klotassin River	Klotassin	W20	583,656	6,935,082
	Klotassin	W21	582,490	6,935,640

Dashes indicate no data were available.

**reference site.*

Four sites were in the Dip Creek Watershed:

- W9 on Dip Creek upstream of its confluence with Casino Creek;
- W5 on Dip Creek downstream of its confluence with Casino Creek;
- W16 on Dip Creek approximately 11 km downstream of site W5 – a far-field site; and
- R2 on a tributary, Victor Creek, to Dip Creek upstream of its confluence with Casino Creek.

Five sites were in the Britannia Creek Watershed:

- W1 on the lower reaches of Britannia Creek;
- W3 on Canadian Creek upstream of the confluence of Canadian and Britannia creeks;
- W14 on Britannia Creek upstream of its confluence with Canadian Creek;
- W2 on Britannia Creek just downstream of the confluence of Canadian and Britannia creeks; and
- W7 located on upper Canadian Creek.

Three sites were located on the Yukon River:

- W6a downstream from the outflow of Britannia Creek;
- W6b upstream of the outflow of Britannia Creek; and
- W15 upstream of the outflow of Excelsior Creek.

Two sites were located on the Klotassin River:

- W20 upstream from its confluence with Dip Creek – a far-field site; and

- W21 downstream from its confluence with Dip Creek – a far-field site.

One site – W17 – was on Sunshine Creek upstream of its confluence with the Yukon River.

Of these 22 sites, four – W9, W17, W6b and R2 – are reference sites, 17 sites are potentially affected by future mine activities, and one – W43 – has already been disturbed by the adit discharge pipe releasing groundwater, a source of natural ARD.

2.1.3 Sediment Quality

A total of five stream sites were sampled for sediment quality between August 8 and 9, 2010:

Two were located on the Yukon River:

- W6a downstream from the outflow of Britannia Creek and
- W6b upstream of the outflow of Britannia Creek.

Two sites were located on the Klotassin River:

- W20 upstream from its confluence with Dip Creek – a far-field site; and
- W21 downstream from its confluence with Dip Creek – a far-field site.

One site on Casino Creek:

- S4 upper Casino Creek (Reach 3) upstream of the confluence with Proctor Gulch

The co-ordinates of the sites are shown in Table 2. Site S4 is a historic site sampled in 1993 by Hallam Knight Piesold (HKP, 1993). Twelve stream sites in Britannia Creek, Casino Creek and Dip Creek watersheds (W1, W2, W3, W7, W14, W4, W11, W12, W8, W13, W9, R2 and W5) were previously sampled in 2008-2009 for sediment quality.

2.1.4 Fish Assessment

Fish communities within Dip and Canadian Creek were sampled using minnow traps and electrofishing from August 10-12 in 2010. The main purpose of the sampling program on Dip Creek was to repeat the DFO survey conducted in 1994, where juvenile chinook salmon were captured using minnow traps. The Canadian Creek survey was conducted to determine presence/absence of fish upstream of a 20% gradient barrier on Canadian Creek.

Three sites were sampled for fish (Figure 3 and Table 3):

- FM1 on Dip Creek halfway between W16 and the confluence with Klotassin River;
- FM2 on Dip Creek just downstream of the confluence with Casino Creek;
- F05 on upper Canadian Creek (2 segments sampled).

In addition to fish sampling, a Chinook spawning survey was conducted on August 10 by helicopter of the Klotassin River from its confluence with the Donjek River and 10km of Dip Creek from its confluence with the Klotassin River.

Table 3. Summary of Fish Assessments and Spawning Surveys Casino Project, 2010

Creek/River	Site	Spawning Assessment	Minnow Trapping	Electrofishing	UTM Coordinates
					Easting Northing
Dip	FM1	-	Aug 10	-	0593032 6938516
Dip	FM2	-	Aug 10	-	0608536 6947307
Canadian	F05	-	Aug 10	Aug 12	0609904 6959022
Klotassin	n/a	Aug 10	-	-	576564 6938058 to 583295 6935574
Dip	n/a	Aug 10	-	-	583290 6935577 to 589671 6936790

Dashes indicate no sampling at that site and date.

2.2 Sample Collection

2.2.1 Water Quality

All surface water samples were grab samples, collected in mid-stream approximately 20 cm under the surface with the bottle mouths facing upstream. Water quality samples were collected for general chemical parameters in two pre-cleaned 1 L plastic bottles supplied by the analytical laboratory. Samples for total metals were collected in 120 mL acid-washed plastic bottles supplied by the laboratory and preserved in the field with laboratory-supplied nitric acid. Samples for dissolved metals were filtered in the field through 0.45-micron disposable filterware and preserved with laboratory-supplied nitric acid immediately after filtration. Samples for nutrients – ammonia, total Kjeldhal nitrogen (TKN), Total Organic Carbon (TOC), and dissolved orthophosphate – were collected in 120 mL bottles and preserved in the field with laboratory-supplied sulphuric acid. Total cyanide was collected in 120 mL bottles and preserved in the field with laboratory-supplied sodium hydroxide.

All samples were kept cold and were not allowed to freeze. They were shipped via air cargo from Whitehorse to Maxxam Analytics in Vancouver, BC. Maxxam Analytics is accredited by the Canadian Association for Environmental Analytical Laboratories. Chain of Custody forms accompanied all samples. Table 4 shows the water quality variables that were measured and their Reported Detection Limits (RDL).

Table 4. Water Quality Parameters and Detection Limits

Parameter	Units	RDL	Parameter	Units	RDL
Physical			**Total and Dissolved Metals**		
Conductivity	μS/cm	1	Boron	mg/L	0.005
pH	pH units	0.1	Cadmium	mg/L	0.000005
Hardness	mg/L $CaCO_3$	0.5	Calcium	mg/L	0.05
Total Dissolved Solids (TDS)	mg/L	1	Chromium	mg/L	0.0001
Total Suspended Solids (TSS)	mg/L	1	Cobalt	mg/L	0.000005

Parameter	Units	RDL	Parameter	Units	RDL
Turbidity	NTU	0.1	Copper	mg/L	0.00005
Anions			Iron	mg/L	0.001
Alkalinity	mg/L $CaCO_3$	0.5	Lead	mg/L	0.000005
Acidity (pH 8.3)	mg/L $CaCO_3$	0.5	Lithium	mg/L	0.0005
Bromide	mg/L	0.1	Magnesium	mg/L	0.05
Chloride	mg/L	0.5	Manganese	mg/L	0.00005
Fluoride	mg/L	0.01	Mercury	mg/L	0.00001
Sulphate	mg/L	0.5	Molybdenum	mg/L	0.00005
Cyanide (Total)	mg/L	0.0005	Nickel	mg/L	0.00002
Cyanide (Weak Acid Dissociable)	mg/L	0.0005	Phosphorus	mg/L	0.002
Nutrients			Potassium	mg/L	0.05
Ammonia (as N)	mg/L	0.005	Selenium	mg/L	0.00004
Nitrate (as N)	mg/L	0.005	Silicon	mg/L	0.1
Nitrite (as N)	mg/L	0.002	Silver	mg/L	0.000005
Total Kjeldahl Nitrogen	mg/L	0.02	Sodium	mg/L	0.05
Ortho-phosphate (as P)	mg/L	0.001	Strontium	mg/L	0.00005
Total and Dissolved Metals			Thallium	mg/L	0.000002
Aluminum	mg/L	0.0002	Tin	mg/L	0.00001
Antimony	mg/L	0.00002	Titanium	mg/L	0.0005
Arsenic	mg/L	0.00002	Uranium	mg/L	0.000002
Barium	mg/L	0.00002	Vanadium	mg/L	0.0002
Beryllium	mg/L	0.00001	Zinc	mg/L	0.0001
Bismuth	mg/L	0.000005	Zirconium	mg/L	0.0001

RDL = Reported Detection Limit from Maxxam Analytics.

μS = micro-Siemens, and NTU = nephelometric units.

Field measurements of pH, temperature and specific electrical conductivity were made at each site using a YSI Pro 556 pH/conductivity/temperature meter.

2.2.2 Sediment Quality

Sediment samples were collected using established protocols from depositional areas of the stream. Where possible, sediment samples were collected using the jar provided by the analytical lab as a scoop. Appropriate measures were taken to reduce potential for sample contamination. For example, field staff wore disposable nitrile gloves when sampling. All samples were kept cold at all times between sample collection and delivery to the laboratory. Chain of Custody forms accompanied all samples. Table 5 shows the sediment quality variables that were measured and their detection limits.

Table 5. Sediment Quality Parameters and Detection Limits

Parameter	Units	RDL	Parameter	Units	RDL
Physical					
Percent moisture		0.3	Manganese	mg/kg	0.2
pH	pH units	0.01	Mercury	mg/kg	0.05
Total Metals			Molybdenum	mg/kg	0.1
Aluminum	mg/kg	100	Nickel	mg/kg	0.8
Antimony	mg/kg	0.1	Phosphorus	mg/kg	10
Arsenic	mg/kg	0.2	Potassium	mg/kg	100
Barium	mg/kg	0.1	Selenium	mg/kg	0.5
Beryllium	mg/kg	0.1	Silver	mg/kg	0.05
Bismuth	mg/kg	0.1	Sodium	mg/kg	100

Parameter	Units	RDL	Parameter	Units	RDL
Cadmium	mg/kg	0.05	Strontium	mg/kg	0.1
Calcium	mg/kg	100	Thallium	mg/kg	0.05
Chromium	mg/kg	1	Tin	mg/kg	0.1
Cobalt	mg/kg	0.3	Titanium	mg/kg	1
Copper	mg/kg	0.5	Vanadium	mg/kg	2
Iron	mg/kg	100	Zinc	mg/kg	1
Lead	mg/kg	0.1	Zirconium	mg/kg	0.5
Magnesium	mg/kg	100			

RDL = Reported Detection Limit from Maxxam Analytics.

2.2.3 Fish Assessment and Spawning Survey

Determining presence/absence of fish was completed following standards established by the Ministry of Environment, Lands and Parks and Ministry of Forests (Johnston and Slaney, 1996). A cascade barrier downstream (20% gradient) was established on June 24, 2010 and then the upstream section of the creek was assessed for deep pools or lakes that may contain overwintering habitat. As the Casino project area is situated in unglaciated areas of the Yukon, no lakes are present. Once an initial assessment was completed on the habitat, electrofishing was conducted on a 200 m section of the creek and as a second method of fish assessment, minnow traps were set.

Between two and four minnow traps were installed at each of three sites in August. Minnow traps are made of galvanized steel wire and are conical in shape with a length of 42 cm, a width of 23 cm and a mesh size of 0.6 cm. Minnow traps were placed at each site in deep pools or among large woody debris or in slow-moving eddies. They were anchored to large woody debris or rocks and rocks were placed within the traps to weight them down. They were marked with red or yellow fluorescent flagging tape. Each trap was baited with salmon roe placed in a small perforated bag. Traps were soaked for approximately 24 hours.

Electrofishing was conducting using a two-person crew and a backpack electrofishing unit. A mixture of single-pass and spot fishing methods were used, while walking the stream in an upstream direction repeatedly sweeping the stream from bank to bank with the wand (anode) of the electrofishing unit. Fish were captured with a dipnet and stored in a bucket of freshwater.

All fish were identified to species and counted. Fork length was measured to the nearest 1 mm with a measuring board (total length was measured for slimy sculpin), and wet weight was measured to the nearest 0.1 g or 1.0 g with a balance (depending on size of fish).

Spawning surveys were conducted by two qualified fisheries biologists, using a Bell Jet Ranger helicopter hovering just above the tree line and travelling at a slow enough speed to allow observers seated on both sides of the helicopter to observe spawning activity. The water was clear, and there were no rain events 72 hours prior to conducting the survey.

2.3 QA/QC

2.3.1 Water Quality

All field equipment was maintained in good working condition and measuring instruments were calibrated frequently. For example, the pH meter was calibrated prior to each field trip using prepared solutions with pHs of 4, 7 and 10, and the conductivity meter was checked prior to each field trip using the standard 1,413 µS/cm conductivity solution.

Water quality samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency. All water samples were collected using industry standard sampling protocols. Appropriate measures were taken to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used bottles and preservative supplied by the analytical laboratory. All samples were collected with the mouth of the sampling bottle facing upstream. Care was taken to insure that no upstream disturbances occurred as the result of walking within the creek bed prior to sampling.

Approximately ten percent of the number of water quality samples were replicated, hence a total of twelve replicate samples were collected: one each in January, February, March, two in May, one in June, two each in July, August and September. Replicate sample locations were chosen randomly. Appendix A8 shows the results of analysis of replicate samples. Relative Percent Difference (RPD) was used to assess analytical variability. RPD was defined as:

$$\%RPD = \frac{2(X_1 - X_2)}{(X_1 + X_2)} * 100$$

where X_1 = the concentration of a parameter in the first sample and X_2 = the concentration of the same parameter in the second sample (i.e., the replicate). An RPD less than 25% is considered an acceptable difference, and an RPD greater than 25% warrants further examination to ensure that the result was not due to sampling error or analytical error. RPD is only relevant when both values are greater than the Practical Quantitation Limit (PQL), which was defined for this project as three times the detection limit. The PQL is considered the lowest concentration that can be accurately measured, as opposed to just detected.

As shown in Appendix A8 and Table 6, between one and nine of the 90 parameters that were measured from each sample had RPDs greater than 25% and met PQL restrictions. This was equivalent to between 1% and 10% of all parameters, which is considered to be an acceptable level of variability.

Table 6. RPD Analysis of Replicate Water Quality Samples, Casino Project, 2010

Month	Replicate	Number of Parameters with RPD>25%	Percent of Parameters with RPD>25%
January	1	3	3.3
February	2	2	2.2
March	3	8	8.9

Month	Replicate	Number of Parameters with RPD>25%	Percent of Parameters with RPD>25%
May	4	3	3.3
May	5	5	5.6
June	6	2	2.2
July	7	6	6.7
July	8	3	3.3
August	9	9	10.0
August	10	7	7.8
September	11	1	1.1
September	12	2	2.2

A total of 90 parameters were measured from each sample.

The sites, dates and parameters for which RPD was greater than 25% were as follows:

- W2, January, ammonia, TKN, total zinc and dissolved cadmium;
- W21, February, TOC, total lead;
- W3, March, TSS, turbidity, DOC, total cobalt, total iron, total manganese, dissolved iron and dissolved manganese;
- W11, May, dissolved lead, dissolved nickel and dissolved zinc;
- W21, May, dissolved aluminum, dissolved copper, dissolved lead, dissolved nickel and dissolved zinc;
- W12, June, TSS and dissolved chromium;
- W8, July, TOC, acidity, total cadmium, dissolved aluminum dissolved iron and dissolved lead;
- W16, July, total aluminum, total lead, total zinc,
- W7, August, turbidity, TOC, DOC, ammonia, fluoride, total aluminum, total iron, total lead, total manganese;
- W5, August, TSS, ammonia, total cobalt, total lead, total manganese, total titanium, total zinc;
- W18, September, total lead; and
- W7, September, total uranium and dissolved uranium.

The results of the field and travel blanks are shown in Appendices A1 to A7. A total of six field blanks and four travel blanks were collected. Slight elevation of total lead was found in the June field blank. Similarly, slight elevations of ammonia, total and dissolved lead and dissolved zinc were found in the August field blank and TKN in the September field blank. This indicates there may have been very minor contamination associated with either field or lab technique. All other values were below detection limits, indicating no contamination of samples.

Maxxam Analytics, which conducted the analyses of water and sediment samples, is a certified member of the Canadian Association of Environmental Analytical Laboratories. Maxxam split several samples into duplicates and analyzed each one separately to provide a measure of their laboratories analytical precision. Duplicates were chosen randomly by Maxxam. The results, which are not reported here, met Maxxam's standards for QA/QC.

2.3.2 Sediment Quality

Sediment quality samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency. All sediment samples were collected using industry standard sampling protocols. Appropriate measures were taken to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used sample bottles supplied by the analytical laboratory.

One sediment sample was replicated. Appendix B2 and Table 11 shows the results of analysis of replicate samples. Relative Percent Difference (RPD) was used to assess analytical variability. RPD was defined above in Section 2.3.1, however, as natural heterogeneity in a soil matrix is more prominent than in water samples, accepted RPD values is 50%. The PQL for sediment samples was defined as five times the detection limit.

As shown in Appendix B2 zero (0) of the 34 parameters measured had an RPD greater than 50% and met PQL restrictions. RPD analysis for total bismuth did exceed 50% but the concentration, 0.1-0.2 mg/kg was within 1-2 times the RDL of 0.1 mg/kg.

Table 7. RPD Analysis of Replicate Sediment Quality Samples, Casino Project, 2010

Month	Replicate	Number of Parameters with RPD>50%	Percent of Parameters with RPD>50%
August	1	0	0

A total of 34 parameters were measured from each sample.

2.3.3 Fish Assessment

All fish assessment field data were recorded on waterproof paper field notes and then transferred to electronic spreadsheets in the office. The spreadsheets were compared with the field notes to identify and correct transcription errors.

2.4 Data Analysis

2.4.1 Water Quality

The minimum, median and maximum concentrations of selected water quality parameters were calculated for each site sampled in 2010. The median, rather than the arithmetic mean, was assumed to be the best estimate of the central tendency of the data because many water quality variables tend not to be normally distributed. To calculate statistics, all data for each site were pooled over the January-October sampling period and values below detection limits were replaced with one-half the detection limit.

Concentrations of water quality parameters were compared to guidelines for the protection of freshwater aquatic life issued by the Canadian Council of the Ministers of the Environment (CCME) (CCME, 2007), and parameters exceeding the guidelines were identified.

2.4.2 Sediment Quality

The 2010 sediment quality data were compared to the CCME (2002) sediment guidelines for the protection of freshwater aquatic life. There are two classes of guidelines: the Probable Effects Level (PEL), which defines the level above which adverse effects are expected to occur frequently and the Interim Sediment Quality Guideline (ISQG), which is lower than the PEL and defines the concentration below which minimal effects on the aquatic environment are expected.

2.4.3 Fish Assessment

As a very few number of fish were caught, no data analyses were conducted for the purposes of this technical report.

3 Results and Discussion

3.1 Water Quality

3.1.1 Statistical Summary

Appendices A1 to A7 show the surface water quality data for the months of January, February, March, April, May, June, July, August, September and October of 2010, and Table 8, Table 9, Table 10, and Table 11 show the minimum, median and maximum values for selected water quality parameters for sites in Casino Creek, Dip Creek, Britannia Creek, and the Yukon River watersheds, respectively.

Station	Hardness (mg/L $CaCO_3$)	Conductivity (uS/cm)	pH	TSS	Ammonia as N	Total Alkalinity (mg/L $CaCO_3$)	Sulfate	Total Cyanide	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Total Zinc
CCME [1]			6.5-9.0		0.137[a]			0.005	0.005-0.1[b]	0.005	[c]	0.001	0.002-0.004[d]	0.3	0.001-0.007[e]	0.073	0.025-0.15[f]	0.001	0.03
W12 - Proctor Gulch before confluence with Casino Creek																			
Min	190	647	3.10	5	0.037	0.25	220	0.00025	5.95	0.00030	0.00156	0.0005	0.486	17.1	0.00106	0.00007	0.0046	0.0002	0.124
Median	286	930	3.35	12	0.065	0.25	380	0.00025	8.04	0.00041	0.00244	0.0006	0.791	23.8	0.00158	0.00016	0.0058	0.0002	0.175
Max	502	1350	3.80	18	0.090	0.25	620	0.00025	14.50	0.00081	0.00364	0.0008	1.30	33.5	0.00273	0.00023	0.0092	0.0003	0.309
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
W8 - Upper Reach of Casino Creek us of confluence with Meloy Creek																			
Min	75	155	7.00	3	0.005	21	56	0.00025	0.36	0.00028	0.000152	0.0001	0.032	0.4	0.00025	0.00015	0.0009	0.00004	0.013
Median	103	220	7.42	5	0.016	35	66	0.00025	0.54	0.00030	0.000215	0.0002	0.060	0.9	0.00029	0.00021	0.0009	0.00006	0.016
Max	107	271	7.60	9	0.048	38	95	0.00060	0.70	0.00038	0.000307	0.0002	0.08	1.5	0.00030	0.00023	0.0010	0.00007	0.022
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W13 - Mouth of Meloy Creek																			
Min	101	201	7.83	3	0.013	84	19	0.00025	0.04	0.00151	0.000050	0.0001	0.001	0.1	0.00398	0.00045	0.0003	0.00005	0.003
Median	116	245	7.98	10	0.030	102	27	0.00025	0.15	0.00171	0.000096	0.0002	0.002	0.2	0.01224	0.00059	0.0006	0.00005	0.007
Max	131	289	8.12	17	0.047	120	34	0.00025	0.25	0.00190	0.000142	0.0004	0.003	0.3	0.02050	0.00072	0.0010	0.00005	0.011
n	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
W11 - Casino Creek (proposed dam outflow)																			
Min	105	210	7.80	2	0.003	57	44	0.00025	0.09	0.00058	0.000044	0.0001	0.005	0.1	0.00029	0.00034	0.0004	0.00009	0.002
Median	109	263	7.89	8	0.014	71	62	0.00025	0.23	0.00075	0.000081	0.0002	0.017	0.4	0.00132	0.00057	0.0006	0.00010	0.007
Max	141	298	8.10	40	0.260	89	71	0.00060	0.59	0.00152	0.000117	0.0010	0.03	1.0	0.00285	0.00084	0.0015	0.00012	0.009
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
W18 - Brynelsen Creek																			
Min	44	82	7.51	1	0.003	32	3	0.00025	0.02	0.00031	0.000008	0.0001	0.001	0.0	0.00000	0.00069	0.0002	0.00002	0.000
Median	59	126	7.80	2	0.016	45	16	0.00025	0.10	0.00040	0.000016	0.0002	0.002	0.1	0.00007	0.00103	0.0004	0.00002	0.002
Max	120	264	8.20	19	0.190	98	45	0.00100	0.49	0.00058	0.000061	0.0007	0.002	0.6	0.00058	0.00222	0.0011	0.00005	0.008
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
W4 - Mouth of Casino Creek																			
Min	85	172	7.40	1	0.003	58	29	0.00025	0.02	0.00034	0.000012	0.0001	0.002	0.0	0.00010	0.00079	0.0002	0.00006	0.001
Median	98	201	7.86	4	0.021	69	36	0.00025	0.09	0.00046	0.000026	0.0001	0.006	0.2	0.00020	0.00110	0.0004	0.00006	0.002
Max	156	326	8.20	7	0.250	110	66	0.00060	0.19	0.00055	0.000034	0.0004	0.010	0.3	0.00106	0.00136	0.0005	0.00008	0.002
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH $\geq$ 6.5, $[Ca^{2+}]$ $\geq$ 4 mg/L, DOC $\geq$ 2 mg/L

c) $10^{\{0.86[\log(hardness)]-3.2\}}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

0.231 result exceeds CCME Aquatic Life Guidelines

Station	Hardness (mg/L $CaCO_3$)	Conductivity (uS/cm)	pH	TSS	Ammonia as N	Total Alkalinity (mg/L $CaCO_3$)	Sulfate	Total Cyanide	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Silver	Total Zinc
CCME [1]			6.5-9.0		0.137[a]			0.005	0.005-0.1[b]	0.005	[c]	0.001	0.002-0.004[d]	0.3	0.001-0.007[e]	0.073	0.025-0.15[f]	0.001	0.0001	0.03
W9 - Dip Creek																				
us of Confluence with Casino Creek																				
Min	57	128	7.60	1	0.003	53.00	10	0.00025	0.01	0.00019	0.000003	0.0001	0.001	0.01	0.00002	0.00043	0.0002	0.00002	0.0000025	0.0003
Median	80	165	7.80	4	0.005	71.50	15	0.00025	0.06	0.00034	0.000011	0.0002	0.001	0.14	0.00009	0.00059	0.0004	0.00004	0.0000025	0.0007
Max	128	265	8.30	64	0.083	110.00	33	0.00070	0.47	0.00074	0.000021	0.0007	0.002	0.89	0.00062	0.00072	0.0010	0.00006	0.0000025	0.0035
n	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
W5 - Dip Creek																				
ds Casino confluence																				
Min	69	144	7.67	1	0.003	55.00	16	0.00025	0.03	0.00027	0.000003	0.0001	0.001	0.1	0.00009	0.00065	0.0003	0.00004	0.0000025	0.0008
Median	81	155	7.85	5	0.058	65.00	20	0.00025	0.10	0.00037	0.000016	0.0002	0.002	0.18	0.00012	0.00078	0.0005	0.00005	0.0000025	0.0012
Max	136	285	8.20	11	0.260	110.00	45	0.00060	0.18	0.00043	0.000019	0.0004	0.004	0.29	0.00058	0.00089	0.0006	0.00007	0.0000025	0.0020
n	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
R2																				
Min	45	100	7.60	1	0.003	43.00	9	0.00025	0.01	0.00013	0.000003	0.0001	0.001	0.01	0.00000	0.00059	0.0003	0.00002	0.0000025	0.0003
Median	67	147	7.70	2	0.005	58.00	14	0.00025	0.04	0.00024	0.000003	0.0002	0.001	0.06	0.00003	0.00065	0.0004	0.00006	0.0000025	0.0005
Max	94	208	7.90	9	0.070	79.00	28	0.00060	0.31	0.00035	0.000010	0.0006	0.003	0.35	0.00014	0.00091	0.0009	0.00007	0.0000025	0.0017
n	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
W16 - Lower Reach of Dip Creek																				
Min	71	148	7.73	1	0.003	55.00	20	0.00025	0.02	0.00038	0.000013	0.0001	0.001	0.10	0.00003	0.00062	0.0004	0.00004	0.0000025	0.0004
Median	93	177	7.84	4	0.025	68.00	27	0.00025	0.07	0.00054	0.000017	0.0003	0.002	0.24	0.00008	0.00080	0.0007	0.00006	0.0000025	0.0010
Max	154	327	8.30	20	0.260	120.00	62	0.00070	0.33	0.00073	0.000021	0.0007	0.004	0.65	0.00038	0.00094	0.0013	0.00008	0.0000025	0.0019
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
W20 - Klotass in river us of Dip Creek																				
Min	57	129	7.60	1	0.003	56.00	12	0.00025	0.005	0.00029	0.000003	0.0002	0.001	0.18	0.00001	0.00051	0.0004	0.00009	0.0000025	0.0002
Median	74	165	7.72	2	0.030	66.00	18	0.00025	0.04	0.00036	0.000012	0.0002	0.001	0.22	0.00007	0.00058	0.0006	0.00012	0.0000025	0.0007
Max	86	187	8.10	6	0.170	73.00	28	0.00070	0.12	0.00192	0.000020	0.0005	0.002	1.90	0.00015	0.00064	0.0009	0.00022	0.0000025	0.0015
n	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
W21 - Klotass in river ds of Dip Creek																				
Min	57	131	7.50	1	0.003	53.00	13	0.00025	0.005	0.00044	0.000005	0.0002	0.001	0.29	0.00002	0.00056	0.0005	0.00010	0.0000025	0.0003
Median	75	169	7.72	3	0.030	69.00	20	0.00025	0.03	0.00056	0.000011	0.0002	0.001	0.43	0.00004	0.00064	0.0006	0.00012	0.0000025	0.0006
Max	108	242	8.10	8	0.200	91.00	39	0.00070	0.13	0.00117	0.000018	0.0005	0.002	1.18	0.00015	0.00108	0.0012	0.00017	0.0000025	0.0022
n	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH $\geq$ 6.5, $[Ca^{2+}]$ $\geq$ 4 mg/L, DOC $\geq$ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

0.231 result exceeds CCME Aquatic Life Guidelines

Station	Hardness (mg/L $CaCO_3$)	Conductivity (uS/cm)	pH	TSS	Ammonia as N	Total Alkalinity (mg/L $CaCO_3$)	Sulfate	Total Cyanide	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Silver	Total Zinc
CCME [1]			6.5-9.0		0.137[a]			0.005	0.005-0.1[b]	0.005	[c]	0.001	0.002-0.004[d]	0.3	0.001-0.007[e]	0.073	0.025-0.15[f]	0.001	0.0001	0.03
W7 - Upper Canadian Creek																				
Min	25	58	6.70	1	0.003	5.70	15	0.00025	0.03	0.00015	0.000108	0.0001	0.002	0.02	0.00002	0.00020	0.0007	0.0000	0.0000025	0.009
Median	40	125	6.95	1	0.040	7.25	45	0.00025	0.08	0.00026	0.000187	0.0003	0.003	0.06	0.00005	0.00024	0.0011	0.0001	0.0000025	0.016
Max	53	145	7.30	37	0.250	12.00	54	0.00080	0.48	0.00089	0.000427	0.0005	0.009	0.65	0.00070	0.00049	0.0020	0.0002	0.0000120	0.023
n	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
W3 - Canadian Creek us of confluence with Britannia Creek																				
Min	90	191	7.70	1	0.003	52.00	32	0.00025	0.01	0.00038	0.000012	0.0001	0.001	0.00	0.00001	0.00066	0.0005	0.0000	0.0000025	0.001
Median	128	266	7.85	1	0.010	72.00	63	0.00025	0.02	0.00065	0.000020	0.0001	0.002	0.03	0.00005	0.00087	0.0007	0.0001	0.0000025	0.001
Max	189	394	8.00	14	0.052	110.00	110	0.00090	0.07	0.00075	0.000033	0.0003	0.004	0.08	0.00014	0.00137	0.0011	0.0001	0.0000025	0.002
n	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
W14 - Mouth of Britannia Creek																				
Min	61	110	7.60	1	0.003	35.00	18	0.00025	0.03	0.00045	0.000003	0.0001	0.001	0.04	0.00001	0.00020	0.0005	0.0001	0.0000025	0.000
Median	104	252	7.91	2	0.020	83.00	50	0.00080	0.06	0.00057	0.000005	0.0003	0.002	0.05	0.00002	0.00049	0.0005	0.0001	0.0000025	0.001
Max	202	411	8.20	8	0.050	120.00	110	0.00150	0.42	0.00070	0.000014	0.0005	0.002	0.37	0.00010	0.00068	0.0010	0.0001	0.0000025	0.003
n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
W2 - Brittania Creek ds from confluence of Canadian Creek																				
Min	83	173	7.70	1	0.003	50.00	33	0.00025	0.01	0.00041	0.000010	0.0001	0.001	0.00	0.00002	0.00040	0.0005	0.0001	0.0000025	0.001
Median	127	259	7.84	2	0.011	76.00	58	0.00038	0.04	0.00062	0.000014	0.0002	0.002	0.05	0.00005	0.00073	0.0007	0.0001	0.0000025	0.001
Max	211	445	8.10	4	0.081	120.00	110	0.00100	0.30	0.00080	0.000030	0.0005	0.003	0.26	0.00020	0.00152	0.0011	0.0002	0.00001	0.006
n	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
W1 - Mouth of Canadian Creek																				
Min	97	193	7.60	1	0.003	54.00	40	0.00025	0.01	0.00037	0.000009	0.0001	0.001	0.01	0.00001	0.00047	0.0005	0.0001	0.0000025	0.000
Median	135	283	7.81	2	0.005	78.50	65	0.00025	0.03	0.00058	0.000015	0.0002	0.002	0.03	0.00002	0.00078	0.0006	0.0001	0.0000025	0.001
Max	248	492	8.20	7	0.052	120.00	140	0.00100	0.24	0.00074	0.000027	0.0003	0.003	0.26	0.00012	0.00108	0.0011	0.0001	0.0000025	0.002
n	8	8	8	8	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH $\geq$ 6.5, $[Ca^{2+}]$ $\geq$ 4 mg/L, DOC $\geq$ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

0.231 result exceeds CCME Aquatic Life Guidelines

Station	Hardness (mg/L $CaCO_3$)	Conductivity (uS/cm)	pH	TSS	Ammonia as N	Total Alkalinity (mg/L $CaCO_3$)	Sulfate	Total Cyanide	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Silver	Total Zinc
CCME [1]			6.5-9.0		0.137[a]			0.005	0.005-0.1[b]	0.005	[c]	0.001	0.002-0.004[d]	0.3	0.001-0.007[e]	0.073	0.025-0.15[f]	0.001	0.0001	0.03
W6b - Yukon River Upstream of Canadian Creek																				
Min	93	190	7.80	1	0.003	73.00	21	0.00025	0.002	0.00022	0.000014	0.0001	0.0004	0.02	0.00002	0.00080	0.0004	0.0004	0.000003	0.001
Median	104	204	8.00	5	0.010	80.00	25	0.00025	0.08	0.00048	0.000023	0.0001	0.0009	0.14	0.00012	0.00114	0.0010	0.0005	0.000003	0.003
Max	117	225	8.20	46	0.060	92.00	33	0.00025	0.49	0.00106	0.000238	0.0006	0.0038	0.90	0.00079	0.00126	0.0065	0.0007	0.000010	0.018
n	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
W6a - Yukon River downstream of Canadian Creek																				
Min	76	164	7.80	1	0.003	69.00	18	0.00025	0.002	0.00014	0.000008	0.0001	0.0003	0.002	0.000003	0.00082	0.0003	0.0003	0.000003	0.001
Median	98	193	8.01	21	0.007	75.50	25	0.00025	0.05	0.00050	0.000033	0.0001	0.0011	0.27	0.00009	0.00102	0.0012	0.0004	0.000003	0.004
Max	115	246	8.20	46	0.051	96.00	34	0.00025	0.48	0.00106	0.000203	0.0008	0.0034	0.89	0.00074	0.00120	0.0042	0.0007	0.000008	0.015
n	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
W15 - Island on Yukon River us from outflow of Excelsior Creek																				
Min	87	164	7.80	1	0.005	69.00	21	0.00025	0.002	0.00014	0.000003	0.0001	0.0002	0.001	0.00001	0.00079	0.0002	0.0003	0.000003	0.001
Median	102	206	8.00	6	0.010	77.00	24	0.00025	0.02	0.00045	0.000017	0.0001	0.0007	0.02	0.00007	0.00083	0.0006	0.0005	0.000003	0.001
Max	109	217	8.10	68	0.047	92.00	32	0.00025	0.64	0.00134	0.000323	0.0009	0.0045	1.26	0.00119	0.00128	0.0062	0.0006	0.000008	0.025
n	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH $\geq$ 6.5, $[Ca^{2+}]$ $\geq$ 4 mg/L, DOC $\geq$ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

0.231	result exceeds CCME Aquatic Life Guidelines

3.1.2 Exceedances of Water Quality Guidelines

Table 12 shows that CCME guidelines for protection of freshwater aquatic life were exceeded for pH, and seven total metals: aluminum (Al), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), zinc (Zn) and mercury (Hg) in 2010. CCME guidelines were exceeded for at least one parameter at all sites. The number of exceedances was highest for copper, aluminum, iron and cadmium and least for mercury (Figure 4). Exceedances of aluminum, cadmium, copper and iron often occurred together at the same sites. Exceedances were least numerous in January to March (n=1), picked up in April (n=10), most numerous in May to August (n=45, n=46, n=36, n=34, respectively) and tapered off in September (n=24) and October (n=6), indicating a seasonal trend related to hydrological factors such as snow melt and stream flow.

Table 12. Water Quality Parameters Exceeding CCME Guidelines, Casino Project, 2010

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
W12	NS	NS	NS	NS	pH, Al, Cd, Cu, Fe, Zn	pH, Al, Cd, Cu, Fe, Zn	pH, Al, Cd, Cu, Fe, Zn	pH, Al, Cd, Cu, Fe, Zn	NS	NS
W8	NS	NS	NS	NS	Al, Cd, Cu, Fe	NS	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	NS	NS
W13	NS	NS	NS	NS	-	NS	Cd	Al, Cd, Cu, Fe, Pb	NS	NS
W11	NS	NS	NS	Cd, Cu	Al, Cd, Cu, Fe	Ammonia, Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe, Pb	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe
W18	NS	NS	NS	Cd	Al	Al, Cd, Cu, Fe	Al	Ammonia, Al, Cd	-	-
W4	NS	NS	NS	-	Cu	Ammonia, Al, Cu	Cu	Al, Cd, Cu	Al, Cu	Cu
W9	-	-	-	-	Al, Fe	Al	-	Al	Al	-
W5	NS	NS	NS	-	NS	Ammonia, Al, Cu	NS	Al, Cu	Cu	Cu
R2	-	-	-	NS	-	-	-	Al, Cu, Fe	Al	-
W16	NS	NS	NS	-	Cu, Fe	Ammonia, Cu	Cu	Al, Cu, Fe	Al, Cu, Fe	-
W20	Fe	Fe	Fe	Fe	-	-	-	Al	-	NS
W21	Fe	Fe	Fe	Fe	Fe	Fe	-	Ammonia, Al, Cu, Fe	Al, Cu, Fe	NS
W7	NS	NS	NS	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	Ammonia, Cd, Cu	Cd, Cu	Cd, Cu	Cd, Cu	NS
W3	-	-	-	-	Cu	-	Cu	Cu	Cu	-
W14	NS	NS	NS	-	Al, Cu, Fe	-	-	-	Al	-
W2	-	NS	-	-	Al, Cu	-	Cu	Cu, Hg	Cu	NS
W1	-	NS	NS	-	Al, Cu	-	Cu	Cu	Cu	-
W6b	-	-	-	-	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	-	Cd	NS
W6a	NS	-	-	Fe	Al, Cd, Cu, Fe	Al, Cd, Cu, Fe	Al, Cd, Fe	-	Cd	NS
W15	-	-	-	-	Al, Cd, Cu, Fe	NS	Al, Cd, Cu, Fe	NS	Cd	NS

Dashes indicate no parameters exceeded CCME guidelines. NS = Not sampled.

Figure 4. Water Quality Exceedances of CCME Guidelines, Casino Project, 2010

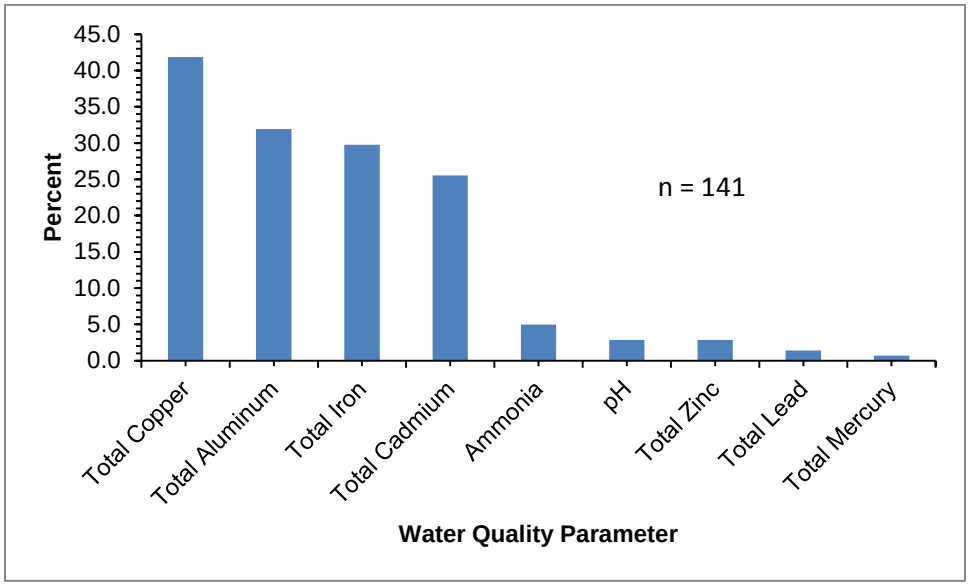


Figure 5, Figure 6 and Figure 7 show the spatial distribution of concentrations of copper, iron and lead, respectively. These spatial distributions show the median concentrations of metals from an upstream to downstream order within the main creeks/rivers of the Casino aquatic regional study area. The error bars represent the minimum and maximum values and the red dashed line represent the CCME guideline for the protection of aquatic life. The spatial distribution of copper concentrations, shown in Figure 5, is a representative pattern for aluminum, cadmium, lead, iron and zinc concentrations in Casino Creek. All of these metals show the highest concentration is observed at Proctor Gulch (W12), a small alpine stream that confluences with the headwaters of Casino Creek. Downstream of the confluence of Proctor Gulch, site W8 shows the next highest concentration. Concentrations of these metals continue to decrease with successive sites downstream (W11 and W4). Meloy (W13) and Brynelson (W18) creeks have low concentrations of these metals and as they flow into Casino Creek and appear to dilute the high metal concentrations in Casino Creek.

Background levels (R2 and W9) in Dip Creek have low concentrations of these metals and appear to be slightly elevated at the site just downstream of the confluence with Casino Creek (W5). Metal concentrations then decrease in a downstream trend to the Klotassin River. The exception is with iron, which increases with downstream sites on Dip Creek and is even above CCME guidelines in the Klotassin River. This spatial distribution is shown in Figure 6.

Although lead concentrations are generally below CCME guidelines in 2010, it is interesting to note that Meloy Creek (W13) appears to be the main source, as shown in Figure 7.

Concentrations of aluminum, copper, cadmium and zinc also appear to show a similar spatial distribution in Canadian and Britannia creeks (Figure 5). The uppermost site on Canadian Creek (W7) appears to have the highest concentration of these metals and decrease in a downstream trend to the Yukon River. Background metal concentrations in the Yukon River are lower than Canadian Creek.

Figure 5. Median Concentration of Total Copper in Sampling Sites, Casino Project, 2010

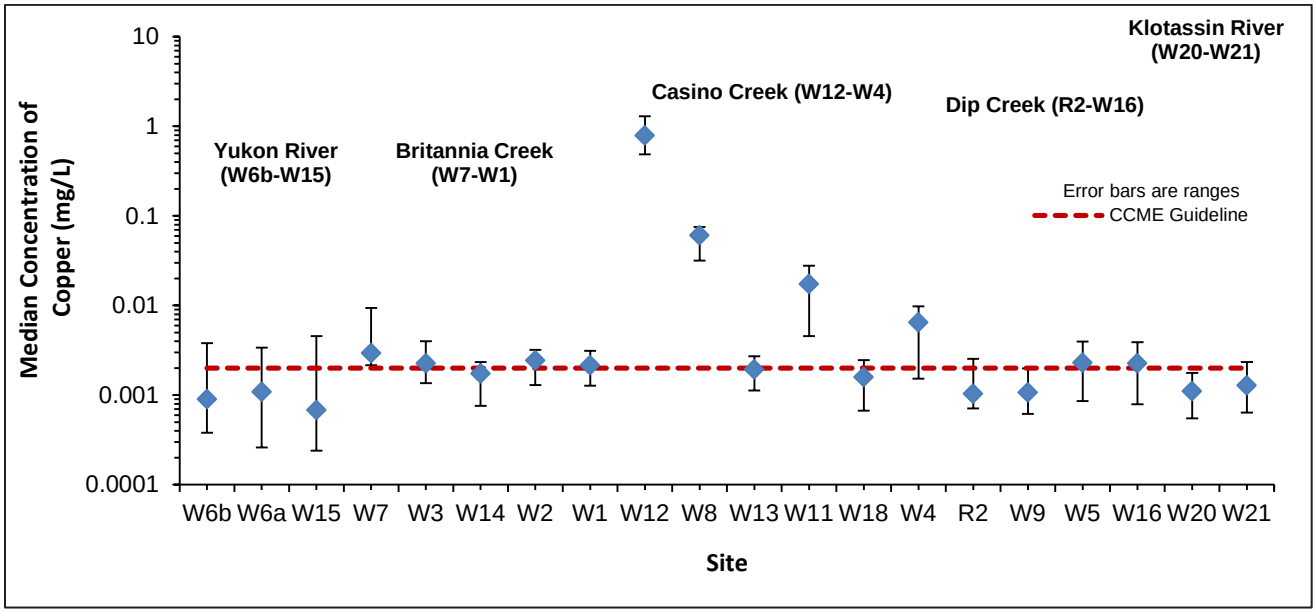


Figure 6. Median Concentration of Total Iron in Sampling Sites, Casino Project, 2010

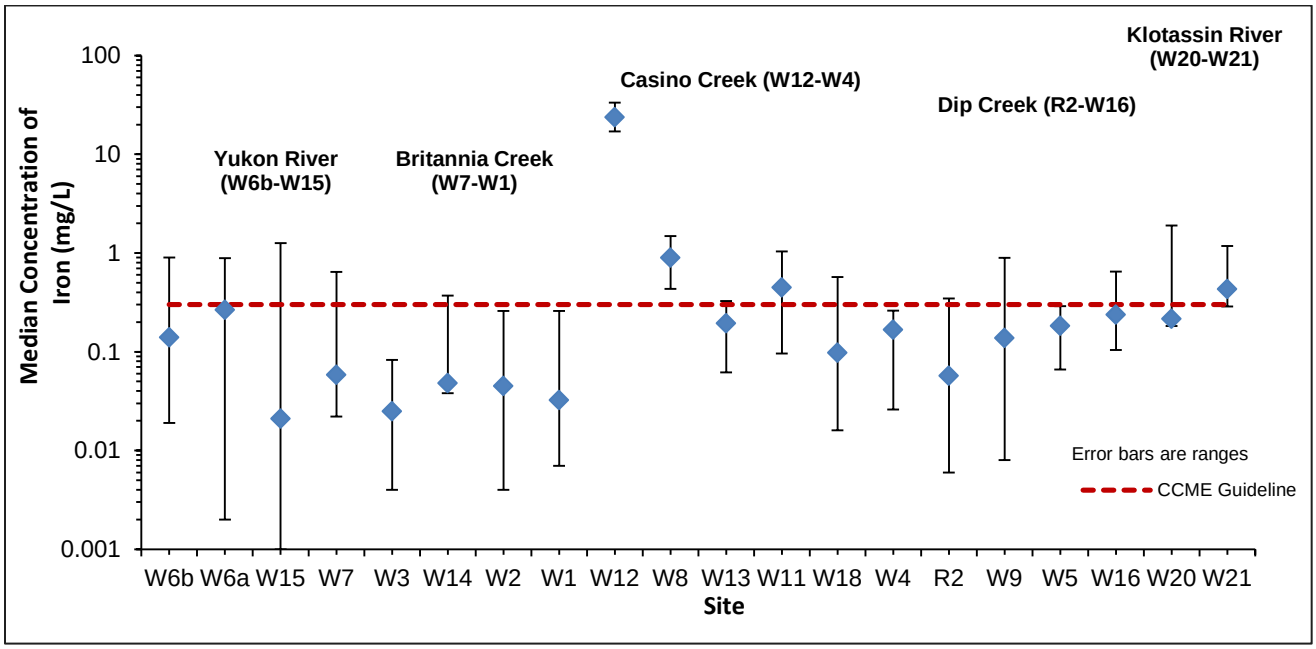
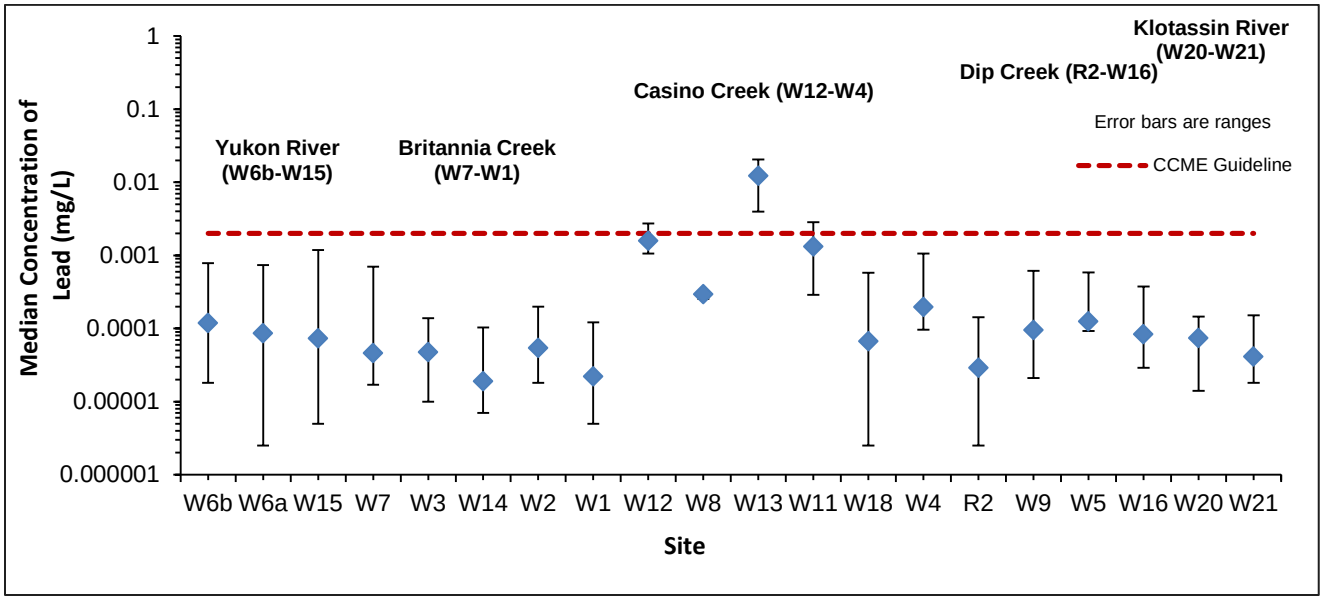


Figure 7. Median Concentration of Total Lead in Monitoring Stations, Casino Project, 2010



3.2 Sediment Quality

Appendix B1 shows the sediment quality data. Table 13 shows the parameters that exceed the CCME sediment guidelines and includes the following three total metals: arsenic (As), cadmium (Cd) and zinc (Zn). The only site to exceed Probable Effects Level was at S4. Site S4 is located in upper Casino Creek upstream of the confluence with Proctor Gulch and was sampled in order to estimate the relative contribution of metals from upper Casino Creek. Results indicate that baseline levels of cadmium and arsenic exceed CCME ISQG guidelines and that arsenic concentrations in the sediment are high in Yukon River and the Klotassin River as well.

Table 13. Sediment Quality Parameters Exceeding CCME Guidelines, Casino Project, 2010

Site	Interim Freshwater Sediment Quality Guideline (ISQG) only	ISQG and Probable Effects Level (PEL)
W6a	As, Cd	-
W6b	As, Cd, Zn	-
S4	Cd	As
W20	As	-
W21	As	-

Dashes indicate sample did not exceed CCME Guidelines.

3.3 Fish Assessment

As shown in Table 14 and Appendix C of the eight minnow traps set in Dip Creek at FM1 and FM2 only 1 fish was caught. A burbot (*Lota lota*) weighing 6.7g and measuring 105mm total length was caught at FM1 (Photograph 1). An aerial survey did not show any evidence of salmonid spawning in Dip Creek or the Klotassin River.

Investigation of fish absence/presence above a cascade barrier on Canadian Creek (site F05) resulted in no fish caught, either by electrofishing or by setting minnow traps. Photograph 2 and photograph 3 show parts of the cascade barrier on Canadian Creek.

Table 14. Fish Sampling Effort on Canadian Creek, August 2010

Site	Method	Distance	EF Effort (sec)	Setting	Comments
FM1	MT (4)	n/a	22 hrs	n/a	1 burbot caught
FM2	MT (4)	n/a	22 hrs	n/a	No Fish Captured
F05	MT (2)	n/a	24 hrs	n/a	No Fish Captured
F05 (segment 1)	EF	150m	678	437v	No Fish Captured
F05 (segment 2)	EF	100m	600	270v	No Fish Captured

MT: Minnow trapping

EF: Electrofishing

Photograph 1: Burbot captured at FM1, August 11, 2010

Photograph 2: Canadian Creek at site F05 (segment 1)

Photograph 3: Canadian Creek at site F05 (segment 2)

4 Summary

In 2010, field studies of the Casino aquatic study area focused on the continuation of the monthly water quality sampling. Additional sampling of the sediment was completed to fill in gaps. Fish assessments focused on determining key questions on the extent of fish distribution in Canadian Creek and salmon spawning in Dip Creek.

Analyses of the water quality showed results similar to previous studies (AECOM 2009, PECG 2011). CCME guidelines were regularly exceeded for copper, aluminum, iron, cadmium and ammonia in Casino Creek; the source of the high metal concentrations appears to be Proctor Gulch, an alpine creek that flows into the headwaters of Casino Creek.

Sediment samples from the Yukon and Klotassin rivers showed arsenic levels that exceeded CCME guidelines. Zinc was also high in the Yukon River.

Fish assessments were focused on determining the presence/absence of fish in upper Canadian Creek (the site of the conceptual footprint of the open pit) and investigating salmonid spawning in Dip Creek. Despite two methods of fish sampling, no fish were caught at site F05 on upper Canadian Creek. This indicates that the cascades identified on June 24, 2010 are most likely a barrier to fish migration.

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Appendix A1

Surface Water Quality Data, Casino Project, January 2010

Appendix A1. Surface Water Quality Analytical Results, Casino Project, January 2010

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from confluence of Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W6b - Yukon River Upstream of Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W15 - Island on Yukon River us from outflow of Excelsior Creek	W20 - Klotass in river us of Dip Creek	W21 - Klotass in river ds of Dip Creek	R2
Date		CCME [1]	29-Jan-10	29-Jan-10	29-Jan-10	29-Jan-10	29-Jan-10	29-Jan-10	29-Jan-10	29-Jan-10	29-Jan-10
Physical Tests											
Temperature °C	-		0.2	0.0	0.0	0.2	0.0	0.4	0.1	0.0	0.0
Conductivity (Field) µS/cm	-		489.9	3	7	200	74.3	223	68	9	39.3
pH (Field)	-		7.77	7.87	7.64	7.94	7.50	7.73	7.68	7.42	7.31
Hardness $CaCO_3$	0.5		248	209	179	105	123	105	76.8	82.4	91.3
Conductivity	1		492	407	368	209	246	216	165	169	183
pH	-	6.5-9.0	7.6	7.8	7.7	7.9	7.6	7.8	7.6	7.6	7.6
Total Suspended Solids	1		<1	<1	<1	<1	<1	<1	1	<1	<1
Total Dissolved Solids	1		350	290	300	170	180	140	120	130	120
Turbidity	0.1		0.1	0.2	0.2	0.5	0.2	0.2	5.4	2.9	0.1
Dissolved Anions & Nutrients											
Ammonia as N	0.01	0.137[a]	<0.01	0.02	0.01	<0.01	0.01	<0.01	0.03	0.04	<0.01
Alkalinity, Total (as $CaCO_3$)	0.5		120	120	100	87	110	90	66	71	74
Acidity (pH 8.3) as $CaCO_3$	0.5		4.8	2.5	1.8	0.6	4.0	1.6	2.0	1.8	2.9
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		<0.5	<0.5	<0.5	<0.5	0.6	1.1	<0.5	<0.5	<0.5
Fluoride (F)	0.01		0.10	0.12	0.12	0.11	0.05	0.10	0.12	0.11	0.05
Sulfate (SO_4)	0.5		120	84	69	21	22	22	18	20	24
Nitrate (as N)	0.002	2.9	0.451	0.407	0.391	0.074	0.240	0.088	0.089	0.096	0.383
Nitrite (as N)	0.002	0.06	0.003	0.002	0.004	0.005	0.003	0.003	0.006	<0.002	0.005
Total Kjeldahl Nitrogen	0.02		0.15	0.21	0.09	0.11	0.11	0.05	0.23	0.11	0.19
Ortho Phosphate as P	0.001		0.002	0.002	0.002	0.001	0.001	0.002	0.001	0.002	0.002
Cyanide, Weak Acid Diss	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Organic Carbon											
Total Organic Carbon	0.5		5.2	5.1	4.3	1.6	4.0	0.7	3.5	4.0	3.7
Total Metals											
Aluminum	0.0002	0.005-0.1[b]	0.0089	0.0079	0.0070	0.0126	0.0073	0.0017	0.0053	0.0060	0.0112
Antimony	0.00002		0.00024	0.00024	0.00024	0.00008	0.00006	0.00009	0.00002	0.00003	0.00002
Arsenic	0.00002	0.005	0.00037	0.00041	0.00038	0.00036	0.00019	0.00017	0.00192	0.00078	0.00014
Barium	0.00002		0.112	0.0801	0.0713	0.0506	0.0816	0.0703	0.0556	0.0550	0.0625
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000015	0.000011	0.000012	0.000017	<0.000005	0.000013	<0.000005	0.000006	<0.000005
Calcium	0.05		62.5	53.6	47.2	29.4	31.9	29.8	18.9	20.3	22.5
Chromium	0.0001	0.001	0.0001	0.0001	0.0001	<0.0001	0.0001	<0.0001	0.0002	0.0002	<0.0001
Cobalt	0.000005		0.000032	0.000024	0.000022	0.000021	0.000037	0.000006	0.000200	0.000209	0.000013
Copper	0.00005	0.002-0.004[d]	0.00135	0.00136	0.00140	0.00054	0.00070	0.00033	0.00055	0.00073	0.00077
Iron	0.001	0.3	0.007	0.008	0.008	0.024	0.018	0.002	*1.90*	*0.642*	0.009
Lead	0.000005	0.001-0.007[e]	0.000115	0.000151	0.000139	0.000147	0.000023	0.000073	0.000146	0.000025	0.000143
Lithium	0.0005		<0.0005	0.0010	0.0006	0.0014	0.0020	0.0012	<0.0005	<0.0005	0.0006
Magnesium	0.05		22.3	18.2	14.9	7.66	10.5	7.50	7.17	7.68	8.54
Manganese	0.00005		0.00011	0.00218	0.00040	0.00696	0.0168	0.00014	0.153	0.154	0.00348
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00108	0.00152	0.00132	0.00126	0.00052	0.00080	0.00061	0.00059	0.00064
Nickel	0.00002	0.025-0.15[f]	0.00058	0.00051	0.00053	0.00085	0.00026	0.00022	0.00044	0.00057	0.00029
Phosphorous	0.002		0.002	0.003	<0.002	<0.002	0.003	<0.002	0.018	0.009	<0.002
Potassium	0.05		2.38	2.50	2.31	0.87	0.94	0.82	0.85	0.88	0.74
Selenium	0.00004	0.001	0.00014	0.00016	0.00010	0.00036	<0.00004	0.00038	0.00009	0.00010	0.00006
Silicon	0.1		4.5	5.3	5.2	3.2	5.3	3.1	5.6	5.4	5.0
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000006	<0.000005	<0.000005	<0.000005
Sodium	0.05		5.68	5.99	5.13	1.99	4.96	1.82	3.50	3.72	3.27
Strontium	0.00005		0.381	0.338	0.283	0.129	0.247	0.124	0.142	0.154	0.176
Thallium	0.000002	0.0008	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0328	0.0397	0.0209	0.00114	0.00811	0.000882	0.000118	0.000194	0.00111
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0007	0.0006	0.0006	0.0022	0.0004	0.0009	0.0006	0.0004	0.0007
Zirconium	0.0001		0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	0.0001	0.0001
Dissolved Metals											
Aluminum	0.0002		0.0087	0.0062	0.0059	0.0023	0.0070	0.0013	0.0036	0.0051	0.0106
Antimony	0.00002		0.00023	0.00024	0.00022	0.00008	0.00006	0.00009	<0.00002	0.00002	0.00002
Arsenic	0.00002		0.00039	0.00040	0.00036	0.00031	0.00020	0.00016	0.00145	0.00067	0.00014
Barium	0.00002		0.106	0.0784	0.0710	0.0515	0.0822	0.0706	0.0564	0.0537	0.0621
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000012	0.000013	0.000012	0.000014	<0.000005	0.000010	<0.000005	<0.000005	<0.000005
Calcium	0.05		63.5	52.0	47.4	29.1	34.1	29.9	19.0	20.9	22.0
Chromium	0.0001		0.0002	0.0001	0.0002	<0.0001	0.0002	<0.0001	0.0001	0.0002	<0.0001
Cobalt	0.000005		0.000025	0.000023	0.000025	0.000010	0.000036	0.000006	0.000182	0.000197	0.000020
Copper	0.00005		0.00138	0.00134	0.00147	0.00051	0.00073	0.00032	0.00052	0.00064	0.00077
Iron	0.001		0.006	0.005	0.006	0.008	0.018	0.003	1.15	0.359	0.008
Lead	0.000005		0.000115	0.000137	0.000131	0.000045	0.000019	0.000076	0.000117	0.000017	0.000133
Lithium	0.0005		<0.0005	0.0009	0.0006	0.0014	0.0020	0.0011	<0.0005	<0.0005	0.0006
Magnesium	0.05		22.5	17.4	14.7	7.47	11.0	7.52	7.13	7.79	8.36
Manganese	0.00005		0.00010	0.00186	0.00024	0.00629	0.0175	0.00012	0.153	0.155	0.00341
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00105	0.00141	0.00126	0.00121	0.00056	0.00078	0.00062	0.00059	0.00065
Nickel	0.00002		0.00057	0.00050	0.00054	0.00079	0.00028	0.00026	0.00042	0.00051	0.00029
Phosphorous	0.002		0.004	<0.002	0.002	<0.002	0.004	<0.002	0.013	0.007	0.002
Potassium	0.05		2.43	2.43	2.31	0.87	0.99	0.83	0.86	0.89	0.72
Selenium	0.00004		5.73	5.78	5.05	1.95	5.11	1.84	3.45	3.75	3.18
Silicon	0.1		0.00013	0.00016	0.00010	0.00039	<0.00004	0.00039	0.00009	0.00010	0.00005
Silver	0.000005		4.5	5.2	5.2	3.4	5.9	3.1	5.7	5.4	4.9
Sodium	0.05		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Strontium	0.00005		0.377	0.333	0.289	0.129	0.252	0.125	0.145	0.159	0.174
Thallium	0.000002		<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0322	0.0396	0.0207	0.00111	0.00835	0.000866	0.000121	0.000189	0.00106
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0001		0.0006	0.0006	0.0005	0.0020	0.0005	0.0010	0.0005	0.0004	0.0005
Zirconium	0.0001		0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0002	0.0002	0.0001

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH $\geq$ 6.5, $[Ca^{2+}]$ $\geq$ 4 mg/L, DOC $\geq$ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L, results exceed CCME Aquatic Life Guidelines

**Average of sample and replicate*

0.231	results exceed CCME Aquatic Life Guidelines

Appendix A2

Surface Water Quality Data, Casino Project, February 2010

Appendix A2. Surface Water Quality Analytical Results, Casino Project, February 2010

Station	Detection Limits	Water Quality Guidelines	W3 - Canadian Creek us of confluence with Britannia Creek	W6a - Yukon River downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W15 - Island on Yukon River us from outflow of Excelsior Creek	W20 - Klotass in river us of Dip Creek	W21 - Klotass in river ds of Dip Creek	R2
Date		CCME [1]	24-Feb-10	24-Feb-10	24-Feb-10	24-Feb-10	24-Feb-10	24-Feb-10	24-Feb-10	24-Feb-10
Physical Tests										
Temperature °C	-		0.0	0.6	0.4	0.0	1.3	0.2	0.0	0.1
Conductivity (Field) µS/cm	-		367	232	216	15.8	212	165	166	72.3
pH (Field)	-		7.75	8.24	8.00	7.23	7.70	7.40	7.83	7.34
Hardness $CaCO_3$	0.5		180	111	104	123	103	74.1	74.2	90.1
Conductivity	1		386	234	221	259	217	169	171	193
pH	-	6.5-9.0	7.8	7.8	7.8	7.7	7.9	7.7	7.5	7.7
Total Suspended Solids	1		<1	<1	<1	<1	2	1	1	<1
Total Dissolved Solids	1		260	130	140	170	120	110	100	120
Turbidity	0.1		2.5	1.4	5.1	0.3	2.5	6.6	6.2	0.3
Dissolved Anions & Nutrients										
Ammonia as N	0.01	0.137[a]	0.01	<0.01	0.01	<0.01	<0.01	0.04	0.03	<0.01
Alkalinity, Total (as $CaCO_3$)	0.5		110	95	92	110	92	69	69	75
Acidity (pH 8.3) as $CaCO_3$	0.5		5.0	1.5	0.9	11.1	1.8	2.5	2.2	4.4
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.01		0.12	0.11	0.12	0.05	0.11	0.13	0.12	0.05
Sulfate (SO_4)	0.5		86	26	22	20	22	16	17	25
Nitrate (as N)	0.002	2.9	0.365	0.119	0.086	0.164	0.092	0.083	0.083	0.386
Nitrite (as N)	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003
Total Kjeldahl Nitrogen	0.02		0.16	<0.02	<0.02	<0.02	<0.02	0.06	0.10	0.03
Ortho Phosphate as P	0.001		0.002	0.001	0.002	0.001	0.001	0.002	0.001	0.001
Cyanide, Weak Acid Diss	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Organic Carbon	0.5		4.4	1.5	1.9	3.3	1.5	3.3	3.4	2.9
Total Organic Carbon	0.5		4.2	1.3	1.8	3.6	1.3	3.1	3.2	2.8
Total Metals										
Aluminum	0.0002	0.005-0.1[b]	0.0063	0.0022	0.0088	0.0075	0.0015	0.0049	0.0048	0.0101
Antimony	0.00002		0.00025	0.00011	0.00010	0.00008	0.00011	0.00003	0.00003	0.00003
Arsenic	0.00002	0.005	0.00039	0.00014	0.00028	0.00020	0.00016	0.00151	0.00082	0.00013
Barium	0.00002		0.0713	0.0694	0.0527	0.0807	0.0715	0.0512	0.0493	0.0599
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000013	0.000018	0.000014	<0.000005	<0.000005	<0.000005	0.000006	<0.000005
Calcium	0.05		47.5	31.2	28.9	32.0	28.6	18.1	18.1	21.9
Chromium	0.0001	0.001	0.0001	0.0001	<0.0001	0.0001	<0.0001	0.0002	0.0002	<0.0001
Cobalt	0.000005		0.000020	<0.000005	0.000020	0.000039	<0.000005	0.000194	0.000201	0.000020
Copper	0.00005	0.002-0.004[d]	0.00136	0.00027	0.00047	0.00076	0.00033	0.00056	0.00064	0.00071
Iron	0.001	0.3	0.004	0.002	0.019	0.026	0.001	*1.35*	*0.595*	0.007
Lead	0.000005	0.001-0.007[e]	0.000125	0.000032	0.000103	0.000145	0.000051	0.000104	0.000119	<0.000005
Lithium	0.0005		0.0008	0.0012	0.0015	0.0019	0.0012	<0.0005	<0.0005	0.0007
Magnesium	0.05		14.9	8.12	7.83	10.4	7.74	7.03	7.07	8.59
Manganese	0.00005		0.00022	0.00174	0.0390	0.0232	0.00017	0.153	0.153	0.00381
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00123	0.00099	0.00118	0.00049	0.00082	0.00061	0.00056	0.00061
Nickel	0.00002	0.025-0.15[f]	0.00045	0.00031	0.00061	0.00027	0.00021	0.00049	0.00051	0.00027
Phosphorous	0.002		0.004	<0.002	0.003	0.005	<0.002	0.017	0.011	0.004
Potassium	0.05		2.30	0.83	0.81	0.93	0.76	0.79	0.77	0.70
Selenium	0.00004	0.001	0.00011	0.00060	0.00045	<0.00004	0.00050	0.00011	0.00010	0.00005
Silicon	0.1		5.0	3.0	3.1	5.5	3.0	5.4	5.2	4.6
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		5.25	2.07	2.05	4.99	1.94	3.48	3.50	3.28
Strontium	0.00005		0.292	0.129	0.128	0.248	0.123	0.140	0.142	0.174
Thallium	0.000002	0.0008	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0203	0.00112	0.00126	0.00756	0.000925	0.000132	0.000169	0.00114
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0007	0.0012	0.0018	0.0008	0.0008	0.0002	0.0003	0.0003
Zirconium	0.0001		<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0002	0.0001	<0.0001
Dissolved Metals										
Aluminum	0.0002		0.0065	0.0017	0.0021	0.0076	0.0013	0.0049	0.0049	0.0106
Antimony	0.00002		0.00024	0.00010	0.00010	0.00007	0.00010	0.00003	0.00003	0.00003
Arsenic	0.00002		0.00035	0.00012	0.00028	0.00020	0.00016	0.00134	0.00074	0.00016
Barium	0.00002		0.0727	0.0701	0.0544	0.0818	0.0723	0.0526	0.0510	0.0602
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000013	0.000015	0.000022	<0.000005	0.000010	<0.000005	0.000008	<0.000005
Calcium	0.05		49.9	32.5	30.4	33.0	30.0	19.0	19.2	23.7
Chromium	0.0001		0.0001	0.0001	<0.0001	0.0001	<0.0001	0.0002	0.0002	0.0001
Cobalt	0.000005		0.000028	0.000008	0.000014	0.000045	<0.000005	0.000193	0.000209	0.000019
Copper	0.00005		0.00134	0.00025	0.00043	0.00076	0.00029	0.00049	0.00059	0.00072
Iron	0.001		0.004	<0.001	0.04	0.024	0.002	1.13	0.405	0.006
Lead	0.000005		0.000128	0.000021	0.000054	0.000138	0.000048	0.000097	0.000097	0.000010
Lithium	0.0005		0.0007	0.0012	0.0014	0.0019	0.0012	<0.0005	<0.0005	0.0006
Magnesium	0.05		15.4	8.19	8.09	10.7	7.76	7.18	7.28	9.18
Manganese	0.00005		0.00021	0.00164	0.0399	0.0233	0.00019	0.155	0.157	0.00389
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00124	0.00103	0.00119	0.00049	0.00081	0.00060	0.00055	0.00059
Nickel	0.00002		0.00044	0.00029	0.00061	0.00030	0.00020	0.00047	0.00054	0.00029
Phosphorous	0.002		0.004	<0.002	<0.002	0.004	0.003	0.014	0.008	0.005
Potassium	0.05		2.39	0.87	0.85	0.96	0.80	0.83	0.83	0.75
Selenium	0.00004		0.00010	0.00059	0.00043	<0.00004	0.00047	0.00010	0.00010	0.00005
Silicon	0.1		4.7	2.8	3.0	5.4	2.8	5.1	5.1	4.4
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		5.40	2.06	2.10	5.08	1.93	3.55	3.65	3.49
Strontium	0.00005		0.301	0.133	0.133	0.254	0.124	0.145	0.145	0.179
Thallium	0.000002		<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0207	0.00114	0.00128	0.00760	0.000869	0.000127	0.000161	0.00116
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002
Zinc	0.0001		0.0007	0.0013	0.0058	0.0009	0.0009	0.0003	0.0004	0.0004
Zirconium	0.0001		<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0002	0.0002	0.0001

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, [Ca^{2+}] < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH $\geq$ 6.5, [Ca^{2+}] $\geq$ 4 mg/L, DOC $\geq$ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at [$CaCO_3$] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; results exceed CCME Aquatic Life Guidelines

**Average of sample and replicate*

0.231	results exceed CCME Aquatic Life Guidelines

Appendix A3

Surface Water Quality Data, Casino Project, March 2010

Appendix A3. Surface Water Quality Analytical Results, Casino Project, March 2010

Station	Detection Limits	Water Quality Guidelines	W2 - Brittania Creek ds from confluence of Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W6a - Yukon River downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W15 - Island on Yukon River us from outflow of Excelsior Creek	W20 - Klotass in river us of Dip Creek	W21 - Klotass in river ds of Dip Creek	R2	Field Blank
Date		CCME [1]	23-Mar-10	23-Mar-10	23-Mar-10	23-Mar-10	23-Mar-10	23-Mar-10	23-Mar-10	23-Mar-10	23-Mar-10	23-Mar-10
Physical Tests												
Temperature °C	-		0.0	0.0	1.2	0.9	0.0	1.1	0.4	0.0	0.1	-
Conductivity (Field) µS/cm	-		343.5	375.4	244.0	219.2	137.7	211.1	167.0	168.8	199.7	-
pH (Field)	-		7.85	8.07	7.96	7.77	7.47	8.32	7.42	7.16	7.61	-
Hardness $CaCO_3$	0.5		211	189	115	107	122	102	73.0	74.5	93.5	<0.5
Conductivity	1		445	393	246	225	265	215	169	167	208	1
pH	-	6.5-9.0	7.7	7.7	7.8	7.8	7.7	7.8	7.6	7.5	7.6	5.9
Total Suspended Solids	1		<1	14	<1	<1	<1	<1	1	1	<4	<1
Total Dissolved Solids	1		280	230	130	130	150	110	88	94	130	<10
Turbidity	0.1		0.1	7.5	0.1	0.2	0.4	0.1	2.7	4.2	1.2	0.4
Dissolved Anions & Nutrients												
Ammonia as N	0.01	0.137[a]	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.17	0.03	0.02	<0.01
Alkalinity, Total (as $CaCO_3$)	0.5		120	100	96	92	110	87	68	69	79	0.7
Acidity (pH 8.3) as $CaCO_3$	0.5		-	-	-	-	-	-	-	-	-	
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.01		0.12	0.11	0.10	0.11	0.05	0.11	0.12	0.12	0.05	<0.01
Sulfate (SO_4)	0.5		110	94	34	25	24	23	19	20	28	<0.5
Nitrate (as N)	0.002	2.9	0.380	0.383	0.126	0.095	0.105	0.099	0.100	0.084	0.403	<0.002
Nitrite (as N)	0.002	0.06	0.004	0.002	<0.002	<0.002	0.005	<0.002	0.004	0.003	0.005	0.004
Total Kjeldahl Nitrogen	0.02		0.09	0.10	0.02	0.03	0.10	0.03	0.16	0.14	0.08	<0.02
Ortho Phosphate as P	0.001		0.002	0.001	0.001	0.001	0.002	<0.001	0.002	0.001	0.001	<0.001
Cyanide, Weak Acid Diss	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Organic Carbon	0.5		3.7	2.0	0.5	0.9	3.9	1.2	3.4	4.0	3.3	0.9
Total Organic Carbon	0.5		3.4	1.5	0.8	4.5	3.8	1.0	3.9	4.4	3.9	0.6
Total Metals												
Aluminum	0.0002	0.005-0.1[b]	0.0059	0.0135	0.0023	0.0024	0.0076	0.0015	0.0437	0.0068	0.0102	0.0008
Antimony	0.00002		0.00024	0.00024	0.00011	0.00011	0.00007	0.00010	0.00005	0.00003	0.00003	<0.00002
Arsenic	0.00002	0.005	0.00042	0.00042	0.00014	0.00022	0.00020	0.00017	0.00092	0.00090	0.00016	<0.00002
Barium	0.00002		0.0786	0.0731	0.0728	0.0603	0.0816	0.0697	0.0488	0.0497	0.0620	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000011	0.000022	0.000022	0.000017	0.000006	0.000011	0.000007	0.000007	<0.000005	<0.000005
Calcium	0.05		52.3	48.2	31.5	29.0	30.6	27.9	17.2	17.5	21.8	<0.05
Chromium	0.0001	0.001	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0002	0.0002	<0.0001	<0.0001
Cobalt	0.000005		0.000020	0.000038	0.000005	0.000035	0.000016	0.000005	0.000106	0.000224	0.000021	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00129	0.00142	0.00026	0.00038	0.00071	0.00024	0.00099	0.00064	0.00075	<0.00005
Iron	0.001	0.3	0.004	0.016	0.002	0.023	0.008	0.003	*0.936*	*0.708*	0.006	<0.001
Lead	0.000005	0.001-0.007[e]	0.000066	0.000056	0.000041	0.000058	0.000021	0.000018	0.000090	0.000018	0.000047	0.000013
Lithium	0.0005		0.0013	0.0008	0.0013	0.0014	0.0021	0.0012	<0.0005	<0.0005	0.0007	<0.0005
Magnesium	0.05		19.6	16.6	8.73	8.41	11.1	7.76	7.34	7.51	9.49	<0.05
Manganese	0.00005		0.00157	0.00357	0.00034	0.0842	0.00247	0.00019	0.0563	0.147	0.00430	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00149	0.00137	0.00104	0.00126	0.00043	0.00087	0.00054	0.00061	0.00063	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00051	0.00052	0.00028	0.00042	0.00027	0.00020	0.00050	0.00052	0.00031	0.00003
Phosphorous	0.002		<0.002	0.004	<0.002	<0.002	0.003	<0.002	0.020	0.012	0.002	<0.002
Potassium	0.05		2.43	2.35	0.81	0.78	0.87	0.75	0.71	0.75	0.68	<0.05
Selenium	0.00004	0.001	0.00020	0.00012	0.00068	0.00046	<0.00004	0.00055	0.00016	0.00012	0.00005	<0.00004
Silicon	0.1		5.0	5.2	3.0	3.0	5.6	2.9	4.8	5.3	4.7	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000006
Sodium	0.05		6.67	5.90	2.19	2.12	5.37	1.96	3.56	3.69	3.52	<0.05
Strontium	0.00005		0.336	0.297	0.135	0.128	0.247	0.121	0.139	0.141	0.176	<0.00005
Thallium	0.000002	0.0008	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0011	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0416	0.0206	0.00125	0.00144	0.00784	0.000940	0.000178	0.000152	0.00118	<0.000002
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0006	<0.0002	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0008	0.0010	0.0014	0.0011	0.0005	0.0008	0.0007	0.0013	0.0005	0.0003
Zirconium	0.0001		<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0001	0.0002	<0.0001	<0.0001
Dissolved Metals												
Aluminum	0.0002		0.0056	0.0060	0.0015	0.0014	0.0071	0.0010	0.0040	0.0043	0.0096	0.0005
Antimony	0.00002		0.00022	0.00023	0.00009	0.00010	0.00006	0.00010	0.00004	0.00003	0.00004	<0.00002
Arsenic	0.00002		0.00036	0.00033	0.00012	0.00018	0.00019	0.00015	0.00048	0.00074	0.00014	<0.00002
Barium	0.00002		0.0755	0.0715	0.0730	0.0613	0.0819	0.0717	0.0483	0.0511	0.0644	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000009	0.000016	0.000019	0.000016	<0.000005	0.000012	<0.000005	0.000009	<0.000005	<0.000005
Calcium	0.05		51.0	50.9	32.8	32.3	30.9	29.1	18.0	18.4	22.9	<0.05
Chromium	0.0001		0.0001	0.0001	0.0001	<0.0001	0.0001	0.0001	0.0002	0.0002	0.0001	<0.0001
Cobalt	0.000005		0.000018	0.000020	<0.000005	0.000034	0.000017	0.000005	0.000079	0.000199	0.000024	<0.000005
Copper	0.00005		0.00121	0.00116	0.00028	0.00032	0.00068	0.00027	0.00072	0.00054	0.00074	<0.00005
Iron	0.001		0.003	0.007	0.001	0.016	0.006	<0.001	0.241	0.420	0.005	<0.001
Lead	0.000005		0.000052	0.000013	0.000037	0.000044	0.000014	0.000021	0.000031	0.000013	0.000047	<0.000005
Lithium	0.0005		0.0012	0.0007	0.0011	0.0013	0.0021	0.0013	<0.0005	<0.0005	0.0007	<0.0005
Magnesium	0.05		17.7	14.9	8.53	8.14	10.2	7.58	7.11	7.14	9.16	<0.05
Manganese	0.00005		0.00158	0.00154	0.00033	0.0853	0.00234	0.00021	0.0558	0.156	0.00454	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00145	0.00129	0.00101	0.00129	0.00045	0.00088	0.00053	0.00058	0.00062	<0.00005
Nickel	0.00002		0.00047	0.00044	0.00027	0.00039	0.00026	0.00019	0.00043	0.00048	0.00032	<0.00002
Phosphorous	0.002		0.002	0.003	<0.002	<0.002	<0.002	<0.002	0.005	0.006	0.003	<0.002
Potassium	0.05		2.41	2.48	0.86	0.85	0.89	0.78	0.76	0.80	0.74	<0.05
Selenium	0.00004		0.00020	0.00011	0.00066	0.00043	<0.00004	0.00057	0.00015	0.00012	0.00006	<0.00004
Silicon	0.1		4.1	4.9	3.2	3.0	4.7	2.5	4.1	4.4	3.9	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		6.08	5.07	2.11	1.97	5.00	1.93	3.46	3.53	3.44	<0.05
Strontium	0.00005		0.338	0.309	0.136	0.138	0.260	0.129	0.150	0.151	0.192	0.00008
Thallium	0.000002		<0.000002	<0.000002	<0.000002	0.138	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0420	0.0208	0.00124	0.00152	0.00799	0.000968	0.000155	0.000157	0.00126	<0.000002
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002
Zinc	0.0001		0.0008	0.0009	0.0013	0.0009	0.0007	0.0008	0.0006	0.0004	0.0008	0.0002
Zirconium	0.0001		<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0001	0.0002	0.0001	<0.0001

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH $\geq$ 6.5, $[Ca^{2+}]$ $\geq$ 4 mg/L, DOC $\geq$ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at [$CaCO_3$] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L results exceed CCME Aquatic Life Guidelines

**Average of sample and replicate*

0.231	results exceed CCME Aquatic Life Guidelines

Appendix A4

Surface Water Quality Data, Casino Project, April 2010

Appendix A4. Surface Water Quality Analytical Results, Casino Project, April 2010

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from confluence of Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino confluence	W6a - Yukon River downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W7 - Upper Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek*	W18 - Brynelsen Creek	W20 - Klotass in river us of Dip Creek	W21 - Klotass in river ds of Dip Creek	Trip Blank
Date		CCME [1]	21-Apr-10	21-Apr-10	21-Apr-10	22-Apr-10	21-Apr-10	21-Apr-10	21-Apr-10	21-Apr-10	22-Apr-10	21-Apr-10	21-Apr-10	21-Apr-10	21-Apr-10	21-Apr-10	21-Apr-10	21-Apr-10	21-Apr-10
Physical Tests																			
Temperature °C	-		0.0	0.5	0.4	-0.1	0.0	0.6	0.5	0.1	-0.1	0.1	0.0	3.4	0.0	0.1	1.2	0.5	-
Conductivity (Field) µS/cm	-		453.0	389.1	378.3	266.0	275.8	182.5	193.9	141.2	252.0	289.8	398.1	194.4	311.2	262.3	177.7	234.1	-
pH (Field)	-		7.95	7.84	7.96	7.44	7.94	8.61	8.43	7.99	7.52	8.15	8.07	8.67	7.98	7.86	8.15	7.83	-
Hardness $CaCO_3$	0.5		234	198	189	156	136	97.7	98.8	52.0	128	141	202	104	154	120	85.7	108	<0.5
Conductivity	1		471	402	394	326	285	188	200	145	263	298	411	206	327	264	187	242	<1
pH	-	6.5-9.0	8.2	8.1	8.0	8.2	8.2	8.2	8.2	7.3	8.3	8.1	8.2	8.1	8.3	8.2	8.1	8.1	*6.4*
Total Suspended Solids	1		2	2	3	<1	4	43	<1	22	2	2	2	<1	1	<1	3	6	-
Total Dissolved Solids	1		320	320	260	210	150	94	100	76	120	190	280	92	180	140	110	160	-
Turbidity	0.1		0.4	0.4	0.4	0.8	0.5	1.8	0.6	4.5	0.7	2.2	0.5	0.2	0.4	0.3	2.6	6.2	-
Dissolved Anions & Nutrients																			
Ammonia as N	0.01	0.137[a]	0.052	0.081	0.052	0.053	0.058	0.008	0.060	0.052	0.015	0.049	0.050	0.037	0.054	0.049	0.074	0.068	<0.005
Alkalinity, Total (as $CaCO_3$)	0.5		120	110	98	110	110	82	86	12	110	89	120	89	120	98	73	91	1.0
Acidity (pH 8.3) as $CaCO_3$	0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.01		0.11	0.10	0.10	0.07	0.06	0.11	0.10	0.09	0.06	0.08	0.10	0.11	0.06	0.05	0.13	0.10	<0.01
Sulfate (SO_4)	0.5		140	110	110	66	45	25	25	54	33	71	110	25	62	45	28	39	<0.5
Nitrate (as N)	0.002	2.9	0.098	0.119	0.205	0.040	0.006	0.032	0.030	<0.002	0.016	0.076	0.006	0.098	0.003	0.037	0.101	0.047	0.003
Nitrite (as N)	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.17	0.26	0.27	0.06	0.14	0.07	0.10	0.18	0.17	0.46	0.32	0.03	0.11	0.16	0.07	0.15	<0.02
Ortho Phosphate as P	0.001		0.001	0.001	0.001	0.001	0.002	<0.001	<0.001	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.002	0.001	<0.001
Cyanide, Weak Acid Diss	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	0.0006	0.0009	0.0009	<0.0005	0.0006	<0.0005	<0.0005	0.0005	0.0006	0.0006	0.0009	<0.0005	0.0005	0.0010	0.0007	0.0007	<0.0005
Dissolved Organic Carbon	0.5		7.7	9.3	7.6	4.4	3.9	1.7	1.6	4.5	5.0	4.9	9.3	0.9	4.8	4.9	3.0	4.8	0.5
Total Organic Carbon	0.5		7.0	9.8	8.9	4.6	4.7	1.6	1.8	4.0	6.1	5.6	12.7	1.2	5.4	5.3	4.4	5.7	
Total Metals																			
Aluminum	0.0002	0.005-0.1[b]	0.0169	0.0301	0.0397	0.0213	0.0393	0.0038	0.0229	*0.220*	0.0349	0.0947	0.0256	0.0028	0.0166	0.0207	0.0214	0.0331	0.0005
Antimony	0.00002		0.00019	0.00022	0.00027	0.00011	0.00007	0.00007	0.00007	0.00006	0.00006	0.00015	0.00013	0.00009	0.00006	0.00014	0.00003	0.00005	<0.00002
Arsenic	0.00002	0.005	0.00054	0.00056	0.00063	0.00034	0.00037	0.00037	0.00036	0.00079	0.00037	0.00075	0.00054	0.00014	0.00038	0.00040	0.00087	0.00117	<0.00002
Barium	0.00002		0.0834	0.0747	0.0687	0.0738	0.0718	0.0419	0.0453	0.0600	0.0713	0.0595	0.0815	0.0699	0.0726	0.0559	0.0473	0.0619	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00003	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000031	<0.000005	0.000010	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000023	0.000030	0.000033	0.000034	0.000019	0.000008	0.000023	*0.000427*	0.000012	*0.000069*	0.000014	0.000015	0.000021	*0.000061*	0.000013	0.000011	<0.000005
Calcium	0.05		58.1	48.7	47.6	40.2	33.1	27.2	27.1	15.5	30.5	37.4	48.0	29.0	36.4	31.8	20.3	26.0	<0.05
Chromium	0.0001	0.001	<0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0002	0.0002	<0.0001
Cobalt	0.000005		0.000068	0.000093	0.000092	0.000035	0.000093	0.000006	0.000027	0.000384	0.000105	0.000188	0.000071	0.000007	0.000078	0.000065	0.000157	0.000236	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00127	0.00138	0.00186	0.00153	0.00086	0.0012	0.00048	*0.00353*	0.00062	*0.00455*	0.00076	0.00025	0.00079	0.00118	0.00070	0.00075	<0.00005
Iron	0.001	0.3	0.026	0.049	0.060	0.026	0.099	*0.379*	0.039	*0.387*	0.110	0.096	0.038	0.004	0.104	0.024	*0.819*	*1.18*	<0.001
Lead	0.000005	0.001-0.007[e]	0.000020	0.000041	0.000062	0.000096	0.000093	<0.000005	0.000018	0.000700	0.000062	0.00218	0.000020	0.000005	0.000029	0.000581	0.000021	0.000041	<0.000005
Lithium	0.0005		0.0009	0.0009	0.0007	0.0015	0.0024	0.0012	0.0015	0.0013	0.0031	0.0015	0.0013	0.0013	0.0019	0.0020	<0.0005	0.0009	<0.0005
Magnesium	0.05		21.5	18.5	17.0	13.4	12.9	7.24	7.56	3.22	12.6	11.6	19.9	7.74	15.4	9.96	8.50	10.5	<0.05
Manganese	0.00005		0.00901	0.0189	0.0197	0.0110	0.0451	0.0175	0.0130	0.0323	0.0486	0.0829	0.0207	0.00062	0.0555	0.0281	0.0901	0.132	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00085	0.00077	0.00088	0.00136	0.00082	0.00115	0.00114	0.00049	0.00070	0.00072	0.00054	0.00079	0.00087	0.00222	0.00051	0.00108	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00057	0.00067	0.00087	0.00021	0.00025	0.0013	0.00070	0.00115	0.00028	0.00036	0.00051	0.00019	0.00037	0.00029	0.00051	0.00053	<0.00002
Phosphorous	0.002		0.009	0.016	0.015	0.006	0.010	<0.002	<0.002	0.048	0.010	0.009	0.014	<0.002	0.009	0.016	0.015	0.018	<0.002
Potassium	0.05		2.90	2.56	2.44	1.51	1.37	0.88	0.79	1.51	1.30	1.36	2.64	0.76	1.52	1.50	0.76	1.33	<0.05
Selenium	0.00004	0.001	0.00014	0.00011	0.00010	0.00008	0.00006	0.00029	0.00036	0.00015	0.00005	0.00012	0.00011	0.00057	0.00007	<0.00004	0.00020	0.00013	<0.00004
Silicon	0.1		4.4	3.9	3.9	4.9	4.8	2.7	2.4	8.5	4.9	4.2	3.3	2.9	4.6	4.8	4.2	4.3	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000009	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		6.09	5.54	5.09	5.76	5.85	2.08	2.01	4.61	5.86	3.77	5.96	1.93	6.72	6.42	3.80	6.22	<0.05
Strontium	0.00005		0.350	0.330	0.285	0.248	0.246	0.120	0.122	0.107	0.247	0.237	0.384	0.122	0.245	0.231	0.167	0.187	<0.00005
Thallium	0.000002	0.0008	<0.000002	<0.000002	<0.000002	0.000002	<0.000002	<0.000002	<0.000002	0.000004	<0.000002	0.000003	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0008	0.0010	0.0019	<0.0005	0.0023	<0.0005	0.0010	0.0136	0.0018	0.0016	0.0013	<0.0005	0.0006	<0.0005	0.0010	0.0013	<0.0005
Uranium	0.000002		0.0242	0.0185	0.0216	0.0106	0.00989	0.00161	0.00114	0.000148	0.00909	0.0115	0.0108	0.000931	0.00971	0.00789	0.000241	0.00340	<0.000002
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0010	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0003	<0.0002
Zinc	0.0001	0.03	0.0014	0.0018	0.0020	0.0017	0.0014	0.0046	0.0017	0.0228	0.0014	0.0069	0.0017	0.0008	0.0010	0.0071	0.0005	0.0007	<0.0001
Zirconium	0.0001		0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0002	<0.0001
Dissolved Metals																			
Aluminum	0.0002		0.0081	0.0119	0.0103	0.0096	0.0094	0.0028	0.0033	0.0279	0.046	0.0168	0.0146	0.0012	0.0097	0.0087	0.0056	0.0062	0.0002
Antimony	0.00002		0.00019	0.00023	0.00030	0.00011	0.00007	0.00007	0.00009	0.00005	<0.0001	0.00011	0.00013	0.00009	0.00006	0.00014	0.00003	0.00004	<0.00002
Arsenic	0.00002		0.00044	0.00049	0.00055	0.00032	0.00031	0.00033	0.00032	0.00031	0.0004	0.00067	0.00048	0.00013	0.00032	0.00034	0.00042	0.00059	<0.00002
Barium	0.00002		0.0850	0.0761	0.0699	0.0760	0.0715	0.0434	0.0468	0.0585	0.0775	0.0619	0.0825	0.0702	0.0741	0.0590	0.0463	0.0612	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.00003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000018	0.000024	0.000033	0.000019	0.000020	0.000019	0.000016	0.000358	<0.00003	0.00013	0.000011	0.000019	0.000015	0.000031	<0.000005	0.000007	<0.000005
Calcium	0.05		58.2	49.6	49.4	40.0	33.2	25.8	27.0	15.7	29.7	37.6	48.7	27.7	36.0	32.7	20.3	27.4	<0.05
Chromium	0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000045	0.000065	0.000066	0.000029	0.000056	0.000010	0.000014	0.000143	0.00010	0.000167	0.000057	<0.000005	0.000067	0.000037	0.000104	0.000173	<0.000005
Copper	0.00005		0.00123	0.00122	0.00159	0.00139	0.00068	0.00046	0.00047	0.00204	0.0007	0.00374	0.00078	0.00025	0.00078	0.00071	0.00065	0.00067	<0.00005
Iron	0.001		0.014	0.020	0.021	0.016	0.039	0.012	0.010	0.052	0.146	0.038	0.026	0.001	0.065	0.013	0.243	0.359	<0.001
Lead	0.000005		<0.000005	<0.000005	0.000008	0.000021	0.000011	<0.000005	<0.000005	0.000026	0.00008	0.000593	<0.000005	<0.000005	0.000038	0.000172	0.000006	0.000013	<0.000005
Lithium	0.0005		0.0009	0.0008	0.0006	0.0015	0.0025	0.0013	0.0016	0.0012	0.003	0.0015	0.0012	0.0013	0.0020	0.0022	<0.0005	0.0009	<0.0005
Magnesium	0.05		21.4	18.6	17.3	13.4	12.8	6.97	7.34	3.16	12.8	11.6	19.7	7.16	14.9	10.2	8.46	10.9	<0.05
Manganese	0.00005		0.00800	0.0176	0.0183	0.0101	0.0410	0.00609	0.0119	0.0255	0.0486	0.0779	0.0203	0.00050	0.0529	0.0266	0.0770	0.121	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00085	0.00079	0.00094	0.00140	0.00084	0.00114	0.00119	0.00054	0.0008	0.00073	0.00054	0.00078	0.00086	0.00234	0.00051	0.00113	<0.00005
Nickel	0.00002		0.00053	0.00064	0.00077	0.00015	0.00026	0.00059	0.00071	0.00102	0.0003	0.00028	0.00040	0.00016	0.00032	0.00018	0.00043	0.00045	<0.00002
Phosphorous	0.002		0.005	0.005	0.007	0.005	0.005	<0.002	<0.002	0.014	<0.01	0.008	0.007	<0.002	0.005	0.007	0.005	0.005	<0.002
Potassium	0.05		2.89	2.56	2.51	1.52	1.34	0.81	0.77	1.51	1.27	1.34	2.67	0.74	1.49	1.50	0.77	1.39	<0.05
Selenium	0.00004		0.00016	0.00011	0.00011	0.00007	0.00006	0.00030	0.00037	0.00014	<0.0002	0.00012	0.00012	0.00050	0.00005	<0.00004	0.00019	0.00013	<0.00004
Silicon	0.1		5.0	3.9	4.1	4.9	4.7	2.3	2.4	7.8	4.6	4.3	3.6	2.3	4.6	4.9	4.2	4.3	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000006	<0.00003	0.000011	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		5.95	5.47	5.09	5.77	5.90	1.96	1.96	4.58	5.88	3.75	5.82	1.79	6.44	6.46	3.80	6.42	<0.05
Strontium	0.00005		0.358	0.340	0.295	0.255	0.243	0.121	0.126	0.114	0.263	0.241	0.388	0.121	0.248	0.250	0.166	0.190	<0.00005
Thallium	0.000002		0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.00001	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0244	0.0190	0.0223	0.0108	0.00987	0.00161	0.00118	0.000066	0.00919	0.0119	0.0110	0.000907	0.00998	0.00839	0.000234	0.00353	0.000003
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0001		0.0012	0.0013	0.0016	0.0017	0.0009	0.0010	0.0014	0.0201	0.0014	0.0046	0.0014	0.0007	0.0012	0.0033	0.0003	0.0005	<0.0001
Zirconium	0.0001		0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH $\geq$ 6.5, $[Ca^{2+}]$ $\geq$ 4 mg/L, DOC $\geq$ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

**Average of sample and replicate*

0.231 results exceed CCME Aquatic Life Guidelines

Appendix A5

Surface Water Quality Data, Casino Project, May 2010

Appendix A5. Surface Water Quality Analytical Results, Casino Project, May 2010

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from confluence of Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W4 - Mouth of Casino Creek	W6a - Yukon River downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W7 - Upper Canadian Creek	W8 - Upper Reach of Casino Creek us of confluence with Meloy Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W12 - Proctor Gulch before confluence with Casino Creek	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek*	W18 - Brynelsen Creek	W20 - Klotass in river us of Dip Creek	W21 - Klotass in river ds of Dip Creek	R2	Field Blank	Trip Blank
Date		CCME [1]	8-May-10	8-May-10	8-May-10	9-May-10	8-May-10	8-May-10	10-May-10	10-May-10	9-May-10	9-May-10	10-May-10	8-May-10	8-May-10	9-May-10	9-May-10	9-May-10	9-May-10	10-May-10	10-May-10	
Physical Tests																						
Temperature °C	-		0.2	1.2	2.2	0.0	2.3	8.4	0.1	-0.1	0.1	-0.1	0.0	0.0	6.8	-0.1	-0.1	5.5	4.7	-0.1	-	-
Conductivity (Field) µS/cm	-		197.0	170.8	255.1	193.8	137.5	201.8	58.7	160.0	150.7	206.8	611.8	111.7	191.8	201.5	118.9	175.0	182.8	155.4	-	-
pH (Field)	-		7.70	7.62	7.73	7.94	8.01	8.02	6.30	7.61	7.52	7.62	3.34	7.50	8.09	7.70	7.47	7.63	7.64	7.55	-	-
Hardness $CaCO_3$	0.5		100	90.6	130	97.5	99.1	109	24.8	75.2	79.0	105	190	60.8	109	99.1	57.8	84.1	88.2	77.3	<0.5	<0.5
Conductivity	1		193	173	263	201	191	204	58	155	157	210	647	110	203	202	118	178	183	163	1	1
pH	-	6.5-9.0	7.7	7.8	8.0	8.0	8.0	8.0	6.7	7.0	8.0	7.8	*3.8*	7.6	8.0	7.9	7.8	8.0	8.0	7.9	*6.1*	*6.2*
Total Suspended Solids	1		7	4	<1	2	46	43	37	5	64	40	18	8	68	6	2	2	3	<1	<1	<1
Total Dissolved Solids	1		150	160	200	140	120	130	34	140	100	150	410	82	130	140	92	120	120	120	<10	<10
Turbidity	0.1		1.1	1.0	0.3	0.8	26.9	27.7	10.1	3.1	8.1	12.0	27.6	1.6	39.7	1.8	1.0	0.6	1.5	0.3	<0.1	<0.1
Dissolved Anions &																						
Ammonia as N	0.01	0.137[a]	0.023	0.010	0.026	<0.01	0.020	0.054	0.028	<0.01	<0.01	<0.01	0.081	0.02	0.011	<0.01	0.009	<0.01	<0.005	0.010	0.005	<0.005
Alkalinity, Total (as $CaCO_3$)	0.5		54	50	67	69	76	80	5.8	21	71	57	<0.5	35	77	75	45	68	73	67	1.4	1.1
Acidity (pH 8.3) as $CaCO_3$	0.5		1.3	1.7	1.1	1.1	0.8	0.6	2.7	2.1	0.7	1.0	58.9	2.3	0.7	0.7	1.0	0.7	0.7	1.2	1.0	0.9
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		1.0	0.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.01		0.07	0.06	0.08	0.06	0.09	0.10	0.04	0.07	0.05	0.07	0.16	0.04	0.10	0.05	0.03	0.12	0.11	0.05	<0.01	<0.01
Sulfate (SO_4)	0.5		45	39	66	36	25	29	15	56	14	50	220	18	29	30	15	23	25	18	<0.5	<0.5
Nitrate (as N)	0.002	2.9	0.08	0.09	0.128	0.022	0.019	0.024	<0.02	0.03	0.020	0.06	0.03	0.07	0.019	0.017	0.05	0.128	0.096	0.032	<0.002	<0.002
Nitrite (as N)	0.002	0.06	<0.02	<0.02	<0.002	<0.002	0.006	0.008	<0.02	<0.02	<0.002	<0.02	<0.02	<0.02	0.009	<0.002	<0.02	<0.002	<0.002	<0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.37	0.44	0.29	0.21	0.15	0.12	0.36	0.32	0.15	0.22	0.26	0.55	0.19	0.18	0.29	0.11	0.12	0.17	<0.02	0.23
Ortho Phosphate as P	0.001		0.002	0.002	0.002	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.001
Cyanide, Weak Acid Diss	0.0005		0.0013	0.0013	<0.0005	<0.0005	<0.0005	<0.0005	0.0011	0.0009	<0.0005	<0.0005	<0.0005	0.0017	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	0.0010	0.0010	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	0.0006	<0.0005	<0.0005	<0.0005	0.0015	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Organic Carbon	0.5		<0.5	21.2	11.1	8.1	7.2	6.2	17.4	12.2	7.0	11.1	7.0	29.2	6.2	7.7	11.8	4.7	5.3	7.4	<0.5	1.2
Total Organic Carbon	0.5		20.0	21.5	12.7	9.6	7.7	7.3	18.5	16.2	8.3	14.3	14.2	28.8	6.9	8.8	14.2	5.7	6.1	8.5	0.7	<0.5
Total Metals																						
Aluminum	0.0002	0.005-0.1[b]	*0.244*	*0.298*	0.0718	0.0869	*0.476*	*0.490*	*0.481*	*0.358*	*0.467*	*0.594*	*5.95*	*0.422*	*0.640*	0.0951	*0.157*	0.0353	0.0477	0.0406	0.0010	0.0013
Antimony	0.00002		0.00018	0.00018	0.00031	0.00012	0.00014	0.00018	0.00006	0.00006	0.00008	0.00011	0.00012	0.00013	0.00018	0.00008	0.00011	0.00003	0.00004	0.00003	<0.00002	<0.00002
Arsenic	0.00002	0.005	0.00074	0.00070	0.00068	0.00055	0.00106	0.00106	0.00089	0.00038	0.00074	0.00152	0.00081	0.00070	0.00134	0.00055	0.00053	0.00029	0.00056	0.00024	<0.00002	<0.00002
Barium	0.00002		0.0519	0.0578	0.0521	0.0522	0.0701	0.0784	0.0424	0.0467	0.0635	0.0597	0.0303	0.0610	0.0925	0.0545	0.0372	0.0397	0.0459	0.0472	<0.00002	0.00006
Beryllium	0.00001		0.00002	0.00002	0.00001	<0.00001	0.00004	0.00004	0.00005	0.00003	0.00004	0.00005	0.00027	0.00004	0.00005	0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	0.000009	0.000011	0.000030	<0.000005	0.000009	0.000007	0.000019	<0.000005	0.000012	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000027	0.000024	0.000021	0.000026	*0.000203*	*0.000238*	*0.000303*	*0.000152*	0.000021	*0.000117*	*0.00156*	0.000012	*0.000323*	0.000016	0.000016	0.000013	0.000011	<0.000005	<0.000005	<0.000005
Calcium	0.05		24.9	22.3	32.6	26.1	26.4	29.1	7.42	22.7	20.2	28.4	56.5	15.2	28.7	24.6	15.8	20.6	21.7	18.4	<0.05	<0.05
Chromium	0.0001	0.001	0.0003	0.0003	0.0001	0.0001	0.0006	0.0006	0.0005	0.0002	0.0007	0.0010	0.0005	0.0005	0.0009	0.0002	0.0002	0.0002	0.0002	0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000211	0.000187	0.000066	0.000079	0.000563	0.000561	0.000502	0.00127	0.000519	0.000862	0.0242	0.000232	0.000853	0.000163	0.000085	0.000079	0.000137	0.000038	<0.000005	<0.000005
Copper	0.00005	0.002-0.004[d]	*0.00311*	*0.00300*	*0.00401*	*0.00649*	*0.00338*	*0.00380*	*0.00942*	*0.0317*	0.00199	*0.0279*	*0.486*	*0.00234*	*0.00454*	*0.00225*	0.00173	0.00110	0.00139	0.00103	<0.00005	0.00012
Iron	0.001	0.3	0.259	0.260	0.083	0.176	*0.890*	*0.903*	*0.646*	*0.434*	*0.894*	*1.04*	*17.1*	*0.370*	*1.26*	*0.319*	0.153	0.182	*0.433*	0.057	<0.001	0.002
Lead	0.000005	0.001-0.007[e]	0.000122	0.000072	0.000042	0.000214	0.000737	0.000787	0.000678	0.000293	0.000616	0.00177	0.00273	0.000103	0.00119	0.000134	0.000067	0.000041	0.000041	0.000010	<0.000005	0.000032
Lithium	0.0005		0.0006	<0.0005	<0.0005	0.0009	0.0021	0.0022	0.0007	0.0006	0.0026	0.0014	0.0029	0.0006	0.0025	0.0015	0.0006	<0.0005	0.0005	0.0011	<0.0005	<0.0005
Magnesium	0.05		9.28	8.50	11.9	7.84	8.07	8.88	1.53	4.52	6.96	8.27	11.9	5.53	9.04	9.15	4.45	7.93	8.26	7.60	<0.05	<0.05
Manganese	0.00005		0.0248	0.0192	0.00527	0.0155	0.0598	0.0669	0.0307	0.0539	0.0661	0.0719	0.696	0.0265	0.0931	0.0470	0.00522	0.0246	0.0530	0.00776	<0.00005	0.00012
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00047	0.00040	0.00073	0.00113	0.00085	0.00091	0.00026	0.00015	0.00055	0.00034	0.00007	0.00020	0.00083	0.00080	0.00103	0.00058	0.00069	0.00084	<0.00005	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00107	0.00108	0.00110	0.00044	0.00419	0.00650	0.00195	0.00101	0.00095	0.00146	0.00457	0.00098	0.00623	0.00068	0.00050	0.00071	0.00065	0.00038	<0.00002	0.00002
Phosphorous	0.002		0.017	0.017	0.007	0.009	0.058	0.054	0.036	0.014	0.050	0.028	0.019	0.027	0.094	0.011	0.012	0.008	0.008	0.006	<0.002	<0.002
Potassium	0.05		1.60	1.47	1.77	1.07	1.02	1.03	1.13	0.88	0.83	0.96	1.29	1.21	1.04	0.96	1.09	0.71	0.82	0.71	<0.05	<0.05
Selenium	0.00004	0.001	0.00008	0.00007	0.00008	0.00006	0.00037	0.00048	0.00007	0.00004	0.00004	0.00010	0.00015	0.00006	0.00047	0.00006	<0.00004	0.00022	0.00017	0.00007	<0.00004	<0.00004
Silicon	0.1		3.3	3.3	4.4	4.3	3.6	3.5	5.1	4.1	4.7	4.8	5.0	2.6	3.6	4.2	4.2	4.8	4.6	3.9	<0.1	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000012	<0.000005	<0.000005	<0.000005	0.000014	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		2.93	2.77	3.98	3.64	2.17	2.06	1.85	2.22	3.43	2.69	3.57	1.77	2.10	3.93	2.47	3.73	3.95	3.00	<0.05	<0.05
Strontium	0.00005		0.155	0.147	0.196	0.157	0.125	0.132	0.0492	0.149	0.160	0.175	0.161	0.114	0.130	0.161	0.0809	0.165	0.164	0.151	<0.00005	0.00006
Thallium	0.000002	0.0008	<0.000002	<0.000002	<0.000002	0.000002	0.000006	0.000007	0.000008	0.000005	0.000008	0.000007	0.000040	0.000003	0.000009	0.000002	0.000004	<0.000002	<0.000002	0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0065	0.0062	0.0016	0.0023	0.0105	0.0096	0.0162	0.0025	0.0271	0.0205	0.0097	0.0073	0.0127	0.0035	0.0029	0.0007	0.0015	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.00710	0.00701	0.0124	0.00534	0.00142	0.00121	0.000294	0.00131	0.00525	0.00706	0.00681	0.00257	0.00141	0.00498	0.00246	0.000366	0.00138	0.00270	0.000007	0.000009
Vanadium	0.0002		0.0006	0.0006	<0.0002	0.0006	0.0017	0.0016	0.0012	0.0003	0.0024	0.0026	0.0006	0.0009	0.0022	0.0007	0.0006	0.0004	0.0005	0.0003	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0014	0.0019	0.0014	0.0016	0.0148	0.0181	0.0206	0.0132	0.0035	0.0089	*0.124*	0.0025	0.0254	0.0011	0.0017	0.0015	0.0005	0.0005	0.0002	0.0008
Zirconium	0.0001		0.0003	0.0003	0.0002	0.0002	0.0003	0.0004	0.0004	0.0002	0.0003	0.0003	0.0003	0.0004	0.0004	0.0002	0.0002	0.0001	0.0002	0.0001	<0.0001	<0.0001
Dissolved Metals																						
Aluminum	0.0002		0.191	0.237	0.0561	0.0472	0.0456	0.0386	0.244	0.191	0.0308	0.113	5.50	0.368	0.0522	0.0324	0.113	0.0147	0.0181	0.0341	0.0009	<0.0002
Antimony	0.00002		0.00018	0.00019	0.00030	0.00012	0.00012	0.00014	0.00005	0.00005	0.00007	0.00010	0.00007	0.00013	0.00013	0.00008	0.00012	0.00003	0.00005	0.00003	<0.00002	<0.00002
Arsenic	0.00002		0.00062	0.00061	0.00066	0.00051	0.00047	0.00043	0.00035	0.00030	0.00040	0.00078	0.00035	0.00061	0.00045	0.00049	0.00043	0.00028	0.00041	0.00024	<0.00002	<0.00002
Barium	0.00002		0.0499	0.0551	0.0504	0.0516	0.0442	0.0494	0.0355	0.0451	0.0526	0.0495	0.0271	0.0595	0.0453	0.0529	0.0357	0.0388	0.0442	0.0469	<0.00002	<0.00002
Beryllium	0.00001		0.00002	0.00002	<0.00001	<0.00001	<0.00001	<0.00001	0.00004	0.00002	0.00001	0.00002	0.00028	0.00003	0.00001	<0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000016	0.000025	0.000015	0.000020	0.000057	0.000063	0.000271	0.000152	0.000007	0.000047	0.00148	0.000019	0.000076	0.000010	0.000010	0.000008	0.000011	<0.000005	<0.000005	<0.000005
Calcium	0.05		24.7	21.5	31.8	26.2	25.1	28.4	7.03	22.1	19.6	27.8	56.0	15.1	26.0	24.2	15.3	20.5	21.5	18.2	<0.05	<0.05
Chromium	0.0001		0.0002	0.0002	0.0002	<0.0001	<0.0001	0.0001	0.0002	0.0002	<0.0001	0.0001	0.0004	0.0003	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000137	0.000154	0.000063	0.000065	0.000072	0.000053	0.000289	0.00114	0.000110	0.000338	0.0243	0.000200	0.000070	0.000102	0.000051	0.000050	0.000093	0.000031	<0.000005	<0.000005
Copper	0.00005		0.00262	0.00277	0.00384	0.00596	0.00188	0.00175	0.00719	0.0253	0.00100	0.0237	0.485	0.00229	0.00211	0.00206	0.00159	0.00096	0.00126	0.00100	<0.00005	<0.00005
Iron	0.001		0.156	0.194	0.070	0.120	0.096	0.078	0.272	0.254	0.193	0.376	15.5	0.284	0.117	0.167	0.086	0.124	0.228	0.047	<0.001	<0.001
Lead	0.000005		0.000023	0.000024	0.000026	0.000092	0.000068	0.000052	0.000106	0.000092	0.000021	0.000219	0.00151	0.000104	0.000079	0.000025	0.000014	0.000006	0.000046	0.000021	<0.000005	<0.000005
Lithium	0.0005		0.0005	0.0005	<0.0005	0.0009	0.0017	0.0019	0.0006	0.0006	0.0021	0.0011	0.0028	0.0006	0.0019	0.0014	<0.0005	0.0005	0.0006	0.0011	<0.0005	<0.0005
Magnesium	0.05		8.62	7.63	10.9	7.92	7.27	8.05	1.41	4.43	6.81	8.09	11.7	5.54	7.67	9.13	4.29	8.01	8.26	7.57	<0.05	<0.05
Manganese	0.00005		0.0184	0.0156	0.00400	0.0121	0.0111	0.0151	0.0212	0.0480	0.0483	0.0608	0.686	0.0227	0.0124	0.0359	0.00299	0.0211	0.0432	0.00585	<0.00005	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	0.00001	<0.00001	0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00048	0.00038	0.00076	0.00106	0.00100	0.00102	0.00021	0.00014	0.00065	0.00038	<0.00005	0.00019	0.00098	0.00077	0.00102	0.00054	0.00069	0.00080	<0.00005	<0.00005
Nickel	0.00002		0.00089	0.00092	0.00111	0.00039	0.00224	0.00258	0.00193	0.00095	0.00044	0.00112	0.00479	0.00099	0.00288	0.00051	0.00049	0.00056	0.00058	0.00043	<0.00002	<0.00002
Phosphorous	0.002		0.010	0.012	0.007	0.007	0.007	0.006	0.016	0.010	0.006	0.008	0.007	0.015	0.009	0.007	0.008	0.005	0.006	0.005	<0.002	<0.002
Potassium	0.05		1.58	1.39	1.71	1.09	0.93	0.99	1.08	0.86	0.80	0.95	1.27	1.21	0.91	0.96	1.08	0.71	0.82	0.71	<0.05	<0.05
Selenium	0.00004		0.00007	0.00007	0.00009	0.00006	0.00038	0.00044	0.00006	0.00005	<0.00004	0.00011	0.00015	0.00006	0.00047	0.00005	<0.00004	0.00020	0.00017	0.00006	<0.00004	<0.00004
Silicon	0.1		3.2	3.0	4.1	4.0	2.8	3.0	4.4	3.8	3.8	4.1	4.4	2.3	2.7	4.0	3.7	4.3	4.1	3.7	<0.1	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		2.67	2.56	3.69	3.65	2.04	1.95	1.82	2.20	3.45	2.73	3.58	1.79	1.89	3.98	2.40	3.73	3.97	3.01	<0.05	<0.05
Strontium	0.00005		0.158	0.147	0.196	0.155	0.124	0.130	0.0486	0.148	0.159	0.171	0.159	0.114	0.123	0.162	0.0810	0.161	0.163	0.149	0.00006	<0.00005
Thallium	0.000002		<0.000002	0.000003	0.000003	0.000002	<0.000002	<0.000002	0.000005	0.000005	<0.000002	0.000004	0.000034	0.000003	0.000003	<0.000002	0.000003	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0021	0.0023	0.0007	<0.0005	<0.0005	<0.0005	0.0014	0.0008	<0.0005	0.0006	0.0011	0.0032	0.0008	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.00707	0.00680	0.0120	0.00527	0.00129	0.00109	0.000220	0.00115	0.00473	0.00667	0.00644	0.00257	0.00118	0.00479	0.00235	0.000370	0.00137	0.00267	0.000005	0.000009
Vanadium	0.0002		0.0003	0.0005	<0.0002	0.0004	0.0003	<0.0002	0.0003	<0.0002	0.0005	0.0005	<0.0002	0.0008	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	<0.0002	<0.0002
Zinc	0.0001		0.0008	0.0014	0.0012	0.0013	0.0027	0.0028	0.0172	0.0099	0.0005	0.0042	0.117	0.0038	0.0034	0.0004	0.0012	0.0003	0.0004	0.0006	0.0002	<0.0001
Zirconium	0.0001		0.0003	0.0003	0.0002	0.0001	0.0001	<0.0001	0.0002	0.0002	0.0001	0.0001	0.0002	0.0004	<0.0001	0.0002	0.0002	0.0001	0.0001	0.0001	<0.0001	<0.0001

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{0.86(\log(hardness))-3.2}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 results exceed CCME Aquatic Life Guidelines

**Average of sample and replicate*

0.231 results exceed CCME Aquatic Life Guidelines

Appendix A6

Surface Water Quality Data, Casino Project, June 2010

Appendix A6. Surface Water Quality Analytical Results, Casino Project, June 2010

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from confluence of Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino confluence	W6a - Yukon River downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W7 - Upper Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W12 - Proctor Gulch before confluence with Casino Creek	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek*	W18 - Brynelsen Creek	W20 - Klotass in river us of Dip Creek	W21 - Klotass in river ds of Dip Creek	R2	Field Blank	Trip Blank
Date		CCME [1]	16-Jun-10	16-Jun-10	16-Jun-10	15-Jun-10	15-Jun-10	16-Jun-10	16-Jun-10	14-Jun-10	15-Jun-10	15-Jun-10	14-Jun-10	16-Jun-10	16-Jun-10	15-Jun-10	14-Jun-10	15-Jun-10	15-Jun-10	15-Jun-10	15-Jun-10	17-Jun-10
Physical Tests																						
Temperature °C	-		5.4	5.2	6.7	1.9	4	13.7	13.9	6	3.4	7.4	8.8	3.7	13.7	6.9	3.1	7.8	8.1	7	-	-
Conductivity (Field) µS/cm	-		311	286	258	199	155.4	166	196.1	78	140	286	1250	349	167.5	177	86	163.9	179.1	112	-	-
pH (Field)	-		7.79	7.7	7.72	7.51	8.7	8.16	8.1	6.82	7.55	7.81	3.35	7.77	8.12	7.67	7.24	7.67	7.69	7.51	-	-
Hardness $CaCO_3$	0.5		151	145	123	100	80.8	87.4	117	32.0	69.3	138	502	178	87.7	92.9	44.1	80.5	84.5	64.4	<0.5	<0.5
Conductivity	1		312	287	258	193	155	164	193	78	135	280	1350	349	164	177	82	159	178	113	1	2
pH	-	6.5-9.0	8.1	8.0	8.0	8.0	8.0	8.1	8.0	6.9	7.9	8.0	*3.1*	8.1	8.0	7.9	7.6	8.0	8.0	7.7	*5.8*	*6.1*
Total Suspended Solids	1		<1	<1	<1	4	10	35	46	<1	5	15	5	<1	28	2	19	<1	1	2	<1	<1
Total Dissolved Solids	1		220	200	190	150	110	110	140	50	88	200	640	250	110	140	54	120	120	70	<10	<10
Turbidity	0.1		0.1	0.2	0.3	0.3	3.3	20.0	20.3	0.3	0.6	1.6	4.0	0.1	11.4	0.8	0.9	0.4	0.8	0.2	0.1	<0.1
Dissolved Anions & Nutrients																						
Ammonia as N	0.01	0.137[a]	<0.01	<0.01	<0.01	*0.25*	*0.26*	<0.01	<0.01	*0.25*	<0.01	*0.26*	0.037	<0.01	<0.01	*0.26*	0.08	<0.01	<0.03	<0.01	<0.01	<0.005
Alkalinity, Total (as $CaCO_3$)	0.5		87	83	72	69	65	69	79	5.7	61	86	<0.5	110	69	68	32	63	67	48	0.7	
Acidity (pH 8.3) as $CaCO_3$	0.5		1.5	1.5	1.6	1.9	3.0	0.9	0.7	5.1	3.4	1.6	190	1.6	0.6	2.3	4.3	1.9	1.7	1.8	<0.5	
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	0.5	<0.5	<0.5
Fluoride (F)	0.01		0.11	0.12	0.11	0.07	0.06	0.10	0.10	0.06	0.06	0.08	0.33	0.12	0.09	0.05	0.04	0.12	0.10	0.08	<0.01	<0.01
Sulfate (SO_4)	0.5		77	66	59	32	20	18	31	30	13	63	620	80	21	29	2.9	22	28	12	<0.5	<0.5
Nitrate (as N)	0.002	2.9	0.115	0.113	0.081	0.106	0.097	0.015	0.017	<0.002	0.069	0.130	0.029	0.201	0.010	0.056	0.132	0.088	0.081	0.073	0.010	0.003
Nitrite (as N)	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	0.003	<0.002	<0.002	0.003	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.17	0.15	0.16	0.21	0.28	0.14	0.12	0.26	0.20	0.24	0.16	0.22	0.14	0.22	0.12	0.20	0.19	0.28	0.05	<0.02
Ortho Phosphate as P	0.001		0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.002	0.002	<0.001	0.001	0.001	0.001	<0.001	<0.001
Cyanide, Weak Acid Diss	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Organic Carbon	0.5		7.2	6.9	6.2	12.3	12.2	3.6	3.8	7.9	12.4	8.0	2.1	9.8	3.2	12.2	21.0	7.5	8.2	15.6	<0.5	<0.5
Total Organic Carbon	0.5		8.9	6.4	6.8	11.6	12.6	2.8	5.9	6.6	11.6	9.3	2.8	10.7	5.1	12.2	19.2	6.7	7.1	15.4	<0.5	<0.5
Total Metals																						
Aluminum	0.0002	0.005-0.1[b]	0.0183	0.0293	0.0237	*0.118*	*0.108*	*0.346*	*0.294*	0.0945	*0.103*	*0.254*	*14.5*	0.0425	*0.270*	0.0705	*0.489*	0.0248	0.0303	0.0991	0.0009	0.0005
Antimony	0.00002		0.00028	0.00030	0.00037	0.00015	0.00011	0.00013	0.00018	0.00008	0.00008	0.00018	0.0001	0.00023	0.00012	0.00009	0.00011	0.00004	0.00006	0.00004	<0.00002	<0.00002
Arsenic	0.00002	0.005	0.00048	0.00051	0.00066	0.00048	0.00041	0.00085	0.00096	0.00028	0.00037	0.00089	0.0004	0.00052	0.00076	0.00049	0.00058	0.00032	0.00044	0.00028	<0.00002	<0.00002
Barium	0.00002		0.0579	0.0602	0.0533	0.0495	0.0468	0.0581	0.0741	0.0345	0.0462	0.0640	0.0106	0.0792	0.0535	0.0480	0.0356	0.0398	0.0451	0.0401	0.00003	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	0.00001	0.00002	0.00002	0.00003	0.00003	0.00002	0.00001	0.00079	0.00001	0.00002	0.00001	0.00003	<0.00001	0.00001	0.00002	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000008	<0.000005	<0.000005	<0.000005	<0.00003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000012	0.000016	0.000025	0.000019	0.000015	*0.000100*	*0.000179*	*0.000108*	0.000012	*0.000044*	*0.00364*	0.000008	*0.000080*	0.000013	*0.000021*	0.000009	0.000005	0.000010	0.000006	<0.000005
Calcium	0.05		38.5	37.7	31.1	26.9	21.1	24.6	33.4	9.78	17.3	36.0	151	42.8	24.7	24.1	12.0	19.9	20.6	16.6	<0.05	<0.05
Chromium	0.0001	0.001	0.0002	0.0002	0.0003	0.0004	0.0004	0.0008	0.0006	0.0003	0.0003	0.0005	0.0008	0.0003	0.0007	0.0003	0.0007	0.0002	0.0003	0.0003	<0.0001	<0.0001
Cobalt	0.000005		0.000028	0.000042	0.000044	0.000083	0.000121	0.000469	0.000581	0.000076	0.000088	0.000242	0.0593	0.000043	0.000337	0.000098	0.000317	0.000058	0.000073	0.000070	<0.000005	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00186	0.00200	0.00250	*0.00472*	*0.00229*	*0.00212*	*0.00262*	*0.00404*	0.00152	*0.00778*	*1.30*	0.00137	0.00187	*0.00219*	*0.00247*	0.00115	0.00128	0.00164	<0.00005	<0.00005
Iron	0.001	0.3	0.014	0.038	0.028	0.168	0.198	*0.688*	*0.813*	0.073	0.188	*0.381*	*33.5*	0.041	*0.525*	0.238	*0.571*	0.196	*0.314*	0.139	<0.001	0.001
Lead	0.000005	0.001-0.007[e]	0.000008	0.000018	0.000020	0.000141	0.000124	0.000481	0.000721	0.000050	0.000084	0.000290	0.00157	0.000015	0.000394	0.000057	0.000254	0.000014	0.000027	0.000029	0.000066	0.000005
Lithium	0.0005		0.0006	0.0006	<0.0005	0.0008	0.0016	0.0017	0.0022	<0.0005	0.0019	0.0014	0.007	0.0009	0.0016	0.0012	0.0005	<0.0005	0.0005	0.0009	<0.0005	<0.0005
Magnesium	0.05		13.3	12.3	11.0	7.97	6.83	6.35	8.09	1.84	6.31	11.6	30.5	17.3	6.35	7.98	3.43	7.46	8.01	5.60	<0.05	<0.05
Manganese	0.00005		0.00067	0.00191	0.00235	0.0111	0.0159	0.0377	0.0545	0.00412	0.0146	0.0335	1.57	0.00163	0.0313	0.0204	0.0147	0.0228	0.0295	0.00499	<0.00005	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00097	0.00090	0.00102	0.00110	0.00078	0.00082	0.00086	0.00022	0.00066	0.00084	<0.0003	0.00068	0.00089	0.00081	0.00069	0.00053	0.00077	0.00069	<0.00005	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00052	0.00047	0.00069	0.00048	0.00053	0.00271	0.00376	0.00101	0.00056	0.00082	0.0092	0.00046	0.00243	0.00059	0.00087	0.00064	0.00058	0.00057	<0.00002	<0.00002
Phosphorous	0.002		<0.002	0.003	<0.002	0.008	0.009	0.049	0.066	0.004	0.009	0.013	<0.01	0.009	0.030	0.007	0.016	0.005	0.005	0.006	<0.002	<0.002
Potassium	0.05		2.09	1.96	2.02	0.92	0.72	0.75	0.73	0.48	0.63	1.00	2.3	2.19	0.73	0.77	0.77	0.71	0.78	0.51	<0.05	<0.05
Selenium	0.00004	0.001	0.00009	0.00008	0.00006	0.00006	0.00007	0.00035	0.00069	0.00006	0.00005	0.00010	0.0003	0.00008	0.00037	0.00006	0.00005	0.00018	0.00012	0.00007	<0.00004	<0.00004
Silicon	0.1		4.3	4.7	4.4	4.7	4.5	3.4	3.8	6.3	3.8	4.3	9.3	4.2	3.2	4.6	3.7	4.1	3.8	4.4	<0.1	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000007	<0.000005	<0.000005	<0.000005	<0.000005	<0.00003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		4.74	4.87	4.61	3.66	3.42	1.55	1.52	2.64	3.28	3.93	9.0	6.15	1.53	3.65	1.97	3.54	3.88	2.30	<0.05	<0.05
Strontium	0.00005		0.231	0.231	0.197	0.151	0.141	0.101	0.115	0.0611	0.140	0.226	0.368	0.334	0.0991	0.141	0.0619	0.153	0.153	0.112	<0.00005	<0.00005
Thallium	0.000002	0.0008	0.000002	0.000002	<0.000002	0.000003	0.000003	0.000008	0.000010	<0.000002	0.000002	0.000004	0.00008	0.000002	0.000005	<0.000002	0.000008	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	0.0010	0.0007	0.0027	0.0037	0.0103	0.0071	0.0011	0.0032	0.0091	<0.003	0.0015	0.0080	0.0017	0.0204	0.0008	0.0007	0.0023	<0.0005	<0.0005
Uranium	0.000002		0.0109	0.0106	0.00720	0.00561	0.00386	0.000963	0.000980	0.000138	0.00353	0.0102	0.0162	0.0125	0.000935	0.00317	0.00183	0.000195	0.00106	0.00176	<0.000002	<0.000002
Vanadium	0.0002		0.0003	0.0003	0.0002	0.0006	0.0007	0.0014	0.0014	0.0003	0.0006	0.0012	<0.001	0.0005	0.0012	0.0007	0.0017	0.0004	0.0005	0.0004	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0003	0.0005	0.0009	0.0013	0.0008	0.0091	0.0170	0.0095	0.0005	0.0024	*0.309*	0.0003	0.0084	0.0008	0.0024	0.0003	0.0004	0.0006	0.0002	0.0003
Zirconium	0.0001		0.0002	0.0002	0.0001	0.0003	0.0002	0.0001	0.0001	0.0002	0.0002	0.0002	<0.0005	0.0003	0.0001	0.0002	0.0004	0.0002	0.0002	0.0003	<0.0001	<0.0001
Dissolved Metals																						
Aluminum	0.0002		0.0161	0.0175	0.0126	0.0763	0.0554	0.0238	0.0393	0.0794	0.0592	0.0345	13.9	0.0290	0.0266	0.0471	0.245	0.0191	0.0175	0.0836	0.0008	<0.0002
Antimony	0.00002		0.00027	0.00028	0.00032	0.00014	0.00010	0.00010	0.00014	0.00008	0.00007	0.00015	0.00009	0.00022	0.00010	0.00009	0.00010	0.00004	0.00005	0.00004	<0.00002	<0.00002
Arsenic	0.00002		0.00042	0.00053	0.00051	0.00044	0.00037	0.00045	0.00042	0.00025	0.00032	0.00071	0.00033	0.00049	0.00042	0.00041	0.00039	0.00030	0.00042	0.00023	<0.00002	<0.00002
Barium	0.00002		0.0572	0.0582	0.0509	0.0473	0.0470	0.0370	0.0437	0.0327	0.0428	0.0557	0.00975	0.0745	0.0384	0.0465	0.0289	0.0379	0.0432	0.0384	0.00002	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	0.00001	0.00001	<0.00001	<0.00001	0.00002	0.00002	<0.00001	0.00060	<0.00001	<0.00001	<0.00001	0.00001	0.00001	<0.00001	0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000012	0.000015	0.000017	0.000021	0.000007	0.000039	0.000036	0.000094	0.000006	0.000027	0.00335	0.000008	0.000026	0.000010	0.000015	0.000005	0.000006	0.000009	<0.000005	<0.000005
Calcium	0.05		35.0	32.8	37.2	21.7	21.8	22.1	24.7	8.93	17.8	43.3	128	37.8	18.5	20.1	11.6	16.6	17.4	11.4	<0.05	<0.05
Chromium	0.0001		0.0002	0.0002	0.0002	0.0003	0.0003	0.0002	0.0002	0.0002	0.0003	0.0001	0.0005	0.0002	0.0002	0.0002	0.0005	0.0002	0.0002	0.0003	<0.0001	<0.0001
Cobalt	0.000005		0.000027	0.000029	0.000030	0.000052	0.000058	0.000024	0.000032	0.000058	0.000050	0.000068	0.0577	0.000041	0.000022	0.000066	0.000086	0.000062	0.000065	0.000048	<0.000005	<0.000005
Copper	0.00005		0.00190	0.00203	0.00219	0.00458	0.00217	0.00099	0.00109	0.00391	0.00142	0.00628	1.26	0.00131	0.00093	0.00202	0.00201	0.00125	0.00134	0.00169	<0.00005	<0.00005
Iron	0.001		0.009	0.014	0.014	0.067	0.096	0.020	0.030	0.042	0.100	0.069	30.0	0.017	0.019	0.145	0.164	0.136	0.197	0.076	<0.001	<0.001
Lead	0.000005		<0.000005	0.000020	<0.000005	0.000110	0.000025	0.000109	0.000039	0.000017	0.000014	0.000027	0.00148	0.000020	0.000023	0.000018	0.000032	0.000008	0.000034	0.000022	0.000006	<0.000005
Lithium	0.0005		0.0007	0.0006	0.0005	0.0007	0.0015	0.0012	0.0018	<0.0005	0.0019	0.0013	0.0067	0.0009	0.0013	0.0012	<0.0005	<0.0005	0.0005	0.0010	<0.0005	<0.0005
Magnesium	0.05		13.7	12.6	10.0	8.18	6.59	6.28	7.85	1.85	6.31	11.2	30.1	17.5	6.34	8.03	3.31	8.24	8.40	5.75	<0.05	<0.05
Manganese	0.00005		0.00044	0.00098	0.00123	0.00491	0.00899	0.00200	0.00288	0.00283	0.00921	0.0236	1.49	0.00078	0.00210	0.0161	0.00341	0.0231	0.0244	0.00314	<0.00005	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00095	0.00094	0.00097	0.00109	0.00081	0.00098	0.00098	0.00021	0.00062	0.00079	0.00008	0.00066	0.00097	0.00077	0.00070	0.00050	0.00073	0.00067	<0.00005	<0.00005
Nickel	0.00002		0.00051	0.00059	0.00058	0.00055	0.00048	0.00097	0.00144	0.00101	0.00055	0.00040	0.00885	0.00048	0.00131	0.00061	0.00070	0.00068	0.00065	0.00059	<0.00002	<0.00002
Phosphorous	0.002		<0.002	0.003	<0.002	0.004	0.005	0.005	0.003	0.004	0.004	0.002	<0.002	0.003	<0.002	0.004	0.004	0.004	0.004	0.004	<0.002	<0.002
Potassium	0.05		2.09	1.97	1.83	0.92	0.70	0.69	0.67	0.47	0.61	0.93	2.11	2.14	0.70	0.75	0.72	0.74	0.78	0.52	<0.05	<0.05
Selenium	0.00004		0.00008	0.00007	0.00009	0.00004	0.00006	0.00036	0.00059	0.00005	0.00005	0.00014	0.00029	0.00009	0.00032	0.00006	0.00005	0.00016	0.00012	0.00006	<0.00004	<0.00004
Silicon	0.1		4.0	4.3	5.4	3.8	4.5	2.8	2.8	6.0	4.2	5.4	8.6	3.8	2.2	3.8	3.7	3.8	3.3	3.2	<0.1	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000006	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		4.78	4.92	4.24	3.75	3.32	1.59	1.51	2.61	3.28	3.79	8.73	6.13	1.55	3.63	1.96	3.79	4.04	2.38	<0.05	<0.05
Strontium	0.00005		0.227	0.227	0.187	0.149	0.147	0.0941	0.111	0.0609	0.134	0.217	0.337	0.326	0.0965	0.143	0.0576	0.145	0.146	0.109	<0.00005	<0.00005
Thallium	0.000002		<0.000002	<0.000002	<0.000002	<0.000002	0.000002	<0.000002	<0.000002	0.000002	<0.000002	0.000002	0.000090	<0.000002	0.000003	<0.000002	0.000003	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.0009	<0.0005	<0.0005	<0.0005	0.0008	0.0018	<0.0005	<0.0005	0.0006	<0.0005	<0.0005
Uranium	0.000002		0.0110	0.0104	0.00694	0.00548	0.00396	0.000872	0.000913	0.000124	0.00333	0.00983	0.0152	0.0121	0.000904	0.00313	0.00156	0.000191	0.00103	0.00170	0.000004	<0.000002
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	0.0004	0.0005	0.0002	<0.0002	<0.0002	0.0003	0.0003	<0.0002	0.0003	<0.0002	0.0004	0.0005	0.0003	0.0003	0.0003	<0.0002	<0.0002
Zinc	0.0001		0.0004	0.0012	0.0005	0.0027	0.0007	0.0018	0.0017	0.0081	0.0004	0.0011	0.296	0.0005	0.0010	0.0005	0.0009	0.0004	0.0005	0.0005	<0.0001	0.0001
Zirconium	0.0001		0.0001	0.0001	0.0001	0.0002	0.0002	<0.0001	<0.0001	0.0001	0.0002	0.0001	<0.0001	0.0002	<0.0001	0.0002	0.0004	0.0001	0.0002	0.0002	<0.0001	<0.0001

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 200

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at [$CaCO_3$] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L, results exceed CCME Aquatic Life Guidelines

**Average of sample and replicate*

0.231 results exceed CCME Aquatic Life Guidelines

Appendix A7

Surface Water Quality Data, Casino Project, July 2010

Appendix A7. Surface Water Quality Analytical Results, Casino Project, July 2010

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from confluence of Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W4 - Mouth of Casino Creek	W6a - Yukon River downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W7 - Upper Canadian Creek	W8 - Upper Reach of Casino Creek us of confluence with Meloy Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W12 - Proctor Gulch before confluence with Casino Creek	W13 - Mouth of Meloy Creek	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek*	W18 - Brynelsen Creek	W20 - Klotass in river us of Dip Creek	W21 - Klotass in river ds of Dip Creek	R2	Field Blank	Trip Blank
Date		CCME [1]	7-Jul-10	7-Jul-10	7-Jul-10	8-Jul-10	7-Jul-10	7-Jul-10	8-Jul-10	8-Jul-10	8-Jul-10	8-Jul-10	9-Jul-10	8-Jul-10	7-Jul-10	7-Jul-10	8-Jul-10	8-Jul-10	7-Jul-10	7-Jul-10	8-Jul-10	9-Jul-10	8-Jul-10
Physical Tests																							
Temperature °C	-		8.5	9.6	10.3	4.1	14.9	16.3	7.7	5.7	5.7	7	4.5	3	7.7	16.5	9	7.5	7.8	8	4.8	-	-
Conductivity (Field) µS/cm	-		247	224.6	212.7	215.3	160	202.7	119.3	267.1	131.6	255.2	922	279.6	250.9	201.9	165.8	139.4	137.3	139.9	104.1	-	-
pH (Field)	-		7.85	7.63	7.73	7.54	7.95	7.94	7.89	7.82	7.38	7.65	3.17	7.89	7.95	7.97	7.43	7.56	8.41	7.92	7.64	-	-
Hardness $CaCO_3$	0.5		111	95.6	97.6	90.8	75.7	93.1	37.6	107	57.0	109	291	131	104	95.4	70.8	61.5	57.3	57.4	45.2	<0.5	<0.5
Conductivity	1		253	231	211	219	164	206	122	271	132	263	1000	289	252	206	170	142	133	144	107	2	1
pH	-	6.5-9.0	7.80	7.87	7.86	7.84	7.93	7.96	7.02	7.60	7.85	7.84	*3.22*	8.12	7.99	8.00	7.84	7.81	7.68	7.79	7.70	*5.90*	*5.92*
Total Suspended Solids	1		1	2	<1	4	36	40	<1	9	6	10	11	3	2	33	4	7	6	7	2	<1	<1
Total Dissolved Solids	1		150	130	160	130	98	110	92	160	92	170	630	160	170	120	110	100	80	84	88	<1	<1
Turbidity	0.1		0.2	0.3	0.3	0.9	6.8	11.8	0.2	9.1	1.2	2.3	13.5	1.3	0.2	20.1	0.9	0.2	1.8	1.7	0.2	<0.1	<0.1
Dissolved Anions & Nutrients																							
Ammonia as N	0.01	0.137[a]	0.009	0.012	0.016	0.021	0.021	0.023	0.017	0.016	0.008	0.016	0.090	0.013	0.036	0.010	0.033	0.016	0.024	0.023	0.016	0.008	<0.005
Alkalinity, Total (as $CaCO_3$)	0.5		73	69	61	73	69	75	8.5	35	60	71	<0.5	120	83	76	66	56	59	59	46	1.1	1.1
Acidity (pH 8.3) as $CaCO_3$	0.5		1.3	1.2	1.1	1.4	0.9	1.5	1.3	4.6	1.5	1.6	124	1.9	1.3	0.5	1.4	1.5	1.3	1.3	1.5	0.7	0.5
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.01		0.10	0.09	0.09	0.06	0.10	0.12	0.06	0.09	0.05	0.08	0.24	0.06	0.09	0.10	0.05	0.04	0.13	0.11	0.04	<0.01	<0.01
Sulfate (SO_4)	0.5		53	49	46	39	18	33	43	95	11	62	400	34	50	32	24	18	15	16	8.9	0.6	0.7
Nitrate (as N)	0.002	2.9	0.131	0.125	0.096	0.114	0.012	0.017	0.003	0.090	0.071	0.129	0.061	0.273	0.218	0.010	0.067	0.171	0.080	0.088	0.059	<0.002	<0.002
Nitrite (as N)	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.24	0.25	0.22	0.27	0.16	0.08	0.13	0.16	0.23	0.18	0.20	0.11	0.30	0.14	4.0	0.27	0.21	0.41	0.27	<0.02	0.03
Ortho Phosphate as P	0.001		0.001	0.002	0.002	0.001	0.002	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.001	<0.001	<0.001	<0.001
Cyanide, Weak Acid Diss	0.0005		0.0011	0.0012	0.0010	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	0.0010	<0.0005	<0.0005	<0.0005	0.0015	<0.0005	0.0010	0.0009	0.0009	0.0009	0.0010	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	0.0007	0.0007	0.0006	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	<0.0005	0.0009	<0.0005	0.0006	0.0007	0.0006	0.0006	0.0006	<0.0005	<0.0005
Dissolved Organic Carbon	0.5		7.2	6.5	7.8	8.2	2.4	3.4	3.9	4.8	10.1	6.8	2.2	4.4	12.5	1.9	10.9	8.6	7.3	4.9	11.5	<0.5	<0.5
Total Organic Carbon	0.5		7.7	6.9	7.8	8.7	2.8	3.4	4.3	5.2	10.4	6.9	3.1	3.9	13.4	2.4	11.3	9.2	7.7	8.9	11.7	<0.5	<0.5
Total Metals																							
Aluminum	0.0002	0.005-0.1[b]	0.0384	0.0423	0.0323	0.0814	*0.224*	*0.270*	0.0343	*0.697*	0.0888	*0.227*	*8.73*	0.0433	0.0631	*0.242*	0.0523	*0.102*	0.0778	0.0861	0.0706	<0.0002	<0.0002
Antimony	0.00002		0.00033	0.00037	0.00041	0.00016	0.00012	0.00017	0.00007	0.00011	0.00009	0.00017	0.00016	0.00027	0.00027	0.00018	0.00011	0.00017	0.00005	0.00006	0.00005	<0.00002	<0.00002
Arsenic	0.00002	0.005	0.00061	0.00067	0.00070	0.00046	0.00074	0.00085	0.00021	0.00028	0.00037	0.00075	0.00042	0.00190	0.00058	0.00082	0.00054	0.00042	0.00034	0.00044	0.00026	<0.00002	<0.00002
Barium	0.00002		0.0520	0.0503	0.0451	0.0516	0.0519	0.0703	0.0447	0.0495	0.0447	0.0567	0.0284	0.0892	0.0645	0.0654	0.0458	0.0407	0.0350	0.0379	0.0372	<0.00002	0.00003
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	0.00002	0.00003	0.00001	0.00005	0.00001	0.00002	0.00048	<0.00001	0.00001	0.00002	<0.00001	0.00001	0.00002	0.00002	0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000006	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000014	0.000011	0.000019	0.000022	*0.000060*	*0.000141*	*0.000111*	*0.000307*	0.000011	*0.000071*	*0.00260*	*0.000050*	<0.000005	*0.000130*	0.000013	0.000013	0.000020	0.000012	0.000005	<0.000005	<0.000005
Calcium	0.05		27.0	23.3	26.0	23.5	20.2	24.5	10.9	31.3	13.9	28.8	86.1	34.6	23.1	25.6	16.8	16.6	13.1	13.4	10.4	<0.05	<0.05
Chromium	0.0001	0.001	0.0001	0.0001	0.0001	0.0002	0.0005	0.0005	0.0001	0.0002	0.0002	0.0002	0.0006	<0.0001	0.0002	0.0004	0.0003	0.0002	0.0003	0.0003	0.0002	<0.0001	<0.0001
Cobalt	0.000005		0.000051	0.000053	0.000049	0.000087	0.000333	0.000439	0.000040	0.00332	0.000096	0.000381	0.0373	0.000035	0.000057	0.000388	0.000088	0.000073	0.000126	0.000127	0.000050	<0.000005	<0.000005
Copper	0.00005	0.002-0.004[d]	*0.00268*	*0.00320*	*0.00315*	*0.00671*	0.00176	*0.00219*	*0.00224*	*0.0751*	0.00156	*0.0173*	*0.770*	0.00113	0.00174	*0.00211*	*0.00250*	0.00158	0.00171	0.00179	0.00149	0.00005	0.00008
Iron	0.001	0.3	0.039	0.041	0.041	0.149	*0.454*	*0.604*	0.022	*1.49*	0.165	*0.461*	*26.2*	0.062	0.048	*0.565*	0.189	0.116	0.195	0.288	0.080	<0.001	<0.001
Lead	0.000005	0.001-0.007[e]	0.000017	0.000035	0.000039	0.000196	0.000363	0.000567	0.000017	0.000296	0.000119	0.000603	0.00158	0.00398	0.000019	0.000504	0.000083	0.000055	0.000074	0.000098	0.000018	0.000007	0.000009
Lithium	0.0005		0.0007	0.0006	<0.0005	0.0010	0.0017	0.0025	0.0007	0.0011	0.0023	0.0013	0.0051	0.0019	0.0008	0.0024	0.0014	0.0007	<0.0005	0.0006	0.0011	<0.0005	<0.0005
Magnesium	0.05		10.5	9.11	7.97	7.76	6.16	7.72	2.51	7.03	5.44	9.09	18.5	10.7	11.3	7.65	7.00	4.89	5.95	5.78	4.65	<0.05	<0.05
Manganese	0.00005		0.00137	0.00277	0.00292	0.00819	0.0290	0.0423	0.00159	0.105	0.0149	0.0327	1.03	0.0252	0.00213	0.0392	0.0207	0.00368	0.0241	0.0282	0.00400	<0.00005	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00074	0.00068	0.00074	0.00097	0.00090	0.00080	0.00021	0.00021	0.00058	0.00057	0.00017	0.00072	0.00049	0.00079	0.00067	0.00112	0.00056	0.00059	0.00059	<0.00005	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00063	0.00065	0.00066	0.00036	0.00187	0.00304	0.00073	0.00092	0.00051	0.00053	0.00575	0.00033	0.00054	0.00287	0.00066	0.00035	0.00080	0.00079	0.00050	0.00002	<0.00002
Phosphorous	0.002		0.004	0.004	0.003	0.007	0.035	0.047	0.003	0.003	0.008	0.011	0.008	0.005	0.005	0.038	0.007	0.006	0.010	0.012	0.005	<0.002	<0.002
Potassium	0.05		1.90	1.71	1.61	0.94	0.79	0.75	0.56	0.89	0.64	0.89	1.60	1.10	1.70	0.75	0.79	1.00	0.68	0.68	0.50	<0.05	<0.05
Selenium	0.00004	0.001	0.00010	0.00007	0.00008	0.00006	0.00030	0.00057	0.00005	0.00006	0.00004	0.00010	0.00027	0.00005	0.0008	0.00057	0.00006	0.00004	0.00012	0.00010	0.00007	<0.00004	<0.00004
Silicon	0.1		3.9	4.0	4.8	4.1	2.7	2.8	6.8	5.0	3.6	4.1	8.0	5.3	3.3	2.9	3.6	4.2	3.5	3.5	3.3	<0.1	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	0.000008	0.000007	<0.000005	<0.000005	<0.000005	<0.000005	0.000014	<0.000005	<0.000005	0.000008	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		3.51	3.36	3.10	3.36	1.64	1.51	3.46	3.30	2.90	3.14	5.65	4.22	3.84	1.52	3.18	2.76	2.99	2.93	1.96	<0.05	<0.05
Strontium	0.00005		0.196	0.184	0.161	0.169	0.107	0.125	0.0876	0.217	0.137	0.209	0.262	0.231	0.240	0.124	0.137	0.0978	0.134	0.129	0.103	<0.00005	<0.00005
Thallium	0.000002	0.0008	0.000003	0.000004	0.000002	<0.000002	0.000007	0.000008	0.000002	0.000008	<0.000002	0.000004	0.000068	0.000003	0.000002	0.000007	<0.000002	0.000004	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	0.00001	<0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0009	0.0012	0.0006	0.0018	0.0077	0.0079	<0.0005	<0.0005	0.0037	0.0056	0.0006	0.0012	0.0015	0.0065	0.0012	0.0038	0.0035	0.0029	0.0010	<0.0005	<0.0005
Uranium	0.000002		0.00602	0.00571	0.00485	0.00472	0.000879	0.000860	0.000092	0.00193	0.00290	0.00639	0.0109	0.0148	0.00557	0.000933	0.00239	0.00256	0.000263	0.000536	0.00144	<0.000002	<0.000002
Vanadium	0.0002		0.0003	0.0003	0.0002	0.0005	0.0011	0.0012	<0.0002	<0.0002	0.0007	0.0006	0.0004	0.0004	0.0005	0.0011	0.0007	0.0006	0.0008	0.0008	0.0004	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0004	0.0009	0.0011	0.0011	0.0060	0.0120	0.0093	0.0223	0.0007	0.0052	*0.178*	0.0029	0.0005	0.0114	0.0004	0.0012	0.0014	0.0006	0.0003	<0.0001	0.0002
Zirconium	0.0001		0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	<0.0001	0.0001	0.0003	0.0002	0.0002	<0.0001	0.0004	0.0001	0.0003	0.0002	0.0002	0.0003	0.0003	<0.0001	<0.0001
Dissolved Metals																							
Aluminum	0.0002		0.0326	0.0359	0.0286	0.0411	0.0208	0.0305	0.0322	0.0883	0.0459	0.0534	8.89	0.0156	0.0609	0.0329	0.0444	0.0695	0.0258	0.0284	0.0660	0.0006	0.0003
Antimony	0.00002		0.00031	0.00035	0.00040	0.00015	0.00010	0.00014	0.00008	0.00009	0.00008	0.00015	0.0002	0.00025	0.00026	0.00015	0.00009	0.00016	0.00004	0.00005	0.00004	<0.00002	<0.00002
Arsenic	0.00002		0.00056	0.00063	0.00067	0.00045	0.00046	0.00046	0.00019	0.00017	0.00033	0.00059	0.0003	0.00176	0.00057	0.00045	0.00048	0.00038	0.00029	0.00036	0.00022	0.00003	0.00003
Barium	0.00002		0.0502	0.0519	0.0472	0.0519	0.0375	0.0439	0.0470	0.0489	0.0424	0.0558	0.0307	0.0871	0.0652	0.0445	0.0481	0.0398	0.0332	0.0355	0.0380	0.00002	0.00003
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00001	0.00001	0.00001	0.00051	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00001	0.00002	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.00003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000009	0.000014	0.000016	0.000015	0.000016	0.000038	0.000119	0.000243	0.000005	0.000063	0.00250	0.000105	0.000007	0.000031	0.000008	0.000007	0.000011	0.000007	<0.000005	<0.000005	<0.000005
Calcium	0.05		26.8	25.9	24.5	25.8	21.9	25.8	12.3	34.0	16.5	31.7	90.3	35.5	26.8	25.8	19.7	17.2	14.8	17.4	12.1	<0.05	<0.05
Chromium	0.0001		<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	0.0001	0.0001	<0.0005	<0.0001	0.0002	<0.0001	0.0003	0.0001	0.0001	0.0002	0.0002	<0.0001	<0.0001
Cobalt	0.000005		0.000042	0.000042	0.000040	0.000068	0.000021	0.000024	0.000037	0.00329	0.000052	0.000299	0.0379	0.000018	0.000047	0.000020	0.000080	0.000037	0.000066	0.000083	0.000039	<0.000005	<0.000005
Copper	0.00005		0.00273	0.00299	0.00326	0.00618	0.00092	0.00149	0.00235	0.0277	0.00142	0.0132	0.866	0.00090	0.00180	0.00114	0.00246	0.00152	0.00161	0.00171	0.00163	<0.00005	<0.00005
Iron	0.001		0.021	0.026	0.022	0.058	0.019	0.023	0.015	0.334	0.076	0.145	25.5	0.020	0.040	0.025	0.166	0.042	0.085	0.156	0.063	0.002	<0.001
Lead	0.000005		0.000010	0.000026	0.000014	0.000029	0.000017	0.000040	0.000034	0.000077	0.000028	0.000093	0.00165	0.000308	0.000008	0.000040	0.000025	0.000013	0.000032	0.000015	0.000010	0.000006	0.000009
Lithium	0.0005		0.0007	0.0006	<0.0005	0.0010	0.0014	0.0021	0.0008	0.0010	0.0022	0.0012	0.005	0.0018	0.0008	0.0020	0.0014	0.0006	<0.0005	<0.0005	0.0010	<0.0005	<0.0005
Magnesium	0.05		11.0	9.74	8.59	8.63	6.15	7.91	2.68	7.51	5.65	9.64	20.8	11.4	12.3	8.13	7.25	5.24	6.22	6.26	5.09	<0.05	<0.05
Manganese	0.00005		0.00066	0.00188	0.00222	0.00491	0.00225	0.00257	0.00131	0.103	0.00834	0.0278	1.04	0.0136	0.00156	0.00281	0.0182	0.00172	0.0182	0.0203	0.00250	0.00006	<0.00005
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00073	0.00073	0.00076	0.00099	0.00106	0.00098	0.00025	0.00021	0.00061	0.00063	0.0003	0.00072	0.00049	0.00104	0.00074	0.00117	0.00054	0.00060	0.00068	<0.00005	<0.00005
Nickel	0.00002		0.00063	0.00084	0.00094	0.00036	0.00083	0.00140	0.00086	0.00092	0.00045	0.00054	0.0062	0.00033	0.00055	0.00140	0.00066	0.00040	0.00072	0.00073	0.00053	<0.00002	<0.00002
Phosphorous	0.002		0.002	0.003	<0.002	0.004	<0.002	0.002	0.002	<0.002	0.004	0.003	<0.01	0.003	0.004	<0.002	0.005	0.002	0.005	0.005	0.004	<0.002	<0.002
Potassium	0.05		1.85	1.67	1.60	0.98	0.72	0.69	0.56	0.87	0.61	0.87	1.8	1.15	1.70	0.71	0.76	0.98	0.67	0.68	0.51	<0.05	<0.05
Selenium	0.00004		0.00009	0.00008	0.00007	0.00006	0.00032	0.00055	0.00006	0.00006	0.00005	0.00010	0.0003	0.00005	0.00009	0.00056	0.00007	0.00004	0.00012	0.00013	0.00007	<0.00004	<0.00004
Silicon	0.1		4.4	4.8	4.9	4.1	3.0	3.0	8.2	5.9	4.8	5.1	9.5	5.3	4.2	3.0	4.8	5.0	4.4	5.0	4.2	<0.1	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.00003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		3.68	3.58	3.35	3.71	1.68	1.58	3.74	3.51	2.99	3.35	6.2	4.30	4.10	1.65	3.30	2.92	3.21	3.19	2.13	<0.05	<0.05
Strontium	0.00005		0.190	0.184	0.160	0.166	0.0987	0.118	0.0880	0.210	0.131	0.204	0.244	0.234	0.236	0.120	0.139	0.0943	0.133	0.125	0.103	<0.00005	<0.00005
Thallium	0.000002		0.000003	0.000003	0.000003	0.000002	<0.000002	0.000004	<0.000002	0.000009	<0.000002	0.000003	0.00007	<0.000002	0.000003	0.000003	<0.000002	0.000003	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00012	0.00002	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.003	<0.0005	0.0006	<0.0005	0.0007	0.0008	0.0006	0.0005	0.0006	<0.0005	<0.0005
Uranium	0.000002		0.00636	0.00613	0.00521	0.00503	0.000875	0.000887	0.000109	0.00108	0.00300	0.00673	0.0112	0.0149	0.00596	0.000964	0.00261	0.00265	0.000240	0.000521	0.00157	<0.000002	<0.000002
Vanadium	0.0002		0.0002	0.0002	<0.0002	0.0003	0.0003	0.0002	<0.0002	<0.0002	0.0004	<0.0002	<0.001	<0.0002	0.0004	0.0003	0.0006	0.0004	0.0005	0.0005	0.0003	<0.0002	<0.0002
Zinc	0.0001		0.0006	0.0006	0.0012	0.0008	0.0010	0.0015	0.0107	0.0139	0.0003	0.0031	0.206	0.0019	0.0002	0.0018	0.0004	0.0006	0.0011	0.0003	0.0005	0.0004	0.0001
Zirconium	0.0001		0.0002	0.0002	0.0002	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	0.0002	<0.0005	<0.0001	0.0003	<0.0001	0.0003	0.0002	0.0002	0.0002	0.0003	<0.0001	<0.0001

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at [$CaCO_3$] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

*f) 0.025 mg/L at [CaCO3] = 0 - 6*results exceed CCME Aquatic Life Guidelines

**Average of sample and replicate*

0.231 results exceed CCME Aquatic Life Guidelines

Appendix A8

Surface Water Quality Data, Casino Project, August 2010

Appendix A8. Surface Water Quality Analytical Results, Casino Project, August 2010

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from confluence of Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino confluence	W6a - Yukon River downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W7 - Upper Canadian Creek	W8 - Upper Reach of Casino Creek us of confluence with Meloy Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W12 - Proctor Gulch before confluence with Casino Creek	W13 - Mouth of Meloy Creek	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek	W18 - Brynelsen Creek	W20 - Klotass in river us of Dip Creek	W21 - Klotass in river ds of Dip Creek	R2	Field Blank
Date		CCME [1]	8-Aug-10	8-Aug-10	8-Aug-10	9-Aug-10	9-Aug-10	8-Aug-10	8-Aug-10	10-Aug-10	8-Aug-10	9-Aug-10	9-Aug-10	10-Aug-10	9-Aug-10	8-Aug-10	8-Aug-10	9-Aug-10	9-Aug-10	8-Aug-10	8-Aug-10	9-Aug-10	10-Aug-10
Physical Tests																							
Temperature °C	-		7.8	6.6	10.7	4.3	4.6	18.08	19.8	5.9	6.2	4.9	7	3.1	3.8	9.48	17.9	6.2	6.5	10.8	10.3	5.6	-
Conductivity (Field) µS/cm	-		258	220	231	185	154	202	206	138	239	139	234	894	210	232	202	154	114	151	146	114	-
pH (Field)			7.17	7.33	7.18	7	7.03	8.02	8.1	6.04	7.06	7.02	7.09	3.14	7.05	7.26	7.98	6.86	6.7	7.24	7.18	6.75	-
Hardness $CaCO_3$	0.5		120	109	101	84.5	70.8	94.9	97.5	42.7	103	64.9	108	280	101	102	87.3	79.7	53.6	61.5	70.2	51.8	<0.5
Conductivity	1		249	221	222	172	144	194	198	128	220	130	223	860	201	213	195	159	110	135	147	105	2
pH	-	6.5-9.0	7.80	7.98	7.89	7.4	7.67	8.05	8.17	7	7.42	7.67	7.81	*3.47*	7.83	7.91	8.06	7.8	7.51	7.74	7.69	7.61	*5.61*
Total Suspended Solids	1		2	2	1	7	11	6	5	<1	3	6	8	13	17	3	7	20	2	4	7	9	<1
Total Dissolved Solids	1		170	150	130	130	110	100	110	110	160	100	150	590	130	170	110	120	90	92	110	90	<10
Turbidity	0.1		0.5	0.3	0.2	1	1.3	1.7	2.3	0.3	4.6	0.8	3.7	26.4	0.3	0.2	1.7	6.7	0.4	0.8	1.3	0.9	<0.1
Dissolved Anions & Nutrients																							
Ammonia as N	0.01	0.137[a]	-	0.044	0.021	0.071	0.11	0.051	0.045	0.14	0.048	0.083	0.014	0.049	0.047	0.05	0.047	<0.05	*0.19*	0.049	*0.2*	0.07	0.062
Alkalinity, Total (as $CaCO_3$)	0.5		73	66	61	58	58	75	75	9.8	38	55	63	<0.5	84	72	75	59	42	57	59	44	0.9
Acidity (pH 8.3) as $CaCO_3$	0.5		-	-	-	-	-	-	-	0.6	-	-	-	107	-	-	-	-	-	1.1	-	1.6	0.7
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		<0.5	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.1	<0.5	<0.5
Fluoride (F)	0.01		0.10	0.05	0.07	0.06	0.06	0.10	0.08	0.07	0.11	0.05	0.09	0.19	0.06	0.07	0.11	0.06	0.04	0.14	0.12	0.05	<0.01
Sulfate (SO_4)	0.5		49	41	32	30	18	24	25	46	66	12	44	360	19	38	24	25	12	12	14	10	1.4
Nitrate (as N)	0.002	2.9	0.16	0.19	0.26	0.16	0.12	<0.02	<0.02	<0.02	0.110	0.11	0.17	0.1	0.3	0.11	<0.02	0.09	0.17	0.050	0.05	0.11	<0.02
Nitrite (as N)	0.002	0.06	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	<0.005	<0.005	<0.005	<0.005	<0.005
Total Kjeldahl Nitrogen	0.02		-	0.22	0.34	0.16	0.22	0.18	0.07	0.23	0.12	0.18	0.14	0.05	0.13	0.47	0.15	0.3	0.18	0.21	0.21	0.23	0.09
Ortho Phosphate as P	0.001		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cyanide, Weak Acid Diss	0.0005		<0.0005	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	<0.0005	0.0011	<0.0005	0.0011	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	<0.0005	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Organic Carbon	0.5		-	-	-	-	-	-	-	8.8	-	-	-	1.9	-	-	-	-	-	7.4	-	11.9	<0.5
Total Organic Carbon	0.5		-	9.7	7.7	8.2	9.2	2.2	2.1	11	5.2	9.4	6.6	2.6	6.3	14.7	2.3	11.5	8.7	7.3	9.1	11.3	<0.5
Total Metals																							
Aluminum	0.0002	0.005-0.1[b]	0.0628	0.066	0.0214	*0.189*	*0.178*	0.0217	0.092	0.0668	*0.542*	*0.14*	*0.283*	*7.34*	*0.247*	0.0814	0.0239	*0.331*	*0.138*	*0.122*	*0.129*	*0.307*	0.001
Antimony	0.00002		0.00034	<0.0005	0.00048	0.00015	0.0001	0.00012	<0.0005	0.00008	0.0001	0.00008	0.00017	0.00018	0.00033	0.0003	0.00012	0.0001	0.00013	0.00005	0.00005	0.00006	<0.00002
Arsenic	0.00002	0.005	0.00063	0.0008	0.00075	0.00053	0.00043	0.0005	0.0005	0.00023	0.0003	0.00035	0.00078	0.0003	0.00151	0.00061	0.00049	0.00073	0.00038	0.00036	0.00046	0.00035	<0.00002
Barium	0.00002		0.0560	0.057	0.0484	0.0486	0.0474	0.046	0.05	0.0502	0.0495	0.0451	0.0583	0.0235	0.0899	0.0608	0.0457	0.0496	0.0367	0.0357	0.0387	0.042	0.00004
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	0.00002	0.00001	<0.00001	<0.0001	<0.00001	<0.00004	0.00002	0.00002	0.00049	0.00002	<0.00001	<0.00001	0.00002	<0.00001	0.00002	0.00002	0.00002	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000014	<0.000005	<0.000005	<0.000005	0.000014	<0.000005	0.000007	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000013	0.00001	0.000014	*0.000033*	0.000016	0.000023	0.00002	*0.000158*	*0.000215*	0.000011	*0.000087*	*0.00227*	*0.000142*	<0.000005	0.000017	0.000021	*0.000028*	0.000012	0.000018	0.000008	<0.000005
Calcium	0.05		29.2	27.4	25.8	23	18.2	26.5	26.9	12.8	30.9	16.5	29.8	83.5	27.7	25.2	24.2	19.7	14.7	15	16.9	12.6	<0.3
Chromium	0.0001	0.001	0.0003	<0.001	0.0002	0.0003	0.0004	0.0001	<0.001	0.0003	0.0001	0.0003	0.0003	0.0006	0.0004	0.0003	<0.0001	0.0007	0.0003	0.0005	0.0005	0.0006	<0.0001
Cobalt	0.000005		0.000065	<0.0005	0.000028	0.000185	0.000193	0.000012	<0.0005	0.000046	0.00243	0.000112	0.000503	0.0347	0.000194	0.000053	0.000017	0.000324	0.000051	0.000124	0.000158	0.000177	<0.000005
Copper	0.00005	0.002-0.004[d]	*0.00244*	*0.00310*	*0.00302*	*0.00854*	*0.00397*	0.0007	0.0009	*0.00235*	*0.0604*	0.00147	*0.0208*	*0.811*	*0.00272*	0.00198	0.00068	*0.00391*	0.00171	0.00176	*0.00202*	*0.00255*	<0.00005
Iron	0.001	0.3	0.06	0.078	0.016	0.261	0.289	0.015	0.147	0.044	*0.901*	0.212	*0.447*	*21.4*	*0.326*	0.051	0.021	*0.651*	0.098	0.216	*0.332*	*0.346*	0.001
Lead	0.000005	0.001-0.007[e]	0.000024	0.0002	0.00001	0.00106	0.000583	0.000033	<0.0002	0.000042	0.000253	0.000105	*0.00285*	0.00106	*0.0205*	0.000007	0.000033	0.000376	0.000094	0.000055	0.000116	0.000133	0.00013
Lithium	0.0005		0.0007	<0.005	0.0005	0.0008	0.0016	0.002	<0.005	0.0009	0.0011	0.0019	0.0012	0.0055	0.0012	0.0009	0.0019	0.0014	0.0005	0.0005	0.0006	0.0012	<0.0005
Magnesium	0.05		11.4	9.77	8.9	6.56	6.16	7	7.35	2.6	6.39	5.73	8.1	17.3	7.74	9.4	6.5	7.42	4.11	5.8	6.82	5	<0.3
Manganese	0.00005		0.00235	0.004	0.00086	0.0141	0.02	0.0028	0.01	0.00271	0.0675	0.013	0.0032	0.991	0.0481	0.00038	0.0031	0.0337	0.00366	0.0218	0.0256	0.01060	<0.00005
Mercury	0.00001	0.000026	<0.00001	*0.00006*	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00068	<0.001	0.0008	0.00079	0.00065	0.00119	0.00100	0.00031	0.00023	0.00061	0.00047	0.00023	0.00045	0.0004	0.00128	0.00062	0.0009	0.00062	0.00068	0.00065	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00072	0.001	0.0011	0.00047	0.00056	0.00061	0.001	0.00093	0.00093	0.00058	0.00062	0.00575	0.00096	0.00056	0.00057	0.00131	0.00109	0.00094	0.00118	0.00088	0.0001
Phosphorous	0.002		0.003	<0.01	<0.002	0.006	0.009	0.0040	0.01	0.005	<0.002	0.006	0.005	0.006	0.009	<0.002	0.004	0.021	0.003	0.009	0.012	0.01100	<0.002
Potassium	0.05		1.87	1.62	1.6	0.86	0.71	0.8	0.85	0.5	0.85	0.61	0.87	1.8	1.05	1.40	0.8	0.78	0.89	0.7	0.78	0.50	<0.3
Selenium	0.00004	0.001	0.00009	0.0001	<0.00004	0.00006	0.00005	0.00033	0.0004	0.00004	0.00007	0.00006	0.00009	0.00018	0.00005	0.00005	0.00034	0.00008	<0.00004	0.00011	0.00012	<0.00004	<0.00004
Silicon	0.1		5.1	5.4	4.9	5.6	5.3	2.7	3	9.8	6.9	5.1	5.8	8.6	5.8	4.2	2.6	5.4	5.6	4.8	5.1	4.9	<0.1
Silver	0.000005	0.0001	<0.000005	<0.00002	<0.000005	<0.000005	<0.000005	<0.000005	<0.00002	<0.000005	<0.000005	<0.000005	0.00001	0.000018	0.000041	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		3.76	3.3	3.20	3.19	3.08	1.6	1.66	3.9	3.53	2.99	3.26	5.2	3.34	2.9	1.5	3.27	2.72	2.9	3.55	1.9	<0.3
Strontium	0.00005		0.197	0.195	0.175	0.137	0.134	0.125	0.133	0.0964	0.2	0.131	0.189	0.269	0.174	0.202	0.127	0.129	0.0742	0.138	0.131	0.111	<0.00005
Thallium	0.000002	0.0008	0.000003	<0.00005	0.000003	0.000004	0.000003	0.000003	<0.00005	0.000003	0.000008	<0.000002	0.000006	0.000076	0.000015	0.000004	0.000003	0.000004	0.000004	<0.000002	<0.000002	0.000004	<0.000002
Tin	0.00001		<0.00001	<0.005	<0.00001	<0.00001	<0.00001	<0.00001	<0.005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00003	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0011	<0.005	<0.0005	0.0049	0.0057	<0.0005	<0.005	0.0012	<0.0005	0.0044	0.0057	<0.0005	0.0119	<0.0005	<0.0005	0.0112	0.0026	0.0033	0.0037	0.0102	<0.0005
Uranium	0.000002		0.00658	0.0063	0.00625	0.00343	0.00288	0.00104	0.001000	0.000055	0.00166	0.00271	0.00496	0.0119	0.0075	0.00425	0.00121	0.00235	0.00138	0.000267	0.000563	0.00154	0.000002
Vanadium	0.0002		0.0003	<0.005	<0.0002	0.0006	0.0008	<0.0002	<0.005	0.0004	<0.0002	0.0007	0.0006	<0.0002	0.001	<0.0002	<0.0002	0.0018	0.0005	0.0008	0.0009	0.0011	<0.0002
Zinc	0.0001	0.03	0.0015	0.006	0.0005	0.0024	0.002	0.0009	<0.005	0.0129	0.0161	0.0011	0.0068	*0.172*	0.0111	0.0002	0.0011	0.0019	0.0032	0.0009	0.0022	0.0017	0.0002
Zirconium	0.0001		0.0003	<0.0005	0.0002	0.0002	0.0003	<0.0001	<0.0005	<0.0001	0.0001	0.0003	0.0002	<0.0001	0.0002	0.0004	<0.0001	0.0005	0.0002	0.0002	0.0003	0.0003	<0.0001
Dissolved Metals																							
Aluminum	0.0002		0.0442	0.0468	0.0261	0.0623	0.0568	0.0129	0.0148	0.0261	0.0564	0.0561	0.0631	8.31	0.0394	0.0877	0.0137	0.0654	0.0967	0.0254	0.0354	0.0668	0.001
Antimony	0.00002		0.00034	0.00042	0.00045	0.00014	0.0001	0.00011	0.00012	0.00006	0.0001	0.00007	0.00017	0.00016	0.00026	0.00027	0.00011	0.0001	0.00012	0.00004	0.00006	0.00004	<0.00002
Arsenic	0.00002		0.00056	0.00065	0.00071	0.0004	0.00032	0.00046	0.0005	0.00017	0.00018	0.0003	0.00056	0.0003	0.0011	0.00058	0.00045	0.00051	0.00032	0.00029	0.00041	0.00025	<0.00002
Barium	0.00002		0.056	0.0534	0.0471	0.0452	0.0426	0.0416	0.0461	0.0466	0.0498	0.0422	0.055	0.0233	0.0821	0.0601	0.0427	0.0412	0.0342	0.0323	0.0376	0.0347	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	0.00051	<0.00001	0.00001	<0.00001	0.00001	0.00001	0.00001	0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000015	0.000016	0.000021	0.000025	0.000011	0.000019	0.00002	0.00014	0.000178	<0.000005	0.000068	0.00239	0.000071	0.00001	0.000019	0.000009	0.000012	0.00001	0.000008	0.000006	<0.000005
Calcium	0.05		29.9	25.8	25.2	23.3	18.2	24.1	26	13.4	31.6	16.3	29.5	86.7	28.7	22.7	25.1	18.8	14.7	15.2	16.5	12.3	<0.3
Chromium	0.0001		0.0002	0.0003	0.0002	0.0002	0.0003	0.0001	<0.0001	0.0002	0.0001	0.0002	0.0002	0.0006	0.0002	0.0004	0.0001	0.0004	0.0003	0.0003	0.0003	0.0003	<0.0001
Cobalt	0.000005		0.000048	0.000052	0.000038	0.000091	0.00005	0.000009	0.000009	0.000029	0.00243	0.000056	0.000389	0.0338	0.000035	0.000073	0.000009	0.000106	0.000032	0.000058	0.000072	0.000058	<0.000005
Copper	0.00005		0.00252	0.00245	0.00275	0.00703	0.00303	0.00053	0.00063	0.00199	0.0271	0.00135	0.0153	0.778	0.00135	0.00232	0.00052	0.00271	0.00135	0.00139	0.00169	0.00135	<0.00005
Iron	0.001		0.031	0.034	0.019	0.08	0.081	0.005	0.005	0.01	0.203	0.083	0.131	22.4	0.043	0.099	0.005	0.189	0.047	0.087	0.141	0.087	<0.001
Lead	0.000005		0.000006	0.000005	0.000005	0.000138	0.000059	<0.000005	0.000010	0.000007	0.000052	0.000015	0.000273	0.00104	0.00147	0.000007	<0.000005	0.000039	0.000009	0.000007	0.000018	<0.000005	0.000022
Lithium	0.0005		0.0008	0.0007	0.0005	0.0008	0.0016	0.0018	0.0018	0.0008	0.0011	0.002	0.0011	0.0054	0.0012	0.0007	0.0017	0.0013	<0.0005	<0.0005	0.0005	0.0010	<0.0005
Magnesium	0.05		11.7	9.6	8.8	6.7	6.07	6.8	7.1	2.7	6.66	5.93	8.14	17.5	7.91	9.6	6.8	7.42	4.05	6	6.89	4.9	<0.3
Manganese	0.00005		0.00121	0.00284	0.00263	0.00649	0.00656	0.0008	0.00133	0.00158	0.069	0.00808	0.0241	0.962	0.0128	0.00347	0.00093	0.0193	0.00166	0.0166	0.0175	0.00603	0.00008
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00073	0.00066	0.00075	0.00082	0.00069	0.00116	0.00121	0.00026	0.00022	0.00065	0.00048	0.00021	0.00053	0.00062	0.00121	0.0007	0.00088	0.00053	0.00074	0.00056	<0.00005
Nickel	0.00002		0.00072	0.00067	0.00069	0.00041	0.00046	0.00053	0.00075	0.00074	0.00106	0.00045	0.00047	0.00561	0.00048	0.00075	0.00051	0.00083	0.00044	0.00074	0.00079	0.00052	<0.00002
Phosphorous	0.002		<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	0.005	0.003	0.003	<0.002	0.005	<0.002	<0.002	0.003	<0.002	<0.002
Potassium	0.05		1.91	1.5	1.50	0.89	0.69	0.8	0.8	0.5	0.91	0.63	0.88	1.8	1.06	1.40	0.8	0.74	0.86	0.7	0.76	0.5	<0.3
Selenium	0.00004		0.00009	0.00007	0.00004	0.00006	0.00005	0.00034	0.00035	0.00005	0.00008	0.00006	0.00009	0.00019	<0.00004	0.00007	0.00034	0.00008	0.00004	0.0001	0.00012	0.00005	<0.00004
Silicon	0.1		5.5	4.9	5	5.7	5.2	2.5	2.5	8.9	7.3	5.2	6	9.4	6.1	4.3	2.5	5.2	6.1	4.4	5.2	4.2	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000016	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		3.84	3.3	3.1	3.24	3.08	1.7	1.7	4.6	3.72	3.05	3.32	6.1	3.44	2.90	1.6	3.29	2.59	3.4	3.63	2.1	<0.3
Strontium	0.00005		0.197	0.189	0.169	0.141	0.132	0.115	0.126	0.0915	0.201	0.131	0.191	0.269	0.172	0.194	0.120	0.128	0.0723	0.124	0.127	0.0986	<0.00005
Thallium	0.000002		0.000004	0.000003	0.000002	0.000002	<0.000002	0.000003	0.000003	0.000002	0.000008	<0.000002	0.000004	0.000076	0.000003	0.000003	0.000004	<0.000002	0.000004	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	0.0008	<0.0005	<0.0005	<0.0005	0.001	<0.0005
Uranium	0.000002		0.00628	0.00666	0.006	0.00313	0.00275	0.000966	0.000977	0.000058	0.00106	0.00265	0.0046	0.0117	0.00708	0.0041	0.00116	0.00225	0.00128	0.000218	0.000491	0.00131	0.000014
Vanadium	0.0002		0.0002	0.0003	<0.0002	0.0002	0.0003	0.0002	0.0003	<0.0002	<0.0002	0.0004	<0.0002	0.0003	<0.0002	0.0004	0.0003	0.0007	0.0003	0.0005	0.0005	0.0003	<0.0002
Zinc	0.0001		0.0004	0.0004	0.0005	0.0015	0.0006	0.0003	0.0007	0.0114	0.0108	0.0002	0.0038	0.171	0.0026	0.0002	0.0003	0.0002	0.0005	0.001	0.0003	0.0008	0.0005
Zirconium	0.0001		0.0003	0.0003	0.0002	0.0002	0.0002	<0.0001	<0.0001	<0.0001	0.0001	0.0003	0.0002	0.0001	0.0001	0.0004	<0.0001	0.0004	0.0003	0.0002	0.0003	0.0002	<0.0001

All units mg/L unless otherwise noted
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N
b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L
c) $10^{(0.86log(hardness)-3.2)}$
d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L
e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L
f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L, results exceed CCME Aquatic Life Guidelines
**Average of sample and replicate*
0.231 results exceed CCME Aquatic Life Guidelines

Appendix A9

Surface Water Quality Data, Casino Project, September 2010

Appendix A9. Surface Water Quality Analytical Results, Casino Project, September 2010

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Brittania Creek ds from confluence of Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino confluence	W6a - Yukon River downstream of Canadian Creek	W6b - Yukon River Upstream of Canadian Creek	W7 - Upper Canadian Creek	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River us from outflow of Excelsior Creek	W16 - Lower Reach of Dip Creek	W18 - Brynelsen Creek	W20 - Klotass in river us of Dip Creek	W21 - Klotass in river ds of Dip Creek	R2	Field Blank
Date		CCME [1]	14-Sep-10	14-Sep-10	14-Sep-10	15-Sep-10	15-Sep-10	14-Sep-10	14-Sep-10	14-Sep-10	15-Sep-10	15-Sep-10	14-Sep-10	14-Sep-10	15-Sep-10	15-Sep-10	14-Sep-10	14-Sep-10	15-Sep-10	14-Sep-10
Physical Tests																				
Temperature °C	-		4	5	6	3.4	3.8	11.8	12.2	3.9	2.5	1.2	3.8	12.9	2.8	5.1	4.7	4.5	1.7	-
Conductivity (Field) µS/cm	-		201	181	121	145	144	192	190	140	124	216	164	193	145	122	126	115	98	-
pH (Field)	-		7.03	7.01	7.05	7.61	7.42	7.34	7.37	6.42	7.29	7.77	7.05	7.31	7.47	7.67	6.52	6.24	7.55	-
Hardness $CaCO_3$	0.5		96.6	83.1	89.9	88.0	69.4	100	98.4	53.1	61.8	109	77.7	99.0	72.6	58.9	58.8	62.4	48.7	<0.5
Conductivity	1		207	186	191	190	148	198	190	142	128	227	168	198	148	126	129	131	100	1
pH	-	6.5-9.0	7.82	7.77	7.80	7.86	7.81	8.02	8.03	6.88	7.79	7.89	7.79	8.03	7.73	7.75	7.72	7.72	7.64	5.55
Total Suspended Solids	1		2	3	2	5	5	6	6	1	5	5	4	6	8	<1	6	8	5	<1
Total Dissolved Solids	1		150	130	140	130	100	140	120	120	92	150	120	130	110	98	98	110	76	<10
Turbidity	0.1		0.6	0.4	0.6	1.5	1.4	5.9	5.7	0.3	2.2	3.0	1.2	5.6	3.6	0.2	2.2	3.2	1.3	<0.1
Dissolved Anions & Nutrients																				
Ammonia as N	0.01	0.137[a]	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.013	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Alkalinity, Total (as $CaCO_3$)	0.5		59	51	52	63	55	73	73	6.0	53	65	56	75	55	45	56	53	43	0.8
Acidity (pH 8.3) as $CaCO_3$	0.5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromide (Br)	0.1		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5
Fluoride (F)	0.01		0.09	0.08	0.08	0.07	0.06	0.13	0.14	0.06	0.05	0.08	0.07	0.13	0.06	0.05	0.16	0.13	0.05	0.02
Sulfate (SO_4)	0.5		40	33	39	29	16	25	25	50	10	44	28	25	20	16	13	13	8.8	<0.5
Nitrate (as N)	0.002	2.9	0.313	0.317	0.266	0.208	0.173	0.003	0.002	<0.002	0.102	0.224	0.420	<0.002	0.140	0.257	0.067	0.073	0.158	<0.002
Nitrite (as N)	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02		0.23	0.28	0.30	0.18	0.24	0.24	0.15	0.16	0.29	0.21	0.36	0.42	0.32	0.22	0.22	0.47	0.31	0.45
Ortho Phosphate as P	0.001		<0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.001	<0.001	0.001	0.001	0.002	0.001	0.002	0.002	<0.001	0.001
Cyanide, Weak Acid Diss	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0010	<0.0005	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Organic Carbon	0.5		10.9	10.1	9.0	7.7	8.8	2.5	2.7	3.3	8.8	5.7	14.4	2.6	11.7	7.2	8.6	9.8	10.9	<0.5
Total Organic Carbon	0.5		11.6	10.7	9.1	7.1	7.9	2.6	2.8	3.8	9.8	6.0	14.7	2.9	11.9	7.7	9.7	10.1	12.0	<0.5
Total Metals																				
Aluminum	0.0002	0.005-0.1[b]	0.0737	0.0878	0.0588	0.119	0.0981	0.0868	0.0790	0.0449	0.110	0.224	0.149	0.0734	0.130	0.0712	0.0966	0.119	0.103	<0.0002
Antimony	0.00002		0.00036	0.00037	0.00045	0.00013	0.00008	0.00012	0.00011	0.00006	0.00008	0.00014	0.00027	0.00011	0.00009	0.00014	0.00005	0.00006	0.00004	<0.00002
Arsenic	0.00002	0.005	0.00063	0.00067	0.00075	0.00042	0.00036	0.00050	0.00048	0.00015	0.00033	0.00060	0.00057	0.00045	0.00058	0.00031	0.00029	0.00045	0.00024	<0.00002
Barium	0.00002		0.0456	0.0460	0.0448	0.0486	0.0424	0.0480	0.0472	0.0506	0.0423	0.0562	0.0554	0.0455	0.0427	0.0385	0.0344	0.0357	0.0372	<0.00002
Beryllium	0.00001		0.00001	0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	0.00001	0.00001	0.00001	0.00002	<0.00001	0.00001	<0.00001	0.00001	0.00002	0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000017	0.000019	0.000027	0.000030	0.000018	0.000042	0.000035	0.000215	0.000013	0.000097	0.000005	0.000036	0.000019	0.000008	0.000012	0.000018	0.000007	<0.000005
Calcium	0.05		25.2	21.4	24.1	24.7	18.9	28.8	28.0	16.3	16.7	31.4	19.8	28.0	19.1	16.8	14.0	16.1	12.5	<0.05
Chromium	0.0001	0.001	0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	<0.0001	0.0002	<0.0001	0.0004	<0.0001	0.0003	0.0002	0.0004	0.0004	0.0003	<0.0001
Cobalt	0.000005		0.000110	0.000080	0.000086	0.000186	0.000120	0.000097	0.000083	0.000081	0.000109	0.000691	0.000105	0.000081	0.000176	0.000041	0.000137	0.000167	0.000072	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00282	0.00286	0.00336	0.00980	0.00395	0.00097	0.00102	0.00215	0.00138	0.0255	0.00189	0.00095	0.00342	0.00129	0.00177	0.00235	0.00152	<0.00005
Iron	0.001	0.3	0.083	0.086	0.065	0.220	0.183	0.153	0.140	0.030	0.206	0.466	0.141	0.126	0.361	0.050	0.206	0.326	0.139	<0.001
Lead	0.000005	0.001-0.007[e]	0.000034	0.000042	0.000040	0.000459	0.000257	0.000130	0.000119	0.000037	0.000143	0.00132	0.000045	0.000118	0.000214	0.000027	0.000078	0.000151	0.000040	0.000015
Lithium	0.0005		0.0006	<0.0005	<0.0005	0.0010	0.0016	0.0019	0.0019	0.0008	0.0022	0.0011	0.0006	0.0019	0.0014	0.0006	<0.0005	0.0007	0.0011	<0.0005
Magnesium	0.05		8.20	7.17	7.24	6.41	5.40	6.90	6.92	3.01	4.90	7.54	6.88	7.05	6.05	4.08	5.81	5.37	4.28	<0.05
Manganese	0.00005		0.00382	0.00479	0.00428	0.0137	0.0151	0.00951	0.00883	0.00530	0.0158	0.0349	0.00608	0.00812	0.0277	0.00292	0.0198	0.0254	0.00683	<0.00005
Mercury	0.00001	0.000026	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00054	0.00050	0.00066	0.00091	0.00066	0.00120	0.00121	0.00020	0.00060	0.00053	0.00028	0.00123	0.00066	0.00099	0.00064	0.00064	0.00068	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00079	0.00079	0.00090	0.00040	0.00048	0.00116	0.00110	0.00109	0.00057	0.00060	0.00064	0.00109	0.00097	0.00030	0.00093	0.00106	0.00061	<0.00002
Phosphorous	0.002		0.004	0.004	0.002	0.004	0.005	0.008	0.007	<0.002	0.005	0.005	0.005	0.006	0.009	<0.002	0.007	0.009	0.004	<0.002
Potassium	0.05		1.26	1.07	1.15	0.80	0.60	0.73	0.74	0.46	0.51	0.77	0.97	0.74	0.65	0.82	0.63	0.58	0.41	<0.05
Selenium	0.00004	0.001	0.00009	0.00008	0.00007	0.00006	0.00004	0.00039	0.00036	0.00006	0.00005	0.00009	0.00008	0.00037	0.00007	<0.00004	0.00012	0.00013	0.00006	<0.00004
Silicon	0.1		5.6	5.4	6.0	5.8	5.5	3.1	3.0	10.0	5.5	6.2	5.1	3.0	5.7	5.9	4.5	5.3	4.9	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		2.70	2.53	2.61	3.08	2.74	1.82	1.82	4.06	2.54	3.02	2.31	1.86	2.85	2.62	3.14	2.86	1.90	<0.05
Strontium	0.00005		0.150	0.139	0.146	0.147	0.127	0.128	0.125	0.0961	0.127	0.186	0.143	0.123	0.118	0.0858	0.130	0.123	0.0989	<0.00005
Thallium	0.000002	0.0008	0.000003	0.000004	0.000004	0.000004	0.000002	0.000003	0.000004	0.000002	0.000002	0.000004	0.000004	0.000004	0.000002	0.000003	<0.000002	<0.000002	0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0013	0.0016	0.0005	0.0015	0.0029	0.0011	0.0013	<0.0005	0.0049	0.0008	0.0031	0.0011	0.0039	<0.0005	0.0019	0.0033	0.0011	<0.0005
Uranium	0.000002		0.00506	0.00486	0.00582	0.00379	0.00308	0.00106	0.000944	0.000066	0.00303	0.00536	0.00298	0.00117	0.00235	0.00183	0.000284	0.000562	0.00154	0.000013
Vanadium	0.0002		0.0004	0.0004	0.0004	0.0004	0.0005	0.0004	0.0004	0.0004	0.0005	0.0002	0.0007	0.0004	0.0010	0.0003	0.0007	0.0009	0.0004	<0.0002
Zinc	0.0001	0.03	0.0009	0.0010	0.0016	0.0024	0.0012	0.0026	0.0026	0.0184	0.0006	0.0070	0.0004	0.0026	0.0008	0.0077	0.0007	0.0015	0.0005	<0.0001
Zirconium	0.0001		0.0003	0.0003	0.0002	0.0002	0.0003	<0.0001	<0.0001	<0.0001	0.0003	0.0002	0.0005	<0.0001	0.0004	0.0002	0.0003	0.0004	0.0004	<0.0001
Dissolved Metals																				
Aluminum	0.0002		0.0575	0.0660	0.0427	0.0443	0.0492	0.0113	0.0116	0.0383	0.0473	0.0455	0.122	0.0120	0.0580	0.0621	0.0370	0.0419	0.0715	0.0006
Antimony	0.00002		0.00035	0.00038	0.00046	0.00013	0.00009	0.00011	0.00010	0.00006	0.00007	0.00013	0.00029	0.00010	0.00009	0.00013	0.00005	0.00006	0.00005	<0.00002
Arsenic	0.00002		0.00060	0.00068	0.00076	0.00038	0.00035	0.00043	0.00042	0.00016	0.00027	0.00043	0.00057	0.00041	0.00047	0.00032	0.00028	0.00038	0.00025	<0.00002
Barium	0.00002		0.0466	0.0457	0.0408	0.0469	0.0413	0.0414	0.0407	0.0533	0.0377	0.0508	0.0562	0.0412	0.0388	0.0368	0.0311	0.0330	0.0362	0.00005
Beryllium	0.00001		0.00001	<0.00001	0.00002	0.00001	<0.00001	<0.00001	<0.00001	0.00002	0.00001	<0.00001	0.00001	<0.00001	0.00001	<0.00001	0.00001	0.00001	0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000049	0.000011	0.000051	0.000029	0.000009	0.000019	0.000023	0.000225	0.000005	0.000087	0.000008	0.000016	<0.000005	0.000009	0.000007	<0.000005	<0.000005	<0.000005
Calcium	0.05		24.2	21.3	22.1	23.0	17.6	25.4	25.6	15.3	15.3	27.3	18.8	25.6	16.8	15.8	14.7	14.7	11.6	<0.05
Chromium	0.0001		0.0002	0.0002	0.0002	0.0002	0.0002	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0004	<0.0001	0.0003	0.0002	0.0002	0.0003	0.0002	<0.0001
Cobalt	0.000005		0.000061	0.000063	0.000061	0.000145	0.000077	0.000011	0.000014	0.000063	0.000046	0.000572	0.000072	0.000013	0.000103	0.000036	0.000062	0.000082	0.000058	<0.000005
Copper	0.00005		0.00385	0.00268	0.00634	0.00806	0.00321	0.00069	0.00069	0.00197	0.00119	0.0168	0.00196	0.00065	0.00276	0.00116	0.00151	0.00180	0.00144	<0.00005
Iron	0.001		0.050	0.052	0.039	0.109	0.087	0.010	0.012	0.018	0.069	0.207	0.092	0.010	0.190	0.035	0.101	0.150	0.076	0.001
Lead	0.000005		0.000247	0.000010	0.000339	0.000164	0.000049	0.000016	0.000045	0.000016	0.000013	0.000165	0.000061	0.000007	0.000062	0.000019	0.000008	0.000017	0.000006	0.000021
Lithium	0.0005		0.0005	<0.0005	<0.0005	0.0008	0.0015	0.0017	0.0016	0.0007	0.0018	0.0009	<0.0005	0.0016	0.0012	<0.0005	<0.0005	<0.0005	0.0009	<0.0005
Magnesium	0.05		8.73	7.57	7.62	6.75	5.62	7.13	7.13	3.12	5.06	7.26	7.59	7.16	6.13	4.23	5.55	5.63	4.42	<0.05
Manganese	0.00005		0.00231	0.00346	0.00328	0.0101	0.00847	0.00100	0.00111	0.00447	0.00854	0.0288	0.00474	0.00122	0.0191	0.00237	0.0141	0.0169	0.00455	0.00011
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005		0.00054	0.00053	0.00059	0.00092	0.00070	0.00125	0.00129	0.00021	0.00055	0.00048	0.00032	0.00129	0.00067	0.00099	0.00066	0.00065	0.00066	<0.00005
Nickel	0.00002		0.00127	0.00072	0.00166	0.00075	0.00043	0.00068	0.00081	0.00103	0.00043	0.00052	0.00223	0.00074	0.00076	0.00030	0.00083	0.00084	0.00054	<0.00002
Phosphorous	0.002		0.005	0.003	0.008	<0.002	0.002	<0.002	<0.002	<0.002	0.003	<0.002	0.005	<0.002	0.004	<0.002	0.002	0.004	0.003	<0.002
Potassium	0.05		1.43	1.20	1.28	0.87	0.65	0.76	0.76	0.50	0.54	0.75	1.12	0.76	0.66	0.87	0.59	0.60	0.44	<0.05
Selenium	0.00004		0.00009	0.00008	0.00007	0.00006	0.00005	0.00036	0.00036	0.00007	0.00005	0.00008	0.00008	0.00035	0.00007	<0.00004	0.00012	0.00010	0.00006	<0.00004
Silicon	0.1		5.1	5.2	5.4	5.3	5.1	2.6	2.7	9.3	4.9	5.2	4.6	2.7	4.9	5.4	4.8	4.8	4.6	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05		2.86	2.64	2.75	3.21	2.84	1.87	1.87	4.19	2.64	2.85	2.51	1.87	2.83	2.71	2.99	2.98	1.94	<0.05
Strontium	0.00005		0.153	0.140	0.134	0.142	0.128	0.123	0.120	0.0985	0.123	0.172	0.147	0.121	0.116	0.0830	0.123	0.119	0.0967	<0.00005
Thallium	0.000002		0.000003	0.000002	0.000004	0.000003	0.000002	0.000002	0.000002	<0.000002	<0.000002	0.000003	0.000003	0.000002	<0.000002	0.000003	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		0.00003	<0.00001	0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	0.0007	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0011	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	<0.0005
Uranium	0.000002		0.00495	0.00485	0.00527	0.00361	0.00305	0.00103	0.000936	0.000053	0.00285	0.00459	0.00297	0.00117	0.00226	0.00172	0.000298	0.000510	0.00158	0.000011
Vanadium	0.0002		0.0005	0.0005	0.0004	0.0004	0.0005	0.0003	0.0003	0.0004	0.0005	0.0002	0.0007	0.0003	0.0008	0.0005	0.0007	0.0008	0.0006	<0.0002
Zinc	0.0001		0.005	0.0008	0.0076	0.006	0.0006	0.0005	0.0014	0.0167	0.0002	0.0047	0.0014	0.0004	0.0004	0.0004	0.0005	0.0004	0.0002	<0.0001
Zirconium	0.0001		0.0003	0.0003	0.0002	0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.0002	0.0001	0.0005	<0.0001	0.0003	0.0002	0.0002	0.0003	0.0003	<0.0001

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at [$CaCO_3$] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L, results exceed CCME Aquatic Life Guidelines

**Average of sample and replicate*

0.231 results exceed CCME Aquatic Life Guidelines

Appendix A10

Surface Water Quality Data, Casino Project, October 2010

Appendix A10. Surface Water Quality Analytical Results, Casino Project, October 2010

Station	W1 - Mouth of Canadian Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek ds Casino confluence	W9 - Dip Creek us of Confluence with Casino Creek	W11 - Casino Creek (proposed dam outflow)	W14 - Mouth of Britannia Creek	W16 - Lower Reach of Dip Creek*	W18 - Brynelsen Creek	R2
Date	15-Oct-10	15-Oct-10	15-Oct-10	15-Oct-10	15-Oct-10	15-Oct-10	15-Oct-10	15-Oct-10	15-Oct-10	15-Oct-10
Physical Tests										
Temperature °C	1.0	1.4	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1
Conductivity (Field) µS/cm	315	272	248	194	174	261	31	199	164	145
pH (Field)	7.73	7.64	7.49	7.31	7.35	7.69	7.57	6.93	7.32	6.92
Hardness $CaCO_3$	149	126	114	91.8	81.4	135	158	93.9	73.1	67.0
Conductivity	315	269	245	197	172	280	315	203	164	147
pH	7.95	7.83	7.86	7.85	7.81	7.90	7.91	7.84	7.83	7.73
Total Suspended Solids	<1	<1	1	<1	1	2	<1	<1	<1	<1
Total Dissolved Solids	190	170	130	110	96	160	190	110	94	82
Turbidity	0.1	0.2	1.3	1.3	0.4	2.2	0.5	0.9	0.1	0.2
Dissolved Anions & Nutrients										
Ammonia as N	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005
Alkalinity, Total (as $CaCO_3$)	84	72	79	74	72	81	97	77	60	58
	-	-	-	-	-	-	-	-	-	-
Bromide (Br)	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloride (Cl)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.12	0.11	0.08	0.07	0.06	0.10	0.12	0.08	0.06	0.06
Sulfate (SO_4)	82	58	42	26	15	62	61	27	23	14
Nitrate (as N)	0.304	0.248	0.231	0.216	0.218	0.260	0.397	0.198	0.244	0.206
Nitrite (as N)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Kjeldahl Nitrogen	0.24	0.21	0.16	0.18	0.21	0.12	0.28	0.20	0.17	0.17
Ortho Phosphate as P	0.002	0.003	0.003	0.003	0.003	0.005	0.002	0.002	0.003	0.031
Cyanide, Weak Acid Diss	0.0007	0.0010	0.0008	0.0007	0.0008	0.0007	0.0010	0.0008	0.0007	0.0007
Cyanide, Total	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	<0.0005
Dissolved Organic Carbon	7.1	5.8	4.0	4.6	5.3	3.1	9.6	5.4	3.6	5.7
Total Organic Carbon	7.4	6.1	3.9	5.1	5.2	3.3	10.1	5.8	3.7	6.1
Total Metals										
Aluminum	0.0185	0.0166	0.0503	0.0331	0.0229	*0.146*	0.0407	0.0238	0.0207	0.0238
Antimony	0.00028	0.00034	0.00013	0.00009	0.00007	0.00014	0.00024	0.00009	0.00013	0.00003
Arsenic	0.00047	0.00054	0.00034	0.00027	0.00025	0.00058	0.00045	0.00042	0.00032	0.00016
Barium	0.0609	0.0540	0.0575	0.0540	0.0489	0.0702	0.0791	0.0533	0.0421	0.0440
Beryllium	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001
Bismuth	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000009	0.000015	0.000012	<0.000005	<0.000005	*0.000081*	<0.000005	0.000017	0.000011	<0.000005
Calcium	37.3	32.9	30.6	24.4	21.2	37.3	37.9	23.8	20.0	16.1
Chromium	0.0002	0.0002	0.0001	<0.0001	0.0001	0.0001	0.0002	0.0001	<0.0001	0.0002
Cobalt	0.000032	0.000038	0.000078	0.000049	0.000045	0.000437	0.000043	0.000063	0.000023	0.000030
Copper	0.00175	0.00201	*0.00506*	*0.00218*	0.00074	*0.0163*	0.00147	0.00176	0.00067	0.00086
Iron	0.014	0.022	0.094	0.066	0.050	*0.303*	0.039	0.130	0.016	0.023
Lead	0.000005	0.000053	0.000182	0.000094	0.000024	0.00102	0.000015	0.000066	<0.000005	0.000012
Lithium	0.0007	0.0005	0.0010	0.0020	0.0024	0.0013	0.0009	0.0013	<0.0005	0.0010
Magnesium	13.7	10.6	9.12	7.51	6.90	10.2	15.4	8.35	5.61	6.53
Manganese	0.00089	0.00460	0.00931	0.0113	0.0125	0.0316	0.00252	0.0227	0.00264	0.00348
Mercury	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00081	0.00086	0.00113	0.00089	0.00072	0.00058	0.00055	0.00094	0.00128	0.00091
Nickel	0.00052	0.00062	0.00022	0.00026	0.00022	0.00039	0.00053	0.00038	0.00018	0.00030
Phosphorous	0.004	0.004	0.004	0.003	0.004	0.004	0.005	0.005	0.003	0.004
Potassium	1.94	1.72	1.00	0.77	0.67	0.94	1.83	0.85	0.96	0.55
Selenium	0.00010	0.00008	0.00007	0.00004	<0.00004	0.00012	0.00009	0.00004	<0.00004	0.00005
Silicon	4.9	5.3	5.6	5.3	5.4	5.8	4.8	5.1	5.3	4.7
Silver	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	4.20	3.85	4.06	3.66	3.54	3.69	4.57	3.98	3.16	2.68
Strontium	0.244	0.206	0.197	0.183	0.170	0.247	0.310	0.169	0.108	0.141
Thallium	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000002	0.000002	<0.000002	<0.000002	<0.000002
Tin	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005
Uranium	0.0114	0.00992	0.00701	0.00595	0.00529	0.00978	0.00956	0.00463	0.00300	0.00261
Vanadium	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0004	0.0022	0.0014	0.0009	0.0003	0.0060	0.0009	0.0014	0.0002	0.0003
Zirconium	0.0002	0.0001	<0.0001	0.0001	0.0001	0.0002	0.0003	0.0002	<0.0001	0.0002
Dissolved Metals										
Aluminum	0.0165	0.0124	0.0164	0.0150	0.0149	0.0276	0.0330	0.0164	0.0178	0.0219
Antimony	0.00028	0.00035	0.00014	0.00010	0.00008	0.00014	0.00023	0.00009	0.00014	0.00003
Arsenic	0.00045	0.00049	0.00030	0.00025	0.00023	0.00045	0.00048	0.00041	0.00027	0.00017
Barium	0.0611	0.0531	0.0565	0.0512	0.0477	0.0643	0.0756	0.0533	0.0414	0.0418
Beryllium	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	<0.000005	0.000013	0.000016	0.000012	0.000006	0.000062	<0.000005	<0.000005	<0.000005	<0.000005
Calcium	37.7	33.1	30.5	24.2	20.2	36.8	35.7	23.7	19.7	15.9
Chromium	0.0002	0.0001	<0.0001	0.0001	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001
Cobalt	0.000032	0.000035	0.000058	0.000055	0.000033	0.000404	0.000049	0.000057	0.000014	0.000029
Copper	0.00181	0.00189	0.00326	0.00175	0.00069	0.00826	0.00146	0.00150	0.00069	0.00084
Iron	0.011	0.015	0.027	0.033	0.037	0.061	0.027	0.107	0.012	0.019
Lead	<0.000005	0.000030	0.000026	0.000023	<0.000005	0.000076	0.000022	0.000013	<0.000005	<0.000005
Lithium	0.0007	<0.0005	0.0010	0.0019	0.0023	0.0013	0.0009	0.0013	<0.0005	0.0010
Magnesium	13.5	10.2	8.38	7.44	6.76	10.2	14.9	8.32	5.44	6.33
Manganese	0.00071	0.00382	0.00740	0.00965	0.0111	0.0281	0.00196	0.0221	0.00259	0.00321
Mercury	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00085	0.00087	0.00117	0.00088	0.00076	0.00063	0.00057	0.00095	0.00129	0.00093
Nickel	0.00054	0.00059	0.00020	0.00029	0.00024	0.00043	0.00052	0.00042	0.00017	0.00031
Phosphorous	0.003	0.003	0.002	0.004	<0.002	<0.002	0.006	0.004	<0.002	<0.002
Potassium	1.90	1.62	0.93	0.77	0.66	0.93	1.81	0.84	0.93	0.53
Selenium	0.00010	0.00008	0.00008	0.00004	<0.00004	0.00012	0.00009	<0.00004	<0.00004	0.00005
Silicon	5.0	5.4	5.5	5.3	4.9	5.6	4.4	5.0	5.1	4.5
Silver	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	4.15	3.63	3.81	3.67	3.49	3.67	4.52	3.96	3.12	2.67
Strontium	0.240	0.206	0.193	0.182	0.172	0.248	0.308	0.168	0.107	0.140
Thallium	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000003	<0.000002	<0.000002	<0.000002	<0.000002
Tin	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001
Titanium	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.0118	0.0102	0.00688	0.00595	0.00542	0.00969	0.00985	0.00457	0.00298	0.00267
Vanadium	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	<0.0002
Zinc	0.0002	0.0008	0.0010	0.0009	0.0001	0.0043	0.0014	0.0005	0.0005	0.0001
Zirconium	0.0002	0.0001	<0.0001	0.0001	0.0001	<0.0001	0.0003	0.0002	<0.0001	0.0002

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, [Ca^{2+}] < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH $\geq$ 6.5, [Ca^{2+}] $\geq$ 4 mg/L, DOC $\geq$ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at [$CaCO_3$] = 0 - 120 mg/L; 0.003 mg/L at [CaCO3] =120 - 180 mg/L; 0.004 mg/L at [CaCO3] >180mg/L

e) 0.001 mg/L at [CaCO3] = 0 - 60 mg/L; 0.002 mg/L at [CaCO3] =60 - 120 mg/L; 0.004 mg/L at [CaCO3] =120 -180mg/L; 0.007 mg/L at [CaCO3] > 180mg/L

f) 0.025 mg/L at [CaCO3] = 0 - 60 mg/L; 0.065 mg/L at [CaCO3] =60 - 120 mg/L; 0.110 mg/L at [CaCO3] =120 -180mg/L; 0.150 mg/L at [CaCO3] > 180mg/L

0.231

Appendix A11

Surface Water Quality Replicate Data, Casino Project, 2010

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A11. QA/QC: Field Replicates, January 2010

Surface Water Analysis Results (mg/L)

Station	W2		RPD	Station	W2		RPD
Date	26-Jan-10		%	Date	26-Jan-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	209	197	5.9%	Ammonia as Nitrogen	0.02	0.01	**66.7%**
Conductivity	407	412	1.2%	Total Alkalinity (mg/L CaCO3)	120	110	8.7%
pH	7.8	7.6	2.6%	Acidity (pH 8.3) (mg/L CaCO3)	2.5	2.7	7.7%
TSS	<1	<1	n/c	Bromide	<0.4	<0.4	n/c
TDS	290	300	3.4%	Chloride	<0.5	<0.5	n/c
Turbidity	0.2	0.2	0.0%	Fluoride	0.12	0.12	0.0%
Dissolved Ortho Phosphate as P	0.002	0.002	0.0%	Sulphate SO4	84	76	10.0%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.407	0.391	4.0%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	0.002	0.003	**40.0%**
Total Organic Carbon	5.1	5.4	5.7%	Total Kjeldahl Nitrogen	0.21	0.11	**62.5%**
Average			2.7%	Average			25%
Total Metals				**Dissolved Metals**			
Aluminum	0.0079	0.0084	6.1%	Aluminum	0.0062	0.0054	13.8%
Antimony	0.00024	0.00023	4.3%	Antimony	0.00024	0.00021	13.3%
Arsenic	0.00041	0.00036	13.0%	Arsenic	0.00040	0.00039	2.5%
Barium	0.0801	0.0739	8.1%	Barium	0.0784	0.0737	6.2%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000011	0.000014	24.0%	Cadmium	0.000013	0.000010	**26.1%**
Calcium	53.6	50.5	6.0%	Calcium	52.0	50.6	2.7%
Chromium	0.0001	<0.0001	n/c	Chromium	0.0001	0.0001	0.0%
Cobalt	0.000024	0.000022	8.7%	Cobalt	0.000023	0.000023	0.0%
Copper	0.00136	0.00130	4.5%	Copper	0.00134	0.00132	1.5%
Iron	0.008	0.008	0.0%	Iron	0.005	0.005	0.0%
Lead	0.000151	0.000166	9.5%	Lead	0.000137	0.000134	2.2%
Lithium	0.0010	0.0010	n/c	Lithium	0.0009	0.0009	0.0%
Magnesium	18.2	17.2	5.6%	Magnesium	17.4	16.9	2.9%
Manganese	0.00218	0.00205	6.1%	Manganese	0.00186	0.00182	2.2%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00152	0.00139	8.9%	Molybdenum	0.00141	0.00135	4.3%
Nickel	0.00051	0.00052	1.9%	Nickel	0.00050	0.00051	2.0%
Phosphorous	0.003	0.003	0.0%	Phosphorous	<0.002	0.003	n/c
Potassium	2.50	2.38	4.9%	Potassium	2.43	2.38	2.1%
Selenium	0.00016	0.00016	0.0%	Selenium	0.00016	0.00014	13.3%
Silicon	5.3	5.1	3.8%	Silicon	5.2	5.1	1.9%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Sodium	5.99	5.72	4.6%	Sodium	5.78	5.62	2.8%
Strontium	0.338	0.312	8.0%	Strontium	0.333	0.308	7.8%
Thallium	<0.000002	<0.000002	n/c	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.0397	0.0365	8.4%	Uranium	0.0396	0.0361	9.2%
Vanadium	<0.0002	<0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0006	0.0008	**28.6%**	Zinc	0.0006	0.0006	0.0%
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c
Average			7.5%	Average			5.1%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A11. QA/QC: Field Replicates, February 2010

Surface Water Analysis Results (mg/L)

Station	W21		RPD	Station	W21		RPD
Date	24-Feb-10		%	Date	24-Feb-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	74.2	78.2	5.2%	Ammonia as Nitrogen	0.03	0.03	0.0%
Conductivity	171	172	0.6%	Total Alkalinity (mg/L CaCO3)	69	72	4.3%
pH	7.5	7.6	1.3%	Acidity (pH 8.3) (mg/L CaCO3)	2.2	2.2	0.0%
TSS	1	1	0.0%	Bromide	<0.4	<0.4	n/c
TDS	100	120	18.2%	Chloride	<0.5	<0.5	n/c
Turbidity	6.2	6.3	1.6%	Fluoride	0.12	0.13	8.0%
Dissolved Ortho Phosphate as P	0.001	0.001	n/c	Sulphate SO4	17	17	0.0%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.083	0.084	1.2%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	3.2	4.4	**31.6%**	Total Kjeldahl Nitrogen	0.10	0.10	0.0%
Dissolved Organic Carbon (C)	3.4	4.1	18.7%	Total Nitrogen (N)	0.18	0.18	0.0%
Average			9.6%	Average			2%
Total Metals				**Dissolved Metals**			
Aluminum	0.0048	0.0050	4.1%	Aluminum	0.0049	0.0047	4.2%
Antimony	0.00003	0.00003	0.0%	Antimony	0.00003	0.00003	0.0%
Arsenic	0.00082	0.00083	1.2%	Arsenic	0.00074	0.00070	5.6%
Barium	0.0493	0.0527	6.7%	Barium	0.0510	0.0518	1.6%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000006	0.000006	0.0%	Cadmium	0.000008	0.000008	0.0%
Chromium	0.0002	0.0001	**66.7%**	Chromium	0.0002	0.0002	0.0%
Cobalt	0.000201	0.000195	3.0%	Cobalt	0.000209	0.000201	3.9%
Copper	0.00064	0.00068	6.1%	Copper	0.00059	0.00057	3.4%
Iron	0.595	0.704	16.8%	Iron	0.405	0.444	9.2%
Lead	0.000119	0.000102	15.4%	Lead	0.000097	0.000028	**110.4%**
Lithium	<0.0005	<0.0005	n/c	Lithium	<0.0005	<0.0005	n/c
Manganese	0.153	0.163	6.3%	Manganese	0.157	0.161	2.5%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00056	0.00057	1.8%	Molybdenum	0.00055	0.00059	7.0%
Nickel	0.00051	0.00051	0.0%	Nickel	0.00054	0.00052	3.8%
Phosphorous	0.011	0.010	9.5%	Phosphorous	0.008	0.009	11.8%
Selenium	0.00010	0.00012	18.2%	Selenium	0.00010	0.00011	9.5%
Silicon	5.2	5.2	0.0%	Silicon	5.1	5.1	0.0%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.142	0.151	6.1%	Strontium	0.145	0.148	2.0%
Thallium	<0.000002	<0.000002	n/c	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.000169	0.000163	3.6%	Uranium	0.000161	0.000161	0.0%
Vanadium	<0.0002	0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0003	0.0003	0.0%	Zinc	0.0004	0.0004	0.0%
Zirconium	0.0001	0.0002	**66.7%**	Zirconium	0.0002	0.0002	0.0%
Calcium	18.1	19.4	6.9%	Calcium	19.2	19.6	2.1%
Magnesium	7.07	7.22	2.1%	Magnesium	7.28	7.43	2.0%
Potassium	0.77	0.85	9.9%	Potassium	0.83	0.84	1.2%
Sodium	3.50	3.55	1.4%	Sodium	3.65	3.70	1.4%
Average			10.5%	Average			7.6%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A11. QA/QC: Field Replicates, March 2010

Surface Water Analysis Results (mg/L)

Station	W3		RPD	Station	W3		RPD
Date	23-Mar-10		%	Date	23-Mar-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	182	189	3.8%	Ammonia as Nitrogen	<0.01	<0.01	n/c
Conductivity	379	393	3.6%	Total Alkalinity (mg/L CaCO3)	110	100	9.5%
pH	7.8	7.7	1.3%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	10	14	**33.3%**	Bromide	<0.4	<0.4	n/c
TDS	230	230	0.0%	Chloride	<0.5	<0.5	n/c
Turbidity	3.2	7.5	**80.4%**	Fluoride	0.11	0.11	0.0%
Dissolved Ortho Phosphate as P	0.002	0.001	n/c	Sulphate SO4	80	94	16.1%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.379	0.383	1.0%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	0.002	n/c
Total Organic Carbon	4.5	1.5	**100.0%**	Total Kjeldahl Nitrogen	0.10	0.10	0.0%
Dissolved Organic Carbon (C)	3.8	2.0	**62.1%**	Total Nitrogen (N)	0.48	0.48	0.0%
Average			35.6%	Average			4%
Total Metals				**Dissolved Metals**			
Aluminum	0.0107	0.0135	23.1%	Aluminum	0.0060	0.0060	0.0%
Antimony	0.00024	0.00024	0.0%	Antimony	0.00023	0.00023	0.0%
Arsenic	0.00041	0.00042	2.4%	Arsenic	0.00037	0.00033	11.4%
Barium	0.0725	0.0731	0.8%	Barium	0.0718	0.0715	0.4%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000020	0.000022	9.5%	Cadmium	0.000015	0.000016	6.5%
Chromium	0.0001	0.0001	0.0%	Chromium	0.0001	0.0001	0.0%
Cobalt	0.000026	0.000038	**37.5%**	Cobalt	0.000017	0.000020	16.2%
Copper	0.00140	0.00142	1.4%	Copper	0.00131	0.00116	12.1%
Iron	0.012	0.016	**28.6%**	Iron	0.004	0.007	**54.5%**
Lead	0.000050	0.000056	11.3%	Lead	0.000015	0.000013	14.3%
Lithium	0.0008	0.0008	n/c	Lithium	0.0008	0.0007	n/c
Manganese	0.00208	0.00357	**52.7%**	Manganese	0.00069	0.00154	**76.2%**
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00135	0.00137	1.5%	Molybdenum	0.00137	0.00129	6.0%
Nickel	0.00052	0.00052	0.0%	Nickel	0.00045	0.00044	2.2%
Phosphorous	0.002	0.004	**66.7%**	Phosphorous	<0.002	0.003	n/c
Selenium	0.00011	0.00012	8.7%	Selenium	0.00012	0.00011	8.7%
Silicon	5.0	5.2	3.9%	Silicon	4.1	4.9	17.8%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.295	0.297	0.7%	Strontium	0.307	0.309	0.6%
Thallium	<0.000002	<0.000002	n/c	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.0204	0.0206	1.0%	Uranium	0.0213	0.0208	2.4%
Vanadium	<0.0002	<0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0008	0.0010	22.2%	Zinc	0.0007	0.0009	25.0%
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c
Calcium	46.4	48.2	3.8%	Calcium	47.5	50.9	6.9%
Magnesium	16.0	16.6	3.7%	Magnesium	14.8	14.9	0.7%
Potassium	2.25	2.35	4.3%	Potassium	2.35	2.48	5.4%
Sodium	5.63	5.90	4.7%	Sodium	5.32	5.07	4.8%
Average			12.5%	Average			12.4%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A11. QA/QC: Field Replicates, May 2010 (1 of 2)

Surface Water Analysis Results (mg/L)

Station	W11		RPD	Station	W11		RPD
Date	9-May-10		%	Date	9-May-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	105	105	0.0%	Ammonia as Nitrogen	<0.01	0.039	n/c
Conductivity	210	207	1.4%	Total Alkalinity (mg/L CaCO3)	57	58	1.7%
pH	7.8	7.9	1.3%	Acidity (pH 8.3) (mg/L CaCO3)	1.0	1.0	0.0%
TSS	40	43	7.2%	Bromide	<0.4	<0.4	n/c
TDS	150	150	0.0%	Chloride	<0.5	<0.5	n/c
Turbidity	12.0	14.3	17.5%	Fluoride	0.07	0.07	0.0%
Dissolved Ortho Phosphate as P	0.001	0.002	**66.7%**	Sulphate SO4	50	49	2.0%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.06	0.06	0.0%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.02	<0.02	n/c
Total Organic Carbon	14.3	14.0	2.1%	Total Kjeldahl Nitrogen	0.22	0.26	16.7%
Dissolved Organic Carbon (C)	11.1	11.2	0.9%	Total Nitrogen (N)	0.28	0.32	13.3%
Average			10.8%	Average			5%
Total Metals				**Dissolved Metals**			
Aluminum	0.594	0.620	4.3%	Aluminum	0.113	0.109	3.6%
Antimony	0.00011	0.00012	8.7%	Antimony	0.00010	0.00010	0.0%
Arsenic	0.00152	0.00150	1.3%	Arsenic	0.00078	0.00080	2.5%
Barium	0.0597	0.0608	1.8%	Barium	0.0495	0.0482	2.7%
Beryllium	0.00005	0.00005	0.0%	Beryllium	0.00002	0.00002	0.0%
Bismuth	0.000007	0.000006	15.4%	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000117	0.000124	5.8%	Cadmium	0.000047	0.000047	0.0%
Chromium	0.0010	0.0010	0.0%	Chromium	0.0001	0.0001	0.0%
Cobalt	0.000862	0.000900	4.3%	Cobalt	0.000338	0.000340	0.6%
Copper	0.0279	0.0282	1.1%	Copper	0.0237	0.0228	3.9%
Iron	1.04	1.07	2.8%	Iron	0.376	0.365	3.0%
Lead	0.00177	0.00187	5.5%	Lead	0.000219	0.000155	**34.2%**
Lithium	0.0014	0.0014	0.0%	Lithium	0.0011	0.0011	0.0%
Manganese	0.0719	0.0756	5.0%	Manganese	0.0608	0.0590	3.0%
Mercury	<0.00001	<0.00001	n/c	Mercury	0.00001	0.00001	0.0%
Molybdenum	0.00034	0.00031	9.2%	Molybdenum	0.00038	0.00035	8.2%
Nickel	0.00146	0.00147	0.7%	Nickel	0.00112	0.00060	**60.5%**
Phosphorous	0.028	0.030	6.9%	Phosphorous	0.008	0.009	11.8%
Selenium	0.00010	0.00010	0.0%	Selenium	0.00011	0.00010	9.5%
Silicon	4.8	4.8	0.0%	Silicon	4.1	4.0	2.5%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.175	0.175	0.0%	Strontium	0.171	0.169	1.2%
Thallium	0.000007	0.000008	13.3%	Thallium	0.000004	0.000004	0.0%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0205	0.0204	0.5%	Titanium	0.0006	0.0007	15.4%
Uranium	0.00706	0.00705	0.1%	Uranium	0.00667	0.00655	1.8%
Vanadium	0.0026	0.0028	7.4%	Vanadium	0.0005	0.0006	18.2%
Zinc	0.0089	0.0090	1.1%	Zinc	0.0042	0.0027	**43.5%**
Zirconium	0.0003	0.0003	0.0%	Zirconium	0.0001	0.0001	0.0%
Calcium	28.4	28.4	0.0%	Calcium	27.8	27.1	2.6%
Magnesium	8.27	8.34	0.8%	Magnesium	8.09	7.89	2.5%
Potassium	0.96	0.97	1.0%	Potassium	0.95	0.92	3.2%
Sodium	2.69	2.73	1.5%	Sodium	2.73	2.67	2.2%
Average			3.3%	Average			7.9%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A11. QA/QC: Field Replicates, May 2010 (2 of 2)

Surface Water Analysis Results (mg/L)

Station	W21		RPD	Station	W21		RPD
Date	9-May-10		%	Date	9-May-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	88.2	86.5	1.9%	Ammonia as Nitrogen	<0.005	<0.005	n/c
Conductivity	183	184	0.5%	Total Alkalinity (mg/L CaCO3)	73	71	2.8%
pH	8.0	7.9	1.3%	Acidity (pH 8.3) (mg/L CaCO3)	0.7	0.7	0.0%
TSS	3	3	0.0%	Bromide	<0.4	<0.4	n/c
TDS	120	120	0.0%	Chloride	<0.5	<0.5	n/c
Turbidity	1.5	1.2	22.2%	Fluoride	0.11	0.11	0.0%
Dissolved Ortho Phosphate as P	0.002	0.002	0.0%	Sulphate SO4	25	25	0.0%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.096	0.096	0.0%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	6.1	6.8	10.9%	Total Kjeldahl Nitrogen	0.12	0.14	15.4%
Dissolved Organic Carbon (C)	5.3	5.3	0.0%	Total Nitrogen (N)	0.21	0.23	9.1%
Average			4.1%	Average			4%
Total Metals				**Dissolved Metals**			
Aluminum	0.0477	0.0486	1.9%	Aluminum	0.0181	0.0258	**35.1%**
Antimony	0.00004	0.00005	22.2%	Antimony	0.00005	0.00005	0.0%
Arsenic	0.00056	0.00054	3.6%	Arsenic	0.00041	0.00039	5.0%
Barium	0.0459	0.0457	0.4%	Barium	0.0442	0.0444	0.5%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	0.000022	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000011	0.000006	**58.8%**	Cadmium	0.000011	0.000026	n/c
Chromium	0.0002	0.0002	0.0%	Chromium	0.0001	0.0002	**66.7%**
Cobalt	0.000137	0.000144	5.0%	Cobalt	0.000093	0.000105	12.1%
Copper	0.00139	0.00138	0.7%	Copper	0.00126	0.00301	**82.0%**
Iron	0.433	0.441	1.8%	Iron	0.228	0.235	3.0%
Lead	0.000041	0.000043	4.8%	Lead	0.000046	0.000678	**174.6%**
Lithium	0.0005	0.0006	n/c	Lithium	0.0006	0.0006	0.0%
Manganese	0.0530	0.0523	1.3%	Manganese	0.0432	0.0443	2.5%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00069	0.00065	6.0%	Molybdenum	0.00069	0.00078	12.2%
Nickel	0.00065	0.00062	4.7%	Nickel	0.00058	0.00314	**137.6%**
Phosphorous	0.008	0.007	13.3%	Phosphorous	0.006	0.010	**50.0%**
Selenium	0.00017	0.00017	0.0%	Selenium	0.00017	0.00018	5.7%
Silicon	4.6	4.6	0.0%	Silicon	4.1	4.2	2.4%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.164	0.164	0.0%	Strontium	0.163	0.162	0.6%
Thallium	<0.000002	<0.000002	n/c	Thallium	<0.000002	0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	0.00013	n/c
Titanium	0.0015	0.0011	**30.8%**	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00138	0.00138	0.0%	Uranium	0.00137	0.00135	1.5%
Vanadium	0.0005	0.0006	18.2%	Vanadium	0.0004	0.0004	0.0%
Zinc	0.0005	0.0005	0.0%	Zinc	0.0004	0.0103	**185.0%**
Zirconium	0.0002	0.0002	0.0%	Zirconium	0.0001	0.0002	**66.7%**
Calcium	21.7	21.3	1.9%	Calcium	21.5	21.8	1.4%
Magnesium	8.26	8.08	2.2%	Magnesium	8.26	8.25	0.1%
Potassium	0.82	0.82	0.0%	Potassium	0.82	0.91	10.4%
Sodium	3.95	3.97	0.5%	Sodium	3.97	4.04	1.7%
Average			6.9%	Average			34.3%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A11. QA/QC: Field Replicates, June 2010

Surface Water Analysis Results (mg/L)

Station	W12		RPD	Station	W12		RPD
Date	14-Jun-10		%	Date	14-Jun-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	519	502	3.3%	Ammonia as Nitrogen	0.028	0.037	**27.7%**
Conductivity	1350	1350	0.0%	Total Alkalinity (mg/L CaCO3)	<0.5	<0.5	n/c
pH	3.1	3.1	0.0%	Acidity (pH 8.3) (mg/L CaCO3)	190	190	0.0%
TSS	8	5	**46.2%**	Bromide	<0.4	<0.4	n/c
TDS	740	640	14.5%	Chloride	<0.5	<0.5	n/c
Turbidity	4.1	4.0	2.5%	Fluoride	0.33	0.33	0.0%
Dissolved Ortho Phosphate as P	0.002	0.002	n/c	Sulphate SO4	640	620	3.2%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.026	0.029	10.9%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	0.004	0.003	**28.6%**
Total Organic Carbon	2.7	2.8	3.6%	Total Kjeldahl Nitrogen	0.14	0.16	13.3%
Dissolved Organic Carbon (C)	2.3	2.1	9.1%	Total Nitrogen (N)	0.17	0.19	11.1%
Average			9.9%	Average			12%
Total Metals				**Dissolved Metals**			
Aluminum	14.8	14.5	2.0%	Aluminum	14.7	13.9	5.6%
Antimony	<0.0001	0.0001	n/c	Antimony	0.0001	0.00009	10.5%
Arsenic	0.0005	0.0004	22.2%	Arsenic	0.00033	0.00033	0.0%
Barium	0.0107	0.0106	0.9%	Barium	0.0104	0.00975	6.5%
Beryllium	0.00075	0.00079	5.2%	Beryllium	0.00065	0.00060	8.0%
Bismuth	<0.00003	<0.00003	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.3	<0.3	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.00359	0.00364	1.4%	Cadmium	0.00332	0.00335	0.9%
Chromium	0.0008	0.0008	0.0%	Chromium	0.0007	0.0005	**33.3%**
Cobalt	0.0616	0.0593	3.8%	Cobalt	0.0601	0.0577	4.1%
Copper	1.34	1.30	3.0%	Copper	1.29	1.26	2.4%
Iron	34.2	33.5	2.1%	Iron	31.0	30.0	3.3%
Lead	0.00180	0.00157	13.6%	Lead	0.00156	0.00148	5.3%
Lithium	0.007	0.007	0.0%	Lithium	0.0061	0.0057	n/c
Manganese	1.64	1.57	4.4%	Manganese	1.54	1.49	3.3%
Mercury	<0.00005	<0.00005	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	<0.0003	<0.0003	n/c	Molybdenum	0.00011	0.00008	**31.6%**
Nickel	0.0093	0.0092	1.1%	Nickel	0.00884	0.00885	0.1%
Phosphorous	<0.01	<0.01	n/c	Phosphorous	<0.002	<0.002	n/c
Selenium	0.0003	0.0003	0.0%	Selenium	0.00029	0.00029	0.0%
Silicon	9.7	9.3	4.2%	Silicon	8.5	8.6	1.2%
Silver	0.00005	<0.00003	n/c	Silver	0.000010	0.000006	n/c
Strontium	0.373	0.368	1.3%	Strontium	0.358	0.337	6.0%
Thallium	0.00010	0.00008	22.2%	Thallium	0.000083	0.000090	8.1%
Tin	<0.00005	<0.00005	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.003	<0.003	n/c	Titanium	0.0009	<0.0005	n/c
Uranium	0.0163	0.0162	0.6%	Uranium	0.0158	0.0152	3.9%
Vanadium	<0.001	<0.001	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.319	0.309	3.2%	Zinc	0.307	0.296	3.6%
Zirconium	<0.0005	<0.0005	n/c	Zirconium	0.0001	<0.0001	n/c
Calcium	155	151	2.6%	Calcium	134	128	4.6%
Magnesium	32.1	30.5	5.1%	Magnesium	31.5	30.1	4.5%
Potassium	2.5	2.3	8.3%	Potassium	2.29	2.11	8.2%
Sodium	9.3	9.0	3.3%	Sodium	8.94	8.73	2.4%
Average			4.8%	Average			6.6%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A11. QA/QC: Field Replicates, July 2010 (1 of 2)

Surface Water Analysis Results (mg/L)

Station	W8		RPD	Station	W8		RPD
Date	8-Jul-10		%	Date	8-Jul-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	107	105	1.9%	Ammonia as Nitrogen	0.016	0.020	22.2%
Conductivity	271	272	0.4%	Total Alkalinity (mg/L CaCO3)	35	35	0.0%
pH	7.60	7.58	0.3%	Acidity (pH 8.3) (mg/L CaCO3)	4.6	1.5	**101.6%**
TSS	9	8	11.8%	Bromide	<0.4	<0.4	n/c
TDS	160	170	6.1%	Chloride	<0.5	<0.5	n/c
Turbidity	9.1	9.4	3.2%	Fluoride	0.09	0.10	10.5%
Dissolved Ortho Phosphate as P	0.002	0.001	**66.7%**	Sulphate SO4	95	90	5.4%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.090	0.075	18.2%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	5.2	9.0	**53.5%**	Total Kjeldahl Nitrogen	0.16	0.18	11.8%
Dissolved Organic Carbon (C)	4.8	5.4	11.8%	Total Nitrogen (N)	0.25	0.26	3.9%
Average			17.3%	Average			22%
Total Metals				**Dissolved Metals**			
Aluminum	0.697	0.693	0.6%	Aluminum	0.0883	0.0436	**67.8%**
Antimony	0.00011	0.00011	0.0%	Antimony	0.00009	0.00009	0.0%
Arsenic	0.00028	0.00036	25.0%	Arsenic	0.00017	0.00016	6.1%
Barium	0.0495	0.0486	1.8%	Barium	0.0489	0.0491	0.4%
Beryllium	0.00005	0.00005	0.0%	Beryllium	0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000307	0.000471	**42.2%**	Cadmium	0.000243	0.000256	5.2%
Chromium	0.0002	0.0002	0.0%	Chromium	<0.0001	<0.0001	n/c
Cobalt	0.00332	0.00341	2.7%	Cobalt	0.00329	0.00335	1.8%
Copper	0.0751	0.0756	0.7%	Copper	0.0277	0.0217	24.3%
Iron	1.49	1.48	0.7%	Iron	0.334	0.177	**61.4%**
Lead	0.000296	0.000294	0.7%	Lead	0.000077	0.000052	**38.8%**
Lithium	0.0011	0.0011	0.0%	Lithium	0.0010	0.0010	0.0%
Manganese	0.105	0.105	0.0%	Manganese	0.103	0.105	1.9%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00021	0.00020	4.9%	Molybdenum	0.00021	0.00023	9.1%
Nickel	0.00092	0.00102	10.3%	Nickel	0.00092	0.00093	1.1%
Phosphorous	0.003	0.005	**50.0%**	Phosphorous	<0.002	<0.002	n/c
Selenium	0.00006	0.00007	15.4%	Selenium	0.00006	0.00005	18.2%
Silicon	5.0	4.8	4.1%	Silicon	5.9	5.8	1.7%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.217	0.215	0.9%	Strontium	0.210	0.215	2.4%
Thallium	0.000008	0.000008	0.0%	Thallium	0.000009	0.000007	25.0%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	0.0015	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00193	0.00190	1.6%	Uranium	0.00108	0.000969	10.8%
Vanadium	<0.0002	<0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0223	0.0226	1.3%	Zinc	0.0139	0.0135	2.9%
Zirconium	0.0001	0.0001	0.0%	Zirconium	<0.0001	<0.0001	n/c
Calcium	31.3	30.4	2.9%	Calcium	34.0	33.4	1.8%
Magnesium	7.03	7.10	1.0%	Magnesium	7.51	7.64	1.7%
Potassium	0.89	0.89	0.0%	Potassium	0.87	0.89	2.3%
Sodium	3.30	3.29	0.3%	Sodium	3.51	3.62	3.1%
Average			6.2%	Average			12.5%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A11. QA/QC: Field Replicates, July 2010 (2 of 2)

Surface Water Analysis Results (mg/L)

Station	W16		RPD	Station	W16		RPD
Date	8-Jul-10		%	Date	8-Jul-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	70.8	71.9	1.5%	Ammonia as Nitrogen	0.033	0.034	3.0%
Conductivity	170	170	0.0%	Total Alkalinity (mg/L CaCO3)	66	64	3.1%
pH	7.84	7.83	0.1%	Acidity (pH 8.3) (mg/L CaCO3)	1.4	1.4	0.0%
TSS	4	4	0.0%	Bromide	<0.4	<0.4	n/c
TDS	110	120	8.7%	Chloride	<0.5	<0.5	n/c
Turbidity	0.9	0.8	11.8%	Fluoride	0.09	0.10	10.5%
Dissolved Ortho Phosphate as P	0.001	0.001	0.0%	Sulphate SO4	24	24	0.0%
Weak Acid Dissociable Cyanide	0.0010	0.0010	0.0%	Nitrate (as Nitrogen)	0.067	0.065	3.0%
Strong Acid Dissociable Cyanide	0.0006	0.0006	0.0%	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	11.3	11.3	0.0%	Total Kjeldahl Nitrogen	4.0	0.25	**176.5%**
Dissolved Organic Carbon (C)	10.9	11.3	3.6%	Total Nitrogen (N)	4.1	0.31	**171.9%**
Average			2.3%	Average			46%
Total Metals				**Dissolved Metals**			
Aluminum	0.0523	0.0767	**37.8%**	Aluminum	0.0444	0.0436	1.8%
Antimony	0.00011	0.00012	8.7%	Antimony	0.00009	0.00010	10.5%
Arsenic	0.00054	0.00054	0.0%	Arsenic	0.00048	0.00049	2.1%
Barium	0.0458	0.0483	5.3%	Barium	0.0481	0.0480	0.2%
Beryllium	<0.00001	0.00002	n/c	Beryllium	<0.00001	0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000013	0.000016	20.7%	Cadmium	0.000008	0.000007	13.3%
Chromium	0.0003	0.0003	0.0%	Chromium	0.0003	0.0002	**40.0%**
Cobalt	0.000088	0.000113	24.9%	Cobalt	0.000080	0.000093	15.0%
Copper	0.00250	0.00260	3.9%	Copper	0.00246	0.00256	4.0%
Iron	0.189	0.243	25.0%	Iron	0.166	0.158	4.9%
Lead	0.000083	0.000115	**32.3%**	Lead	0.000025	0.000026	3.9%
Lithium	0.0014	0.0016	13.3%	Lithium	0.0014	0.0014	0.0%
Manganese	0.0207	0.0224	7.9%	Manganese	0.0182	0.0190	4.3%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00067	0.00068	1.5%	Molybdenum	0.00074	0.00073	1.4%
Nickel	0.00066	0.00076	14.1%	Nickel	0.00066	0.00066	0.0%
Phosphorous	0.007	0.008	13.3%	Phosphorous	0.005	0.006	18.2%
Selenium	0.00006	0.00006	0.0%	Selenium	0.00007	0.00007	0.0%
Silicon	3.6	3.7	2.7%	Silicon	4.8	4.5	6.5%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.137	0.142	3.6%	Strontium	0.139	0.138	0.7%
Thallium	<0.000002	<0.000002	n/c	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0012	0.0023	**62.9%**	Titanium	0.0007	0.0010	**35.3%**
Uranium	0.00239	0.00249	4.1%	Uranium	0.00261	0.00266	1.9%
Vanadium	0.0007	0.0008	13.3%	Vanadium	0.0006	0.0006	0.0%
Zinc	0.0004	0.0019	**130.4%**	Zinc	0.0004	0.0003	**28.6%**
Zirconium	0.0003	0.0003	0.0%	Zirconium	0.0003	0.0003	0.0%
Calcium	16.8	17.4	3.5%	Calcium	19.7	18.9	4.1%
Magnesium	7.00	6.91	1.3%	Magnesium	7.25	7.55	4.1%
Potassium	0.79	0.79	0.0%	Potassium	0.76	0.79	3.9%
Sodium	3.18	3.14	1.3%	Sodium	3.30	3.45	4.4%
Average			16.0%	Average			7.7%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A11. QA/QC: Field Replicates, August 2010 (1 of 2)

Surface Water Analysis Results (mg/L)

Station	W7		RPD	Station	W16		RPD
Date	10-Aug-10		%	Date	8-Jul-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	109	97.5	11.1%	Ammonia as Nitrogen	0.14	0.057	**84.3%**
Conductivity	128	147	13.8%	Total Alkalinity (mg/L CaCO3)	9.8	9.3	5.2%
pH	7.00	7.11	1.6%	Acidity (pH 8.3) (mg/L CaCO3)	0.6	3.6	**142.9%**
TSS	<1	<1	n/c	Bromide	<0.4	<0.4	n/c
TDS	110	100	9.5%	Chloride	<0.5	<0.5	n/c
Turbidity	0.3	0.7	**80.0%**	Fluoride	0.07	0.05	**33.3%**
Dissolved Ortho Phosphate as P	<0.005	<0.005	n/c	Sulphate SO4	46	49	6.3%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	<0.02	<0.02	n/c
Cyanide + Thiocyanate	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.005	<0.005	n/c
Total Organic Carbon	11.0	3.3	**107.7%**	Total Kjeldahl Nitrogen	0.23	0.11	**70.6%**
Dissolved Organic Carbon (C)	8.8	3.0	**98.3%**	Total Nitrogen (N)	0.23	0.11	**70.6%**
Average			46.0%	Average			59%
Total Metals				**Dissolved Metals**			
Aluminum	0.0668	0.0330	**67.7%**	Aluminum	0.0261	0.0255	2.3%
Antimony	0.00008	0.00007	13.3%	Antimony	0.00006	0.00006	0.0%
Arsenic	0.00023	0.00020	14.0%	Arsenic	0.00017	0.00019	11.1%
Barium	0.0502	0.0493	1.8%	Barium	0.0466	0.0464	0.4%
Beryllium	<0.00001	0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000158	0.000152	3.9%	Cadmium	0.000140	0.000138	1.4%
Chromium	0.0003	0.0002	**40.0%**	Chromium	0.0002	0.0002	0.0%
Cobalt	0.000046	0.000040	14.0%	Cobalt	0.000029	0.000034	15.9%
Copper	0.00235	0.00221	6.1%	Copper	0.00199	0.00201	1.0%
Iron	0.044	0.021	**70.8%**	Iron	0.010	0.012	18.2%
Lead	0.000042	0.000021	**66.7%**	Lead	0.000007	0.000015	**72.7%**
Lithium	0.0009	0.0009	n/c	Lithium	0.0008	0.0007	n/c
Manganese	0.00271	0.00204	**28.2%**	Manganese	0.00158	0.00182	14.1%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00031	0.00026	17.5%	Molybdenum	0.00026	0.00023	12.2%
Nickel	0.00093	0.00088	5.5%	Nickel	0.00074	0.00069	7.0%
Phosphorous	0.005	0.003	**50.0%**	Phosphorous	<0.002	<0.002	n/c
Selenium	0.00004	0.00004	0.0%	Selenium	0.00005	0.00005	0.0%
Silicon	9.8	9.4	4.2%	Silicon	8.9	9.0	1.1%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.0964	0.0950	1.5%	Strontium	0.0915	0.0928	1.4%
Thallium	0.000003	0.000003	0.0%	Thallium	0.000002	0.000002	0.0%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0012	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.000055	0.000052	5.6%	Uranium	0.000058	0.000050	14.8%
Vanadium	0.0004	0.0003	**28.6%**	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0129	0.0131	1.5%	Zinc	0.0114	0.0130	13.1%
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c
Calcium	12.8	13.6	6.1%	Calcium	13.4	13.4	0.0%
Magnesium	2.6	2.7	3.8%	Magnesium	2.7	2.6	3.8%
Potassium	0.5	0.5	0.0%	Potassium	0.5	0.5	0.0%
Sodium	3.9	4.1	5.0%	Sodium	4.6	4.6	0.0%
Average			18.2%	Average			8.3%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

Appendix A11. QA/QC: Field Replicates, June 2009 (1 of 2)

Surface Water Analysis Results (mg/L)

Station	W5		RPD	Station	W5		RPD
Date	9-Aug-10		%	Date	9-Aug-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	70.8	71.2	0.6%	Ammonia as Nitrogen	0.11	0.019	**141.1%**
Conductivity	144	145	0.7%	Total Alkalinity (mg/L CaCO3)	58	58	0.0%
pH	7.67	7.66	0.1%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	11	7	**44.4%**	Bromide	<0.4	<0.4	n/c
TDS	110	110	0.0%	Chloride	<0.5	<0.5	n/c
Turbidity	1.3	1.4	7.4%	Fluoride	0.06	0.06	0.0%
Dissolved Ortho Phosphate as P	<0.005	<0.005	n/c	Sulphate SO4	18	19	5.4%
Weak Acid Dissociable Cyanide	<0.0005	0.0009	n/c	Nitrate (as Nitrogen)	0.12	0.12	0.0%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.005	<0.005	n/c
Total Organic Carbon	9.2	8.2	11.5%	Total Kjeldahl Nitrogen	0.22	0.20	9.5%
Dissolved Organic Carbon (C)	-	-	n/c	Total Nitrogen (N)	0.34	0.32	6.1%
Average			9.2%	Average			23%
Total Metals				**Dissolved Metals**			
Aluminum	0.178	0.157	12.5%	Aluminum	0.0568	0.0543	4.5%
Antimony	0.00010	0.00009	10.5%	Antimony	0.00010	0.00010	0.0%
Arsenic	0.00043	0.00040	7.2%	Arsenic	0.00032	0.00032	0.0%
Barium	0.0474	0.0465	1.9%	Barium	0.0426	0.0428	0.5%
Beryllium	0.00001	0.00001	0.0%	Beryllium	0.00001	0.00001	0.0%
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000016	0.000015	6.5%	Cadmium	0.000011	0.000012	8.7%
Chromium	0.0004	0.0003	**28.6%**	Chromium	0.0003	0.0002	**40.0%**
Cobalt	0.000193	0.000127	**41.3%**	Cobalt	0.000050	0.000064	24.6%
Copper	0.00397	0.00365	8.4%	Copper	0.00303	0.00291	4.0%
Iron	0.289	0.232	21.9%	Iron	0.081	0.079	2.5%
Lead	0.000583	0.000431	**30.0%**	Lead	0.000059	0.000056	5.2%
Lithium	0.0016	0.0016	n/c	Lithium	0.0016	0.0015	n/c
Manganese	0.0200	0.0128	**43.9%**	Manganese	0.00656	0.00641	2.3%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00065	0.00067	3.0%	Molybdenum	0.00069	0.00068	1.5%
Nickel	0.00056	0.00054	3.6%	Nickel	0.00046	0.00045	2.2%
Phosphorous	0.009	0.007	25.0%	Phosphorous	0.002	0.002	0.0%
Selenium	0.00005	0.00006	18.2%	Selenium	0.00005	0.00005	0.0%
Silicon	5.3	5.3	0.0%	Silicon	5.2	5.3	1.9%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.134	0.132	1.5%	Strontium	0.132	0.129	2.3%
Thallium	0.000003	0.000004	**28.6%**	Thallium	<0.000002	0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0057	0.0043	**28.0%**	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00288	0.00287	0.3%	Uranium	0.00275	0.00280	1.8%
Vanadium	0.0008	0.0007	13.3%	Vanadium	0.0003	0.0003	0.0%
Zinc	0.0020	0.0014	**35.3%**	Zinc	0.0006	0.0006	0.0%
Zirconium	0.0003	0.0003	0.0%	Zirconium	0.0002	0.0002	0.0%
Calcium	18.2	18.5	1.6%	Calcium	18.2	18.0	1.1%
Magnesium	6.16	6.06	1.6%	Magnesium	6.07	6.02	0.8%
Potassium	0.71	0.71	0.0%	Potassium	0.69	0.69	0.0%
Sodium	3.08	3.05	1.0%	Sodium	3.08	2.99	3.0%
Average			13.3%	Average			4.1%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A11. QA/QC: Field Replicates, September 2010 (1 of 2)

Surface Water Analysis Results (mg/L)

Station	W18		RPD	Station	W18		RPD
Date	15-Sep-10		%	Date	15-Sep-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	58.9	59.8	1.5%	Ammonia as Nitrogen	<0.005	<0.005	n/c
Conductivity	126	126	0.0%	Total Alkalinity (mg/L CaCO3)	45	47	4.3%
pH	7.75	7.74	0.1%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	<1	<1	n/c	Bromide	<0.4	<0.4	n/c
TDS	98	92	6.3%	Chloride	<0.5	<0.5	n/c
Turbidity	0.2	0.3	**40.0%**	Fluoride	0.05	0.04	22.2%
Dissolved Ortho Phosphate as P	0.001	<0.001	n/c	Sulphate SO4	16	16	0.0%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.257	0.255	0.8%
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	7.7	7.5	2.6%	Total Kjeldahl Nitrogen	0.22	0.24	8.7%
Dissolved Organic Carbon (C)	7.2	7.6	5.4%	Total Nitrogen (N)	0.47	0.50	6.2%
Average			8.0%	Average			7%
Total Metals				**Dissolved Metals**			
Aluminum	0.0712	0.0700	1.7%	Aluminum	0.0621	0.0607	2.3%
Antimony	0.00014	0.00013	7.4%	Antimony	0.00013	0.00013	0.0%
Arsenic	0.00031	0.00031	0.0%	Arsenic	0.00032	0.00034	6.1%
Barium	0.0385	0.0377	2.1%	Barium	0.0368	0.0371	0.8%
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000008	0.000006	**28.6%**	Cadmium	0.000009	0.000008	11.8%
Chromium	0.0002	0.0002	0.0%	Chromium	0.0002	0.0002	0.0%
Cobalt	0.000041	0.000038	7.6%	Cobalt	0.000036	0.000031	14.9%
Copper	0.00129	0.00121	6.4%	Copper	0.00116	0.00112	3.5%
Iron	0.050	0.049	2.0%	Iron	0.035	0.033	5.9%
Lead	0.000027	0.000018	**40.0%**	Lead	0.000019	<0.000005	n/c
Lithium	0.0006	<0.0005	n/c	Lithium	<0.0005	<0.0005	n/c
Manganese	0.00292	0.00271	7.5%	Manganese	0.00237	0.00240	1.3%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00099	0.00092	7.3%	Molybdenum	0.00099	0.00094	5.2%
Nickel	0.00030	0.00029	3.4%	Nickel	0.00030	0.00029	3.4%
Phosphorous	<0.002	<0.002	n/c	Phosphorous	<0.002	<0.002	n/c
Selenium	<0.00004	<0.00004	n/c	Selenium	<0.00004	<0.00004	n/c
Silicon	5.9	6.0	1.7%	Silicon	5.4	5.4	0.0%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.0858	0.0837	2.5%	Strontium	0.0830	0.0831	0.1%
Thallium	0.000003	0.000003	0.0%	Thallium	0.000003	0.000003	0.0%
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00183	0.00168	8.5%	Uranium	0.00172	0.00169	1.8%
Vanadium	0.0003	0.0003	0.0%	Vanadium	0.0005	0.0005	0.0%
Zinc	0.0077	0.0002	**189.9%**	Zinc	0.0004	0.0003	**28.6%**
Zirconium	0.0002	0.0002	0.0%	Zirconium	0.0002	0.0002	0.0%
Calcium	16.8	17.3	2.9%	Calcium	15.8	15.5	1.9%
Magnesium	4.08	4.03	1.2%	Magnesium	4.23	4.19	1.0%
Potassium	0.82	0.80	2.5%	Potassium	0.87	0.85	2.3%
Sodium	2.62	2.58	1.5%	Sodium	2.71	2.69	0.7%
Average			13.5%	Average			4.0%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

Appendix A11. QA/QC: Field Replicates, September 2010 (2 of 2)

Surface Water Analysis Results (mg/L)

Station	W7		RPD	Station	W7		RPD
Date	14-Sep-10		%	Date	14-Sep-10		%
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Hardness	50.2	53.1	5.6%	Ammonia as Nitrogen	<0.005	<0.005	n/c
Conductivity	142	142	0.0%	Total Alkalinity (mg/L CaCO3)	6.6	6.0	9.5%
pH	6.92	6.88	0.6%	Acidity (pH 8.3) (mg/L CaCO3)	-	-	n/c
TSS	<1	1	n/c	Bromide	<0.4	<0.4	n/c
TDS	120	120	0.0%	Chloride	<0.5	<0.5	n/c
Turbidity	0.3	0.3	0.0%	Fluoride	0.06	0.06	0.0%
Dissolved Ortho Phosphate as P	0.001	0.001	0.0%	Sulphate SO4	51	50	2.0%
Weak Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrate (as Nitrogen)	0.002	<0.002	n/c
Strong Acid Dissociable Cyanide	<0.0005	<0.0005	n/c	Nitrite (as Nitrogen)	<0.002	<0.002	n/c
Total Organic Carbon	3.8	3.8	0.0%	Total Kjeldahl Nitrogen	0.21	0.16	**27.0%**
Dissolved Organic Carbon (C)	3.4	3.3	3.0%	Total Nitrogen (N)	0.21	0.16	**27.0%**
Average			1.1%	Average			13%
Total Metals				**Dissolved Metals**			
Aluminum	0.0454	0.0449	1.1%	Aluminum	0.0384	0.0383	0.3%
Antimony	0.00006	0.00006	0.0%	Antimony	0.00006	0.00006	0.0%
Arsenic	0.00016	0.00015	6.5%	Arsenic	0.00016	0.00016	0.0%
Barium	0.0520	0.0506	2.7%	Barium	0.0526	0.0533	1.3%
Beryllium	0.00002	0.00001	**66.7%**	Beryllium	0.00002	0.00002	0.0%
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000210	0.000215	2.4%	Cadmium	0.000215	0.000225	4.5%
Chromium	<0.0001	<0.0001	n/c	Chromium	<0.0001	<0.0001	n/c
Cobalt	0.000077	0.000081	5.1%	Cobalt	0.000070	0.000063	10.5%
Copper	0.00204	0.00215	5.3%	Copper	0.00197	0.00197	0.0%
Iron	0.032	0.030	6.5%	Iron	0.019	0.018	5.4%
Lead	0.000038	0.000037	2.7%	Lead	0.000006	0.000016	**90.9%**
Lithium	0.0008	0.0008	n/c	Lithium	0.0006	0.0007	n/c
Manganese	0.00519	0.00530	2.1%	Manganese	0.00477	0.00447	6.5%
Mercury	<0.00001	<0.00001	n/c	Mercury	<0.00001	<0.00001	n/c
Molybdenum	0.00023	0.00020	14.0%	Molybdenum	0.00021	0.00021	0.0%
Nickel	0.00108	0.00109	0.9%	Nickel	0.00103	0.00103	0.0%
Phosphorous	<0.002	<0.002	n/c	Phosphorous	<0.002	<0.002	n/c
Selenium	0.00007	0.00006	15.4%	Selenium	0.00007	0.00007	0.0%
Silicon	9.5	10.0	5.1%	Silicon	9.2	9.3	1.1%
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.0969	0.0961	0.8%	Strontium	0.0986	0.0985	0.1%
Thallium	0.000002	0.000002	0.0%	Thallium	0.000003	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.000105	0.000066	**45.6%**	Uranium	0.000073	0.000053	**31.7%**
Vanadium	0.0003	0.0004	**28.6%**	Vanadium	0.0005	0.0004	22.2%
Zinc	0.0174	0.0184	5.6%	Zinc	0.0169	0.0167	1.2%
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c
Calcium	15.3	16.3	6.3%	Calcium	15.1	15.3	1.3%
Magnesium	2.89	3.01	4.1%	Magnesium	3.14	3.12	0.6%
Potassium	0.45	0.46	2.2%	Potassium	0.50	0.50	0.0%
Sodium	3.94	4.06	3.0%	Sodium	4.19	4.19	0.0%
Average			9.7%	Average			7.7%

Notes:

Bold	*Exceedes Data Quality objective of 25%.*
Bold	*Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*
"n/c"	*Not able to be calculated because one or both values not precisely known.*
"<"	*Less than detection limit.*

Appendix B1

Sediment Quality Data, Casino Project, August 2010

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B1. Sediment Quality Data, August 2010

Sediment Parameters	RDL	CCME Sediment Quality Guidelines for the Protection of Aquatic Life[a]		W6A	W6B-1	W6B-2	S4	W20	W21
		ISQG[b]	PEL[c]	8-Aug-10	8-Aug-10	8-Aug-10	9-Aug-10	8-Aug-10	8-Aug-10
Physical Properties									
pH	0.01			8.00	7.73	7.96	7.23	6.65	7.27
Moisture (%)	0.3			27	28	42	63	39	25
Total Metals by ICPMS									
Total Aluminum (Al)	100			6540	7130	8990	13100	15000	7850
Total Antimony (Sb)	0.1			0.8	1.0	0.9	1.0	0.4	0.3
Total Arsenic (As)	0.2	5.9	17	*7.2*	*9.6*	*9.0*	***17.3***	*6.4*	*7.2*
Total Barium (Ba)	0.1			248	350	340	336	172	109
Total Beryllium (Be)	0.1			0.3	0.3	0.4	0.4	0.6	0.4
Total Bismuth (Bi)	0.1			0.1	0.1	0.2	0.3	0.2	0.1
Total Cadmium (Cd)	0.05	0.6	3.5	*0.70*	*1.28*	*1.14*	*1.28*	0.29	0.18
Total Calcium (Ca)	100			9350	8810	10700	10400	6310	3670
Total Chromium (Cr)	1	37.3	90	22	24	28	15	38	19
Total Cobalt (Co)	0.3			7.0	8.7	9.8	8.8	11.7	7.3
Total Copper (Cu)	0.5	35.7	197	18.0	27.5	28.5	23.6	29.9	14.9
Total Iron (Fe)	100			17200	20500	22900	22600	26100	18400
Total Lead (Pb)	0.1	35	91.3	6.3	8.3	8.1	17.8	7.4	5.0
Total Lithium (Li)	5			9	10	10	11	13	8
Total Magnesium (Mg)	100			6640	6720	7910	4690	8670	4360
Total Manganese (Mn)	0.2			359	348	554	609	439	355
Total Mercury (Hg)	0.05	0.17	0.486	0.06	0.07	0.10	0.09	<0.05	<0.05
Total Molybdenum (Mo	0.1			1.0	1.2	1.2	1.2	0.9	0.7
Total Nickel (Ni)	0.8			28.8	37.2	40.5	11.2	30.8	17.0
Total Phosphorus (P)	10			868	960	891	677	902	607
Total Potassium (K)	100			562	669	817	787	843	552
Total Selenium (Se)	0.5			0.5	0.8	0.6	0.5	0.8	<0.5
Total Silver (Ag)	0.05			0.10	0.13	0.14	0.21	0.10	0.06
Total Sodium (Na)	100			113	114	165	154	265	196
Total Strontium (Sr)	0.1			42.1	44.2	51.5	135	52.9	29.0
Total Thallium (Tl)	0.05			0.08	0.11	0.10	0.18	0.09	0.06
Total Tin (Sn)	0.1			0.3	0.4	0.4	0.4	0.5	0.3
Total Titanium (Ti)	1			275	310	415	615	698	447
Total Uranium (U)	0.05			1.31	1.12	1.55	19.8	3.20	1.74
Total Vanadium (V)	2			30	39	42	42	57	35
Total Zinc (Zn)	1	123	315	98	*147*	*129*	101	84	53
Total Zirconium (Zr)	0.5			1.6	1.7	2.0	2.5	2.7	1.3

Notes
All units mg/kg unless otherwise noted
a) Canadian Sediment quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2002.
b) ISQG: Interim Freshwater Sediment Quality Guidelines.
c) PEL: Probable Effects Levels.

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RDL = Reportable Detection Limit

Appendix B2

Sediment Quality Replicate Data, Casino Project, August 2010

Appendix B2. QA/QC: Replicate Data, August 2010
Sediment Quality Analysis Results (mg/kg)

Station	W6B		RPD
Date	8-Aug-10		%
Physical Tests			
pH	7.73	7.96	2.9%
Moisture (%)	28	42	40.0%
Average			21.5%
Total Metals			
Total Aluminum (Al)	7130	8990	23.1%
Total Antimony (Sb)	1.0	0.9	10.5%
Total Arsenic (As)	*9.6*	*9.0*	6.5%
Total Barium (Ba)	350	340	2.9%
Total Beryllium (Be)	0.3	0.4	28.6%
Total Bismuth (Bi)	0.1	0.2	66.7%
Total Cadmium (Cd)	*1.28*	*1.14*	11.6%
Total Calcium (Ca)	8810	10700	19.4%
Total Chromium (Cr)	24	28	15.4%
Total Cobalt (Co)	8.7	9.8	11.9%
Total Copper (Cu)	27.5	28.5	3.6%
Total Iron (Fe)	20500	22900	11.1%
Total Lead (Pb)	8.3	8.1	2.4%
Total Lithium (Li)	10	10	0.0%
Total Magnesium (Mg)	6720	7910	16.3%
Total Manganese (Mn)	348	554	45.7%
Total Mercury (Hg)	0.07	0.10	35.3%
Total Molybdenum (Mo)	1.2	1.2	0.0%
Total Nickel (Ni)	37.2	40.5	8.5%
Total Phosphorus (P)	960	891	7.5%
Total Potassium (K)	669	817	19.9%
Total Selenium (Se)	0.8	0.6	28.6%
Total Silver (Ag)	0.13	0.14	7.4%
Total Sodium (Na)	114	165	36.6%
Total Strontium (Sr)	44.2	51.5	15.3%
Total Thallium (Tl)	0.11	0.10	9.5%
Total Tin (Sn)	0.4	0.4	0.0%
Total Titanium (Ti)	310	415	29.0%
Total Uranium (U)	1.12	1.55	32.2%
Total Vanadium (V)	39	42	7.4%
Total Zinc (Zn)	*147*	*129*	17.1%
Total Zirconium (Zr)	1.7	2.0	16.9%

Notes:

Bold	*Exceeds Data Quality objective of 50%.*
Bold	*Exceeds Data Quality objective of 50%, but does not meet Practical Quantitation Limit.*
RPD	*Relative Percent Difference.*

Appendix C

Fish Assessment Details, Casino Project, 2010

Site	Chemical Characteristics				Method	Minnow Trapping			Electrofishing					Fish Caught			
	Temper-ature	Conductivity (µs/cm)	TDS (mg/L)	pH		Set Time	Retrieval time	Set in depth (m)	Time Sampled	Distance (m)	EF Effort (sec)	Voltage (V)	Current (A)	Number	Species	Total Length (mm)	Weight (g)
FM1	8.5-8.9	170.2	111.15	6.85	MT (4)	6:15 PM	4:00 PM	0.5-1.0	n/a	n/a	n/a	n/a	n/a	1	Burbot	105	6.7
FM2	8	-	-	-	MT (4)	6:45 PM	4:30 PM	0.7-1.0	n/a	n/a	n/a	n/a	n/a	nfc	n/a	n/a	n/a
F05	5.9-7.0	123.1	79.95	6.13	MT (2)	8:30 PM	2:00 PM	-	n/a	n/a	n/a	n/a	n/a	nfc	n/a	n/a	n/a
F05 (Segment 1)	5.9-7.0	123.1	79.95	6.13	EF	n/a	n/a	n/a	13:20	150	678	437	0.05A	nfc	n/a	n/a	n/a
F05 (Segment 2)	5.9-7.0	123.1	79.95	6.13	EF	n/a	n/a	n/a	14:00	100	600	270	0.05A	nfc	n/a	n/a	n/a

Notes:

n/a: not applicable

nfc: no fish caught

dashes (-) indicate no data collected

Site	Physical		Bed Material (%)				Habitat Type (%)					Comments
	Water Depth (cm)	Pool Depth (cm)	Wetted With (m)	Cobble	Boulder	Gravel	Channel Width (m)	Pool	Run	Riffle	Other	
F05 (Segment 1)	9, 16, 7, 16, 10, 13, 9	20, 21, 28, 23, 22, 36, 24, 30, 26	4.8, 6.4, 2.4, 13.1, 4.4	-	-	-	n/a, braided	s. pool	-	section	-	Good riparian cover, 90% macrophyte cover
F05 (Segment 2)	23, 37, 17, 23, 20, 14, 9, 19, 21, 23, 19, 21, 10, 14, 10, 13, 17, 32, 25	34, 40, 28, 50	2.2, 1.7, 2.0, 2.5, 2.4, 3.1	65	30	5	3.9, 3.7, 3.9, 3.8, 3.8, 3.7	-	-	-	Cascade	WQ captured day before, alder, willow, blueberry, horsetail, 0.9 debris

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Casino Project:

2011 Aquatic Studies Report

draft for discussion

Prepared for

Casino Mining Corporation

May 2012

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

1199 West Hastings Street, Suite 800, Vancouver, BC V6E 375
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May 11, 2012

Jesse Duke
Project Director
Casino Mining Corporation
2050-1111 West Georgia Street
Vancouver, BC V6E 4M3

Dear Mr. Duke,

Re: Casino Project: 2011 Aquatic Studies Report

Palmer Environmental Consulting Group Inc. is pleased to submit the attached draft report describing the studies conducted in 2011 on the aquatic environment of the Casino Project area. If there are any questions or comments on this report, then please contact the undersigned.

Thank you for the opportunity to work with you on this project.

Yours truly,

Palmer Environmental Consulting Group Inc.

R. Palmer

Rick Palmer, M.Sc. R.P. Bio
President, Senior Fisheries Biologist

RP:mq

Distribution List

# of Hard Copies	PDF Required	Association / Company Name
1	Yes	Casino Mining Corporation
1	Yes	Palmer Environmental Consulting Group

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	Neil Hutchinson & Bev Clark (HESL)	April 24, 2012	Senior Review
2	Rick Palmer (PECG)	May 9, 2012	Senior Review

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Executive Summary

This report describes the studies conducted in 2011 on the aquatic environment of the Casino Project area. Casino Mining Corporation, formerly Western Copper Corporation, has 100% ownership of the Casino property. The Casino Project is a proposed porphyry copper-gold-molybdenum mine located at 611379E 6956218N in west-central Yukon, approximately 380 km northwest of the territorial capital of Whitehorse.

Surveys of the aquatic environment in 2011 were completed on March 28 – April 2, April 27 -30, May 16-23, August 8-10, August 16-23, September 7-14 and October 3-7. The objectives were to sample water quality, stream sediment quality, periphyton communities, benthic invertebrate communities and fish communities.

A total of 26 sites were chosen for water quality sampling. Water samples were collected from each site in March to October and analyzed for the full suite of physical parameters, anions, nutrients and total and dissolved metals. Exceedances of the Canadian Council of Ministers of the Environment (CCME) guidelines for protection of freshwater aquatic life were observed for seven parameters. The number of exceedances was highest for cadmium, copper, aluminum and iron. Exceedances were least numerous in March, June and April. Exceedances were most numerous in August and tapered off in October indicating a seasonal trend related to hydrological factors such as snow melt and stream flow.

Sediment samples were collected from four stream sites for four different watersheds in August. Exceedances of CCME sediment guidelines were identified for three metals: arsenic, cadmium, copper and zinc. One sample site, W15, exceeds Probable Effect Level (PEL) for arsenic.

In 2011, the periphyton and benthic invertebrate programs were intended to collect additional data for the overall baseline characterization of the Casino aquatic study area. Periphyton and benthic invertebrates were sampled in August at six locations. Although, these sites were not sampled with the specific objective to do direct comparisons, statistical comparisons were made for the purpose of this report. Blue-green algae were dominant in Sunshine, Brynelson, Casino and Dip creeks, while diatoms were dominant in Excelsior Creek. One-way ANOVA of the data showed there were significant differences in mean density, richness and diversity. Dip Creek generally had the highest periphyton density, richness and diversity values of all the sites sampled in 2011. Benthic invertebrate communities showed highest densities and Total EPT in Excelsior Creek, lowest diversity in Casino Creek and comparable richness in all sites but Meloy Creek. Dipterans (stoneflies) were dominant in Casino, Meloy and Dip creeks, while ephemeropterans (mayflies) were dominant in Excelsior and Sunshine creeks.

Fish communities at 19 stream sites were sampled in August and September either with an electrofisher or with minnow traps. A total of 45 fish from three species were captured from the Project study area. The three species caught were Arctic grayling (*Thymallus arcticus*), slimy sculpin (*Cottus cognatus*), and chinook salmon (*Oncorhynchus tshawytscha*). Chinook salmon were captured at only one site (F15).

Acknowledgements

The studies described in this report were carried out by the following PECG staff:

- Project Management:
  - Rick Palmer, M.Sc., R.P. Bio., Senior Fisheries Biologist
- Report Preparation/editing:
  - May Quach, M.Sc., Aquatic Ecologist
  - Katie Tableman, B.Sc., Environmental Planner
- Senior Review:
  - Neil Hutchinson, Ph.D., & Bev Clark, Hutchinson Environmental Sciences Ltd.
  - Rick Palmer, M.Sc., R.P. Bio., Senior Fisheries Biologist
- Field Studies:
  - Eric Cleveland, Environmental Technician
  - Laura Grieve, B.Sc. Environmental Biologist
  - May Quach, M.Sc., Aquatic Ecologist

Acronyms and Abbreviations

ARD	Acid Rock Drainage
BC MOE	British Columbia Ministry of Environment
CCME	Canadian Council of Ministers of the Environment
CPUE	Catch-per-unit-effort
DFO	Fisheries and Oceans Canada
DIAND	Department of Indian Affairs and Northern Development
DOC	Dissolved Organic Carbon
EEM	Environmental Effects Monitoring
FISS	Fisheries Information Summary System
GPS	Global Positioning System
HKP	Hallam Knight Piésold Ltd.
INAC	Indian and Northern Affairs Canada
ISQG	Interim Sediment Quality Guideline
LSA	Local Study Area
LT_{50}	Lethal Time for 50% of the test organisms
MMER	Metal Mining Effluent Regulations
µS	micro-Siemens
NA	Not applicable
NAN	Not a Number
NS	Not sampled
NTU	Nephelometric unit
PEL	Probable Effects Level
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
RDL	Reported Detection Limit
RPD	Relative Percent Difference
RSA	Regional Study Area
SE	Standard error
TDS	Total Dissolved Solids
TIA	Tailings Impoundment Area
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TSS	Total Suspended Solids
U.S. EPA	United States Environmental Protection Agency
YESAB	Yukon Environmental and Socio-Economic Assessment Board

Table of Contents

Letter
Executive Summary
Acknowledgements
Acronyms and Abbreviations

1 Introduction 1
1.1 Overview 1
1.2 Study Areas 5
1.3 Study Objectives 7

2 Methods 8
2.1 Dates and Locations of Sampling Surveying 8
2.1.1 General 8
2.1.2 Water Quality 8
2.1.3 Sediment Quality 10
2.1.4 Periphyton and Benthic Invertebrates 11
2.1.5 Fish Assessment 11
2.2 Sample Collection 12
2.2.1 Water Quality 12
2.2.2 Sediment Quality 13
2.2.3 Periphyton 14
2.2.4 Benthic Invertebrates 14
2.2.5 Fish Habitat Assessment 15
2.2.6 Fish Assessment 15
2.2.7 Fish Tissue Metals Concentrations 16
2.3 QA/QC 17
2.3.1 Water Quality 17
2.3.2 Sediment Quality 18
2.3.3 Periphyton and Benthic Invertebrates 19
2.3.4 Fish and Fish Habitat 19
2.4 Data Analysis 20
2.4.1 Water Quality 20
2.4.2 Sediment Quality 20
2.4.3 Periphyton and Benthic Invertebrates 20
2.4.4 Fish Assessment 21

3 Results and Discussion 21
3.1 Water Quality 21
3.1.1 Statistical Summary 21
3.1.2 Exceedances of Water Quality Guidelines 26
3.2 Sediment Quality 27

3.3 Periphyton 29
3.4 Benthic Invertebrates 31
3.5 Periphyton and Benthic Invertebrate Summary 34
3.6 Fish Assessment 35

4 Summary 37

5 References 38

List of Figures

Figure 1. Aquatic RSA in Relation to the Yukon River 3
Figure 2. Proposed Casino Project General Arrangement 4
Figure 3. Aquatic RSA with Sampling Sites 6
Figure 4. Water Quality Exceedances of CCME Guidelines, Casino Project, 2011 27
Figure 5. Mean Density of Periphyton by Site, Casino Project, 2011 29
Figure 6. Mean Taxonomic Richness of Periphyton Communities, Casino Project, 2011 30
Figure 7. Mean Shannon-Wiener Diversity Index of Periphyton Communities, Casino Project, 2011 31
Figure 8. Mean Density of Benthic Invertebrates by Site, Casino Project, 2011 32
Figure 9. Mean Taxonomic Richness of Benthic Invertebrate Communities, Casino Project, 2011 33
Figure 10. Mean Total EPT of Benthic Invertebrate Communities, Casino Project, 2011 33
Figure 11. Mean Shannon-Weiner Index of Diversity of Benthic Invertebrate Communities, Casino Project, 2011 34

List of Tables

Table 1. Sampling Trips, Aquatic Environment, Casino Project, 2011 8
Table 2. Summary of Water Quality Sampling Sites, Casino Project, 2011 9
Table 3. Summary of Benthos and Periphyton Sampling Sites and Dates, Casino Project, 2011 11
Table 4. Summary of Fish Sampling Sites, Casino Project, 2011 12
Table 5. Water Quality Parameters and Detection Limits 13
Table 6. Sediment Quality Parameters and Detection Limits 14
Table 7. Fish Tissue Metals and Detection Limits 16
Table 8. RPD Analysis of Replicate Water Quality Samples, Casino Project, 2011 17
Table 9. Water Quality Summary Statistics, Casino Creek Watershed, 2011 22
Table 10. Water Quality Summary Statistics, Dip Creek Watershed, 2011 23
Table 11. Water Quality Summary Statistics, Britannia Creek Watershed, 2011 24
Table 12. Water Quality Summary Statistics, Yukon River Watershed, 2011 25
Table 13. Water Quality Parameters Exceeding CCME Guidelines, Casino Project, 2011 26
Table 14. Sediment Quality Summary Statistics, Casino Project, 2011 28
Table 15. Sediment Quality Parameters Exceeding CCME Guidelines, Casino Project, 2011 29
Table 16. Percentage Composition of Periphyton Communities, Casino Project, 2011 30
Table 17. Percentage Composition of Benthic Invertebrate Communities, Casino Project, 2011 32

Table 18. Fish Catch, Casino Project, 2011 35
Table 19. Mean Whole-Body Metal Concentrations, slimy sculpin, Casino Project, 2011 36

List of Appendices

A. Surface Water Quality Data and Replicate Data, Casino Project, 2011
B. Sediment Quality Data, Casino Project, August 2011
C. Periphyton Taxonomy, Casino Project, 2011
D. Benthic Invertebrate Taxonomy, Casino Project, 2011
E1. Electrofishing Effort, Catch and CPUE, Casino Project, 2011
E2. Fish Biological Characteristics, Casino Project, 2011
E3. Fish Tissue Metal Concentrations, Casino Project, 2011
F. Environment Canada Water Quality and Toxicity Testing Results, 2011

1 Introduction

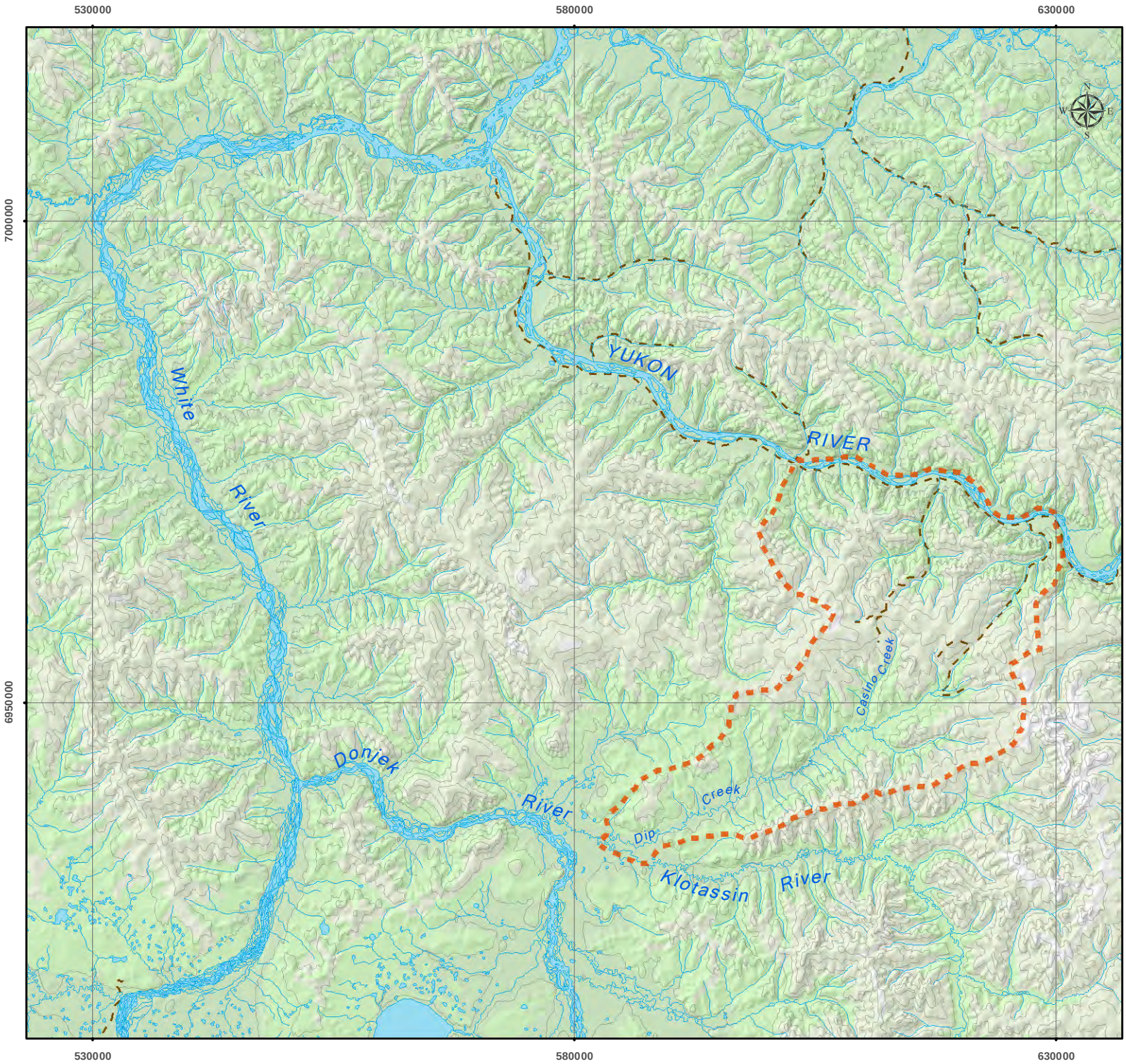
1.1 Overview

This report describes the studies conducted in 2011 on the aquatic environments of the Casino Project (Project), which specifically includes water quality, sediment quality and fish and fish habitat. Studies conducted in 2011 on hydrology, climate and meteorology, hydrogeology and geochemistry are reported separately. The purpose of these studies was to characterize the pre-development environment in support of the permitting process for the Project. The results from 2011 studies will be included with those from previous surveys to describe the complete environmental baseline for the project in a future report. The Project is owned by the Casino Mining Corporation (CMC). It is a proposed porphyry copper-gold-molybdenum mine located at in west-central Yukon, 611379E 6956218N, approximately 380 km northwest of the territorial capital of Whitehorse. Figure 1 shows the location of the Project, surrounded by the aquatic Regional Study Area (RSA), in relation to the Yukon River – to which all of the streams in the Casino Project area eventually discharge.

In August 2008, a pre-feasibility study of the Project was completed (M3 Engineering, 2008). It envisioned a conventional truck-shovel, open pit mine. Heap leach, ore stockpile and oxide waste will be stored in the interior of the impoundment (Figure 2). Tailings, process water, treated sewage effluent, leachate from the waste rock dumps and surface runoff from the mine site will be directed to the Tailings Impoundment Area (TIA) located in the headwaters of Casino Creek. Historical studies on the aquatic ecosystem of the Project property were conducted from 1993 to 1995 (Hallam Knight Piésold 1997). In 1994, Fisheries and Oceans Canada (DFO) and Indian and Northern Affairs Canada (INAC), then known as Department of Indian Affairs and Northern Development (DIAND), conducted an overview investigation of waters that may be affected by the Project (DFO, 1994). This included the Klotassin River, Dip Creek, Britannia Creek, Selwyn River and Hayes Creek. In 1998, White River First Nation commissioned a study to identify areas of the Lower Donjek River drainage utilized by Chinook salmon (Otto, 1998). This was conducted in order to serve as a pilot study to develop a strategic plan for future Chinook salmon restoration and enhancement work in the lower Donjek. In 2001, on behalf of Selkirk First Nation, studies were conducted on selected Yukon River tributaries between McGregor Creek and Coffee Creek in 2001 by Laberge Environmental Services. Basic data on flow, water quality, benthic invertebrate and fish were collected. Otherwise, there are limited data available on the aquatic environment of the Project area. DFO has conducted surveys of fish and fish habitat in watersheds in the area, including the reaches of the Yukon River adjacent to the Project property and the lower reaches of Dip Creek and the Klotassin, Donjek and White rivers. These were conducted for the purposes of managing Pacific salmon fisheries in the Yukon River, and for classifying fish habitat in support of the Yukon Placer Authorization (Government of Canada, 2000). The results of the DFO surveys are reported in Appendix B10 of AECOM (2009).

Recent studies of the aquatic ecosystem of the RSA began in 2008 with sampling trips in May, July, September and October. Study components included stream flows, water quality, sediment quality, periphyton, benthic invertebrates, fish and fish habitat. The results of those surveys were reported in "*Casino Project: 2008 Environmental Studies Report*" (AECOM, 2009). The continuation of these studies was carried out in 2009 with monthly water quality sampling between May and December and sediment quality, periphyton, benthic invertebrates, fish and fish habitat sampling in August. The results of these surveys are reported in "*Casino Project: 2009 Aquatic Studies Report*" (PECG, 2011). Monthly water

quality sampling continued in 2010, with some sediment sampling and fish assessment to fill in data gaps. The studies conducted in 2011 and reported here are a continuation of the 2008 program. All data from 2008-2011, plus additional data from 2012 will be compiled into a future report describing the baseline aquatic environment.



Legend

- Regional Study Area
- Access Road
- Contours
- Watercourse
- Waterbody

0 2.5 5 10 15 km

Map scale 1:500,000 (printed at 8.5x11)

Figure 1. Aquatic Regional Study Area

Drawn By:	L. Grieve
Checked By:	M. Power / M. Kearns
Date:	16 December 2011
Projection:	North American Datum

1:250,000 Topographic Spatial Data: Canvec; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Digital Elevation Model provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

This document is not an official land survey and the spatial data presented is subject to change without any notice.

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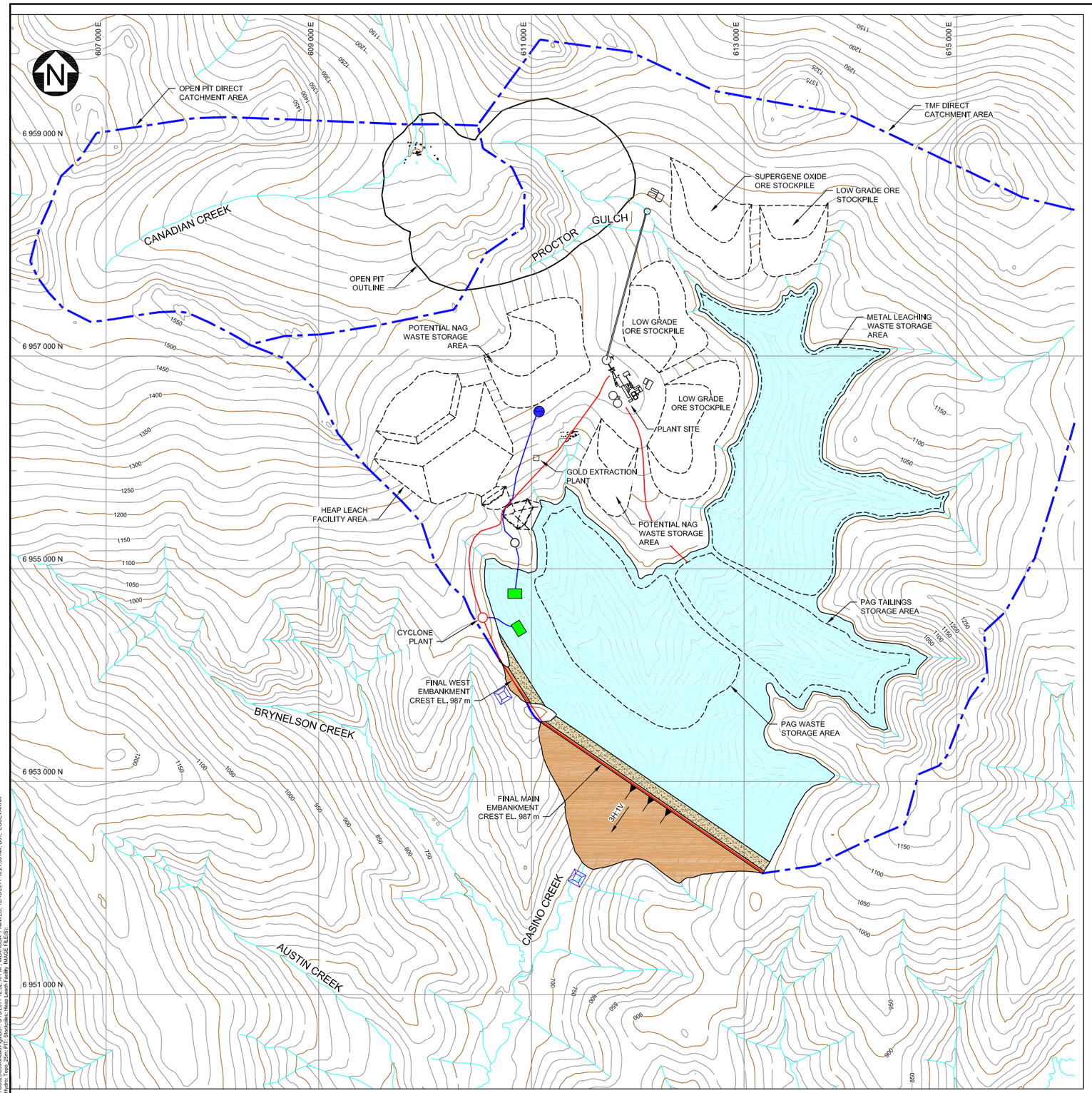


NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3ENGINEERING AND TECHNOLOGY CORPORATION (APRIL 9, 2008).
5. ORE STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE DURING OPERATIONS.

LEGEND:

- TAILINGS PIPELINES
- RECLAIM PIPELINES
- SUPERNATANT POND
- TAILINGS BEACH
- RECLAIM BOOSTER PUMP STATION
- RECLAIM WATER HEAD TANK
- RECLAIM BARGE
- SEDIMENT AND SEEPAGE COLLECTION PONDS

SCALE A 400 200 0 400 800 1200 1600 2000 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	07JUN'11	ISSUED WITH REPORT	AG	ELG	GRG	KJB

WESTERN COPPER CORPORATION

CASINO COPPER-GOLD PROJECT

PROJECT GENERAL ARRANGEMENT

Knight Piésold CONSULTING

P/A NO. VA101-325/3

REF NO. 5

FIGURE 2

REV 0

SAVED: M:\101\00325\03\A\Acad\Figs\B31, 01/5/2011 12:42:10 PM , VILAHUDA , PRINTED: 12/16/2011 10:21:33 AM , B31 , EQUEVIARRA
XREF FILE(S): Hydro; Topo_25m; PIT; Stockpiles; Heap Leach Facility; IMAGE FILE(S):

1.2 Study Areas

The Local Study Area (LSA) for the aquatic ecosystems of the Project is defined by the boundaries of the two watersheds surrounding the Project deposit: the Britannia Creek Watershed to the north and the Casino Creek Watershed to the south. This area includes the direct footprint of the proposed Project mine and near-field effects. The boundaries of the LSA are shown as dotted line within the RSA in Figure 3.

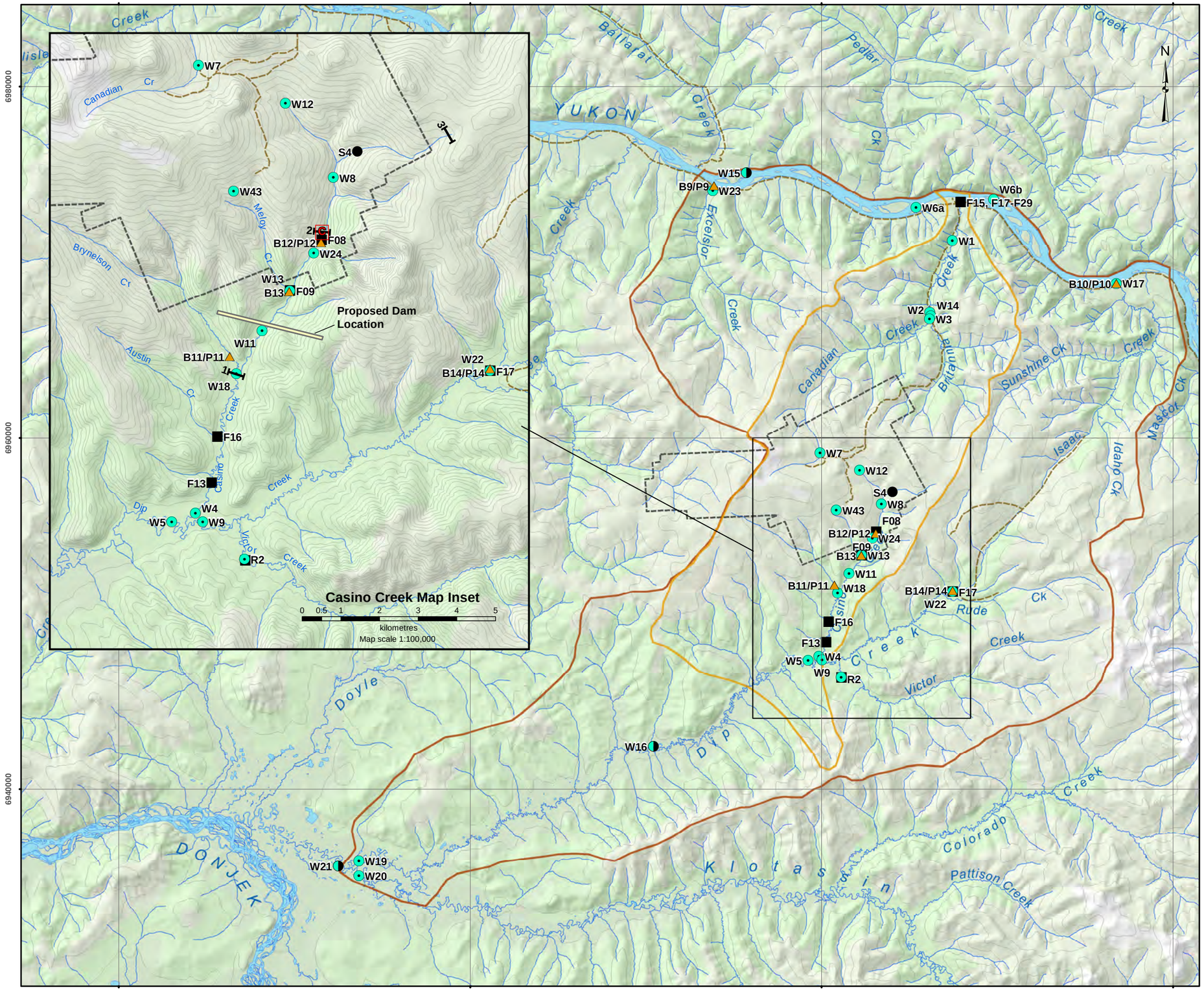
Most of the proposed mine infrastructure will be in the Casino Creek Watershed, but some (e.g., the northern corner of the open pit) will be in the Britannia Creek Watershed. The northern part of the LSA is drained by Britannia Creek and one of its tributaries, Canadian Creek. Britannia Creek flows into the Yukon River. The northern edge of the LSA includes a 2 km-long reach of the Yukon River. The southern part of the property is drained by Casino Creek which flows south to Dip Creek and thence to the Yukon River via the Klotassin, Donjek and White rivers. The southern edge of the LSA includes a 2 km-long reach of Dip Creek.

The aquatics Regional Study Area (RSA) was defined as the LSA plus four adjacent areas. It includes water bodies which are not directly impacted, but which are either indirectly affected or are suitable for providing references sites (mid-to-far field effects):

- ***Dip Creek Watershed***. The headwaters of Dip Creek are not expected to be affected by Project activities, but the reaches of Dip Creek downstream of the confluence of Dip and Casino creeks may be affected by a reduction in flows from Casino Creek caused by the impoundment of its headwaters. The effects of those flow reductions may decrease with downstream distance from the confluence of Dip and Casino creeks. One water quality site (W16) was placed approximately 11 km downstream of the confluence to monitor far-field effects.
- **Sunshine Creek Watershed**. This watershed, located to the east of the Britannia Creek Watershed, is not expected to be affected by Project activities. For that reason a reference water quality station – site W17 – was located on Sunshine Creek upstream of its confluence with the Yukon River.
- ***Excelsior Creek Watershed***. This watershed, located to the west of Britannia Creek Watershed, is also not expected to be affected by Project activities. It was originally intended to be the site of a reference water quality site, but that site (W17) was eventually moved to Sunshine Creek for logistical reasons. This watershed may serve as a location for a reference site in the future.
- ***Yukon River***. This river will be the receiving environment for flows from Britannia Creek. Therefore, water quality sampling stations were placed upstream (W6b – a reference site) and downstream (W6a and W15) of the confluence of Britannia Creek and the Yukon River.

In September 2009, the RSA was extended in a south-western direction to include the confluence of Dip Creek and the Klotassin River (Figure 3). Two water sampling stations (W20 and W21) were established in the Klotassin River: W20 downstream of the Dip Creek confluence and W21 upstream of the confluence. In addition to W20 and W21, another reference site, R2, was established on a tributary to Dip Creek in August 2009 for water quality sampling, benthos, periphyton and fish communities.

In 2011, three reference sites for water quality, sediment quality, periphyton and benthic invertebrates were added to the local and regional study area. These new reference sites include Sunshine Creek and Excelsior Creek, which were previously considered reference sites for water quality, and upper Dip Creek.



Legend

- Water Quality Site
- Sediment & Water Quality Site
- Sediment Quality Site
- Fish Sampling Site
- Benthos and Periphyton Site
- Stream Feature (Cascade)
- Reach Break
- Secondary Road or Trail
- Contours
- Casino Property
- Local Study Area
- Regional Study Area

0 1 2 4 6 8 10
kilometres

Map scale 1:220,000 (printed at 11x17)

Figure 3. 2011 Casino Aquatic Sampling Sites

Drawn By:	L. Grieve / M. Power
Checked By:	K. Tableman (PECG)
Date:	29 March 2012
Projection:	NAD1983 UTM Zone 7

1:50,000 Topographic Spatial Data: Canvec; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Digital Elevation Model provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

This document is not an official land survey and the spatial data is subject to change without any notice.

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1.3 Study Objectives

As in 2008 to 2010, the overall objective of the 2011 aquatic studies was to collect information that will be used to characterize the pre-development aquatic environment of the Project area. The sampling strategy was to use, as much as was possible, the same sampling sites or areas and methods that were monitored by Hallam Knight Piésold Ltd. (HKP) from 1993 to 1995 in order to develop further a multi-year database that will allow assessment of natural inter-annual variability.

The specific objectives for the 2011 aquatic studies were the following:

- Continue to sample stream water quality at all sites in the LSA and RSA on a seasonal basis from March through to October. The 2011 water quality sampling data will be combined with the previous water quality sampling that began in September 2008 prior to submission of the Casino Project Proposal to the Yukon Environmental and Socio-Economic Assessment Board (YESAB).
- Sample stream sediment quality at sites in the LSA and RSA that have not been sampled before.
- Conduct fish assessments at established sites within the LSA and RSA to further develop understanding of species distribution, fish abundance and habitat utilization.
- Conduct a fish habitat assessment to identify barriers to upstream migration on Casino Creek.
- Obtain a baseline description of periphyton and benthic invertebrate communities in the study area.
- Obtain a baseline of metals concentrations in fish from the study area.

2 Methods

2.1 Dates and Locations of Sampling Surveying

2.1.1 General

The study design for the 2011 aquatics work was similar to the study design used in 2008-2010. The same sampling locations were used and the same sampling techniques were employed. Six sampling trips were made from March to October (Table 1). For each trip during the spring, summer and fall, a fixed-wing aircraft was chartered from Alkan Air to fly from Whitehorse to the Casino property. During March, access to the site was by helicopter, while based in the town of Carmacks. While on the property, aquatic biologists travelled to sampling sites by helicopter, by all-terrain vehicles or by foot, depending on weather and trail conditions.

Table 1. Sampling Trips, Aquatic Environment, Casino Project, 2011

Date	Water Quality	Sediment Quality	Periphyton	Benthic Invertebrates	Fish and Fish Habitat Assessment
March 28 – April 2	X	-	-	-	-
April 27-30	X	-	-	-	-
May 16-23	X	-	-	-	-
August 8-10	-	-	-	-	X
August 16-23	X	X	X	X	-
September 7-14	X	-	-	-	X
October 3-7	X	-	-	-	-

Note: Dashes indicate no data collection.

2.1.2 Water Quality

A total of 26 sites were chosen for water quality sampling (Table 2). Eight sites were in the Casino Creek Watershed:

- W12 in Proctor Gulch, a tributary to reach 3 of Casino Creek;
- W24 on an eastern tributary to Casino Creek;
- W8 in the upper reach of Casino Creek, upstream of the confluence of Meloy Creek;
- W43 on the adit discharge pipe of the lower camp (which discharges to surface about 1 km from upper Meloy Creek);
- W13 on Meloy Creek upstream of its confluence with Casino Creek;
- W11 in reach 1 of Casino Creek outside of the southern edge of the proposed TIA;
- W18 on Brynelsen Creek upstream of its confluence with reach 1 of Casino Creek; and
- W4 on reach 1 of Casino Creek upstream of its confluence with Dip Creek.

Table 2. Summary of Water Quality Sampling Sites, Casino Project, 2011

Watershed	Creek/River	Site	UTM Co-ordinates	
			Easting	Northing
Casino Creek	Procter Gulch (Casino Tributary)	W12	612,163	6,958,175
	Casino (Reach 3)	W8	613,398	6,956,258
	Casino (Reach 1)	W11	611,557	6,952,289
	Casino (Reach 1)	W4	609,833	6,947,575
	Adit	W43	610,823	6,955,906
	Meloy	W13	612,275	6,953,326
	Brynelson	W18	610,893	6,951,180
	Unnamed Tributary	W24	612,888	6,954302
Dip Creek	Dip	W22*	617,447	6,951,308
	Dip	W9*	610,018	6,947,352
	Dip	W5	609,219	6,947,348
	Dip	W16	600,423	6,942,454
	Dip	W19	583,657	6,935,916
	Victor	R2*	611,102	6,946,387
Klotassin River	Klotassin	W20	583,656	6,935,082
	Klotassin	W21	582,490	6,935,640
Britannia Creek	Britannia	W1	617,439	6,971,241
	Britannia	W2	616,158	6,967,156
	Britannia	W14	616,205	6,966,952
	Canadian	W3	616,141	6,966,789
	Canadian	W7	609,913	6,959,158
Yukon River	Yukon	W6a	615,375	6,973,129
	Yukon	W6b*	619,781	6,973,576
	Yukon	W15	605,721	6,975,108
Sunshine Creek	Sunshine	W17*	626,775	6,968,802
Excelsior Creek	Excelsior	W23*	603,878	6,974,354

Notes: Dashes indicate no data was available.

**reference site.*

Six sites were in the Dip Creek Watershed:

- W9 on Dip Creek upstream of its confluence with Casino Creek;
- W22 on upper Dip Creek, upstream of R2 and the placer mining operation;
- W5 on Dip Creek downstream of its confluence with Casino Creek;
- W16 on Dip Creek approximately 11 km downstream of site W5 – a far-field site;
- W19 on Dip Creek just upstream of Klotassin River; and
- R2 on a tributary, Victor Creek, to Dip Creek upstream of its confluence with Casino Creek.

Five sites were in the Britannia Creek Watershed:

- W1 on the lower reaches of Britannia Creek;
- W3 on Canadian Creek upstream of the confluence of Canadian and Britannia creeks;
- W14 on Britannia Creek upstream of its confluence with Canadian Creek;
- W2 on Britannia Creek just downstream of the confluence of Canadian and Britannia creeks; and
- W7 located on upper Canadian Creek.

Three sites were located on the Yukon River:

- W6a downstream from the outflow of Britannia Creek;
- W6b upstream of the outflow of Britannia Creek; and
- W15 upstream of the outflow of Excelsior Creek.

Two sites were located on the Klotassin River:

- W20 upstream from its confluence with Dip Creek – a far-field site; and
- W21 downstream from its confluence with Dip Creek – a far-field site.

One site – W17 – was on Sunshine Creek upstream of its confluence with the Yukon River, and another site – W23 was on Excelsior Creek also upstream of its confluence with the Yukon River

Of these 26 sites, four – W9, W17, W6b and R2 – are reference sites, 17 sites are potentially affected by future mine activities, and one – W43 – has already been disturbed by the adit discharge pipe releasing groundwater, a source of natural Acid Rock Drainage (ARD).

Additionally, on July 12, 2011, Environment Canada visited the Casino project site and collected a water sample at W43 for testing at their Pacific and Yukon Laboratory in North Vancouver.

2.1.3 Sediment Quality

A total of four stream sites were sampled in four different watersheds for sediment quality between August 22nd and 23rd, 2011:

One site located on the Dip Creek:

- W16 on Dip Creek approximately 11 km downstream of site W5 – a far-field site.

One site located on the Yukon River:

- W15 upstream of the outflow of Excelsior Creek.

One site located on the Klotassin River:

- W21 downstream from its confluence with Dip Creek – a far-field site.

One site located on Casino Creek.

- W24 on an eastern tributary to Casino Creek.

The co-ordinates of the sites are shown in Table 2. Site S4 is a historic site sampled in 1993 by HKP (HKP, 1993) and sampled in 2010 (PECG 2010). Twelve stream sites in Britannia Creek, Casino Creek and Dip Creek watersheds (W1, W2, W3, W7, W14, W4, W11, W12, W8, W13, W9, R2 and W5) were previously sampled in 2008-2009 for sediment quality.

2.1.4 Periphyton and Benthic Invertebrates

Periphyton and benthic invertebrates were sampled from August 21st - 22nd, 2011.

Two sites were sampled in the Yukon River Watershed (Figure 3 and Table 3):

- B9/P9 (where "B" refers to benthic invertebrates and "P" to periphyton) in lower Excelsior Creek, upstream of its confluence with the Yukon River and
- B10/P10 in lower Sunshine Creek upstream of its confluence with the Yukon River.

Three sites were sampled in the Casino Creek Watershed:

- B11/P11 in mid Brynelson Creek, upstream its confluence with Casino Creek;
- B12/P12 in upper Casino Creek, upstream of its confluence with Meloy Creek; and
- B13 in lower Meloy Creek upstream of its confluence with Casino Creek. Periphyton sampling was not completed in Meloy Creek due to the dominant sandy substrate material.

One site (B14/P14) was sampled in upper Dip Creek approximately 10 km upstream of Casino Creek.

Table 3. Summary of Benthos and Periphyton Sampling Sites and Dates, Casino Project, 2011

Watershed	Creek	Site	GPS Co-ordinates		Date
			Easting	Northing	
Yukon River	Excelsior	B9/P9	603878	6974354	Aug 22
	Sunshine	B10/P10	626768	6968801	Aug 22
Casino	Brynelson	B11/P11	610718	6951624	Aug 21
	Casino	B12/P12	613081	6954572	Aug 21
	Meloy	B13	612258	6953302	Aug 21
Dip	Dip	B14/P14	617447	6951308	Aug 21

2.1.5 Fish Assessment

Fish communities within Dip, Casino, Meloy and Britannia Creek were sampled using minnow traps and electrofishing from August 9th to 11th, and September 7th to 9th in 2011. The main purpose of the sampling program was to examine distribution and relative abundance at all of the sampling locations, in order to further define baseline conditions at the site and to collect samples for submission for tissue metals analysis.

Nineteen sites were sampled for fish (Table 4):

- F15, F16 to F28 on Britannia Creek, near the confluence with the Yukon River;
- F08 on Casino Creek, above the proposed tailing management facility;
- F16 on Casino Creek, below Brynelson Creek;
- W13 on Meloy Creek;
- R2, Victor Creek reference site;
- F17, upper Dip Creek; and
- F13, lower Casino Creek near the confluence with Dip Creek.

Table 4. Summary of Fish Sampling Sites, Casino Project, 2011

Creek/River	Site	Minnow Trapping	Electrofishing	UTM Coordinates Easting Northing
Britannia	F15	-	Aug 11	617909 6973421
Casino	F16	-	Sept 8	610402 6949554
Britannia	F17	Aug 10	-	*
Britannia	F18	Aug 10	-	*
Britannia	F19	Aug 10	-	*
Britannia	F20	Aug 10	-	*
Britannia	F21	Aug 10	-	*
Britannia	F22	Aug 10	-	*
Britannia	F23	Aug 10	-	*
Britannia	F24	Aug 10	-	*
Britannia	F25	Aug 10	-	*
Britannia	F26	Aug 10	-	*
Britannia	F27	Aug 10	-	*
Britannia	F28	Aug 10	-	*
Britannia	F29	Aug 10	-	*
Casino	F08	Sept 7	Aug 11	613100 6954647
Meloy	F09	-	Sep 8	612284 6953325
Victor	R2	-	Sep 8	611102 6946387
Casino	F13	-	Sep 9	610258 6948357
Dip	F17	-	Sep 9	617447 6951308

*Note: * Approximately 50-100m apart stating at F15, the second being F7; dashes indicate no sampling at that site and date.*

2.2 Sample Collection

2.2.1 Water Quality

All surface water samples were grab samples, collected in mid-stream approximately 20 cm under the surface with the bottle mouths facing upstream. Water quality samples were collected for general chemical parameters in two pre-cleaned 1 L plastic bottles supplied by the analytical laboratory. Samples for total metals were collected in 120 mL acid-washed plastic bottles supplied by the laboratory and preserved in the field with laboratory-supplied nitric acid. Samples for dissolved metals were filtered in the field through 0.45-micron disposable filterware and preserved with laboratory-supplied nitric acid immediately after filtration. Samples for nutrients – ammonia, total Kjeldhal nitrogen (TKN), Total Organic Carbon (TOC), and dissolved orthophosphate – were collected in 120 mL bottles and preserved in the field with laboratory-supplied sulphuric acid. Total cyanide was collected in 120 mL bottles and preserved in the field with laboratory-supplied sodium hydroxide.

All samples were kept cold and were not allowed to freeze. They were shipped via air cargo from Whitehorse to Maxxam Analytics in Burnaby, BC. Maxxam Analytics is accredited by the Canadian Association for Environmental Analytical Laboratories. Chain of Custody forms accompanied all samples. Table 5 shows the water quality variables that were measured and their Reported Detection Limits (RDL).

Table 5. Water Quality Parameters and Detection Limits

Parameter	Units	RDL	Parameter	Units	RDL
Physical			**Total and Dissolved Metals**		
Conductivity	μS/cm	1	Boron	mg/L	0.005
pH	pH units	0.1	Cadmium	mg/L	0.000005
Hardness	mg/L $CaCO_3$	0.5	Calcium	mg/L	0.05
Total Dissolved Solids (TDS)	mg/L	1	Chromium	mg/L	0.0001
Total Suspended Solids (TSS)	mg/L	1	Cobalt	mg/L	0.000005
Turbidity	NTU	0.1	Copper	mg/L	0.00005
Anions			Iron	mg/L	0.001
Alkalinity	mg/L $CaCO_3$	0.5	Lead	mg/L	0.000005
Acidity (pH 8.3)	mg/L $CaCO_3$	0.5	Lithium	mg/L	0.0005
Bromide	mg/L	0.1	Magnesium	mg/L	0.05
Chloride	mg/L	0.5	Manganese	mg/L	0.00005
Fluoride	mg/L	0.01	Mercury	mg/L	0.00001
Sulphate	mg/L	0.5	Molybdenum	mg/L	0.00005
Cyanide (Total)	mg/L	0.0005	Nickel	mg/L	0.00002
Cyanide (Weak Acid Dissociable)	mg/L	0.0005	Phosphorus	mg/L	0.002
Nutrients			Potassium	mg/L	0.05
Ammonia (as N)	mg/L	0.005	Selenium	mg/L	0.00004
Nitrate (as N)	mg/L	0.005	Silicon	mg/L	0.1
Nitrite (as N)	mg/L	0.002	Silver	mg/L	0.000005
Total Kjeldahl Nitrogen (TKN)	mg/L	0.02	Sodium	mg/L	0.05
Ortho-phosphate (as P)	mg/L	0.001	Strontium	mg/L	0.00005
Total Phosphorus (as P)	mg/L	0.02	Thallium	mg/L	0.000002
Total and Dissolved Metals			Tin	mg/L	0.00001
Aluminum	mg/L	0.0002	Titanium	mg/L	0.0005
Antimony	mg/L	0.00002	Uranium	mg/L	0.000002
Arsenic	mg/L	0.00002	Vanadium	mg/L	0.0002
Barium	mg/L	0.00002	Zinc	mg/L	0.0001
Beryllium	mg/L	0.00001	Zirconium	mg/L	0.0001
Bismuth	mg/L	0.000005			

Notes: RDL = Reported Detection Limit from Maxxam Analytics.

μS = micro-Siemens, and NTU = nephelometric units.

Field measurements of pH, temperature, dissolved oxygen and specific electrical conductivity were made at each site using a HI 9828 Hanna Meter.

2.2.2 Sediment Quality

Sediment samples were collected using established protocols from depositional areas of the stream. Where possible, sediment samples were collected using the jar provided by the analytical lab as a scoop. Appropriate measures were taken to reduce potential for sample contamination. For example, field staff wore disposable nitrile gloves when sampling. All samples were kept cold at all times between sample collection and delivery to the laboratory. Chain of Custody forms accompanied all samples. Table 6 shows the sediment quality variables that were measured and their detection limits.

Table 6. Sediment Quality Parameters and Detection Limits

Parameter	Units	RDL	Parameter	Units	RDL
Physical					
Percent moisture		0.3	Manganese	mg/kg	0.2
pH	pH units	0.01	Mercury	mg/kg	0.05
Total Metals			Molybdenum	mg/kg	0.1
Aluminum	mg/kg	100	Nickel	mg/kg	0.8
Antimony	mg/kg	0.1	Phosphorus	mg/kg	10
Arsenic	mg/kg	0.2	Potassium	mg/kg	100
Barium	mg/kg	0.1	Selenium	mg/kg	0.5
Beryllium	mg/kg	0.1	Silver	mg/kg	0.05
Bismuth	mg/kg	0.1	Sodium	mg/kg	100
Cadmium	mg/kg	0.05	Strontium	mg/kg	0.1
Calcium	mg/kg	100	Thallium	mg/kg	0.05
Chromium	mg/kg	1	Tin	mg/kg	0.1
Cobalt	mg/kg	0.3	Titanium	mg/kg	1
Copper	mg/kg	0.5	Vanadium	mg/kg	2
Iron	mg/kg	100	Zinc	mg/kg	1
Lead	mg/kg	0.1	Zirconium	mg/kg	0.5
Magnesium	mg/kg	100			

Note: RDL = Reported Detection Limit from Maxxam Analytics.

2.2.3 Periphyton

Five samples of periphyton were collected from each of the four sampling sites from August 21st to 22nd, for a total of 20 samples. Each sample was collected from one rock selected from the stream bed. For each sample, a template was used to determine a surface area of 100 cm^2. Each rock was scraped with a scalpel and the scrapings were washed into a sterile 500 mL plastic bottle jar with a squeeze bottle containing stream water. Each sample was preserved by adding Lugol's iodine solution.

All samples were stored in coolers and kept cool until they could be shipped to Fraser Environmental Services Ltd. (FES) of Surrey, BC, for analysis of taxonomic composition. Chain of Custody forms accompanied all samples.

Periphyton density (cells/cm^2) was calculated for each sample by dividing the total number of cells estimated for a sample by the surface area that was scraped for each sample. Sub-sampling was required to estimate numbers of cells (FES, 1994).

2.2.4 Benthic Invertebrates

Five samples of benthic invertebrates were collected from each of the six sampling sites from August 21st to 22nd. Sampling methods followed the RISC standard for the British Columbia Ministry of Environment (MOE 2009), which recommends the Canadian Aquatic Biomonitoring Network (CABIN) approach (NWRI, 2009).

A CABIN protocol benthic kick net manufactured by Halltech Aquatic Research Inc. was used. The kicknet was triangular in shape with a 400 µm mesh and detachable collection cup. Starting from the edge of the stream bank, the sampler placed the net facing into the stream current with the flat side of the net resting on the substrate of the stream. The sampler then walked backward in the upstream direction, dragging the net along

the bottom of the stream as the sampler walked and kicked the substrate to disturb it to a depth of ~5-10 cm. Sampling was zig-zagged over the stream bottom from bank to bank in an upstream direction for a timed period of three minutes.

The organisms caught in the sampling nets were then washed into a sample bottle and preserved with 85% ethanol. This was repeated four more times at nearby areas to obtain five replicate samples at each site. Samples of benthos were shipped to Cordillera Consulting in Summerland, BC, for taxonomic identification to the lowest practical taxonomic level, which was to the Family level for most aquatic insects, to the Class level for oligochaetes and to the Phylum level for nematodes. Chain of Custody forms accompanied all samples. All organisms in each sample were counted and identified – no sub-sampling was required.

Total density of benthic invertebrates collected by the kick net sampler was calculated by total number of organisms from a sample per kick net.

2.2.5 Fish Habitat Assessment

On August 9, 2011 a fish habitat assessment to determine reach breaks and potential barriers to upstream migration was conducted on Casino Creek by two qualified fisheries biologists. A more detailed fish habitat assessment of the entire creek from the confluence of Dip Creek to the headwaters was conducted for the instream flow program (Normandeau and PECG, 2012).

2.2.6 Fish Assessment

Electrofishing and minnow trapping were both used in 2011 for sampling fish communities. Between one and six minnow traps were installed at fifteen of the sites in August and/or September. Minnow traps were made of galvanized steel wire and were conical in shape with a length of 42 cm, a width of 23 cm and a mesh size of 0.6 cm. Minnow traps were placed at each site in deep pools or among large woody debris or in slow-moving eddies. They were anchored to large woody debris or rocks and rocks were placed within the traps to weight them down. They were marked with red or yellow fluorescent flagging tape. Each trap was baited with salmon roe placed in a small perforated bag. Traps were soaked for approximately 24 hours.

Electrofishing was conducted using a two-person crew and a backpack electrofishing unit. A mixture of single-pass, three pass and spot fishing methods were used, while walking the stream in an upstream direction repeatedly sweeping the stream from bank to bank with the wand (anode) of the electrofishing unit. Fish were captured with a dip net and stored in a bucket of freshwater.

Whenever possible, the three pass method was used in order to best establish population densities. Stop nets were installed at the top and bottom of the sampling site, in order to prevent escapement of fish during sampling. Similar effort (electrofisher settings, time) was put forth during each of the three passes. Fifteen to twenty minutes was allowed to elapse between passes in order to allow any uncaptured fish to recover before sampling recommenced.

The single pass method was used when flows were too high for the installation of stop nets at the top and bottom of the sampling sites. Site length was increased, along with effort, in order to better determine populations in this case.

Spot fishing was used only at Meloy Creek, where dense willow brush made continuous sampling impossible. All quality fish habitat that could be accessed with the electrofisher was sampled.

All fish were identified to species and counted. Fork length was measured to the nearest 1 mm with a measuring board (total length was measured for slimy sculpin), and wet weight was measured to the nearest 0.1 g or 1.0 g with a balance (depending on size of fish). Otoliths were collected from Arctic grayling and slimy sculpin mortalities, and sent to Jon Tost of North Shore Environmental Services for aging. A Chain of Custody form accompanied the samples

2.2.7 Fish Tissue Metals Concentrations

A sub-set of 20 slimy sculpins and 2 Arctic grayling, captured by electrofishing in August and September were collected for analysis of tissue metals concentrations. Arctic grayling were sampled using a portion of muscle tissue, while slimy sculpin were sampled using whole-body tissue. Each fish was placed in a labeled plastic bag and frozen immediately. The samples were sent to Maxxam analytics in Vancouver, BC. Chain of Custody forms accompanied all samples. At Maxxam, samples were digested using a nitric acid-hydrochloric acid mixture based on U.S. EPA method 200.8 (Creed *et al*., 1994). The concentrations of 29 metals were measured using Inductively Coupled Atomic Emission Spectrometry (ICP-AES) or ICP Mass Spectroscopy (ICP-MS) (Table 7). The concentrations of mercury were measured using Cold Vapour Atomic Absorption Spectrophotometry (CVAAS).

Table 7. Fish Tissue Metals and Detection Limits

Metal	RDL	Metal	RDL
Aluminum	1	Manganese	0.1
Antimony	0.1	Mercury	0.01
Arsenic	0.01	Molybdenum	0.1
Barium	0.1	Nickel	0.1
Beryllium	0.1	Phosphorus	10
Bismuth	0.1	Potassium	10
Boron	5	Selenium	0.01
Cadmium	0.01	Silver	0.05
Calcium	10	Sodium	10
Chromium	0.5	Strontium	0.1
Cobalt	0.1	Thallium	1
Copper	0.5	Uranium	0.05
Iron	10	Vanadium	2
Lead	0.01	Zinc	0.1
Magnesium	10		

Notes: All units are mg/kg wet weight.

RDL = Reported Detection Limit.

2.3 QA/QC

2.3.1 Water Quality

All field equipment was maintained in good working condition and measuring instruments were calibrated frequently. For example, the pH meter was calibrated prior to each field trip using prepared solutions with pHs of 4, 7 and 10, and the conductivity meter was checked prior to each field trip using the standard 1,413 µS/cm conductivity solution.

Water quality samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency. All water samples were collected using industry standard sampling protocols. Appropriate measures were taken to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used bottles and preservative supplied by the analytical laboratory. All samples were collected with the mouth of the sampling bottle facing upstream. Care was taken to insure that no upstream disturbances occurred as the result of walking within the creek bed prior to sampling.

Approximately ten percent of the number of water quality samples were replicated, hence a total of eight replicate samples were collected: one in March, two in April, three in August and two in September. Replicate sample locations were chosen randomly. Appendix A shows the results of analysis of replicate samples. Relative Percent Difference (RPD) was used to assess analytical variability. RPD was defined as:

$$\%RPD = \frac{2(X_1 - X_2)}{(X_1 + X_2)} * 100$$

where X_1 = the concentration of a parameter in the first sample and X_2 = the concentration of the same parameter in the second sample (i.e., the replicate). An RPD less than 25% is considered an acceptable difference and an RPD greater than 25% warrants further examination to ensure that the result was not due to sampling error or analytical error. RPD is only relevant when both values are greater than the Practical Quantitation Limit (PQL), which was defined for this project as three times the detection limit. The PQL is considered the lowest concentration that can be accurately measured, as opposed to just detected.

As shown in Appendix A and Table 8, between three and ten of the 92 to 94 parameters that were measured from each sample had RPDs greater than 25% and met PQL restrictions. This was equivalent to between 3% and 9% of all parameters, which is considered to be an acceptable level of variability.

Table 8. RPD Analysis of Replicate Water Quality Samples, Casino Project, 2011

Month	Replicate	Number of Parameters with RPD>25%	Percent of Parameters with RPD>25%
March	1	3	3%
April	2	10	11%
April	3	3	3%

Month	Replicate	Number of Parameters with RPD>25%	Percent of Parameters with RPD>25%
August	4	6	6%
August	5	7	7%
August	6	5	5%
October	7	4	4%
October	8	7	8%

Note: A total of 92 to 94 parameters were measured from each sample.

The sites, dates and parameters for which RPD was greater than 25% were as follows:

- W16, March, dissolved cadmium, dissolved lead, and total nickel;
- W16, April, TSS, total aluminum, cadmium, chromium, cobalt, iron, lead, titanium and vanadium, and dissolved cadmium;
- W18, April, ammonia, acidity (pH 8.3), and dissolved zinc;
- W4, August orthophosphate, total beryllium and molybdenum, dissolved cadmium, cobalt, manganese;
- W7, August, turbidity, total arsenic, nickel, kjeldahl nitrogen and nitrogen, dissolved arsenic and vanadium;
- W14, August, turbidity, total cadmium, total lead, acidity (pH 8.3), and dissolved zinc;
- W7, October, ammonia, dissolved manganese, tin and uranium;
- W16, October, nitrate, orthophosphate, dissolved zinc, ammonia, nitrate plus nitrite, total nitrogen, and dissolved lead.

The results of the field and travel blanks are shown in Appendices A. A total of three field blanks and three travel blanks were collected. Slight elevation of dissolved aluminum was found in the March travel blank and October field blank. Similarly, slight elevations of total Kjeldahl nitrogen and total nitrogen were found in the August field blank and Cyanide + thiocyanate in the March travel blank. This indicates there may have been very minor contamination associated with either field or lab technique. All other values were below detection limits, indicating no contamination of samples.

Maxxam Analytics, which conducted the analyses of water and sediment samples, is a certified member of the Canadian Association of Environmental Analytical Laboratories. Maxxam split several samples into duplicates and analyzed each one separately to provide a measure of their laboratories analytical precision. Duplicates were chosen randomly by Maxxam. The results, which are not reported here, met Maxxam's standards for QA/QC (QC limits of 80%-100%).

2.3.2 Sediment Quality

Sediment quality samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency. All sediment samples were collected using industry standard sampling protocols. Appropriate measures were taken to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used sample bottles supplied by the analytical laboratory.

2.3.3 Periphyton and Benthic Invertebrates

Periphyton and benthic invertebrate samples were collected by a qualified aquatic biologist and were carried out by the same individual at each sampling site to insure consistency.

Fraser Environmental Services Ltd. (FES) has over fifteen years experience in analysis of periphyton from streams and rivers of western Canada. FES has the following standard QA/QC procedures (FES 1994):

- all microscopes are calibrated on a regular basis;
- consistent sample concentration and sub-sampling techniques are employed for identifications;
- taxonomic identifications are verified by comparison with reference collections, including an in-house reference collection;
- difficult, typical or dominant specimens are sent to external experts for confirmation. Part of this process includes compiling a list of experts for different groups of organisms. Verified specimens are incorporated into FES' reference collection; and
- all FES personnel actively participate in a taxonomists' working group.

Cordillera Consulting has over ten years experience in taxonomic analysis of benthic invertebrates from streams, rivers and lakes of western Canada. The following QA/QC procedures are followed by Cordillera Consulting (http://www.cordilleraconsulting.com):

- sorting efficiency – 10% of the whole sample number was resorted with an expectation of >90% efficiency in the sorting process.
- taxonomic efficiency – 10% of the identified sample vials were sent to another taxonomist. The two results were compared with simple statistics and the taxonomists discussed how best to correct their differences and make appropriate changes to the results.
- taxonomic precision – an externally verified reference collection is maintained by Cordillera Consulting. Any new specimens are sent away to experts of that taxon and the collection is reviewed every five years.

2.3.4 Fish and Fish Habitat

All fish and fish habitat field data were recorded on waterproof paper field notes and then transferred to electronic spreadsheets in the office. The spreadsheets were compared with the field notes to identify and correct transcription errors. A variety of other measures were taken to further ensure the validity of the data. For example, fish weights were plotted against fish lengths for each species separately to identify outliers that may have been due to errors in recording or transcription. Outliers were then corrected, if possible, or excluded from the analysed dataset.

Quality Assurance (QA) was run by Maxxam Analytics for the batch of Arctic grayling and slimy sculpin tissue that was analyzed for metals concentration shown in Appendix E3. Maxxam Analytics uses spiked blanks, method blanks, and Quality Control (QC) standard as their QA methods. A spiked blank is a blank matrix with a known amount of added analyte. A method blank is a blank matrix containing all reagents used in the analytical procedure. A QC standard is a blank matrix with a known amount of added analyte. All blanks were within the QC limits (75%-125%), indicating no contamination of equipment.

2.4 Data Analysis

2.4.1 Water Quality

The minimum, median and maximum concentrations of selected water quality parameters were calculated for each site sampled in 2011. The median, rather than the arithmetic mean, was assumed to be the best estimate of the central tendency of the data because many water quality variables tend not to be normally distributed. To calculate statistics, all data for each site were pooled over the March-October sampling period and values below detection limits were replaced with one-half the detection limit.

Concentrations of water quality parameters were compared to guidelines for the protection of freshwater aquatic life issued by the Canadian Council of the Ministers of the Environment (CCME) (CCME, 2007), and parameters exceeding the guidelines were identified.

Water Quality and Toxicity testing results from Environment Canada`s sample are shown in Appendix F. This data will be combined with the full dataset for the baseline study and is not analysed in this report.

2.4.2 Sediment Quality

The minimum, mean and maximum concentrations of selected sediment quality parameters were calculated for each site sampled in 2011.

The 2011 sediment quality data were compared to the CCME (2002) sediment guidelines for the protection of freshwater aquatic life. There are two classes of guidelines: the Probable Effects Level (PEL), which defines the level above which adverse effects are expected to occur frequently and the Interim Sediment Quality Guideline (ISQG), which is lower than the PEL and defines the concentration below which minimal effects on the aquatic environment are expected.

2.4.3 Periphyton and Benthic Invertebrates

One-way Analysis of Variance (ANOVA) was used to compare mean densities of periphyton and of benthic invertebrates between sites. ANOVA assesses the statistical significance of differences using F-ratios. Significance was assessed as none ($p>0.05$), low ($0.01<p<0.05$), medium ($0.001<p<0.01$) and high ($p<0.001$), where p is the probability of making a Type I error (i.e., rejecting a true null hypothesis). Density values were transformed using natural logarithmic values to normalize the frequency distributions and to satisfy the assumption of equal variances – two prerequisites of parametric statistics.

Post-hoc comparisons of means were calculated using the Bonferroni test to show which sites were significantly different from one another. This is denoted on the graphs using letters; sites that are not significantly different are labelled with the same letter, while sites that are significantly different will not share the same letters.

The taxonomic composition of periphyton and benthos communities were assessed using tabular means after pooling replicates for each site.

Two indices of taxonomic diversity were calculated for each sample of periphyton and three indices were calculated for each sample of benthic invertebrates using the protocols recommended by the Canadian Aquatic Biomonitoring Network (CABIN), which is supported by the National Water Research Institute (NWRI) of Environment Canada (NWRI 2008):

- taxonomic richness (S), calculated as the total number of families in a sample, regardless of their relative abundances;
- EPT abundance (EPT), defined as the total number of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) in a sample. These three orders of aquatic insects are typically most sensitive to habitat disturbance. EPT was not calculated for periphyton; and
- Shannon-Weiner diversity index (H'), calculated as - $\square(p_i \ln(p_i))$, where $p_i = n_i/N$, n_i = the total number of individuals in the ith species, N = the total number of organisms in the sample, and H' was calculated by summing over all species (i.e., over S).

For the purposes of calculating S and H', those taxa that could not be identified to the family or species level (e.g., unidentified flagella for periphyton and Phylum Nematoda for benthos) were treated as if they were a family or a species. The periphyton data reported by Fraser Environmental Services included less than signs (<) for some species or genus, indicating that the species or genus were present in the sample but not in sufficient numbers to allow density to be calculated. Those data were used to calculate periphyton richness, but they were not used to calculate densities and Shannon-Wiener diversity indices.

2.4.4 Fish Assessment

There was no data analysis conducted for the 2011 field data, as too few fish were captured to produce any meaningful results. Fish data from 2011 will be combined with previous years in the baseline report.

3 Results and Discussion

3.1 Water Quality

3.1.1 Statistical Summary

Appendix A show the surface water quality data for the months of March, April, June, August, and October of 2011, and Table 9, Table 10, Table 11, and Table 12 show the minimum, median and maximum values for selected water quality parameters for sites in Casino Creek, Dip Creek, Britannia Creek, and the Yukon River watersheds, respectively.

Table 9. Water Quality Summary Statistics, Casino Creek Watershed, 2011

Station	Conductivity (uS/cm)	pH	Total Suspended Solids	Total Hardness ($CaCO_3$)	Dissolved Sulphate	Ammonia as N	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Total Silver	Total Zinc
CCME[1]		6.5-9.0				0.137[a]	0.005-0.1[b]	0.005	0.000017[c]	0.001	0.002-0.004[d]	0.3	0.001-0.007[e]	0.073	0.025-0.15[f]	0.001	0.0001	0.03
W12 - Proctor Gulch																		
Min	721	3.2	7.0	227	260	0.007	5.790	0.00032	0.001660	0.00040	0.5880	6.5	0.0012	0.0002	0.0045	0.00019	0.0000240	0.1220
Median	1040	3.5	20.5	388	500	0.160	10.600	0.00065	0.002760	0.00050	0.9110	13.0	0.0012	0.0002	0.0074	0.00025	0.0000330	0.2110
Max	1140	4.0	34.0	442	520	0.180	18.500	0.00094	0.003980	0.00070	1.1400	31.1	0.0021	0.0003	0.0082	0.00027	0.0000450	0.2600
n	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W8 - Lower Casino Creek																		
Min	224	7.4	2.0	91	63	0.006	0.359	0.00025	0.000214	0.00005	0.0369	0.1	0.0002	0.0002	0.0007	0.00005	0.0000025	0.0182
Median	324	7.7	3.0	139	96	0.015	0.486	0.00030	0.000252	0.00005	0.0460	0.1	0.0002	0.0002	0.0008	0.00006	0.0000025	0.0183
Max	350	7.7	5.0	156	100	0.026	0.493	0.00032	0.000306	0.00020	0.0604	0.8	0.0003	0.0003	0.0010	0.00006	0.0000060	0.0217
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W13 - Meloy Creek																		
Min	206	7.6	0.5	94	20	0.006	0.098	0.00047	0.000081	0.00005	0.0010	0.0	0.0000	0.0004	0.0004	0.00002	0.0000140	0.0059
Median	247	8.0	11.0	119	27	0.035	0.135	0.00104	0.000120	0.00040	0.0022	0.2	0.0045	0.0005	0.0004	0.00002	0.0000180	0.0065
Max	444	8.0	19.0	214	110	0.045	0.358	0.00110	0.000176	0.00190	0.0092	0.6	0.0146	0.0005	0.0011	0.00028	0.0000440	0.0119
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W11 - Casino Creek (proposed dam outflow)																		
Min	168	7.7	0.5	111	46	0.007	0.059	0.00073	0.000080	0.00005	0.0046	0.0	0.0006	0.0005	0.0003	0.00014	0.0000025	0.0053
Median	310	7.8	1.75	146	65	0.041	0.117	0.00090	0.000110	0.00010	0.0141	0.2	0.0018	0.0007	0.0005	0.00016	0.0000060	0.0054
Max	412	7.9	39.0	194	89	0.058	0.443	0.00125	0.000117	0.00090	0.0215	0.8	0.0029	0.0009	0.0017	0.00022	0.0000110	0.0121
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
W18 - Brynelsen Creek																		
Min	157	7.6	0.5	75	25	0.008	0.010	0.00033	0.000003	0.00005	0.0004	0.0	0.0000	0.0009	0.0001	0.00002	0.0000025	0.0002
Median	241	7.8	1.0	115	29	0.020	0.068	0.00059	0.000040	0.00010	0.0019	0.1	0.0004	0.0011	0.0004	0.00005	0.0000025	0.0029
Max	257	7.9	29.0	116	49	0.068	0.283	0.00110	0.000071	0.00050	0.0080	0.5	0.0007	0.0017	0.0007	0.00009	0.0000060	0.0043
n	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
W4 - Mouth of Casino Creek																		
Min	232	7.6	0.5	103	32	0.003	0.016	0.00041	0.000025	0.00005	0.0015	0.0	0.0001	0.0008	0.0002	0.00007	0.0000025	0.0011
Median	262	7.9	9.0	119	44	0.033	0.084	0.00056	0.000049	0.00020	0.0067	0.2	0.0007	0.0010	0.0004	0.00010	0.0000025	0.0038
Max	358	7.9	23.0	169	61	0.063	0.265	0.00089	0.000062	0.00050	0.0107	0.5	0.0012	0.0013	0.0007	0.00011	0.0000025	0.0043
n	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
W43 - Adit																		
Min	220	7.4	0.5	80	36	0.015	0.007	0.00057	0.039600	0.00005	0.0524	0.0	0.0085	0.0000	0.0004	0.00002	0.0001270	2.2200
Median	222	7.4	1.25	90	37	0.015	0.025	0.00068	0.040200	0.00005	0.0697	0.1	0.0144	0.0000	0.0005	0.00002	0.0001970	2.5300
Max	224	7.5	2.0	100	38	0.015	0.027	0.00071	0.045600	0.00005	0.0909	0.1	0.0183	0.0000	0.0006	0.00002	0.0002150	2.5500
n	2	2	2	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20ºC for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

0.123	Results exceed CCME Aquatic Life Guidelines

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Table 10. Water Quality Summary Statistics, Dip Creek Watershed, 2011

Station	Conductivity (uS/cm)	pH	Total Suspended Solids	Total Hardness ($CaCO_3$)	Dissolved Sulphate	Ammonia as N	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Total Zinc
CCME[1]		6.5-9.0				0.137[a]	0.005-0.1[b]	0.005	0.000017[c]	0.001	0.002-0.004[d]	0.3	0.001-0.007[e]	0.073	0.025-0.15[f]	0.001	0.03
W22 - Upper Dip Creek																	
Min	69	7.3	0.5	28	8	0.020	0.016	0.00026	0.000003	0.00005	0.00052	0.1	0.00001	0.0003	0.0002	0.00002	0.0003
Median	220	7.9	0.5	71	9	0.021	0.087	0.00026	0.000011	0.00020	0.00090	0.1	0.00013	0.0004	0.0003	0.00002	0.0009
Max	238	7.9	9.0	102	15	0.046	0.109	0.00029	0.000017	0.00020	0.00166	0.2	0.00044	0.0004	0.0003	0.00004	0.0012
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
R2 - Victor Creek																	
Min	160	7.4	0.5	74	14	0.003	0.009	0.00010	0.000003	0.00005	0.00045	0.0	0.00001	0.0007	0.0002	0.00002	0.0005
Median	202	7.7	0.5	92	21	0.015	0.014	0.00018	0.000005	0.00010	0.00055	0.0	0.00001	0.0008	0.0002	0.00007	0.0006
Max	263	7.8	1.0	118	43	0.016	0.034	0.00021	0.000016	0.00010	0.00094	0.0	0.00002	0.0009	0.0004	0.00009	0.0011
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W9 - Dip Creek us of Confluence with Casino Creek																	
Min	145	7.4	0.5	66	12	0.003	0.010	0.00019	0.000007	0.00005	0.00049	0.0	0.00002	0.0006	0.0002	0.00002	0.0005
Median	220	7.8	2.0	101	18	0.021	0.028	0.00030	0.000015	0.00008	0.00078	0.1	0.00005	0.0007	0.0003	0.00002	0.0009
Max	253	7.9	14.0	113	29	0.079	0.165	0.00045	0.000021	0.00040	0.00142	0.3	0.00024	0.0007	0.0005	0.00005	0.0013
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
W5 - Dip Creek ds Casino Confluence																	
Min	172	7.5	0.5	75	18	0.003	0.011	0.00026	0.000013	0.00005	0.00078	0.1	0.00003	0.0008	0.0002	0.00002	0.0004
Median	250	7.9	1.8	112	29	0.010	0.033	0.00034	0.000015	0.00008	0.00241	0.1	0.00013	0.0008	0.0003	0.00005	0.0016
Max	281	8.0	16.0	134	34	0.053	0.169	0.00059	0.000031	0.00040	0.00433	0.3	0.00049	0.0009	0.0006	0.00007	0.0057
n	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4
W16 - Lower Reach of Dip Creek																	
Min	108	7.4	2.0	57	15	0.006	0.018	0.00041	0.000007	0.00005	0.00085	0.2	0.00004	0.0005	0.0003	0.00002	0.0010
Median	258	7.9	2.0	119	29	0.010	0.069	0.00054	0.000012	0.00020	0.00188	0.2	0.00018	0.0009	0.0005	0.00006	0.0022
Max	293	8.0	27.0	134	53	0.041	0.467	0.00087	0.000048	0.00070	0.00469	0.8	0.00090	0.0010	0.0015	0.00009	0.0058
n	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
W19 - Dip Creek at Klotassin																	
Min	101	7.5	2.0	53	12	0.014	0.052	0.00090	0.000013	0.00020	0.00164	0.7	0.00007	0.0005	0.0006	0.00002	0.0005
Median	174	7.9	12.0	80	20	0.027	0.226	0.00093	0.000015	0.00060	0.00307	0.8	0.00038	0.0008	0.0011	0.00006	0.0029
Max	224	7.9	68.0	105	25	0.059	0.642	0.00140	0.000043	0.00120	0.00523	1.5	0.00102	0.0010	0.0021	0.00008	0.0047
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W20 - Klotass in River us of Dip Creek																	
Min	126	7.3	0.5	59	10	0.008	0.008	0.00033	0.000011	0.00005	0.00072	0.2	0.00001	0.0004	0.0004	0.00009	0.0005
Median	167	7.8	0.75	76	17	0.019	0.031	0.00043	0.000013	0.00015	0.00097	0.3	0.00005	0.0005	0.0005	0.00015	0.0008
Max	201	7.9	11.0	85	28	0.033	0.162	0.00067	0.000018	0.00060	0.00194	0.5	0.00012	0.0006	0.0011	0.00029	0.0037
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
W21 - Klotass in River ds of Dip Creek																	
Min	136	7.3	1.0	61	11	0.003	0.007	0.00039	0.000005	0.00010	0.00066	0.3	0.00001	0.0005	0.0005	0.00007	0.0004
Median	177	7.8	3.0	79	18	0.023	0.027	0.00061	0.000014	0.00020	0.00098	0.5	0.00003	0.0007	0.0006	0.00014	0.0009
Max	218	7.9	9.0	92	28	0.045	0.222	0.00099	0.000026	0.00070	0.00227	1.0	0.00018	0.0007	0.0012	0.00022	0.0016
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic — Results exceed CCME Aquatic Life Guidelines

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Table 11. Water Quality Summary Statistics, Britannia Creek Watershed, 2011

Station	Conductivity (uS/cm)	pH	Total Suspended Solids	Total Hardness ($CaCO_3$)	Dissolved Sulphate	Ammonia as N	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Total Zinc	Total Alkalinity (mg/L $CaCO_3$)
CCME[1]		6.5-9.0				0.137[a]	0.005-0.1[b]	0.005	0.000017[c]	0.001	0.002-0.004[d]	0.3	0.001-0.007[e]	0.073	0.025-0.15[f]	0.001	0.03	
W7 - Upper Canadian Creek																		
Min	82.0	6.3	0.5	31	27	0.008	0.020	0.00015	0.000155	0.00005	0.00093	0.0	0.00004	0.0001	0.0007	0.00002	0.0132	3
Median	145	6.9	1.5	51	51	0.028	0.042	0.00019	0.000226	0.00008	0.00179	0.0	0.00006	0.0002	0.0010	0.00006	0.0163	7
Max	170	7.1	40.0	61	54	0.040	0.589	0.00099	0.000505	0.00040	0.00861	0.4	0.00086	0.0004	0.0022	0.00015	0.0280	15
n	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
W3 - Canadian Creek us of Confluence with Britannia Creek																		
Min	267	7.7	0.5	104	47	0.005	0.007	0.00041	0.000021	0.00005	0.00137	0.0	0.00001	0.0008	0.0005	0.00006	0.0006	89
Median	353	7.9	1.3	166	81	0.014	0.021	0.00056	0.000025	0.00008	0.00197	0.0	0.00002	0.0008	0.0007	0.00011	0.0009	96
Max	393	8.2	3.0	184	95	0.042	0.053	0.00078	0.000043	0.00040	0.00297	0.1	0.00006	0.0011	0.0009	0.00011	0.0011	130
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
W14 - Mouth of Britannia Creek																		
Min	209	7.5	0.5	95	35	0.006	0.013	0.00046	0.000013	0.00005	0.00100	0.0	0.00001	0.0003	0.0005	0.00008	0.0008	65
Median	389	7.9	4.0	180	81	0.041	0.038	0.00050	0.000025	0.00030	0.00147	0.0	0.00002	0.0005	0.0006	0.00010	0.0010	110
Max	585	8.1	13.0	291	130	0.047	0.173	0.00068	0.000030	0.00040	0.00198	0.2	0.00008	0.0013	0.0007	0.00045	0.0017	160
n	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
W2 - Brtittania Creek ds from Confluence of Canadian Creek																		
Min	230	7.7	0.5	103	44	0.003	0.008	0.00041	0.000013	0.00005	0.00125	0.0	0.00001	0.0005	0.0005	0.00010	0.0005	64
Median	383	7.9	1.3	176	87	0.015	0.026	0.00052	0.000024	0.00015	0.00166	0.0	0.00004	0.0008	0.0006	0.00011	0.0009	104
Max	413	8.0	3.0	187	98	0.044	0.089	0.00074	0.000031	0.00030	0.00258	0.1	0.00006	0.0012	0.0008	0.00015	0.0015	110
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
W1 - Mouth of Canadian Creek																		
Min	257	7.5	0.5	115	51	0.007	0.021	0.00038	0.000009	0.00005	0.00135	0.0	0.00002	0.0005	0.0005	0.00012	0.0007	72
Median	414	7.9	1.5	192	101	0.014	0.024	0.00046	0.000020	0.00010	0.00170	0.0	0.00003	0.0008	0.0006	0.00015	0.0010	105
Max	492	8.0	4.0	241	120	0.026	0.075	0.00064	0.000026	0.00030	0.00246	0.1	0.00005	0.0010	0.0008	0.00017	0.0014	120
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20ºC for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(\text{hardness})]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic	Results exceed CCME Aquatic Life Guidelines

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Table 12. Water Quality Summary Statistics,Yukon River Watershed, 2011

Station	Conductivity (uS/cm)	pH	Total Suspended Solids	Total Hardness ($CaCO_3$)	Dissolved Sulphate	Ammonia as N	Total Aluminum	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Iron	Total Lead	Total Molybdenum	Total Nickel	Total Selenium	Total Zinc
CCME[1]		**6.5-9.0**				**0.137[a]**	**0.005-0.1[b]**	**0.005**	**0.000017[c]**	**0.001**	**0.002-0.004[d]**	**0.3**	**0.001-0.007[e]**	**0.073**	**0.025-0.15[f]**	**0.001**	**0.03**
W17 - Sunshine Creek																	
Min	193	7.9	0.5	90	30	0.006	0.017	0.00052	0.000014	0.00010	0.00093	0.0	0.00002	0.0004	0.0005	0.00002	0.0007
Median	274	7.9	0.5	128	41	0.021	0.022	0.00053	0.000021	0.00010	0.00144	0.0	0.00006	0.0004	0.0007	0.00009	0.0018
Max	350	8.1	4.0	159	66	0.059	*0.123*	0.00072	0.000032	0.00030	0.00184	0.2	0.00007	0.0004	0.0010	0.00011	0.0027
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W6b - Yukon River Upstream of Britannia Creek																	
Min	192	7.8	2.0	81.7	19	0.003	0.012	0.00025	0.000044	0.00005	0.00046	0.1	0.00003	0.0008	0.0009	0.00035	0.0022
Median	220.5	7.9	6.0	100	26	0.023	*0.120*	0.00052	*0.000071*	0.00020	0.00106	0.2	0.00013	0.0010	0.0022	0.00045	0.0051
Max	226	8.1	31.0	105	29	0.038	*0.192*	0.00069	*0.000117*	0.00040	0.00184	*0.4*	0.00041	0.0010	0.0025	0.00051	0.0083
n	4	4	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3
W6a - Yukon River Downstream of Britannia Creek																	
Min	174	7.6	4.0	79	18	0.003	0.035	0.00035	0.000030	0.0001	0.00058	0.1	0.00007	0.0009	0.0006	0.00027	0.0022
Median	201	7.9	4.0	84	25	0.019	*0.116*	0.00051	*0.000041*	0.00020	0.00116	0.2	0.00013	0.0010	0.0014	0.00029	0.0032
Max	257	8.0	24.0	101	34	0.023	*0.158*	0.0006	*0.000064*	0.00040	0.00143	0.3	0.00023	0.0011	0.0023	0.00046	0.0051
n	4	4	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3
W15 - Island on Yukon River us from Outflow of Excelsior Creek																	
Min	214	7.9	0.5	100	23	0.003	0.009	0.00020	0.000029	0.00005	0.00035	0.0	0.00001	0.0010	0.0004	0.00047	0.0015
Median	217	8.0	5.0	100	29	0.020	*0.116*	0.00049	*0.000064*	0.00020	0.00111	0.2	0.00011	0.0010	0.0024	0.00047	0.0053
Max	224	8.1	21.0	104	29	0.037	*0.173*	0.00067	*0.000079*	0.00030	0.00171	*0.3*	0.00035	0.0011	0.0024	0.00052	0.0077
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W23 - Excelsior Creek																	
Min	214	7.8	0.5	104	43	0.025	0.038	0.00070	0.000009	0.00010	0.00145	0.0	0.00001	0.0004	0.0006	0.00012	0.0004
Median	302	7.9	1.25	146	69	0.055	0.099	0.00082	0.000014	0.00025	0.00174	0.1	0.00002	0.0004	0.0007	0.00014	0.0006
Max	390	8.0	2.0	187	94	0.085	*0.159*	0.00094	0.000018	0.00040	0.00203	0.1	0.00004	0.0004	0.0008	0.00016	0.0007
n	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20ºC for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic	Results exceed CCME Aquatic Life Guidelines

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3.1.2 Exceedances of Water Quality Guidelines

Table 13 shows that CCME guidelines for protection of freshwater aquatic life were exceeded for pH, and six total metals: aluminum (Al), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), and zinc (Zn) in 2011. CCME guidelines were exceeded for at least one parameter at all sites. The number of exceedances was highest for cadmium, copper, aluminum, and least for silver (Figure 4). Exceedances of aluminum, cadmium, copper and iron often occurred together at the same sites. Casino Creek seem to contribute copper and cadmium as these exceedances were seen in Dip Creek downstream of Casino Creek but not upstream of Casino Creek. Exceedances were least numerous in March (n=17), June (n=18, the month with the least samples) and April (n=21), most numerous in August (n=63) and tapered off in October (n=33) indicating a seasonal trend related to hydrological factors such as snow melt and stream flow, which were highest in August .

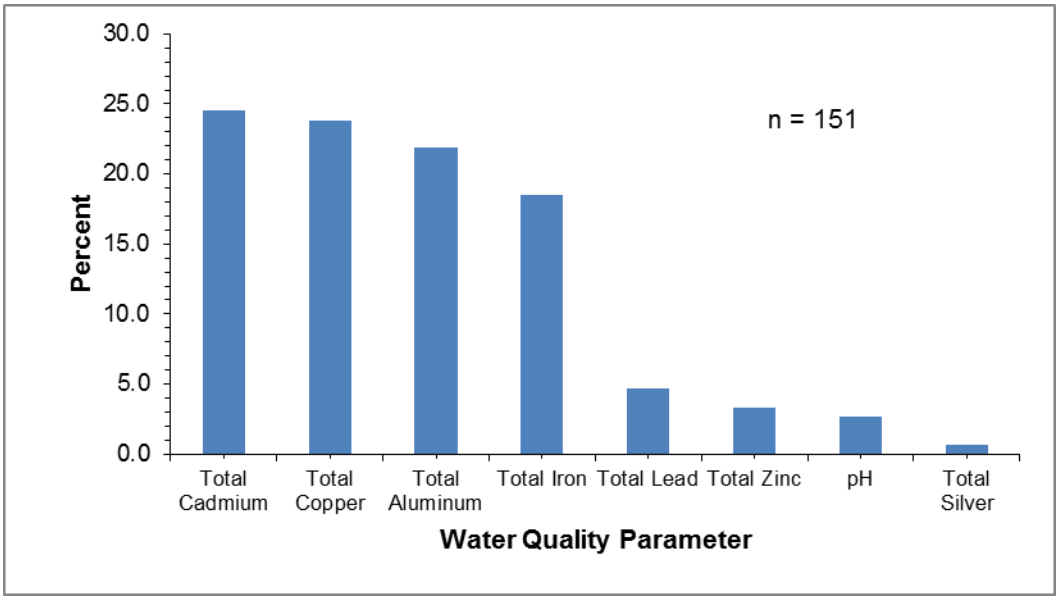
Table 13. Water Quality Parameters Exceeding CCME Guidelines, Casino Project, 2011

Site	March	April	June	August	October
R2	-	-	NS	NS	-
W1	-	-	NS	Cu	-
W2	-	-	NS	Cu	-
W3	-	-	NS	Cu	-
W4	-	Cu, Cd	NS	Al, Cu, Cd, Fe	Cu
W5	-	Cu	NS	Al, Cu, Cd,Fe	Cu
W6A	-	Cd	NS	Al, Cd	Al, Cd
W6B	-	Cd	NS	Al, Cd, Fe	Al, Cd
W7	Cd	pH, Al, Cu, Cd, Fe	NS	Cu, Cd	Cd
W8	Al, Cd, Cu	Al, Cu, Cd	NS	Al, Cu, Cd, Fe	Al, Cu, Cd, Fe
W9	-	-	NS	Al, Fe	-
W11	Cd, Cu	Cu, Cd	NS	Al, Cu, Pb, Cd, Fe	Al, Cd, Cu, Fe
W12	pH, Al, Cd, Cu, Fe, Zn	NS	NS	pH, Al, Cu, Zn, Cd, Fe	pH, Al, Cd, Cu, Zn, Fe
W13	Cd, Cu	NS	NS	Al, Cr, Cu, Pb, Cd, Fe	Al, Cd, Pb
W14	-	-	NS	Al	-
W15	NS	-	NS	Al, Cd, Fe	Al, Cd
W16	Fe	Al, Fe, Cd	Al, Cd, Cu, Fe	Al, Cu, Fe	Cu
W17	NS	-	NS	Al	-
W18	-	Cu, Cd	NS	Al, Cd, Fe	-
W19	-	NS	Al, Cd, Cr, Cu, Pb, Fe	Al, Cu, Fe	Fe
W20	Fe	-	NS	Al, Fe	-
W21	Fe	Fe	NS	Al, Cu, Fe	-

Site	March	April	June	August	October
W22	NS	NS	Al, Cd	-	-
W23	NS	NS	NS	Al, Cu	-
W24	NS	NS	NS	-	NS
W43	NS	NS	`	Cu, Pb, Zn, Cd	Ag, Cd, Cu, Pb, Zn

Note: Dashes indicate no parameters exceeded CCME Guidelines. NS = Not sampled.

Figure 4. Water Quality Exceedances of CCME Guidelines, Casino Project, 2011



Results from Environment Canada`s sample from W43 showed that the adit water was acutely lethal to Daphnia magna (48 hr - LT50[1] @ 100%):

- At 100% concentration, the 48 hour LT50 was > 1 hour but < 3.5 hours of exposure for Daphnia magna.
- At 100% concentration, the sample had 100% mortality to Daphnia magna after 3.5 hours of exposure.
- Control had no mortality, normal behavior.

3.2 Sediment Quality

Appendix B shows the sediment quality data. Table 14 shows the summary statistics and Table 15 shows the parameters that exceed the CCME sediment guidelines and includes the following four total metals: arsenic (As), cadmium (Cd), Copper (Cu) and zinc (Zn). The only site to exceed PEL was at W15.

[1] *Lethal Time for 50% of the organisms – the time for 50% of the organisms to die during a lethal exposure.*

Table 14. Sediment Quality Summary Statistics, Casino Project, 2011

Sediment Parameters	Detection Limits	CCME Sediment Quality Guidelines for the Protection of Aquatic Life[a]		W15				W16				W21				W24			
		ISQG[d]	PEL[c]	min	mean	max	count	min	mean	max	count	min	mean	max	count	min	mean	max	count
Physical Properties																			
Moisture (%)	0.3			31	36	41	2	15	18	20	4	18	22	24	4	34	50	75	4
pH	0.01			7.39	7.76	7.96	3	7.30	7.38	7.45	4	7.07	7.27	7.39	4	5.91	6.34	6.61	4
Total Metals																			
Aluminum	100			4680	8083	11500	3	7270	8400	9440	4	4720	5210	6150	4	5880	8460	12600	4
Antimony	0.1			0.50	1.1	1.6	3	0.40	0.48	0.60	4	0.20	0.20	0.20	4	1.4	2.2	3.1	4
Arsenic	0.5	5.9	17	4.4	*9.0*	*14.3*	3	*6.1*	*7.0*	*8.5*	4	4.5	4.75	5.1	4	***37.2***	***42.4***	***45.8***	4
Barium	0.1			262	407	558	3	110	115	121	4	59.4	64.7	69.6	4	88.3	142	231	4
Beryllium	0.4			0.4	0.5	0.6	2	-	-	-	0	-	-	-	0	0.5	0.6	0.8	3
Bismuth	0.1			0.2	0.2	0.2	1	0.1	0.1	0.1	1	0.1	0.1	0.1	1	0.2	0.3	0.6	4
Cadmium	0.05	0.6	3.5	*0.7*	*1.3*	*2.1*	3	0.13	0.14	0.16	4	0.050	0.065	0.080	2	0.29	0.45	*0.77*	4
Calcium	100			4980	10727	15600	3	2850	3133	3400	4	1910	2190	2690	4	2320	5620	13600	4
Chromium	1	37.3	90	13	22	31	3	10	12	15	4	11	13	17	4	12	17	24	4
Cobalt	0.3			5.3	9.1	13.1	3	6.8	7.1	7.5	4	4.6	5.0	5.8	4	6.7	7.6	8.9	4
Copper	0.5	35.7	197	13	27	*42*	3	10	11	11	4	5.9	6.3	7.1	4	16	19	24	4
Iron	100			13200	20367	27600	3	17800	20275	25100	4	12500	13800	16300	4	17200	18900	19800	4
Lead	0.1	35	91.3	4.40	9.50	15.9	3	6.70	7.40	8.10	4	2.90	3.13	3.50	4	11.1	12.9	16.2	4
Magnesium	100			3860	7010	9850	3	3230	3735	4110	4	2950	3378	4120	4	2040	3033	4920	4
Manganese	0.2			320	488	701	3	356	383	431	4	196	207	219	4	245	386	594	4
Mercury	0.05	0.17	0.486	0.060	0.090	0.12	2	-	-	-	0	-	-	-	0	0.050	0.070	0.100	3
Molybdenum	0.1			0.7	1	2	3	0.6	0.6	0.7	4	0.5	0.6	0.7	4	0.9	1.0	1	4
Nickel	0.8			21.7	38.1	55.9	3	8.2	9.0	9.9	4	10.4	11.5	13.4	4	12.7	14.8	17.8	4
Phosphorus	10			664	846	1040	3	467	506	556	4	445	494	569	4	452	562	786	4
Potassium	100			448	824	1230	3	826	939	1030	4	385	423	491	4	616	801	1120	4
Selenium	0.5			0.8	1.25	1.7	2	0.7	0.7	0.7	1	-	-	-	0	0.8	1.4	2.4	3
Silver	0.05			0.08	0.18	0.3	3	-	-	-	0	-	-	-	0	0.08	0.14	0.27	4
Sodium	100			131	162	193	2	153	174	193	4	141	149	163	4	120	148	175	2
Strontium	0.1			29.1	51.8	73.4	3	19.7	21.1	22.6	4	13.1	15.0	17.7	4	10.2	23.1	51.6	4
Thallium	0.05			0.05	0.12	0.18	3	0.1	0.1	0.12	4	-	-	-	0	0.19	0.3	0.3	4
Tin	0.1			0.50	1	2	3	0.4	0.5	0.5	4	0.3	0.3	0.3	4	0.5	0.8	1.3	4
Titanium	1			218	293	387	3	520	587	650	4	282	320	404	4	260	379	550	4
Vanadium	2			24	37	52	3	35	44	64	4	23	28	36	4	32	36	44	4
Zinc	1	123	315	70	*145*	*212*	3	45	52	57	4	32	34	36	4	60	67	73	4
Zirconium	0.5			1.3	1.7	2.1	3	1.1	1.2	1.3	4	1.8	1.9	2.0	4	0.80	1.7	3.4	3

Notes

All units mg/kg unless otherwise noted

a) Canadian sediment quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2002.

b) ISQG: Interim Freshwater Sediment Quality Guidelines

c) PEL: Probable Effects Levels

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Table 15. Sediment Quality Parameters Exceeding CCME Guidelines, Casino Project, 2011

Site	ISQG only	ISQG and PEL
W15	Cd, Cu, Zn	As
W16	As	-
W21	-	-
W24	As, Cd	-

Note: Dashes indicate sample did not exceed CCME Guidelines.

3.3 Periphyton

Appendix C shows the densities (cells/cm^2) by taxa for each of the 40 samples of periphyton collected from the five sampling sites in August 2011.

Figure 8 shows the mean densities of periphyton for each site. One-way ANOVA of the data transformed using natural logarithmic values showed there were significant differences in mean density among sites ($F_{4,20}$ = 10.663, P=0.000086). Post-hoc comparisons of means using the Bonferroni test showed that mean density at site P14 in Dip Creek was significantly higher than the other sites.

Figure 5. Mean Density of Periphyton by Site, Casino Project, 2011

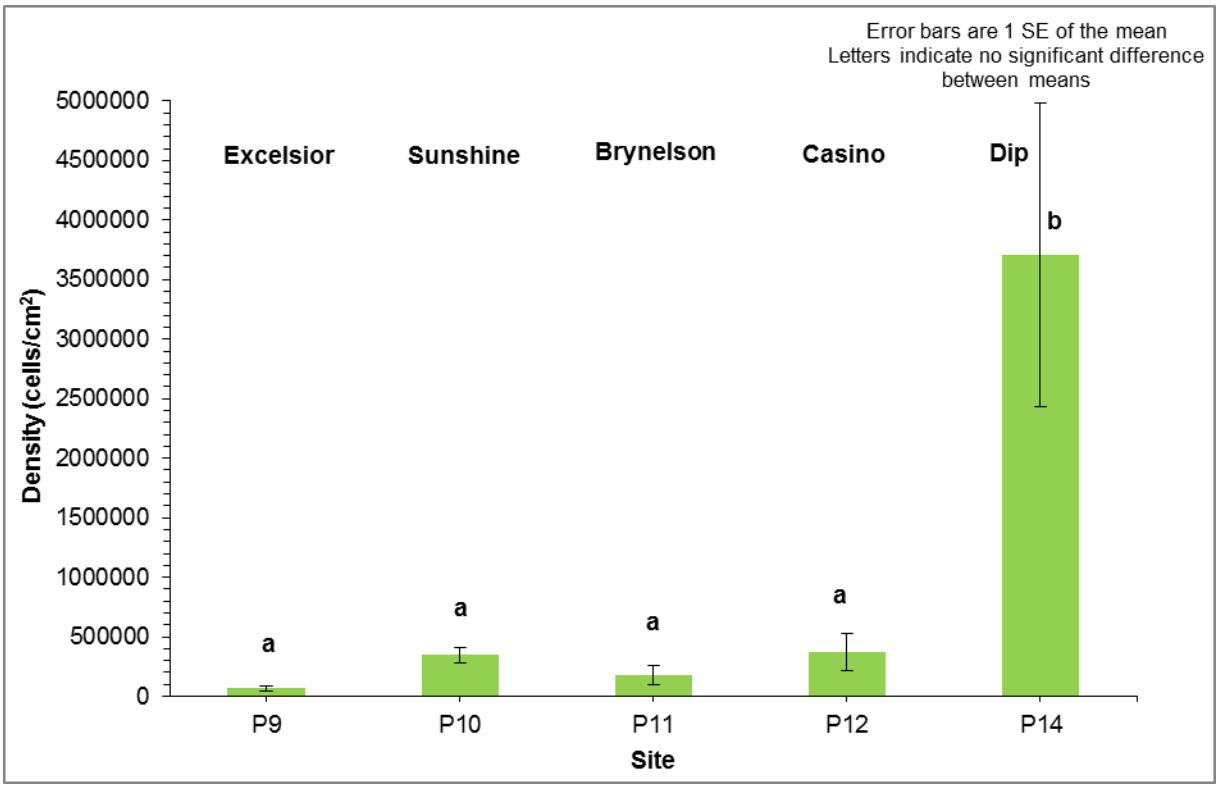


Table 16 shows the percentage composition of the periphyton community at each sampling site

Excelsior Creek (P9) was dominated by diatoms and golden algae, whereas the rest of the sites were dominated by blue-green algae.

Table 16. Percentage Composition of Periphyton Communities, Casino Project, 2011

Sample Site	P9	P10	P11	P12	P14
Diatoms (Bacillariophycae)	32.3	3.86	3.11	1.89	10.1
Green Algae (Chlorophyta)	0.00	0.00	0.00	0.08	0.00
Golden Algae (Chrysophyta)	58.8	0.10	0.52	6.57	0.170
Blue-Green Algae (Cyanophyta)	8.30	95.7	96.1	91.4	81.5
Red Algae (Rhodophyta)	0.677	0.329	0.306	0.041	8.26

Figure 9 and Figure 10 show the mean taxonomic richness and Shannon-Wiener diversity index by site. There were highly significant differences among sites in taxonomic richness ($F_{4,20}$ = 7.33, P<0.001), as well as moderate significant differences among sites in diversity ($F_{4,20}$ = 6.69, P=0.0014). Post-hoc tests using Bonferroni test for richness showed that mean richness at sites P14 in Dip Creek was significantly higher than the richness at all other sites except P9 in Excelsior Creek. Post-hoc comparisons of means using the Bonferroni tests showed that mean diversity at site P9 was significantly higher that the diversities at all other sites except for P14.

Figure 6. Mean Taxonomic Richness of Periphyton Communities, Casino Project, 2011

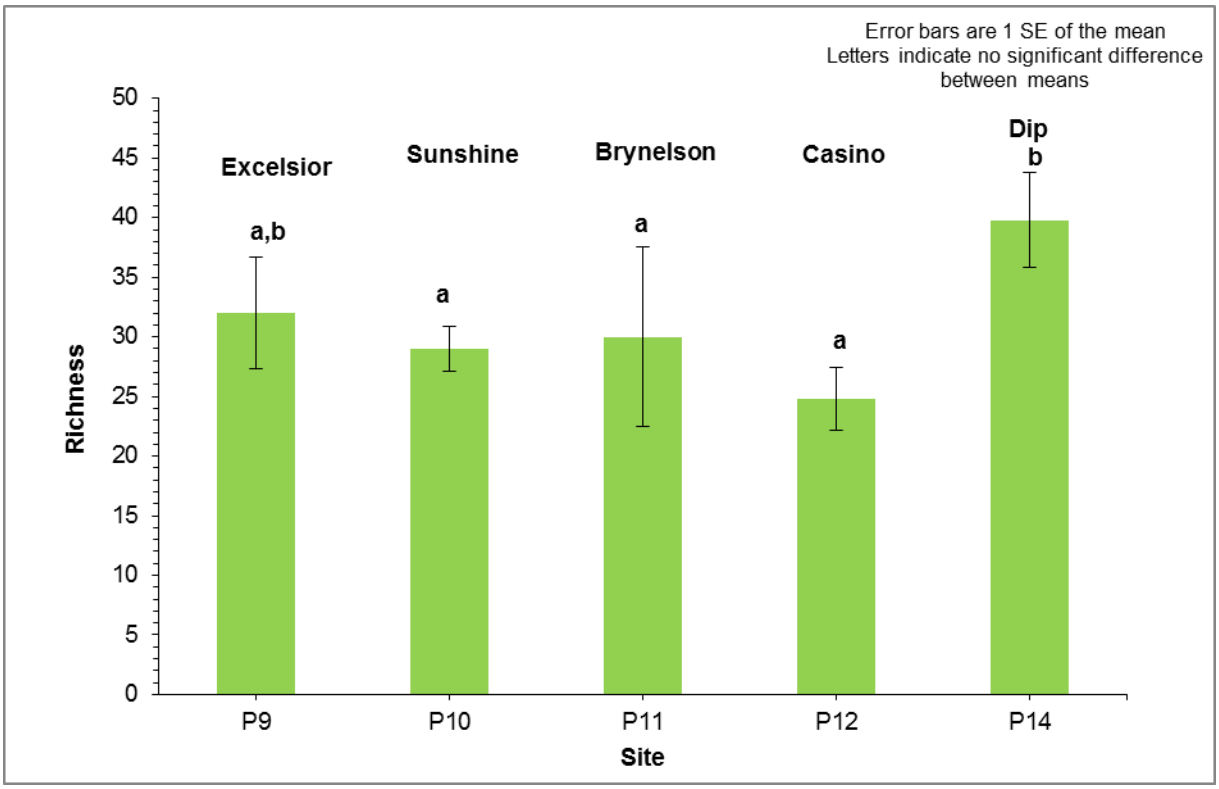
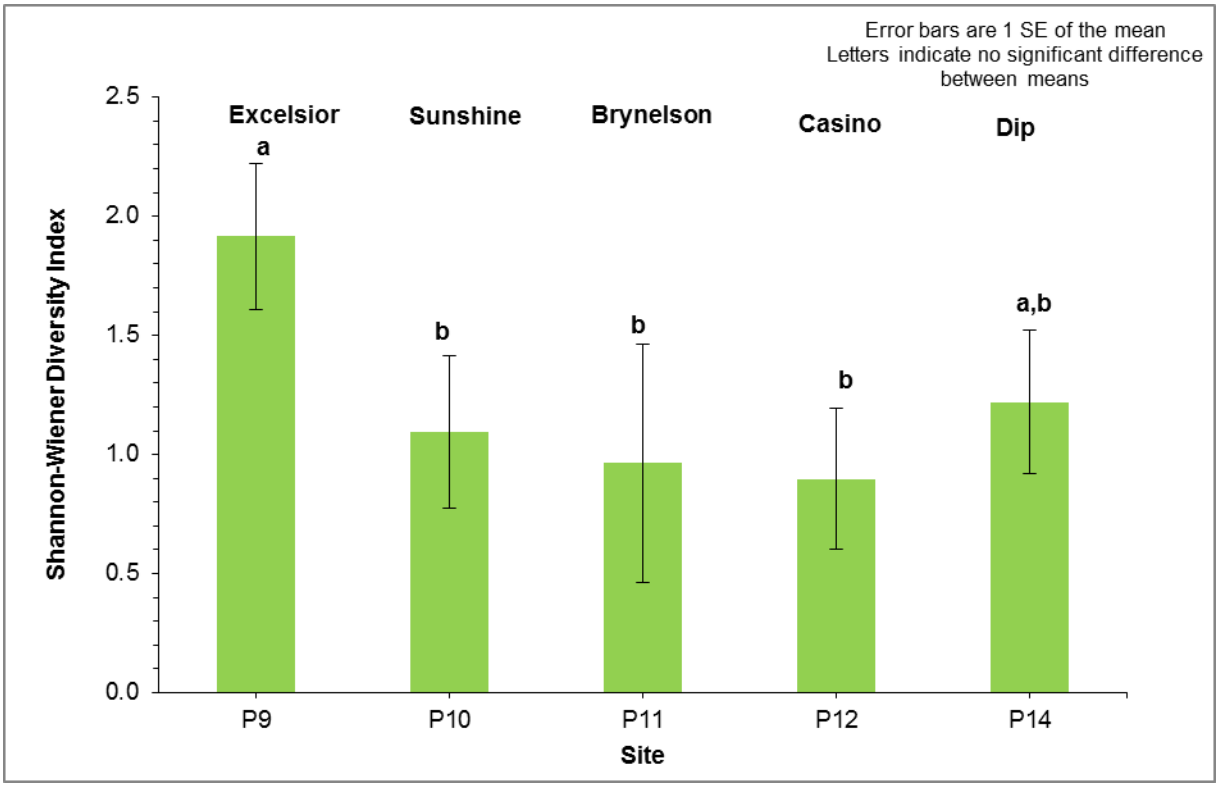


Figure 7. Mean Shannon-Wiener Diversity Index of Periphyton Communities, Casino Project, 2011



3.4 Benthic Invertebrates

Appendix D shows the number of organisms counted and identified to taxa in each of the 30 samples of benthos collected from the eight sampling sites in August 2011.

Figure 8 shows the mean density of benthic invertebrates by site. One-way ANOVA of the ln-transformed densities showed there were highly significant differences in mean density among sites sampled with a kick net ($F_{5,23}$ = 10.587, P<0.001). Post-hoc comparisons of means using the Bonferroni test showed that mean density at site B9 was significantly higher than the densities at all other sites except at B10 (densities are not significantly different).

Table 17 shows the percentage composition of the benthic invertebrate community at each sampling site. Dipterans dominated the communities at all sites except for sites B5 and B8 where Ephemeropterans dominated. Over 95% of the organisms at each site belonged to six taxa: the insect Orders of Diptera, Plecoptera, Ephemeroptera, Trichoptera, plus the mite of Superorder Acariformes and the worm of Phylum Annelida.

Figure 8. Mean Density of Benthic Invertebrates by Site, Casino Project, 2011

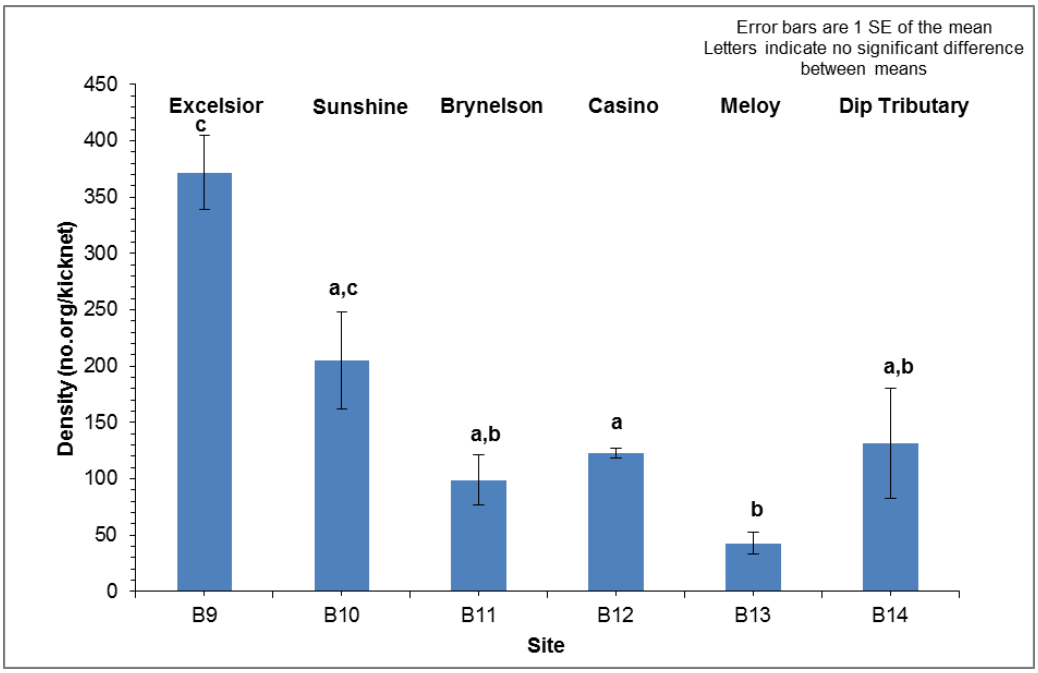


Table 17. Percentage Composition of Benthic Invertebrate Communities, Casino Project, 2011

Taxon	Percent of Total Number of Organisms					
	Excelsior	Sunshine	Brynelson	Casino	Meloy	Dip
	B9	**B10**	**B11**	**B12**	**B13**	**B14**
Order: Ephemeroptera	62.5	49.1	34.4	9.8	8.8	12.7
Order: Plecoptera	9.4	2.4	14.8	8.6	3.5	1.8
Order: Trichoptera	1.1	1.2	3.0	2.0	0.0	0.3
Order: Coleoptera	0.0	0.2	0.0	0.2	0.6	0.2
Order: Diptera	25.9	43.7	36.0	74.6	59.1	75.0
Order: Lepidoptera	0.1	0.1	0.6	0.5	2.3	4.6
Order: Collembola	0.1	0.0	0.0	0.0	0.0	0.0
Class: Copepoda	0.0	0.1	0.0	0.0	0.0	0.0
Order: Amphipoda	0.1	0.0	0.0	0.0	0.0	0.2
Order: Trombidiformes	0.2	0.0	0.4	0.0	0.0	0.0
Order: Oribatei	0.1	0.1	0.4	0.3	4.7	0.5
Order: Heterostropha	0.1	0.1	0.0	0.0	0.0	0.0
Order: Hypsogastropoda	0.1	0.1	0.2	0.0	1.2	0.0
Phylum: Annelida	0.1	2.2	4.5	3.9	9.4	3.4
Order: Tubificida	0.0	0.1	5.1	0.0	3.5	0.3
Phylum: Nemata	0.2	0.6	0.6	0.2	4.7	0.9
Phylum: Platyhelminthes	0.0	0.0	0.0	0.0	2.3	0.3
Phylum: Tardigrada	0.1	0.0	0.0	0.0	0.0	0.0

Figure 9, Figure 10 and Figure 11 show the mean taxonomic richness, total EPT abundance and Shannon – Weiner index of diversity, respectively, by site. There were medium significant differences among sites in richness ($F_{5,23}$ = 5.1341, P = 0.003) and highly significant differences in total EPT ($F_{5,23}$ = 43.7556, P<0.001) and in Shannon-Wiener diversity index ($F_{5,23}$ = 23.801, P<0.001). Post-hoc tests using the Bonferroni test showed that site B13 on Meloy Creek was significantly different than B9, B10 on the

Yukon River watershed and B11 on Brynelson. The main cause for variation in total EPT was high total EPT at site B9 on Excelsior compared to all the other sites. Post-hoc tests using the Bonferroni test showed that the main cause for variation in Shannon-Wiener diversity index was lower diversity for site B12 on Casino compared to all other sites.

Figure 9. Mean Taxonomic Richness of Benthic Invertebrate Communities, Casino Project, 2011

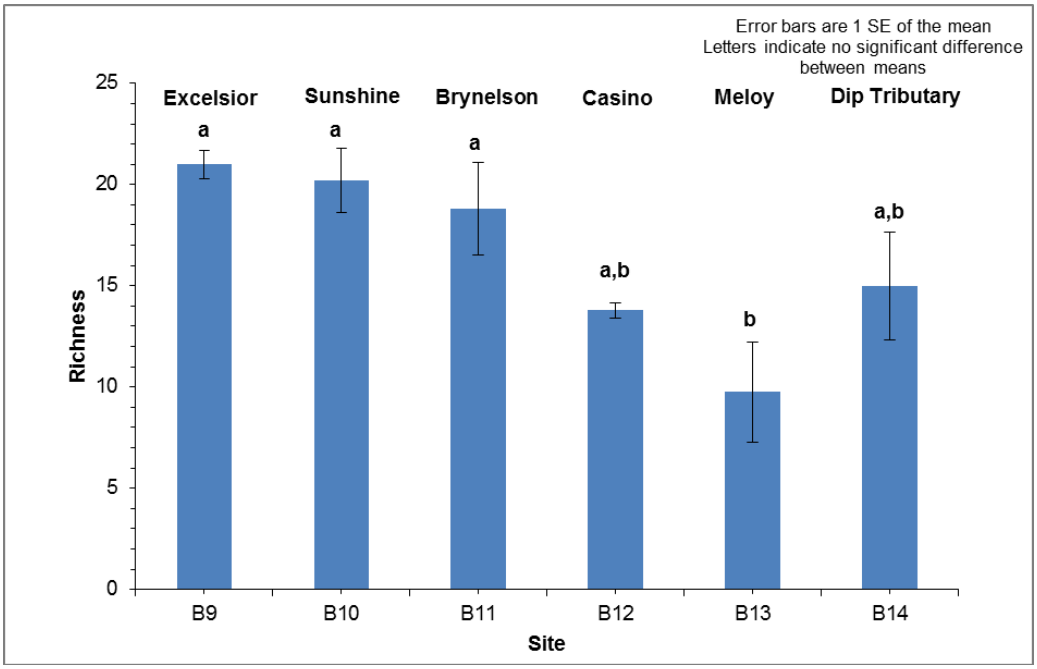


Figure 10. Mean Total EPT of Benthic Invertebrate Communities, Casino Project, 2011

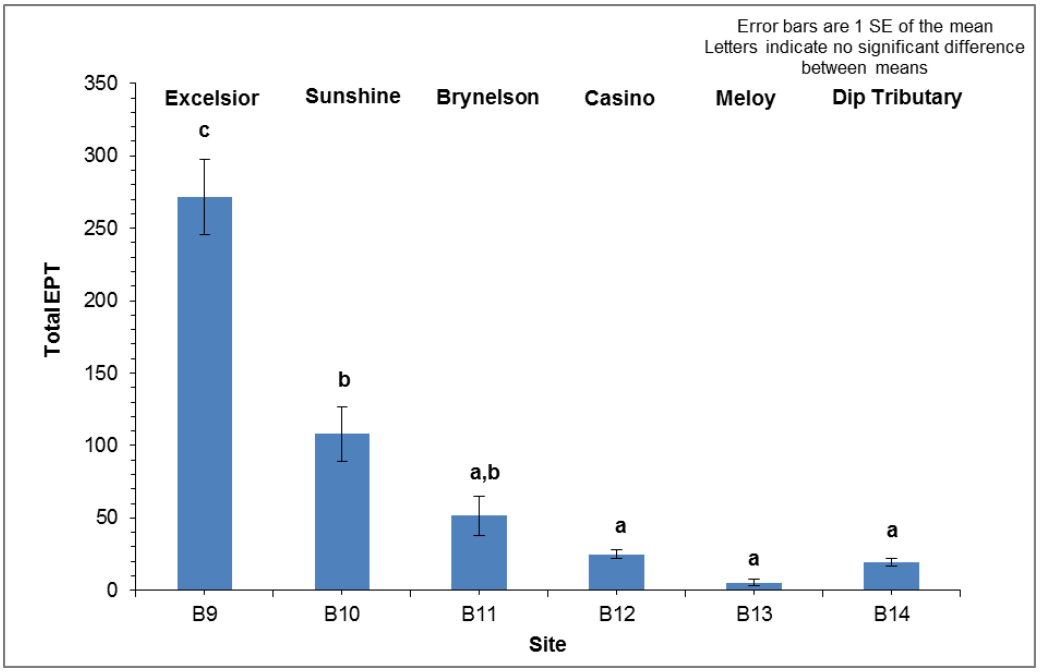
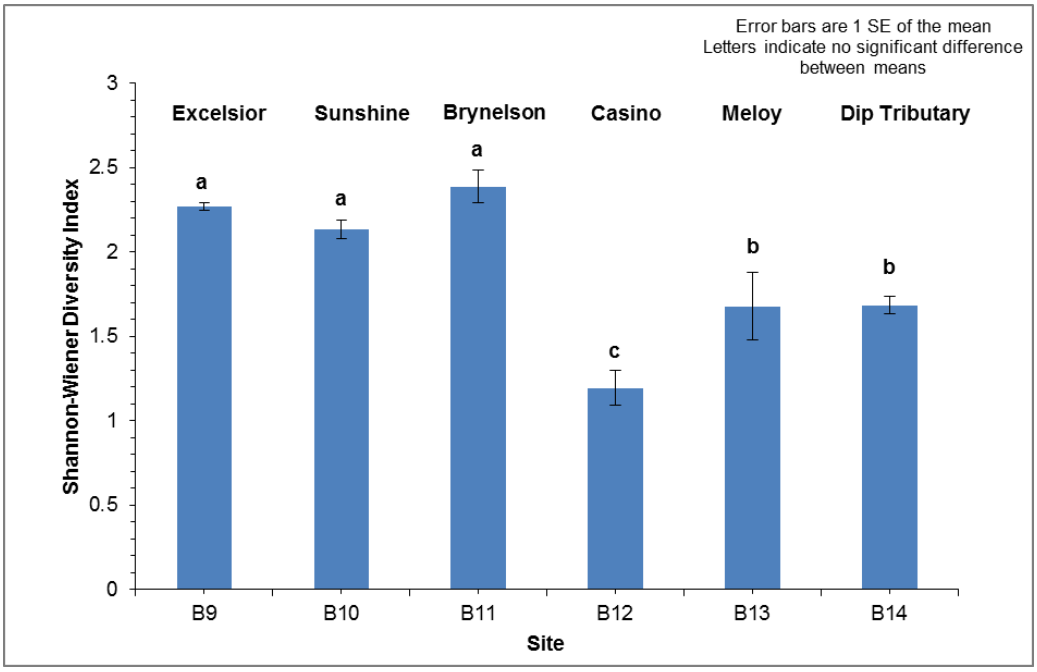


Figure 11. Mean Shannon-Weiner Index of Diversity of Benthic Invertebrate Communities, Casino Project, 2011



3.5 Periphyton and Benthic Invertebrate Summary

In 2011, the periphyton and benthic invertebrate programs were intended to collect additional data for the overall baseline characterization of the Casino aquatic study area. These sites were not meant to be compared to each other but to contribute to the overall picture. Some similarities were observed. For example, periphyton indices were comparable between Sunshine, Brynelson and Casino creeks. Dip/Excelsior exhibited higher density, richness and diversity. Also, the composition of major algae groups in Excelsior was different than the rest of the sites. With benthic invertebrates, Excelsior Creek also showed high values in all the indices measured.

3.6 Fish Assessment

Appendix E1 shows the fish catch, effort and CPUE for electrofishing. A total of 45 fish from three species were captured from the Project LSA in August and September of 2011 (Table 18). The three species were Arctic grayling (*Thymallus arcticus*), slimy sculpin (*Cottus cognatus*), and chinook salmon (*Oncorhynchus tshawytscha*).

Table 18. Fish Catch, Casino Project, 2011

Site	Creek	Arctic Grayling	Slimy Sculpin	Chinook Salmon[1]	Total
F15	Britannia	1	12	10	23
F08	Casino	3	-	-	3
F16	Casino	-	-	-	-
F13	Casino	-	10	-	10
F09	Meloy	-	-	-	-
F17	Dip	-	-	-	-
R2	Victor	-	9	-	9
Totals		4	31	10	45

Note: [1] All fish were age 0+, based on the assessment by Bradford *et al.* (2008)

A total of seven sites were electrofished; three of the sites, F15, F17 and F09 were new in 2011. Of the sites sampled, three were fished using three-passes and five were fished using a single pass (F08 was sampled in both August and September, using a single pass in August and a three-pass during the September visit). Effort ranged from 314 to 1132 seconds with a mean of 813 seconds.

Of the three three-pass surveys (F08, F16, F17), one survey (F08) showed a decrease in catch of fish with successive passes. No fish were caught in any of the three passes at the other two sites. A decrease in the number of fish caught per pass (depletion) is required to estimate total fish number using standardized abundance estimation methods (e.g., Peterson *et al*. 2004). The low number of three-pass surveys meant that total fish number was not estimated using the three-pass algorithm. Instead, the CPUE of each survey was used as an index of population abundance.

Chinook salmon were captured at only one site (F15), which further reinforces previous sampling studies (AECOM, 2009; PECG, 2011) that this species is not widely distributed within the study area.

Aging was completed on seven fish: five slimy sculpin in Britannia Creek (F15) and two Arctic grayling in Casino Creek (F08). Slimy sculpin ages ranged from 1+ to 3+ and Arctic grayling ages were 4+ and 11+.

3.6.1.1 Tissue Metals Concentrations

Appendix E3 shows the concentrations of metals measured in whole-body samples of slimy sculpin collected from Casino, Britannia and the reference (Victor Creek) watersheds in August and September of 2011. Of the 30 metals, three (beryllium, bismuth and silver) were excluded from analysis because all values were below detection limits. For the remaining twenty-seven metals, all values below detection

limits were replaced by one-half the detection limit to allow for statistical analysis. Table 20 shows the mean, standard error (SE), minimum and maximum values of metals concentrations.

None of the slimy sculpins had mercury concentrations that exceeded the 0.5 mg/kg guideline established by Health Canada (http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/mercur/q12-q17-eng.php#q-15).

Table 19. Mean Whole-Body Metal Concentrations, slimy sculpin, Casino Project, 2011

Total Metal	Britannia Creek (F15)					Victor Creek (R2)					Casino Creek (F13)				
	Mean	Min	Max	SE	n	Mean	Min	Max	SE	n	Mean	Min	Max	SE	n
Aluminum (Al)	43.6	13.9	76.9	8.79	6	9.90	0.90	15.6	3.23	4	16.0	5.20	25.4	1.96	10
Antimony (Sb)	0.01	0.002	0.02	0.002	6	0.001	0.000	0.002	0.000	4	0.002	0.002	0.004	0.0002	10
Arsenic (As)	0.197	0.050	0.360	0.043	6	0.060	0.040	0.080	0.009	4	0.105	0.080	0.130	0.005	10
Barium (Ba)	4.11	1.29	6.14	0.72	6	3.58	2.70	4.48	0.37	4	3.49	2.34	4.62	0.26	10
Boron (B)	1.42	1.10	1.90	0.12	6	1.10	0.80	1.90	0.27	4	0.41	0.20	0.70	0.06	10
Cadmium (Cd)	0.203	0.028	0.485	0.064	6	0.019	0.014	0.026	0.003	4	0.089	0.052	0.127	0.008	10
Calcium (Ca)	10035	3620	16200	1689	6	10358	6930	12000	1161	4	1093	9160	12700	401	10
Chromium (Cr)	0.130	0.040	0.220	0.029	6	0.020	0.020	0.020	0.000	4	0.051	0.020	0.100	0.009	10
Cobalt (Co)	0.079	0.037	0.161	0.019	6	0.022	0.013	0.028	0.003	4	0.077	0.049	0.106	0.005	10
Copper (Cu)	1.23	0.75	1.91	0.16	6	1.02	0.82	1.29	0.10	4	1.79	1.48	2.07	0.07	10
Iron (Fe)	104.8	40.0	194.0	21.9	6	30.3	14.0	41.0	5.9	4	39.6	21.0	58.0	3.7	10
Lead (Pb)	0.169	0.028	0.281	0.035	6	0.061	0.021	0.088	0.015	4	0.197	0.118	0.296	0.016	10
Magnesium (Mg)	355	280	423	22.2	6	336	317	382	15.4	4	350	311	382	8.30	10
Manganese (Mn)	9.94	1.20	17.00	2.28	6	5.91	4.82	7.92	0.72	4	8.57	6.20	11.10	0.44	10
Mercury (Hg)	0.042	0.021	0.054	0.005	6	0.073	0.048	0.102	0.012	4	0.053	0.032	0.087	0.006	10
Molybdenum (Mo)	0.04	0.02	0.07	0.01	6	0.02	0.02	0.03	0.00	4	0.03	0.01	0.03	0.00	10
Nickel (Ni)	0.163	0.030	0.240	0.032	6	0.030	0.020	0.040	0.004	4	0.048	0.020	0.080	0.006	10
Phosphorus (P)	7035	3470	9870	879	6	7218	5440	8120	603	4	7905	6780	8950	235	10
Potassium (K)	2130	1870	2590	121	6	2643	2330	2910	150	4	2537	2150	2860	63	10
Selenium (Se)	1.25	0.59	1.70	0.16	6	1.38	0.58	1.92	0.32	4	0.81	0.54	1.16	0.06	10
Sodium (Na)	765	275	1110	121	6	1125	1030	1350	76	4	1059	841	1310	51	10
Strontium (Sr)	15.1	5.3	24.0	2.5	6	22.8	13.8	26.6	3.0	4	20.5	15.0	26.0	1.0	10
Thallium (Tl)	0.005	0.004	0.006	0.0003	6	0.007	0.006	0.007	0.000	4	0.008	0.006	0.01	0.0004	10
Tin (Sn)	0.027	0.010	0.040	0.005	6	0.043	0.010	0.060	0.012	4	0.075	0.010	0.260	0.028	10
Titanium (Ti)	3.03	1.50	5.00	0.51	6	1.15	0.40	1.90	0.32	4	1.15	0.60	1.80	0.11	10
Uranium (U)	0.050	0.020	0.073	0.009	6	0.073	0.064	0.079	0.003	4	0.061	0.031	0.116	0.008	10
Vanadium (V)	0.30	0.06	0.52	0.07	6	0.19	0.08	0.28	0.04	4	0.22	0.18	0.30	0.01	10
Zinc (Zn)	28.2	21.4	42.3	3.2	6	26.6	22.3	35.7	3.1	4	27.3	21.9	33.3	1.2	10

SE = Standard Error, Min = Minimum, Max = Maximum

3.6.1.2 Fish Habitat Assessment

In August 2011, a 400m fisheries assessment was conducted at F08 (Figure 3) to determine the extent of upstream fish migration. At the upstream extent of F08 (UTM: 0613048/6954518) a barrier to upstream fish migration was identified. At this point the creek falls approximately 1.9m over a distance of 18.7m (an

inferred gradient of 10.2%). The measurement was verified using a Sunnto field clinomter and showed a measurement of 8%. Following this section of the creek, there is a sustained series of rapids with gradients varying from 5 to 7% (>400m distance). The combination of a single steep gradient section, followed by a long run of moderate gradient sections lacking identifiable resting pools likely represents a barrier to movement for most fish. Electrofishing was conducted at selective locations (i.e. undercut banks, resting areas) for approximately 400m (360sec of effort) upstream of the barrier and no fish were captured.

Following this assessment, three reach breaks for Casino Creek were identified:

- Reach 1: the lower reach starts at the mouth of Casino Creek and ends where Brynelson Creek joins Casino Creek
- Reach 2: the middle reach starts at Brynelson Creek, continues through to the proposed location of the Tailings dam and ends at the fish barrier (cascades) on Casino Creek
- Reach 3: the upper reach is Casino Creek above the fish barrier.

4 Summary

In 2011, field studies of the Casino aquatic study area focused on the continuation of the seasonal water quality sampling. Additional sampling of the sediment was completed to fill in gaps. In 2011, the periphyton and benthic invertebrate programs were intended to collect additional data for the overall baseline characterization of the Casino aquatic study area. Fish assessments focused on determining key questions on the extent of fish distribution.

Analyses of the water quality showed results similar to previous studies (AECOM 2009, PECG 2011).-CCME guidelines were regularly exceeded for copper, aluminum, iron, cadmium and ammonia at various sample locations.

Sediment samples from the Dip Creek and Casino Creek showed arsenic levels that exceeded CCME guidelines. Excelsior Creek exceeded three CCME guidelines and PEL for arsenic.

The periphyton and benthic invertebrate programs were intended to collect additional data for the overall baseline characterization of the Casino aquatic study area. Some similarities were observed. For example, periphyton indices were comparable between Sunshine, Brynelson and Casino creeks. Dip/Excelsior exhibited higher density, richness and diversity. Also, the composition of major algae groups in Excelsior was different than the rest of the sites. With benthic invertebrates, Excelsior Creek also showed high values in all the indices measured.

Fish assessments were focused on determining the presence/absence of fish in Casino Creek and Britannia Creek and documenting baseline metals concentrations in fish tissue.

5 References

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Appendix A – Surface Water Quality and Replicate Data

- **A1. Surface Water Quality Data, Casino Project, March 2011**
- **A1. Surface Water Quality Data, Casino Project, April 2011**
- **A1. Surface Water Quality Data, Casino Project, June 2011**
- **A1. Surface Water Quality Data, Casino Project, August 2011**
- **A1. Surface Water Quality Data, Casino Project, October 2011**
- **A2. Surface Water Quality Replicate Data, Casino Project, April 2011**
- **A2. Surface Water Quality Replicate Data, Casino Project, August 2011**
- **A2. Surface Water Quality Replicate Data, Casino Project, October 2011**

Appendix A1. Surface Water Quality Data, Casino Project, March 2011

Station	Detection Limits	Water Quality Guidelines	R2 - Victor Creek	W1 - Mouth of Canadian Creek	W2 - Britannia Creek D/S of Canadian Creek	W3 - Canadian Creek U/S of Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek D/S Casino	W6a - Yukon River Downstream of Britannia Creek	W6b - Yukon River Upstream of Britannia Creek	W7 - Upper Canadian Creek	W8 - Upper Casino Creek	W9 - Dip Creek U/S of Casino Creek	W11 - Casino Creek (proposed dam)	W12 - Proctor Gulch	W13 - Meloy Creek	W14 - Mouth of Britannia Creek	W16 - Lower Reach of Dip Creek*	W18 - Brynelsen Creek	W20 - Klotassin River U/S of Dip Creek	W21 - Klotassin River D/S of Dip Creek	Trip Blank
Date		**CCME[1]**	**30-Mar-11**	**1-Apr-11**	**31-Mar-11**	**31-Mar-11**	**30-Mar-11**	**29-Mar-11**	**1-Apr-11**	**1-Apr-11**	**31-Mar-11**	**30-Mar-11**	**30-Mar-11**	**29-Mar-11**	**30-Mar-11**	**29-Mar-11**	**31-Mar-11**	**29-Mar-11**	**31-Mar-11**	**29-Mar-11**	**29-Mar-11**	**29-Mar-11**
Physical Properties																						
Conductivity (uS/cm)	1		202	492	413	393	358	281	257	223	170	350	243	412	1040	444	585	282.5	241	178	185	1
pH		6.5-9.0	7.38	7.50	7.71	7.68	7.62	7.51	7.60	7.75	6.88	7.35	7.39	7.73	4.00	7.64	7.45	7.405	7.64	7.25	7.31	5.58
Total Suspended Solids	1		<1	1	<1	<1	<1	<1	-	-	2	2	<1	<1	34	<1	13	2	<1	<1	1	<1
Total Dissolved Solids	10		100	310	260	240	220	160	140	110	110	210	120	220	820	260	370	155	140	90	92	<10
Turbidity	0.1		0.1	0.3	0.2	0.2	0.2	0.2	1.3	0.3	0.5	2.0	0.2	0.6	17.2	0.4	0.2	0.75	0.2	1.2	1.8	0.1
Calculated Parameters																						
Total Hardness	0.5		92.0	241	185	184	169	134	-	-	60.6	156	113	194	442	214	291	133.5	115	78.4	81.9	<0.5
Ion Balance	0.01		1.0	1.0	1.0	1.0	1.0	1.1	-	-	1.1	1.0	1.0	1.0	1.1	1.0	1.0	1.1	1.1	1.0	1.1	7.4
Nitrate	0.002		0.336	0.470	0.402	0.400	0.264	0.300	0.168	0.088	<0.002	0.165	0.317	0.281	0.105	0.224	0.314	0.2725	0.320	0.142	0.121	<0.002
Dissolved Anions & Nutrients																						
Orthophosphate	0.001		<0.001	0.002	0.002	0.001	0.001	0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	0.001	0.001	<0.001	<0.001	0.001	0.002	<0.001
Dissolved Sulphate	0.5		21	120	96	90	61	29	34	23	51	100	19	89	520	110	130	29.5	29	19	18	<0.5
Dissolved Chloride	0.5		0.6	0.8	0.6	<0.5	0.6	0.9	0.7	<0.5	0.5	0.6	0.7	0.9	0.8	0.8	1.0	0.85	0.7	1.0	0.9	<0.5
Ammonia	0.005	0.137[a]	<0.005	0.007	<0.005	0.007	0.007	<0.005	-	-	0.008	0.006	<0.005	0.007	0.007	0.006	0.006	0.009	0.008	0.017	0.021	<0.005
Total Kjeldahl Nitrogen	0.02		0.07	0.09	0.08	0.08	0.11	0.06	0.02	0.06	0.07	0.08	0.16	0.06	0.09	0.08	0.09	0.095	0.03	0.12	0.15	0.03
Nitrate plus Nitrite	0.002	2.9	0.336	0.470	0.402	0.400	0.264	0.3	0.168	0.088	<0.002	0.165	0.317	0.281	0.105	0.224	0.314	0.2725	0.320	0.145	0.121	<0.002
Nitrite	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002
Total Nitrogen	0.02		0.41	0.56	0.48	0.48	0.37	0.36	0.19	0.15	0.07	0.24	0.47	0.34	0.19	0.30	0.41	0.37	0.35	0.26	0.27	0.03
Total Metals																						
Aluminum	0.0002	0.005-0.1[b]	0.0094	0.0276	0.0078	0.0073	0.0155	0.0105	-	-	0.0195	0.486	0.0100	0.0589	18.5	0.0975	0.0131	0.01935	0.0098	0.0081	0.0074	0.0010
Antimony	0.00002		0.00003	0.00022	0.00023	0.00025	0.00013	0.00008	-	-	0.00006	0.00007	0.00006	0.00012	0.00017	0.00010	0.00019	0.00008	0.00015	0.00003	0.00003	<0.00002
Arsenic	0.00002	0.005	0.00010	0.00038	0.00041	0.00041	0.00041	0.00026	-	-	0.00018	0.00025	0.00019	0.00093	0.00094	0.00047	0.00049	0.000425	0.00033	0.00067	0.00065	<0.00002
Barium	0.00002		0.0636	0.101	0.0797	0.0796	0.0904	0.0821	-	-	0.0652	0.0702	0.0762	0.0839	0.0102	0.0779	0.121	0.08415	0.0612	0.0496	0.0551	0.00006
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	<0.00001	0.00002	<0.00001	<0.00001	0.00088	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	-	-	<0.000005	<0.000005	<0.000005	<0.000005	0.000007	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000005	0.000026	0.000024	0.000021	0.000025	0.000015	-	-	0.000318	0.000306	0.000012	0.000108	0.00398	0.000120	0.000030	0.0000095	<0.000005	0.000014	0.000005	<0.000005
Chromium	0.0001	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	0.0004	<0.0001	<0.0001		<0.0001	<0.0001	0.0001	<0.0001
Cobalt	0.000005		0.000019	0.000056	0.000029	0.000023	0.000024	0.000043	-	-	0.000024	0.00231	0.000038	0.000136	0.0472	0.000302	0.000024	0.0001105	0.000016	0.000152	0.000194	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00045	0.00135	0.00125	0.00137	0.00149	0.00078	-	-	0.00093	0.0460	0.00049	0.00457	1.14	0.00918	0.00103	0.00085	0.00038	0.00072	0.00066	<0.00005
Iron	0.001	0.3	0.008	0.036	0.007	0.007	0.011	0.053	-	-	0.010	0.076	0.037	0.032	6.48	0.038	0.008	0.1885	0.007	0.536	0.577	0.001
Lead	0.000005	0.001-0.007[e]	0.000007	0.000045	0.000007	0.000010	0.000105	0.000031	-	-	0.000039	0.000176	0.000015	0.00169	0.00213	0.000025	0.000015	0.000042	<0.000005	0.000011	0.000011	0.000008
Lithium	0.0005		0.0008	0.0005	0.0010	0.0007	0.0016	0.0020	-	-	0.0012	0.0012	0.0029	0.0023	0.0065	0.0027	0.0025	0.0013	0.0008	<0.0005	<0.0005	<0.0005
Manganese	0.00005		0.00376	0.00199	0.00217	0.00096	0.0118	0.0251	-	-	0.00155	0.0881	0.0252	0.0685	1.42	0.0608	0.00045	0.0533	0.00307	0.0972	0.129	0.00009
Molybdenum	0.00005	0.073	0.00072	0.00095	0.00118	0.00106	0.00129	0.00080	-	-	0.00039	0.00031	0.00059	0.00094	0.00024	0.00053	0.00127	0.000845	0.00171	0.00043	0.00048	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00024	0.00054	0.00049	0.00050	0.00018	0.00020	-	-	0.00090	0.00075	0.00022	0.00031	0.00815	0.00041	0.00053	0.000395	0.00013	0.00043	0.00047	0.00003
Selenium	0.00004	0.001	0.00007	0.00017	0.00015	0.00011	0.00011	0.00005	-	-	0.00015	0.00005	<0.00004	0.00022	0.00027	0.00028	0.00045	0.00006	0.00004	0.00016	0.00014	<0.00004
Silicon	0.1		5.0	4.8	4.5	4.9	5.8	5.9	-	-	11.2	6.5	5.2	5.5	13.0	5.9	5.4	5.55	5.8	4.8	5.1	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	-	-	<0.000005	<0.000005	<0.000005	<0.000005	0.000045	0.000014	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Strontium	0.00005		0.189	0.367	0.326	0.308	0.289	0.255	-	-	0.141	0.345	0.252	0.346	0.416	0.380	0.531	0.2365	0.154	0.161	0.163	0.00015
Thallium	0.000002	0.0008	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	-	-	<0.000002	0.000004	<0.000002	<0.000002	0.000065	0.000003	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	0.0007	0.0047	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.00227	0.0327	0.0354	0.0249	0.0155	0.0108	-	-	0.000075	0.00373	0.00914	0.0213	0.0228	0.0214	0.0971	0.007635	0.00592	0.000217	0.000298	0.000033
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	-	-	<0.0002	<0.0002	<0.0002	<0.0002	0.0006	<0.0002	<0.0002	0.0002	0.0003	0.0002	0.0002	<0.0002
Zinc	0.0001	0.03	0.0005	0.0007	0.0008	0.0006	0.0011	0.0004	-	-	0.0260	0.0217	0.0006	0.0053	0.260	0.0065	0.0015	0.00155	0.0002	0.0006	0.0005	0.0010
Zirconium	0.0001		<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0001	0.0001	<0.0001	0.0001	0.0001	<0.0001
Calcium	0.05		22.0	60.9	46.1	48.2	44.2	35.4	-	-	18.2	46.4	28.8	51.1	131	56.6	68.1	33.6	30.6	18.6	19.8	0.09
Magnesium	0.05		9.02	21.6	16.9	15.5	14.2	11.2	-	-	3.66	9.67	9.97	16.2	27.9	17.6	29.5	11.95	9.30	7.78	7.89	<0.05
Potassium	0.05		0.70	2.28	2.27	2.23	1.24	1.01	-	-	0.84	0.97	0.90	1.13	1.97	1.02	2.82	1.12	1.41	0.76	0.82	<0.05
Sodium	0.05		3.60	5.66	5.77	5.47	5.97	5.10	-	-	5.19	4.68	5.11	4.97	8.76	4.87	9.44	5.615	4.60	3.60	3.77	<0.05
Sulphur	10		<10	50	38	36	23	13	-	-	21	39	<10	31	213	39	57	13.5	13	<10	<10	<10

Note:

All units mg/L unless otherwise noted

Dashes (-) indicate parameter not sampled.

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic Results exceed CCME Aquatic Life Guidelines

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A1. Surface Water Quality Data, Casino Project, March 2011

Station	Detection Limits	Water Quality Guidelines	R2 - Victor Creek	W1 - Mouth of Canadian Creek	W2 - Britannia Creek D/S of Canadian Creek	W3 - Canadian Creek U/S of Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek D/S Casino	W6a - Yukon River Downstream of Britannia Creek	W6b - Yukon River Upstream of Britannia Creek	W7 - Upper Canadian Creek	W8 - Upper Casino Creek	W9 - Dip Creek U/S of Casino Creek	W11 - Casino Creek (proposed dam)	W12 - Proctor Gulch	W13 - Meloy Creek	W14 - Mouth of Britannia Creek	W16 - Lower Reach of Dip Creek*	W18 - Brynelsen Creek	W20 - Klotassin River U/S of Dip Creek	W21 - Klotassin River D/S of Dip Creek	Trip Blank
Date		**CCME[1]**	**30-Mar-11**	**1-Apr-11**	**31-Mar-11**	**31-Mar-11**	**30-Mar-11**	**29-Mar-11**	**1-Apr-11**	**1-Apr-11**	**31-Mar-11**	**30-Mar-11**	**30-Mar-11**	**29-Mar-11**	**30-Mar-11**	**29-Mar-11**	**31-Mar-11**	**29-Mar-11**	**31-Mar-11**	**29-Mar-11**	**29-Mar-11**	**29-Mar-11**
Dissolved Metals																						
Aluminum	0.0002		0.0084	0.0078	0.0062	0.0069	0.0060	0.0068	-	-	0.0092	0.0346	0.0065	0.0093	18.8	0.0149	0.0085	0.0064	0.0069	0.0075	0.0063	0.0026
Antimony	0.00002		<0.00002	0.00021	0.00023	0.00022	0.00012	0.00008	-	-	0.00006	0.00007	0.00006	0.00012	<0.0001	0.00009	0.00019	0.00007	0.00015	0.00003	0.00003	<0.00002
Arsenic	0.00002		0.00015	0.00032	0.00044	0.00040	0.00037	0.00022	-	-	0.00017	0.00012	0.00019	0.00091	0.0005	0.00045	0.00037	0.00036	0.00038	0.00065	0.00058	<0.00002
Barium	0.00002		0.0591	0.101	0.0811	0.0780	0.0835	0.0815	-	-	0.0611	0.0659	0.0726	0.0785	0.0085	0.0734	0.118	0.082	0.0589	0.0495	0.0541	0.00004
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	<0.00001	0.00002	<0.00001	<0.00001	0.00088	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	-	-	<0.000005	<0.000005	<0.000005	<0.000005	<0.00003	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000005	0.000022	0.000024	0.000012	0.000023	0.000010	-	-	0.000289	0.000275	0.000012	0.000085	0.00397	0.000120	0.000021	0.000014	0.000007	0.000010	0.000008	<0.000005
Chromium	0.0001		<0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	0.0001	<0.0001	<0.0001	0.0002	0.0002	<0.0001
Cobalt	0.000005		0.000022	0.000023	0.000017	0.000017	0.000020	0.000037	-	-	0.000018	0.00231	0.000031	0.000101	0.0501	0.000253	0.000022	0.000089	0.000010	0.000145	0.000183	<0.000005
Copper	0.00005		0.00047	0.00125	0.00129	0.00128	0.00142	0.00076	-	-	0.00090	0.0345	0.00046	0.00406	1.34	0.00688	0.00100	0.000895	0.00043	0.00067	0.00086	<0.00005
Iron	0.001		0.007	0.004	0.004	0.004	0.004	0.041	-	-	0.005	0.015	0.027	0.007	0.460	0.004	0.004	0.106	0.004	0.478	0.424	<0.001
Lead	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	0.000008	<0.000005	-	-	0.000008	0.000074	<0.000005	0.000048	0.00175	0.000007	<0.000005	0.00002	0.000017	<0.000005	<0.000005	<0.000005
Lithium	0.0005		0.0008	0.0005	0.0010	0.0007	0.0015	0.0019	-	-	0.0012	0.0012	0.0026	0.0023	0.006	0.0027	0.0024	0.0013	0.0008	<0.0005	<0.0005	<0.0005
Manganese	0.00005		0.00388	0.00041	0.00186	0.00069	0.0113	0.0252	-	-	0.00147	0.0889	0.0240	0.0625	1.56	0.0616	0.00014	0.05225	0.00259	0.104	0.137	0.00008
Molybdenum	0.00005		0.00069	0.00099	0.00128	0.00109	0.00130	0.00083	-	-	0.00042	0.00028	0.00056	0.00094	<0.0003	0.00050	0.00138	0.0009	0.00171	0.00051	0.00052	<0.00005
Nickel	0.00002		0.00023	0.00056	0.00047	0.00047	0.00016	0.00021	-	-	0.00084	0.00080	0.00043	0.00065	0.0092	0.00043	0.00044	0.0003	0.00011	0.00048	0.00052	0.00004
Selenium	0.00004		0.00006	0.00016	0.00014	0.00011	0.00011	0.00005	-	-	0.00015	0.00004	<0.00004	0.00019	0.0003	0.00031	0.00043	0.00005	<0.00004	0.00018	0.00012	<0.00004
Silicon	0.1		5.2	4.7	5.0	5.1	6.4	5.7	-	-	11.9	7.2	6.2	6.4	14.1	6.5	5.3	5.55	5.8	5.4	5.4	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	-	-	<0.000005	<0.000005	<0.000005	<0.000005	<0.00003	0.000006	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Strontium	0.00005		0.182	0.367	0.323	0.300	0.276	0.253	-	-	0.138	0.337	0.237	0.336	0.408	0.366	0.522	0.236	0.151	0.164	0.165	0.00011
Thallium	0.000002		<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	-	-	<0.000002	0.000004	<0.000002	<0.000002	0.00007	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.0001	-	-	<0.00001	<0.00001	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.00225	0.0334	0.0360	0.0244	0.0153	0.0106	-	-	0.000069	0.00220	0.00878	0.0204	0.0209	0.0207	0.0954	0.00768	0.00594	0.000193	0.000295	0.000029
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	-	-	<0.0002	<0.0002	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	0.0002	0.0002	0.0002	<0.0002
Zinc	0.0001		0.0003	0.0007	0.0005	0.0004	0.0011	0.0004	-	-	0.0253	0.0218	0.0004	0.0043	0.307	0.0063	0.0006	0.0011	0.0015	0.0004	0.0002	<0.0001
Zirconium	0.0001		<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001
Calcium	0.05		23.2	61.2	51.8	49.7	46.6	35.0	-	-	19.1	49.5	30.9	55.2	143	58.6	68.9	34.35	29.8	20.2	20.8	0.10
Magnesium	0.05		9.35	21.6	17.5	15.6	14.5	11.2	-	-	3.74	9.75	9.91	16.9	32.2	18.6	29.2	12.1	9.19	8.05	8.26	<0.05
Potassium	0.05		0.72	2.30	2.34	2.31	1.23	1.02	-	-	0.83	1.00	0.89	1.35	2.1	1.15	2.97	1.11	1.32	0.82	0.90	<0.05
Sodium	0.05		3.83	5.58	5.88	5.41	6.04	5.12	-	-	5.03	4.89	5.02	5.33	9.7	5.25	9.41	5.51	4.38	3.74	3.89	<0.05
Sulphur	10		<10	47	37	35	25	12	-	-	20	42	<10	33	199	42	55	12.5	13	<10	<10	<10
Misc. Inorganics																						
Acidity (pH 4.5)	0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	14.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acidity (pH 8.3)	0.5		4.4	5.3	3.4	3.6	4.5	4.9	1.3	2.2	3.9	3.5	5.7	3.9	119	5.7	12.0	5.4	2.8	3.8	4.4	<0.5
Bromide	0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	-	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Fluoride	0.01		0.06	0.11	0.13	0.12	0.09	0.07	0.12	0.13	0.13	0.12	0.06	0.10	0.36	0.11	0.14	0.065	0.05	0.13	0.13	0.01
Weak Acid Dissoc. Cyanide	0.0005		0.0011	0.0014	0.0014	0.0014	0.0017	0.0013	-	-	0.0013	0.0011	0.0011	0.0011	0.0007	0.0013	0.0009	0.0011	0.0012	0.0011	0.0012	0.0009
Cyanide + Thiocyanate	0.0005		0.0015	0.0016	0.0014	0.0015	0.0021	0.0015	-	-	0.0015	0.0014	0.0013	0.0016	0.0013	0.0015	0.0014	0.00155	0.0015	0.0015	0.0015	0.0021
Dissolved Hardness	0.5		96.4	242	201	188	176	134	-	-	63.1	164	118	207	490	223	292	136	112	83.5	85.8	<0.5
Dissolved Organic Carbon	0.5		2.4	5.3	4.5	4.1	2.1	2.5	-	-	1.8	1.4	2.8	2.4	2.7	2.3	5.2	3.55	1.9	3.8	4.1	<0.5
Alkalinity	0.5		78	120	110	100	120	110	89	89	15	59	100	120	<0.5	120	160	110	84	69	71	<0.5
Total Organic Carbon	0.5		2.4	5.3	4.0	4.2	2.3	2.7	-	-	1.9	1.5	3.1	1.9	3.8	1.9	5.2	3.65	1.8	4.0	4.3	<0.5

Note:

All units mg/L unless otherwise noted

Dashes (-) indicate parameter not sampled.

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic Results exceed CCME Aquatic Life Guidelines

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A1. Surface Water Quality Data, Casino Project, April 2011

Station	Detection Limits	Water Quality Guidelines	R2 - Victor Creek	W1 - Mouth of Canadian Creek	W2 - Britannia Creek D/S of Canadian Creek	W3 - Canadian Creek U/S of Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek D/S Casino	W6a - Yukon River D/S of Britannia Creek	W6b - Yukon River U/S of Britannia Creek	W7 - Upper Canadian Creek	W8 - Upper Casino Creek	W9 - Dip Creek U/S of Casino Creek	W11 - Casino Creek (proposed dam)	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River U/S from Excelsior Creek	W16 - Mouth of Canadian Creek*	W17 - Sunshine Creek	W18 - Brynelsen Creek*	W20 - Klotassin River U/S of Dip Creek	W21 - Klotassin River D/S of Dip Creek	Field Blank
Date		**CCME[1]**	**29-Apr-11**	**29-Apr-11**	**28-Apr-11**	**28-Apr-11**	**29-Apr-11**	**29-Apr-11**	**29-Apr-11**	**29-Apr-11**	**30-Apr-11**	**30-Apr-11**	**29-Apr-11**	**30-Apr-11**	**28-Apr-11**	**29-Apr-11**	**29-Apr-11**	**29-Apr-11**	**30-Apr-11**	**29-Apr-11**	**29-Apr-11**	**29-Apr-11**
Physical Properties																						
Conductivity (uS/cm)	1		263	437	403	371	262	264	186	192	82	324	253	303	443	214	292	350	257	201	218	1
pH		6.5-9.0	7.69	7.95	8.01	7.91	7.89	7.81	7.98	7.87	*6.26*	7.70	7.82	7.90	8.06	7.89	7.95	8.06	7.85	7.86	7.87	*6.15*
Total Suspended Solids	1		<1	2	2	2	9	3	4	2	40	3	3	<1	1	<1	5	<1	1	<1	4	<1
Total Dissolved Solids	10		150	270	250	220	160	150	98	98	74	210	140	200	280	120	180	210	170	110	130	<10
Turbidity	0.1		0.3	0.3	0.4	0.4	1.6	1.1	0.6	0.5	15.5	1.9	1.1	1.6	0.5	0.3	2.25	0.5	1.05	0.7	5.6	0.1
Calculated Parameters																						
Total Hardness	0.5		118	198	187	179	119	117	84.4	81.7	30.6	139	112	141	216	100	128.5	159	115.5	85.1	92.4	<0.5
Nitrate	0.002		0.268	0.201	0.125	0.221	0.114	0.179	0.034	0.046	0.008	0.109	0.205	0.154	<0.002	0.071	0.124	0.155	0.1355	0.133	0.082	<0.002
Dissolved Anions & Nutrients																						
Orthophosphate	0.001		0.001	<0.001	0.002	0.002	<0.001	0.001	<0.001	<0.001	0.002	0.001	0.001	0.001	0.001	<0.001	0.002	<0.001	0.0015	0.001	0.001	<0.001
Dissolved Sulphate	0.5		43	110	98	95	45	34	21	19	27	96	29	67	110	23	52.5	66	48.5	28	28	<0.5
Dissolved Chloride	0.5		0.6	0.9	0.7	0.5	0.7	0.7	<0.5	<0.5	1.9	<0.5	0.9	<0.5	0.9	<0.5	0.5	1.1	0.7	<0.5	0.6	<0.5
Ammonia	0.005	0.137[a]	0.015	0.007	0.005	0.005	<0.005	<0.005	<0.005	<0.005	0.031	0.015	<0.005	0.058	0.006	<0.005	0.0065	0.006	0.021	0.008	<0.005	<0.005
Total Kjeldahl Nitrogen	0.02		0.12	0.27	0.21	0.19	0.22	0.19	0.07	0.08	0.63	0.11	0.16	0.26	1510	0.18	0.17	0.24	0.295	0.16	0.16	0.06
Nitrate plus Nitrite	0.002	2.9	0.268	0.201	0.125	0.221	0.114	0.179	0.034	0.046	0.012	0.109	0.205	0.154	<0.002	0.071	0.125	0.155	0.1355	0.133	0.084	<0.002
Nitrite	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	0.002	<0.002
Total Nitrogen	0.02		0.38	0.47	0.34	0.41	0.34	0.37	0.10	0.12	0.64	0.22	0.36	0.41	1510	0.25	0.295	0.39	0.43	0.29	0.24	0.06
Total Metals																						
Aluminum	0.0002	0.005-0.1[b]	0.0138	0.0207	0.0252	0.0242	0.0808	0.0342	0.0350	0.0117	*0.589*	*0.359*	0.0218	0.0847	0.0222	0.0092	*0.10985*	0.0171	0.06795	0.0149	0.0183	0.0009
Antimony	0.00002		0.00003	0.00021	0.00020	0.00027	0.00011	0.00008	0.00008	0.00009	0.00008	0.00007	0.00005	0.00012	0.00013	0.00009	0.00006	0.00019	0.00013	0.00003	0.00004	<0.00002
Arsenic	0.00002	0.005	0.00018	0.00048	0.00053	0.00057	0.00050	0.00035	0.00035	0.00025	0.00099	0.00032	0.00029	0.00073	0.00050	0.00020	0.000585	0.00053	0.000595	0.00044	0.00099	<0.00002
Barium	0.00002		0.0657	0.0765	0.0744	0.0653	0.0599	0.0666	0.0427	0.0526	0.0704	0.0655	0.0664	0.0620	0.0871	0.0603	0.06715	0.0913	0.05275	0.0460	0.0532	0.00004
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00004	0.00002	<0.00001	0.00001	0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000017	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000016	0.000026	0.000031	0.000043	0.000062	0.000025	0.000030	0.000044	0.000505	0.000252	0.000021	0.000112	0.000027	0.000029	0.000035	0.000032	0.0000675	0.000018	0.000026	0.000005
Chromium	0.0001	0.001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	<0.0001	0.0004	<0.0001	<0.0001	0.0001	0.0001	<0.0001	0.00025	0.0001	0.0001	0.0001	0.0002	<0.0001
Cobalt	0.000005		0.000028	0.000048	0.000081	0.000083	0.000119	0.000062	0.000046	0.000078	0.000793	0.00195	0.000071	0.000135	0.000060	0.000011	0.0001865	0.000036	0.0000855	0.000102	0.000192	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00055	0.00146	0.00148	0.00186	*0.00507*	*0.00206*	0.00058	0.00046	*0.00861*	*0.0369*	0.00068	*0.0123*	0.00100	0.00035	0.00153	0.00093	*0.00799*	0.00074	0.00074	<0.00005
Iron	0.001	0.3	0.019	0.031	0.042	0.044	0.114	0.075	0.064	0.059	0.448	0.081	0.082	0.074	0.041	0.013	0.307	0.030	0.0555	0.296	1.01	<0.001
Lead	0.000005	0.001-0.007[e]	0.000013	0.000021	0.000032	0.000033	0.000660	0.000191	0.000072	0.000028	0.000856	0.000178	0.000047	0.00191	0.000024	0.000009	0.0003545	0.000017	0.0007085	0.000068	0.000031	0.000009
Lithium	0.0005		0.0012	0.0008	0.0009	0.0005	0.0014	0.0021	0.0010	0.0011	<0.0005	0.0011	0.0028	0.0015	0.0013	0.0013	0.00135	0.0011	0.00125	<0.0005	0.0006	<0.0005
Manganese	0.00005		0.00650	0.00708	0.0200	0.0204	0.0330	0.0309	0.00818	0.0901	0.0845	0.0817	0.0401	0.0539	0.0181	0.00137	0.05475	0.00689	0.02695	0.0593	0.113	<0.00005
Molybdenum	0.00005	0.073	0.00076	0.00082	0.00071	0.00080	0.00104	0.00080	0.00091	0.00076	0.00007	0.00019	0.00058	0.00076	0.00052	0.00100	0.00084	0.00037	0.000885	0.00045	0.00072	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00024	0.00064	0.00058	0.00063	0.00038	0.00029	0.00062	0.00086	0.00217	0.00073	0.00030	0.00053	0.00072	0.00042	0.000585	0.00101	0.00045	0.00045	0.00057	0.00006
Selenium	0.00004	0.001	0.00009	0.00012	0.00011	0.00011	0.00007	0.00007	0.00029	0.00035	0.00008	0.00006	0.00005	0.00014	0.00011	0.00047	0.00006	0.00011	0.00009	0.00029	0.00022	<0.00004
Silicon	0.1		4.9	4.5	4.5	5.2	4.5	5.0	2.5	2.3	2.4	6.5	5.0	5.0	4.2	2.8	4.4	4.4	4.7	4.8	4.8	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000026	<0.000005	<0.000005	0.000007	<0.000005	<0.000005	<0.000005	<0.000005	0.0000055	<0.000005	<0.000005	<0.000005
Strontium	0.00005		0.229	0.332	0.340	0.283	0.203	0.230	0.115	0.104	0.0510	0.296	0.244	0.240	0.427	0.122	0.207	0.265	0.1925	0.173	0.173	0.00007
Thallium	0.000002	0.0008	<0.000002	0.000002	0.000003	0.000003	<0.000002	0.000002	0.000002	0.000002	0.000011	0.000004	<0.000002	0.000004	<0.000002	<0.000002	0.000003	0.000002	0.0000035	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00014	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	0.0006	0.0009	0.0006	0.0023	0.0011	0.0014	<0.0005	0.0075	<0.0005	0.0007	0.0009	0.0006	<0.0005	0.0047	<0.0005	0.00065	0.0006	0.0006	<0.0005
Uranium	0.000002		0.00465	0.0266	0.0206	0.0223	0.00895	0.00885	0.00158	0.000910	0.000377	0.00280	0.00842	0.0124	0.0136	0.00153	0.007065	0.00554	0.00828	0.000358	0.00145	0.000035
Vanadium	0.0002		<0.0002	0.0002	0.0002	<0.0002	0.0004	0.0003	0.0002	<0.0002	0.0009	<0.0002	0.0002	<0.0002	0.0002	<0.0002	0.00075	0.0002	0.0002	0.0003	0.0004	<0.0002
Zinc	0.0001	0.03	0.0011	0.0011	0.0015	0.0011	0.0043	0.0057	0.0022	0.0022	0.0280	0.0182	0.0011	0.0054	0.0017	0.0015	0.0026	0.0018	0.00415	0.0010	0.0012	0.0016
Zirconium	0.0001		<0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0005	<0.0001	<0.0001	0.0001	0.0002	<0.0001	0.00015	0.0001	0.0001	0.0001	0.0002	<0.0001
Calcium	0.05		26.2	48.1	45.4	46.5	30.3	29.0	23.0	22.2	8.70	41.4	27.0	36.9	51.2	27.3	29.5	37.7	30.1	19.5	22.1	<0.05
Magnesium	0.05		12.7	18.8	17.8	15.3	10.5	10.9	6.53	6.37	2.15	8.73	10.8	11.8	21.5	7.76	13.35	15.7	9.77	8.87	9.02	<0.05
Potassium	0.05		0.85	2.49	2.43	2.26	1.54	1.31	0.76	0.96	2.53	1.16	1.13	1.41	2.71	0.75	1.285	1.73	1.5	0.77	1.12	<0.05
Sodium	0.05		4.04	5.12	5.02	4.57	4.10	4.52	1.80	1.43	1.03	3.94	4.67	3.50	5.73	1.79	4.815	5.05	3.5	3.67	4.62	<0.05
Sulphur	10		16	41	36	35	16	13	<10	<10	<10	36	<10	23	37	<10	19	23	17	<10	11	<10

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20°C for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic Results exceed CCME Aquatic Life Guidelines

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A1. Surface Water Quality Data, Casino Project, April 2011

Station	Detection Limits	Water Quality Guidelines	R2 - Victor Creek	W1 - Mouth of Canadian Creek	W2 - Britannia Creek D/S of Canadian Creek	W3 - Canadian Creek U/S of Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek D/S Casino	W6a - Yukon River D/S of Britannia Creek	W6b - Yukon River U/S of Britannia Creek	W7 - Upper Canadian Creek	W8 - Upper Casino Creek	W9 - Dip Creek U/S of Casino Creek	W11 - Casino Creek (proposed dam)	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River U/S from Excelsior Creek	W16 - Mouth of Canadian Creek*	W17 - Sunshine Creek	W18 - Brynelsen Creek*	W20 - Klotassin River U/S of Dip Creek	W21 - Klotassin River D/S of Dip Creek	Field Blank
Date		**CCME[1]**	**29-Apr-11**	**29-Apr-11**	**28-Apr-11**	**28-Apr-11**	**29-Apr-11**	**29-Apr-11**	**29-Apr-11**	**29-Apr-11**	**30-Apr-11**	**30-Apr-11**	**29-Apr-11**	**30-Apr-11**	**28-Apr-11**	**29-Apr-11**	**29-Apr-11**	**29-Apr-11**	**30-Apr-11**	**29-Apr-11**	**29-Apr-11**	**29-Apr-11**
Dissolved Metals																						
Aluminum	0.0002		0.0101	0.0124	0.0130	0.0107	0.0205	0.0142	0.0031	0.0025	0.391	0.0362	0.0087	0.0430	0.0154	0.0018	0.00985	0.0142	0.0361	0.0063	0.0063	0.0008
Antimony	0.00002		0.00003	0.00021	0.00021	0.00026	0.00010	0.00008	0.00008	0.00010	0.00006	0.00007	0.00006	0.00012	0.00013	0.00010	0.000055	0.00020	0.000115	0.00003	0.00003	<0.00002
Arsenic	0.00002		0.00018	0.00049	0.00050	0.00054	0.00040	0.00035	0.00030	0.00035	0.00064	0.00025	0.00026	0.00072	0.00052	0.00015	0.00035	0.00056	0.00054	0.00038	0.00045	<0.00002
Barium	0.00002		0.0687	0.0809	0.0759	0.0642	0.0629	0.0669	0.0437	0.0458	0.0568	0.0628	0.0677	0.0619	0.0882	0.0685	0.06305	0.0937	0.0559	0.0466	0.0520	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00003	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000015	0.000021	0.000025	0.000030	0.000043	0.000019	0.000020	0.000018	0.000431	0.000241	0.000014	0.000081	0.000028	0.000031	0.0000195	0.000024	0.000063	0.000021	0.000011	0.000008
Chromium	0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	<0.0001
Cobalt	0.000005		0.000019	0.000045	0.000055	0.000061	0.000037	0.000040	0.000007	0.000011	0.000554	0.00200	0.000043	0.000106	0.000052	<0.000005	0.0000735	0.000031	0.0000745	0.000095	0.000158	<0.000005
Copper	0.00005		0.00051	0.00147	0.00138	0.00181	0.00406	0.00194	0.00041	0.00044	0.00785	0.0297	0.00055	0.0114	0.00090	0.00028	0.000955	0.00095	0.007555	0.00070	0.00060	<0.00005
Iron	0.001		0.012	0.024	0.023	0.020	0.030	0.036	0.006	0.008	0.231	0.028	0.044	0.044	0.029	0.002	0.092	0.024	0.043	0.212	0.301	<0.001
Lead	0.000005		0.000006	<0.000005	0.000007	0.000005	0.000070	0.000039	<0.000005	<0.000005	0.000130	0.000070	0.000011	0.000267	0.000015	0.000006	0.0000075	0.000043	0.000197	0.000005	<0.000005	<0.000005
Lithium	0.0005		0.0011	0.0007	0.0009	0.0006	0.0014	0.0021	0.0011	0.0014	<0.0005	0.0010	0.0026	0.0015	0.0012	0.0013	0.00135	0.0011	0.0013	<0.0005	0.0005	<0.0005
Manganese	0.00005		0.00597	0.00657	0.0178	0.0189	0.0165	0.0251	0.00357	0.00723	0.0672	0.0809	0.0349	0.0454	0.0184	0.00069	0.0446	0.00695	0.0236	0.0581	0.103	<0.00005
Molybdenum	0.00005		0.00077	0.00082	0.00068	0.00076	0.00111	0.00084	0.00090	0.00109	<0.00005	0.00019	0.00057	0.00063	0.00049	0.00102	0.00088	0.00034	0.00086	0.00046	0.00073	<0.00005
Nickel	0.00002		0.00024	0.00059	0.00053	0.00061	0.00028	0.00033	0.00044	0.00057	0.00188	0.00074	0.00022	0.00054	0.00047	0.00027	0.000375	0.00047	0.000465	0.00049	0.00051	<0.00002
Selenium	0.00004		0.00012	0.00014	0.00012	0.00012	0.00007	0.00006	0.00030	0.00039	0.00008	0.00005	0.00005	0.00015	0.00011	0.00047	0.00006	0.00011	0.00011	0.00028	0.00020	<0.00004
Silicon	0.1		5.0	4.6	4.5	4.8	4.6	4.4	2.5	2.7	2.3	6.4	4.9	4.9	4.1	2.8	4.35	4.3	4.8	4.7	4.9	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000022	<0.000005	<0.000005	0.000007	<0.000005	<0.000005	<0.000005	<0.000005	0.000007	<0.000005	<0.000005	<0.000005
Strontium	0.00005		0.233	0.337	0.341	0.274	0.209	0.233	0.116	0.13	0.0516	0.309	0.239	0.238	0.414	0.122	0.21	0.264	0.1965	0.170	0.172	<0.00005
Thallium	0.000002		<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000007	0.000003	<0.000002	0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000002	<0.000002	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0030 (2)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.00475	0.0273	0.0207	0.0225	0.00920	0.00875	0.00162	0.00123	0.000289	0.00219	0.00845	0.0121	0.0135	0.00154	0.00695	0.00561	0.00865	0.000287	0.00139	<0.000002
Vanadium	0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	<0.0002
Zinc	0.0001		0.0006	0.0009	0.0016	0.0010	0.0025	0.0024	0.0011	0.0012	0.0248	0.0173	0.0007	0.0050	0.0017	0.0013	0.0009	0.0014	0.00435	0.0006	0.0005	0.0005
Zirconium	0.0001		<0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	0.0001	0.0002	<0.0001	<0.0001	0.0001	0.0001	<0.0001	0.0001	<0.0001
Calcium	0.05		29.0	52.6	47.1	45.0	31.5	27.6	23.9	27.2	9.23	43.0	27.3	38.6	51.0	27.8	29.65	38.9	33.45	20.2	22.7	<0.05
Magnesium	0.05		12.7	19.7	18.6	16.1	10.8	11.2	6.47	7.93	2.15	8.84	11.1	12.2	21.9	7.88	13.6	16.9	9.945	9.09	9.27	<0.05
Potassium	0.05		0.84	2.62	2.49	2.29	1.57	1.32	0.77	0.84	2.57	1.20	1.16	1.47	2.82	0.75	1.325	1.84	1.505	0.81	1.19	<0.05
Sodium	0.05		3.95	5.31	5.23	4.73	4.21	4.61	1.80	2.05	1.06	4.02	4.78	3.65	5.78	1.70	4.92	5.31	3.55	3.77	4.64	<0.05
Sulphur	10		14	39	35	33	15	11	<10	<10	<10	34	<10	22	36	<10	19	23	15.5	<10	10	<10
Misc. Inorganics																						
Acidity (pH 4.5)	0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acidity (pH 8.3)	0.5		1.6	0.5	<0.5	<0.5	<0.5	1.6	<0.5	<0.5	7.6	1.6	1.6	1.1	<0.5	<0.5	<0.5	<0.5	1.7	<0.5	<0.5	<0.5
Bromide	0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Fluoride	0.01		0.05	0.10	0.11	0.09	0.06	0.05	0.10	0.09	0.03	0.10	0.05	0.08	0.10	0.10	0.06	0.08	0.06	0.12	0.11	<0.01
Weak Acid Dissoc. Cyanide	0.0005		<0.0005	0.0007	0.0012	0.0007	0.0010	0.0009	<0.0005	<0.0005	0.0012	<0.0005	0.0008	0.0006	0.0013	<0.0005	0.00105	0.0005	0.0006	0.0008	0.0010	<0.0005
Cyanide + Thiocyanate	0.0005		0.0008	0.0007	0.0007	0.0007	0.0006	0.0007	<0.0005	<0.0005	0.0014	<0.0005	0.0007	0.0009	0.0008	<0.0005	0.00065	0.0007	0.0007	0.0006	0.0007	<0.0005
Dissolved Hardness	0.5		125	212	194	178	123	115	86.3	101	31.9	1.10	114	146	218	102	130	167	124.5	87.8	94.8	<0.5
Dissolved Organic Carbon	0.5		4.4	8.5	8.5	6.6	8.3	6.7	1.4	1.9	10.2	<0.0005	4.8	10.6	11.1	0.9	6.2	9.2	10.5	3.4	4.9	<0.5
Alkalinity	0.5		88	110	110	91	92	97	75	81	3.4	<0.0005	100	90	130	86	96.5	110	83.5	74	81	<0.5
Total Organic Carbon	0.5		4.5	8.5	8.4	6.3	8.6	6.0	1.5	1.6	10.6	2.10	4.8	10.0	11.4	1.1	6.55	9.0	10.25	3.6	5.5	<0.5

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20ºC for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic Results exceed CCME Aquatic Life Guidelines

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A1. Surface Water Quality Data, Casino Project, June 2011

Station	Detection Limits	Water Quality Guidelines	W16 - Lower Reach of Dip Creek	W19 - Dip Creek at Klotassin	W22 - Upper Dip Creek	W43 - Adit
Date		**CCME[1]**	**13-Jun-11**	**13-Jun-11**	**13-Jun-11**	**13-Jun-11**
Physical Properties						
Conductivity (uS/cm)	1		108	101	69	-
pH		6.5-9.0	7.55	7.48	7.26	-
Total Suspended Solids	1		27	68	<1	-
Total Dissolved Solids	10		100	100	54	-
Turbidity	0.1		12.1	16.5	0.2	-
Calculated Parameters						
Total Hardness	0.5		56.7	52.7	27.8	79.8
Nitrate	0.002		0.050	0.036	0.092	-
Dissolved Anions & Nutrients						
Orthophosphate	0.001		0.002	0.002	0.001	-
Dissolved Sulphate	0.5		15	12	15	-
Dissolved Chloride	0.5		0.6	0.9	<0.5	-
Ammonia	0.01	0.137[a]	0.011	0.014	0.020	-
Total Kjeldahl Nitrogen	0.02		0.40	0.46	0.26	-
Nitrate plus Nitrite	0.002	2.9	0.054	0.039	0.092	-
Nitrite	0.002	0.06	0.004	0.003	<0.002	-
Total Nitrogen	0.02		0.45	0.50	0.35	-
Total Metals						
Aluminum	0.0002	0.005-0.1[b]	*0.467*	*0.642*	*0.109*	0.0269
Antimony	0.00002		0.00009	0.00008	0.00006	0.00294
Arsenic	0.00002	0.005	0.00087	0.00140	0.00026	0.00071
Barium	0.00002		0.0430	0.0463	0.00971	0.0408
Beryllium	0.00001		0.00003	0.00005	0.00001	<0.00001
Bismuth	0.000005		0.000010	0.000010	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	*0.000048*	*0.000043*	*0.000017*	*0.0396*
Chromium	0.0001	0.001	0.0007	*0.0012*	0.0002	<0.0001
Cobalt	0.000005		0.000446	0.000682	0.000041	0.000223
Copper	0.00005	0.002-0.004[d]	*0.00469*	*0.00523*	0.00166	*0.0909*
Iron	0.001	0.3	0.820	1.49	0.056	0.070
Lead	0.000005	0.001-0.007[e]	0.000902	*0.00102*	0.000131	*0.0144*
Lithium	0.0005		0.0012	0.0011	0.0034	0.0016
Manganese	0.00005		0.0591	0.0792	0.00110	0.357
Mercury	0.00001		<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00049	0.00048	0.00037	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00151	0.00207	0.00027	0.00040
Phosphorus	0.002		0.025	0.052	0.003	<0.002
Selenium	0.00004	0.001	0.00009	0.00008	0.00004	<0.00004
Silicon	0.1		4.4	4.3	4.7	5.8
Silver	0.000005	0.0001	0.000008	0.000009	<0.000005	*0.000197*
Strontium	0.00005		0.0911	0.0819	0.0519	0.195
Thallium	0.000002	0.0008	0.000009	0.000009	0.000003	0.000026
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0183	0.0280	0.0009	<0.0005
Uranium	0.000002		0.00234	0.00161	0.00163	0.000877
Vanadium	0.0002		0.0022	0.0034	0.0002	<0.0002
Zinc	0.0001	0.03	0.0058	0.0047	0.0009	*2.22*
Zirconium	0.0001		0.0005	0.0006	0.0001	<0.0001
Calcium	0.05		14.2	13.1	8.29	21.4
Magnesium	0.05		5.15	4.88	1.71	6.38
Potassium	0.05		0.63	0.65	0.36	1.10
Sodium	0.05		2.30	2.33	1.88	2.74
Sulphur	10		<10	<10	<10	11
Dissolved Metals						
Aluminum	0.0002		0.117	0.121	0.114	-
Antimony	0.00002		0.00008	0.00008	0.00006	-
Arsenic	0.00002		0.00047	0.00063	0.00023	-
Barium	0.00002		0.0313	0.0314	0.0101	-
Beryllium	0.00001		0.00002	0.00002	0.00001	-
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	-
Boron	0.05		<0.05	<0.05	<0.05	-
Cadmium	0.000005		0.000007	0.000013	0.000019	-
Chromium	0.0001		0.0004	0.0004	0.0002	-
Cobalt	0.000005		0.000102	0.000123	0.000035	-
Copper	0.00005		0.00341	0.00337	0.00174	-
Iron	0.001		0.217	0.345	0.058	-
Lead	0.000005		0.000066	0.000081	0.000124	-
Lithium	0.0005		0.0009	0.0008	0.0035	-
Manganese	0.00005		0.0133	0.0193	0.00096	-
Molybdenum	0.00005		0.00065	0.00062	0.00042	-
Nickel	0.00002		0.00093	0.00120	0.00029	-
Selenium	0.00004		0.00008	0.00008	<0.00004	-
Silicon	0.1		3.9	3.7	5.0	-
Silver	0.000005		<0.000005	<0.000005	<0.000005	-
Strontium	0.00005		0.0894	0.0809	0.0552	-
Thallium	0.000002		0.000002	<0.000002	0.000003	-
Tin	0.00001		<0.00001	<0.00001	<0.00001	-
Titanium	0.0005		0.0011	0.0020	0.0006	-
Uranium	0.000002		0.00177	0.00114	0.00170	-
Vanadium	0.0002		0.0007	0.0009	0.0003	-
Zinc	0.0001		0.0008	0.0008	0.0012	-
Zirconium	0.0001		0.0003	0.0004	0.0001	-
Calcium	0.05		13.4	13.0	9.05	-
Magnesium	0.05		5.03	4.69	1.84	-
Potassium	0.05		0.57	0.60	0.38	-
Sodium	0.05		2.32	2.41	2.01	-
Sulphur	10		<10	<10	<10	-
Misc. Inorganics						
Acidity (pH 4.5)	0.5		<0.5	<0.5	<0.5	-
Acidity (pH 8.3)	0.5		<0.5	<0.5	<0.5	-
Bromide	0.4		<0.4	<0.4	<0.4	-
Fluoride	0.01		0.06	0.06	0.04	-
Weak Acid Dissoc. Cyanide	0.0005		0.0009	0.0011	0.0007	-
Cyanide + Thiocyanate	0.0005		<0.0005	<0.0005	<0.0005	-
Dissolved Hardness	0.5		54.2	51.7	30.2	-
Dissolved Organic Carbon	0.5		15.5	17.8	7.3	-
Alkalinity	0.5		38	34	16	-
Total Organic Carbon	0.5		15.5	17.8	7.4	-

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20ºC for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{\{0.86[\log(hardness)]-3.2\}}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic	*Results exceed CCME Aquatic Life Guidelines*

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A1. Surface Water Quality Data, Casino Project, August 2011

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Britannia Creek D/S of Canadian Creek	W3 - Canadian Creek U/S of Britannia Creek	W4 - Mouth of Casino Creek*	W5 - Dip Creek D/S Casino	W6a - Yukon River D/S of Britannia Creek	W6b - Yukon River U/S of Britannia Creek	W6 - Yukon River D/S of Canadian Creek*	W7 - Upper Canadian Creek*	W8 - Upper Casino Creek	W9 - Dip Creek U/S of Casino Creek	W11 - Casino Creek (proposed dam)	W12 - Proctor Gulch	W13 - Meloy Creek	W14 - Mouth of Britannia Creek*	W15 - Island on Yukon River U/S from Excelsior Creek	W16 - Lower Reach of Dip Creek	W17 - Sunshine Creek	W18 - Brynelsen Creek	W19 - Dip Creek at Klotassin River	W20 - Klotass in River U/S of Dip Creek	W21 - Klotass in River D/S of Dip Creek	W22 - Upper Dip Creek	W23 - Excelsior Creek	W24 - Unnamed Casino Creek Tributary	W43 - Adit	Field Blank	Trip Blank
Date		CCME[1]	22-Aug-2011	22-Aug-2011	22-Aug-2011	23-Aug-2011	23-Aug-2011	22-Aug-2011	22-Aug-2011	22-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	22-Aug-2011	22-Aug-2011	23-Aug-2011	22-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	22-Aug-2011	23-Aug-2011	23-Aug-2011	22-Aug-2011	22-Aug-2011
Physical Properties																														
Conductivity (uS/cm)	1		257	230	267	232	172	174	226	200	139	224	145	168	721	206	211.5	224	178	193	157	174	126	136	238	214	132	220	1	1
pH		6.5-9.0	7.91	7.81	8.21	7.84	7.89	8.02	8.07	8.045	6.845	7.72	7.76	7.72	*3.46*	8.01	7.85	8.07	7.92	7.91	7.92	7.91	7.83	7.82	7.92	7.83	7.69	7.36	*6.13*	*6.22*
Total Suspended Solids	1		4	3	3	22.5	16	24	31	27.5	<1	5	14	39	7	19	4.5	21	23	4	29	12	11	9	9	2	<1	2	<1	<4
Total Dissolved Solids	10		170	170	170	140	110	96	130	113	110	150	94	140	450	110	155	140	140	130	160	130	84	96	82	150	74	150	<10	<10
Turbidity	0.1		0.5	0.4	0.6	3.5	2.5	6.9	18.2	12.55	0.7	3.2	2.9	6.6	35.7	6.7	0.85	11.6	6.0	0.6	4.6	5.4	2.5	2.8	2.2	0.3	0.4	3.7	0.2	<0.1
Calculated Parameters																														
Total Hardness	10		115	103	104	103.5	75	79	105	92	51	91	66	111	227	94	95	104	80	90	75	80	59	61	71	104	62	90	<10	<10
Nitrate	0.002		0.322	0.316	0.273	0.1495	0.139	0.010	0.006	0.008	0.011	0.071	0.134	0.226	0.093	0.297	0.29	0.005	0.142	0.197	0.168	0.104	0.050	0.061	0.196	0.313	0.205	0.479	<0.002	<0.002
Dissolved Anions & Nutrients																														
Orthophosphate	0.001		0.001	0.002	0.001	0.006	0.002	0.002	0.002	0.002	0.0015	0.001	0.007	0.016	0.015	0.002	0.001	0.002	0.011	0.001	0.002	0.011	0.007	0.007	0.001	0.002	0.001	0.001	0.001	<0.001
Dissolved Sulphate	5		51	44	47	33.5	18	18	29	23.5	51	63	12	46	260	20	35	29	21	30	25	20	9.5	11	8.1	43	21	38	2.3	1.0
Dissolved Chloride	0.5		0.8	0.6	<0.5	<0.5	0.6	2.2	0.5	1.35	0.7	2.0	0.6	4.6	1.1	0.6	0.85	0.8	0.6	1.1	1.9	<0.5	0.5	1.4	0.8	1.4	<0.5	<0.5	0.9	<0.5
Ammonia	0.005	0.137[a]	0.020	0.044	0.042	0.059	0.053	0.023	0.038	0.0305	0.0385	0.026	0.039	0.034	0.16	0.035	0.041	0.037	0.036	0.059	0.068	0.059	0.033	0.045	0.046	0.085	0.043	0.015	0.027	<0.005
Total Kjeldahl Nitrogen	0.02		0.05	0.06	0.09	0.04	0.02	0.23	0.25	0.24	0.175	0.17	0.02	<0.02	0.26	0.24	0.125	0.34	<0.02	0.16	<0.02	0.08	0.04	0.05	0.02	0.23	0.03	0.10	0.29	<0.02
Nitrate plus Nitrite	0.002	2.9	0.331	0.328	0.275	0.1495	0.139	0.01	0.01	0.01	0.011	0.071	0.134	0.228	0.097	0.297	0.29	0.009	0.145	0.197	0.168	0.106	0.05	0.061	0.199	0.313	0.205	0.479	<0.002	<0.002
Nitrite	0.002	0.06	0.01	0.012	0.002	<0.002	<0.002	<0.002	0.004	0.004	<0.002	<0.002	<0.002	0.002	0.004	<0.002	<0.002	0.004	0.003	<0.002	<0.002	0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Total Nitrogen	0.02		0.38	0.39	0.37	0.17	0.16	0.24	0.26	0.25	0.19	0.24	0.16	0.21	0.36	0.53	0.415	0.35	0.15	0.36	0.18	0.19	0.09	0.11	0.22	0.54	0.24	0.58	0.29	<0.02
Total Metals																														
Aluminum	0.0002	0.005-0.1[b]	0.0745	0.0890	0.0533	*0.2645*	*0.169*	*0.158*	*0.192*	0.175	0.0572	*0.493*	*0.165*	*0.443*	*5.79*	*0.358*	*0.162*	*0.173*	*0.263*	*0.123*	*0.283*	*0.226*	*0.162*	*0.222*	0.0874	*0.159*	0.0436	0.0254	0.0014	0.0024
Antimony	0.00002		0.00034	0.00036	0.00042	0.000135	0.00010	0.00010	0.00014	0.00012	0.000055	0.00010	0.00007	0.00015	0.00014	0.00023	0.000275	0.00014	0.00010	0.00026	0.00016	0.00009	0.00004	0.00006	0.00008	0.00046	0.00030	0.00201	<0.00002	<0.00002
Arsenic	0.00002	0.005	0.00064	0.00074	0.00078	0.00086	0.00059	0.00060	0.00069	0.000645	0.000215	0.00030	0.00045	0.00125	0.00032	0.00104	0.000635	0.00067	0.00075	0.00072	0.00110	0.00093	0.00042	0.00056	0.00029	0.00094	0.00063	0.00068	<0.00002	<0.00002
Barium	0.00002		0.0574	0.0556	0.0469	0.05865	0.0480	0.0460	0.0649	0.05545	0.05285	0.0504	0.0469	0.0680	0.0267	0.105	0.0692	0.0597	0.0503	0.0686	0.0502	0.0530	0.0317	0.0375	0.0638	0.0464	0.0396	0.0646	0.00002	<0.00002
Beryllium	0.00001		0.00001	<0.00001	0.00001	0.000015	0.00002	0.00002	0.00001	0.000015	0.000015	0.00004	0.00001	0.00004	0.00035	0.00002	0.00002	0.00002	0.00003	0.00001	0.00002	0.00002	0.00002	0.00002	<0.00001	0.00002	0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000009	0.000024	0.000026	*0.000053*	*0.000031*	*0.000041*	*0.000117*	*0.000079*	*0.0002255*	*0.000214*	0.000017	*0.000117*	*0.00166*	*0.000176*	0.0000195	*0.000079*	0.000011	0.000021	*0.000040*	0.000015	0.000011	0.000019	0.000011	0.000018	0.000013	*0.0456*	<0.000005	<0.000005
Chromium	0.0001	0.001	0.0003	0.0003	0.0004	0.00045	0.0004	0.0004	0.0004	0.0004	0.00015	0.0002	0.0004	0.0009	0.0005	*0.0019*	0.0004	0.0003	0.0006	0.0003	0.0005	0.0006	0.0006	0.0007	0.0002	0.0004	0.0003	<0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000091	0.000089	0.000095	0.000465	0.000224	0.000210	0.000298	0.000254	0.0000855	0.00240	0.000174	0.000959	0.0247	0.000389	0.0001215	0.000244	0.000322	0.000118	0.000335	0.000271	0.000181	0.000256	0.000128	0.000103	0.000043	0.000524	<0.000005	<0.000005
Copper	0.00005	0.002-0.004[d]	*0.00246*	*0.00258*	*0.00297*	*0.0106*	*0.00433*	0.00143	0.00184	0.001635	*0.00217*	*0.0604*	0.00142	*0.0215*	*0.588*	*0.00216*	0.00195	0.00171	*0.00375*	0.00184	0.00185	*0.00307*	0.00194	*0.00227*	0.00090	*0.00203*	0.00144	*0.0697*	<0.00005	<0.00005
Iron	0.001	0.3	0.080	0.098	0.069	0.4855	0.335	0.295	0.398	0.3465	0.0485	0.758	0.329	0.762	13.0	0.556	0.1695	0.332	0.566	0.164	0.492	0.748	0.348	0.496	0.205	0.145	0.039	0.072	<0.001	<0.001
Lead	0.000005	0.001-0.007[e]	0.000046	0.000063	0.000063	0.001185	0.000488	0.000230	0.000408	0.000319	0.0000975	0.000303	0.000240	*0.00293*	0.00121	*0.0146*	0.00007	0.000349	0.000462	0.000073	0.000383	0.000375	0.000122	0.000178	0.000438	0.000041	0.000081	*0.0183*	0.000034	<0.000005
Lithium	0.0005		0.0008	0.0006	0.0006	0.0014	0.0018	0.0014	0.0022	0.0018	0.0008	0.0010	0.0020	0.0012	0.0039	0.0011	0.00075	0.0022	0.0016	0.0009	0.0010	0.0013	0.0006	0.0007	0.0016	0.0007	<0.0005	0.0020	<0.0005	<0.0005
Manganese	0.00005		0.00448	0.00600	0.00490	0.0335	0.0242	0.0185	0.0306	0.02455	0.00537	0.0679	0.0220	0.0522	0.698	0.0641	0.00875	0.0259	0.0320	0.00773	0.0231	0.0474	0.0248	0.0309	0.0364	0.00735	0.00064	1.07	<0.00005	<0.00005
Mercury	0.00001		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	0.073	0.00052	0.00049	0.00081	0.00092	0.00081	0.00101	0.00100	0.001005	0.00017	0.00019	0.00074	0.00051	0.00016	0.00035	0.000285	0.00099	0.00086	0.00039	0.00114	0.00075	0.00058	0.00059	0.00033	0.00036	0.00028	<0.00005	<0.00005	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00075	0.00079	0.00086	0.000695	0.00056	0.00144	0.00253	0.001985	0.001315	0.00097	0.00054	0.00167	0.00450	0.00106	0.00067	0.00241	0.00099	0.00067	0.00071	0.00105	0.00109	0.00120	0.00033	0.00078	0.00064	0.00062	<0.00002	<0.00002
Phosphorus	0.002		0.005	0.005	0.004	0.0145	0.015	0.022	0.033	0.0275	0.004	0.005	0.017	0.023	0.010	0.017	0.008	0.024	0.021	0.005	0.015	0.018	0.014	0.018	0.008	0.005	0.004	0.005	<0.002	<0.002
Selenium	0.00004	0.001	0.00014	0.00010	0.00010	0.0001	0.00005	0.00027	0.00051	0.00039	0.000055	0.00006	<0.00004	0.00017	0.00019	<0.00004	0.000095	0.00052	0.00008	0.00009	0.00005	0.00006	0.00013	0.00013	<0.00004	0.00012	0.00043	<0.00004	<0.00004	<0.00004
Silicon	0.1		4.9	5.0	5.2	5.65	5.2	3.2	3.4	3.3	9.55	6.5	5.0	5.9	9.6	5.6	4.55	3.3	5.2	4.6	5.5	5.4	5.1	5.1	5.1	4.2	2.8	5.5	<0.1	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000007	0.000007	0.000006	0.000006	<0.000005	0.000011	0.000033	0.000044	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000007	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000215	<0.000005	<0.000005
Strontium	0.00005		0.186	0.170	0.160	0.1725	0.142	0.107	0.131	0.119	0.0945	0.183	0.133	0.191	0.215	0.168	0.179	0.131	0.140	0.154	0.120	0.135	0.120	0.125	0.153	0.182	0.0438	0.231	<0.00005	<0.00005
Thallium	0.000002	0.0008	0.000003	0.000003	0.000003	0.000005	0.000004	0.000005	0.000007	0.000006	0.0000025	0.000007	0.000003	0.000009	0.000055	0.000015	0.0000035	0.000006	0.000004	0.000004	0.000008	0.000003	<0.000002	0.000002	0.000002	0.000005	0.000004	0.000029	<0.000002	<0.000002
Tin	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0021	0.0027	0.0015	0.01065	0.0070	0.0045	0.0044	0.00445	0.00125	0.0012	0.0074	0.0158	<0.0005	0.0289	0.00485	0.0043	0.0109	0.0061	0.0141	0.0108	0.0060	0.0097	0.0031	0.0032	0.0011	0.0006	<0.0005	<0.0005
Uranium	0.000002		0.00667	0.00637	0.00688	0.006875	0.00487	0.000899	0.000931	0.000915	0.000055	0.00181	0.00436	0.00829	0.00768	0.00656	0.003675	0.00112	0.00430	0.00198	0.00371	0.00343	0.000341	0.00102	0.00371	0.00693	0.000312	0.000765	0.000055	<0.000002
Vanadium	0.0002		0.0002	0.0003	<0.0002	0.0013	0.0010	0.0007	0.0007	0.0007	0.0002	<0.0002	0.0010	0.0014	<0.0002	0.0014	0.00055	0.0006	0.0018	0.0007	0.0019	0.0016	0.0011	0.0013	0.0005	0.0008	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0014	0.0009	0.0011	0.004	0.0021	0.0032	0.0083	0.00575	0.0163	0.0183	0.0013	0.0121	*0.122*	0.0119	0.00095	0.0077	0.0022	0.0027	0.0029	0.0029	0.0037	0.0016	0.0012	0.0007	0.0031	*2.55*	<0.0001	0.0008
Zirconium	0.0001		0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	<0.0001	<0.0001	0.0002	0.0002	<0.0001	<0.0001	0.00045	0.0001	0.0003	0.0003	0.0002	0.0004	0.0003	0.0003	0.0001	0.0004	0.0002	<0.0001	<0.0001	<0.0001
Calcium	0.05		28.7	25.8	26.6	27.35	19.6	21.7	28.5	25.1	15.35	27.1	17.1	30.3	67.5	26.4	23.15	28.0	20.3	22.5	20.1	20.7	14.7	15.2	19.0	26.8	16.3	24.7	<0.05	<0.05
Magnesium	0.05		10.4	9.37	9.22	8.56	6.44	5.91	8.27	7.09	3.095	5.64	5.55	8.60	14.1	6.83	9.08	8.39	7.07	8.33	6.02	7.01	5.41	5.55	5.74	8.99	5.19	6.91	<0.05	<0.05
Potassium	0.05		1.57	1.41	1.45	0.905	0.67	0.69	0.70	0.695	0.49	0.73	0.54	0.83	1.54	0.96	1.22	0.71	0.73	1.10	0.94	0.81	0.58	0.62	0.68	1.43	0.43	1.35	<0.05	<0.05
Sodium	0.05		2.93	2.89	2.81	3.51	3.10	1.85	1.80	1.825	4.185	3.11	2.83	3.09	4.73	2.92	2.785	1.83	3.33	3.07	3.22	3.76	2.90	2.96	2.82	2.53	0.90	2.92	<0.05	<0.05
Sulphur	10		19	16	17	13	<10	<10	11	11	17.5	21	<10	16	107	<10	12.5	12	<10	10	<10	<10	<10	<10	<10	14	<10	16	<10	<10

Note:
All units mg/L unless otherwise noted
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Guideline based on pH=8.5 and temperature=20ºC for total ammonia-N
b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L
c) $10^{(0.86[\log(hardness)]-3.2)}$
d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L
e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L
f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic	Results exceed CCME Aquatic Life Guidelines

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A1. Surface Water Quality Data, Casino Project, August 2011

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Britannia Creek D/S of Canadian Creek	W3 - Canadian Creek U/S of Britannia Creek	W4 - Mouth of Casino Creek*	W5 - Dip Creek D/S Casino	W6a - Yukon River D/S of Britannia Creek	W6b - Yukon River U/S of Britannia Creek	W6 - Yukon River D/S of Canadian Creek*	W7 - Upper Canadian Creek*	W8 - Upper Casino Creek	W9 - Dip Creek U/S of Casino Creek	W11 - Casino Creek (proposed dam)	W12 - Proctor Gulch	W13 - Meloy Creek	W14 - Mouth of Britannia Creek*	W15 - Island on Yukon River U/S from Excelsior Creek	W16 - Lower Reach of Dip Creek	W17 - Sunshine Creek	W18 - Brynelsen Creek	W19 - Dip Creek at Klotassin River	W20 - Klotass in River U/S of Dip Creek	W21 - Klotass in River D/S of Dip Creek	W22 - Upper Dip Creek	W23 - Excelsior Creek	W24 - Unnamed Casino Creek Tributary	W43 - Adit	Field Blank	Trip Blank
Date		CCME[1]	22-Aug-2011	22-Aug-2011	22-Aug-2011	23-Aug-2011	23-Aug-2011	22-Aug-2011	22-Aug-2011	22-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	22-Aug-2011	22-Aug-2011	23-Aug-2011	22-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	23-Aug-2011	22-Aug-2011	23-Aug-2011	23-Aug-2011	22-Aug-2011	22-Aug-2011
Dissolved Metals																														
Aluminum	0.0002		0.0524	0.0598	0.0320	0.0631	0.0493	0.0277	0.0488	0.03825	0.0324	0.0923	0.0404	0.0777	5.71	0.0218	0.1075	0.0449	0.0517	0.0488	0.0400	0.0389	0.0338	0.0373	0.0256	0.107	0.0395	0.0038	0.0007	<0.0002
Antimony	0.00002		0.00031	0.00034	0.00040	0.000135	0.00010	0.00009	0.00013	0.00011	0.00006	0.00009	0.00007	0.00013	0.00004	0.00019	0.00027	0.00012	0.00010	0.00024	0.00016	0.00008	0.00005	0.00005	0.00007	0.00044	0.00030	0.00180	<0.00002	<0.00002
Arsenic	0.00002		0.00057	0.00063	0.00083	0.000515	0.00038	0.00048	0.00054	0.00051	0.00022	0.00024	0.00040	0.00067	0.00031	0.00071	0.000605	0.00050	0.00049	0.00060	0.00050	0.00056	0.00037	0.00039	0.00033	0.00076	0.00060	0.00031	0.00004	<0.00002
Barium	0.00002		0.0533	0.0513	0.0456	0.05085	0.0442	0.0373	0.0443	0.0408	0.04905	0.0451	0.0411	0.0538	0.0260	0.0800	0.0649	0.0429	0.0426	0.0624	0.0408	0.0417	0.0271	0.0319	0.0586	0.0420	0.0386	0.0607	<0.00002	0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	0.00029	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00001	0.00001	<0.00001	0.00002	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005		<0.000005	0.000013	0.000013	0.0000155	0.000009	0.000007	0.000027	0.000017	0.0001875	0.000131	<0.000005	0.000028	0.00162	0.000028	0.00001	0.000021	0.000016	<0.000005	0.000009	0.000007	<0.000005	0.000006	<0.000005	<0.000005	<0.000005	0.0415	<0.000005	<0.000005
Chromium	0.0001		0.0003	0.0003	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.00015	<0.0001	0.0002	<0.0001	0.0003	<0.0001	0.0004	<0.0001	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0001	0.0004	0.0003	<0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000056	0.000070	0.000051	0.000107	0.000052	0.000016	0.000021	0.0000185	0.0000625	0.00207	0.000038	0.000307	0.0238	0.000015	0.000815	0.000028	0.000043	0.000041	0.000069	0.000044	0.000025	0.000080	0.000047	0.000071	0.000029	0.000488	<0.000005	<0.000005
Copper	0.00005		0.00248	0.00246	0.00282	0.00604	0.00292	0.00098	0.00107	0.001025	0.00205	0.0284	0.00107	0.0102	0.559	0.00077	0.001885	0.00112	0.00248	0.00162	0.00104	0.00224	0.00157	0.00176	0.00066	0.00184	0.00133	0.0555	<0.00005	<0.00005
Iron	0.001		0.040	0.047	0.025	0.059	0.059	0.023	0.035	0.029	0.013	0.197	0.065	0.078	1.05	0.013	0.076	0.053	0.106	0.050	0.040	0.241	0.092	0.157	0.050	0.076	0.026	0.011	0.001	<0.001
Lead	0.000005		0.000015	0.000022	0.000010	0.000113	0.000054	0.000054	0.000032	0.000043	0.000014	0.000058	0.000017	0.000197	0.00108	0.000265	0.0000185	0.000030	0.000045	0.000031	0.000013	0.000057	0.000020	0.000025	0.000007	0.000027	0.000012	0.0126	<0.000005	<0.000005
Lithium	0.0005		0.0006	<0.0005	<0.0005	0.0012	0.0015	0.0012	0.0019	0.00155	0.0006	0.0008	0.0017	0.0009	0.0036	0.0008	0.0006	0.0018	0.0014	0.0007	0.0006	0.0010	<0.0005	0.0006	0.0013	0.0005	<0.0005	0.0018	<0.0005	<0.0005
Manganese	0.00005		0.00088	0.00142	0.00105	0.00696	0.00137	0.00049	0.00118	0.000835	0.004275	0.0617	0.00146	0.0221	0.701	0.00154	0.00198	0.00127	0.00080	0.00030	0.00538	0.00241	0.00084	0.0194	0.0120	0.00103	0.00019	1.08	<0.00005	<0.00005
Molybdenum	0.00005		0.00050	0.00065	0.00071	0.0011	0.00076	0.00112	0.00113	0.001125	0.000175	0.00021	0.00060	0.00057	<0.00005	0.00051	0.00037	0.00117	0.00072	0.00055	0.00098	0.00099	0.00078	0.00066	0.00036	0.00045	0.00030	0.00035	<0.00005	<0.00005
Nickel	0.00002		0.00076	0.00073	0.00081	0.000325	0.00033	0.00075	0.00133	0.00104	0.001075	0.00079	0.00037	0.00031	0.00432	0.00016	0.00063	0.00146	0.00050	0.00053	0.00028	0.00074	0.00070	0.00074	0.00024	0.00065	0.00054	0.00060	<0.00002	<0.00002
Selenium	0.00004		0.00014	0.00012	0.00012	0.000095	0.00006	0.00027	0.00048	0.000375	0.000085	0.00009	<0.00004	0.00015	0.00019	0.00005	0.000105	0.00047	0.00009	0.00009	0.00006	0.00009	0.00015	0.00012	0.00004	0.00011	0.00036	<0.00004	<0.00004	<0.00004
Silicon	0.1		4.6	4.8	5.1	5.4	4.9	2.9	3.0	2.95	8.9	5.8	4.8	5.1	10.0	4.8	4.15	3.0	4.8	4.4	5.0	4.9	4.6	4.9	5.1	4.1	2.6	5.4	<0.1	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	0.000009	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000022	<0.000005	<0.000005	<0.000005	<0.000005	0.000006	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000090	<0.000005	<0.000005
Strontium	0.00005		0.185	0.169	0.163	0.1725	0.147	0.110	0.131	0.1205	0.09375	0.177	0.133	0.184	0.215	0.163	0.179	0.127	0.140	0.147	0.118	0.132	0.118	0.123	0.155	0.174	0.0443	0.230	0.00006	<0.00005
Thallium	0.000002		0.000004	0.000003	0.000004	0.0000225	0.000004	0.000003	0.000004	0.0000035	0.0000025	0.000007	0.000002	0.000003	0.000055	0.000002	0.0000045	0.000005	0.000002	0.000004	0.000003	<0.000002	<0.000002	<0.000002	<0.000002	0.000004	0.000005	0.000026	<0.000002	<0.000002
Tin	0.00001		0.00002	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0005		0.0009	0.0011	0.0009	0.0007	0.0008	0.0008	0.0016	0.0012	0.0007	0.0009	0.0012	0.0007	0.0007	0.0008	0.00165	0.0016	0.0014	0.0011	0.0010	0.0017	0.0011	0.0009	<0.0005	0.0011	0.0011	0.0010	<0.0005	<0.0005
Uranium	0.000002		0.00788	0.00731	0.00780	0.007305	0.00533	0.000952	0.000994	0.000973	0.000049	0.00157	0.00460	0.00843	0.00781	0.00655	0.00418	0.00112	0.00460	0.00201	0.00350	0.00344	0.000336	0.000915	0.00398	0.00682	0.000278	0.000813	0.000007	<0.000002
Vanadium	0.0002		0.0006	0.0006	0.0004	0.0008	0.0008	0.0006	0.0005	0.00055	0.0006	0.0002	0.0008	0.0006	<0.0002	0.0003	0.0008	0.0006	0.0012	0.0008	0.0010	0.0011	0.0008	0.0007	0.0006	0.0008	0.0004	<0.0002	0.0003	<0.0002
Zinc	0.0001		0.0012	0.0006	0.0006	0.00075	0.0012	0.0006	0.0012	0.0009	0.0128	0.0063	0.0002	0.0013	0.113	0.0011	0.0005	0.0012	0.0003	0.0004	0.0005	0.0007	0.0003	0.0007	0.0004	0.0003	0.0004	2.26	0.0005	<0.0001
Zirconium	0.0001		0.0003	0.0003	0.0002	0.0002	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	0.0001	<0.0001	<0.0001	0.0005	<0.0001	0.0003	0.0002	0.0002	0.0004	0.0002	0.0002	0.0002	0.0004	0.0002	<0.0001	<0.0001	<0.0001
Calcium	0.05		27.7	26.2	26.5	28.05	20.0	21.0	26.2	23.6	14.65	25.1	16.9	28.0	68.8	23.6	22.2	26.2	19.4	22.9	19.2	20.0	14.0	15.6	18.6	26.6	14.4	24.7	0.22	<0.05
Magnesium	0.05		10.8	9.32	9.33	8.48	6.49	5.99	8.18	7.085	3.11	5.61	5.61	8.42	14.2	6.84	9.365	8.22	7.10	8.29	5.92	6.86	5.14	5.72	5.68	8.74	5.41	6.81	<0.05	<0.05
Potassium	0.05		1.63	1.39	1.48	0.915	0.68	0.71	0.72	0.715	0.49	0.73	0.56	0.81	1.54	0.95	1.3	0.70	0.73	1.04	0.92	0.77	0.55	0.62	0.70	1.35	0.45	1.36	<0.05	<0.05
Sodium	0.05		3.07	2.88	2.87	3.57	3.07	1.89	1.84	1.865	4.21	3.09	2.93	3.10	4.72	2.98	2.875	1.83	3.32	3.07	3.19	3.67	2.76	3.09	2.82	2.55	0.90	2.89	<0.05	<0.05
Sulphur	10		18	15	16	12	<10	<10	10	10	17.5	19	<10	16	108	<10	12.5	10	<10	<10	<10	<10	<10	<10	<10	14	<10	16	<10	<10
Misc. Inorganics																														
Acidity (pH 4.5)	0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	33.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acidity (pH 8.3)	0.5		2.0	2.2	1.6	1.65	2.5	1.0	1.2	1.1	1	2.2	1.3	2.3	69.6	1.9	1.8	1.0	1.1	2.0	1.4	1.6	1.7	1.6	2.1	1.9	1.8	15.2	<0.5	<0.5
Bromide	0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Fluoride	0.01		0.09	0.08	0.08	0.07	0.06	0.11	0.12	0.115	0.07	0.10	0.05	0.08	0.20	0.05	0.08	0.12	0.06	0.07	0.04	0.07	0.14	0.12	0.05	0.07	0.06	0.08	<0.01	<0.01
Weak Acid Dissoc. Cyanide	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0012	<0.0005	<0.0005	0.0014	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0016	<0.0005	<0.0005	<0.0005	0.0007
Cyanide + Thiocyanate	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	0.0012	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0014	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Hardness	10		113	104	104	105	77	77	99	88	49.5	86	65	105	230	87	94	99	78	91	72	78	56	63	70	102	58	90	<10	<10
Dissolved Organic Carbon	0.5		11.3	11.1	6.9	6.3	7.2	4.5	4.7	4.6	3.05	4.1	7.8	3.5	2.4	3.6	13.2	4.7	8.7	11.3	6.2	10.2	8.9	9.2	6.3	13.7	8.8	2.0	<0.5	0.9
Alkalinity	0.5		72	64	130	77.5	67	68	81	74.5	6	37	60	59	<0.5	82	65.5	81	68	67	72	67	53	57	65	64	40	59	1.8	1.1
Total Organic Carbon	0.5		9.7	10.9	8.8	6.35	7.2	4.7	4.8	4.75	3.15	5.2	7.9	6.1	2.5	3.6	14.7	4.8	8.8	11.5	7.1	11.1	8.5	9.3	5.9	14.0	9.2	2.0	<0.5	<0.5

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20ºC for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic Results exceed CCME Aquatic Life Guidelines

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A1. Surface Water Quality Data, Casino Project, October 2011

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Britannia Creek D/S of Canadian Creek	W3 - Canadian Creek U/S of Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek D/S Casino	W6a - Yukon River Downstream of Britannia Creek	W6b - Yukon River Upstream of Britannia Creek	W7 - Upper Canadian Creek*	W8 - Upper Casino Creek	W9 - Dip Creek U/S of Casino Creek	W11 - Casino Creek (proposed dam)	W12 - Proctor Gulch	W13 - Meloy Creek	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River U/S of Excelsior Creek	W16 - Lower Reach of Dip Creek*	W17 - Sunshine Creek	W18 - Brynelsen Creek	W19 - Dip Creek at Klotassin River	W20 - Klotassin River U/S of Dip Creek	W21 - Klotassin River D/S of Dip Creek	W22 - Upper Dip Creek	W23 - Excelsior Creek	W43 - Adit	PG1 - Casino Creek U/S of Proctor Gulch	PG2 - Proctor Gulch, 10m D/S of Casino Creek	PG3 - Proctor Gulch, 30m D/S of Casino Creek	PG4 - Proctor Gulch U/S of W12	R2 - Victor Creek	FIELD BLANK	TRAVEL BLANK
Date		**CCME[1]**	**6-Oct-11**	**6-Oct-11**	**6-Oct-11**	**4-Oct-11**	**5-Oct-11**	**5-Oct-11**	**5-Oct-11**	**6-Oct-11**	**10-Oct-11**	**4-Oct-11**	**4-Oct-11**	**7-Oct-11**	**4-Oct-11**	**6-Oct-11**	**5-Oct-11**	**4-Oct-11**	**5-Oct-11**	**3-Oct-11**	**4-Oct-11**	**4-Oct-11**	**4-Oct-11**	**5-Oct-11**	**5-Oct-11**	**7-Oct-11**	**7-Oct-11**	**7-Oct-11**	**7-Oct-11**	**7-Oct-11**	**4-Oct-11**	**7-Oct-11**	**6-Oct-11**
Physical Properties																																	
Conductivity (uS/cm)	1		391	362	334	288	235	216	218	151.5	265	196	317	1140	247	389	217	234	274	190	224	156	169	220	390	224	330	510	498	1220	160	2	1
pH		6.5-9.0	8.01	7.98	7.91	7.89	7.95	7.86	7.98	6.99	7.60	7.86	7.92	*3.16*	7.99	7.97	7.99	7.92	7.94	7.84	7.85	7.80	7.77	7.94	7.96	7.45	7.16	4.66	4.74	3.16	7.83	6.06	6.06
Total Suspended Solids	1		<1	<1	<1	4	<1	4	6	1.5	3	1	3		11	<1	5	2	<1	5	2	1	2	<1	<1	<1					1	<1	<1
Total Dissolved Solids	10		220	230	190	180	140	130	140	91	170	120	200	690	170	230	120	140	160	120	140	90	94	130	240	110	220	370	340	760	100	<10	<10
Turbidity	0.1		0.1	<0.1	0.1	0.9	0.4	2.2	2.7	0.15	3.3	0.3	1.8	19.5	1.3	0.1	2.9	0.55	0.3	0.2	1.1	0.3	0.4	0.2	0.1	0.3	2.4	8.2	6.8	10.8	0.1	<0.1	<0.1
Calculated Parameters																																	
Total Hardness (CaCO3)	0.5		185	167	153	133	107	101	100	52.45	109	90.8	151	388	119	180	100	109.5	128	84.0	105	72.7	76.6	102	187	99.5	-	-	-	-	73.6	<0.5	<0.5
Ion Balance	0.01		1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.05	1.0	0.98	0.99	1.0	0.97	1.1	0.96	0.98	1.0	1.0	1.0	1.0	1.0	0.99	1.0	1.1	-	-	-	-	0.98	0.05	0.04
Nitrate	0.002		0.356	0.343	0.305	0.209	0.192	<0.002	0.005	<0.002	0.119	0.190	0.265	0.042	0.360	0.390	<0.002	0.133	0.282	0.190	0.088	0.008	<0.002	0.254	0.443	0.152	0.090	0.066	0.070	0.019	0.172	<0.002	<0.002
Dissolved Anions & Nutrients																																	
Orthophosphate	0.001		0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.007	0.003	0.003	0.004	0.004	0.002	0.002	0.0035	0.003	0.003	0.005	0.004	0.003	0.003	0.006	0.003	0.004	0.004	0.003	0.010	0.002	0.001	<0.001
Dissolved Sulphate	0.5		91	78	72	44	28	28	29	51.5	73	16	63	500	27	81	29	28.5	41	29	25	14	17	9.2	94	36	140	210	190	560	14	<0.5	<0.5
Dissolved Chloride	0.5		0.6	0.7	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5
Ammonia	0.005	0.137[a]	0.026	0.025	0.020	0.033	0.017	0.019	0.023	0.02	0.025	0.079	0.048	0.18	0.045	0.047	0.020	0.027	0.021	0.020	0.027	0.021	0.025	0.021	0.025	0.015	ND	ND	ND	ND	0.016	0.006	0.005
Total Kjeldahl Nitrogen	0.02		0.25	0.26	0.30	0.20	0.17	0.11	0.12	0.1	0.09	0.23	0.17	0.26	0.24	0.34	0.11	0.31	0.26	0.24	0.22	0.36	0.23	0.16	0.31	0.07	0.14	0.16	0.17	0.17	0.20	<0.02	<0.02
Nitrate plus Nitrite	0.002	2.9	0.356	0.343	0.305	0.209	0.192	<0.002	0.005	<0.002	0.119	0.19	0.265	0.042	0.36	0.39	<0.002	0.133	0.282	0.19	0.088	0.008	<0.002	0.254	0.443	0.152	0.09	0.066	0.07	0.022	0.172	<0.002	<0.002
Nitrite	0.002	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002
Total Nitrogen	0.02		0.61	0.60	0.60	0.41	0.36	0.11	0.13	0.1	0.21	0.42	0.43	0.30	0.60	0.73	0.11	0.45	0.54	0.43	0.30	0.37	0.23	0.42	0.76	0.22	0.23	0.22	0.24	0.20	0.37	<0.02	<0.02
Total Metals																																	
Aluminum	0.0002	0.005-0.1[b]	0.0206	0.0262	0.0187	0.0843	0.0327	*0.116*	*0.120*	0.0267	0.421	0.0345	*0.150*	*10.6*	*0.135*	0.0383	*0.116*	0.0521	0.0218	0.0801	0.0518	0.0462	0.0354	0.0161	0.0380	0.0068	-	-	-	-	0.0344	0.0041	0.0008
Antimony	0.00002		0.00026	0.00027	0.00031	0.00013	0.00008	0.00010	0.00011	0.00004	0.00008	0.00007	0.00014	0.00017	0.00019	0.00020	0.00011	0.00008	0.00023	0.00014	0.00008	0.00003	0.00004	0.00006	0.00034	0.00237	-	-	-	-	0.00003	<0.00002	<0.00002
Arsenic	0.00002	0.005	0.00043	0.00050	0.00054	0.00056	0.00033	0.00051	0.00052	0.000165	0.00029	0.00030	0.00087	0.00065	0.00110	0.00046	0.00049	0.000485	0.00052	0.00050	0.00090	0.00033	0.00039	0.00026	0.00070	0.00057	-	-	-	-	0.00021	<0.00002	<0.00002
Barium	0.00002		0.0757	0.0786	0.0646	0.0715	0.0594	0.0477	0.0482	0.04985	0.0563	0.0572	0.0754	0.0104	0.0972	0.0937	0.0475	0.063	0.0808	0.0500	0.0642	0.0401	0.0437	0.0786	0.0657	0.0497	-	-	-	-	0.0498	0.00015	<0.00002
Beryllium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00003	<0.00001	0.00001	0.00049	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	-	-	-	-	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	<0.05	<0.05	<0.05
Cadmium	0.000005	0.000017[c]	0.000013	0.000013	0.000023	0.000034	0.000013	*0.000064*	*0.000071*	*0.000158*	0.000186	0.000007	*0.000080*	*0.00276*	*0.000081*	0.000013	*0.000064*	0.0000105	0.000014	0.000013	0.000013	0.000011	0.000009	<0.000005	0.000009	*0.0402*	-	-	-	-	<0.000005	<0.000005	<0.000005
Chromium	0.0001	0.001	0.0001	0.0001	<0.0001	0.0002	<0.0001	0.0002	0.0002	<0.0001	<0.0001	0.0001	0.0001	0.0007	0.0004	0.0003	0.0002	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	<0.0001	0.0001	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001
Cobalt	0.000005		0.000046	0.000044	0.000045	0.000186	0.000093	0.000123	0.000128	0.0000285	0.00219	0.000065	0.000528	0.0469	0.000135	0.000045	0.000108	0.0001235	0.000034	0.000077	0.000207	0.000116	0.000120	0.000066	0.000042	0.000221	-	-	-	-	0.000041	<0.000005	<0.000005
Copper	0.00005	0.002-0.004[d]	0.00193	0.00183	0.00207	*0.00673*	*0.00275*	0.00116	0.00106	0.001355	0.0506	0.00088	*0.0159*	*0.911*	0.00104	0.00147	0.00111	*0.002105*	0.00144	0.00081	0.00164	0.00119	0.00121	0.00052	0.00145	*0.0524*	-	-	-	-	0.00094	0.00009	<0.00005
Iron	0.001	0.3	0.020	0.029	0.021	0.188	0.078	0.185	0.187	0.0285	0.693	0.084	0.360	31.1	0.219	0.033	0.186	0.198	0.026	0.121	0.755	0.200	0.260	0.077	0.024	0.035	-	-	-	-	0.044	0.003	<0.001
Lead	0.000005	0.001-0.007[e]	0.000019	0.000042	0.000009	0.000267	0.000060	0.000129	0.000127	0.000039	0.000207	0.000049	0.000588	0.00122	*0.00451*	0.000013	0.000112	0.0000965	0.000055	0.000079	0.000074	0.000031	0.000034	0.000012	0.000008	*0.00854*	-	-	-	-	0.000015	0.000131	0.000007
Lithium	0.0005		0.0007	0.0007	<0.0005	0.0014	0.0018	0.0017	0.0019	0.00055	0.0009	0.0023	0.0015	0.0058	0.0013	0.0009	0.0018	0.0016	0.0008	0.0008	0.0011	<0.0005	<0.0005	0.0024	0.0006	0.0018	-	-	-	-	0.0009	<0.0005	<0.0005
Manganese	0.00005		0.00213	0.00497	0.00546	0.0252	0.0205	0.0142	0.0135	0.0013	0.0608	0.0254	0.0490	1.15	0.0321	0.00479	0.0131	0.03815	0.00506	0.00677	0.0965	0.0342	0.0439	0.0531	0.00347	0.358	-	-	-	-	0.00573	0.00019	<0.00005
Molybdenum	0.00005	0.073	0.00078	0.00080	0.00088	0.00116	0.00088	0.00105	0.00104	0.00026	0.00023	0.00071	0.00061	0.00032	0.00053	0.00054	0.00114	0.00095	0.00040	0.00127	0.00101	0.00062	0.00071	0.00043	0.00041	<0.00005	-	-	-	-	0.00087	<0.00005	<0.00005
Nickel	0.00002	0.025-0.15[f]	0.00065	0.00057	0.00067	0.00032	0.00029	0.00228	0.00217	0.000735	0.00071	0.00034	0.00041	0.00736	0.00039	0.00061	0.00235	0.00043	0.00046	0.00027	0.00060	0.00061	0.00058	0.00024	0.00059	0.00054	-	-	-	-	0.00037	<0.00002	<0.00002
Selenium	0.00004	0.001	0.00015	0.00010	0.00006	0.00007	<0.00004	0.00046	0.00045	<0.00004	<0.00004	<0.00004	0.00014	0.00025	<0.00004	0.00008	0.00047	<0.00004	<0.00004	<0.00004	<0.00004	0.00009	0.00007	<0.00004	0.00016	<0.00004	-	-	-	-	<0.00004	<0.00004	<0.00004
Silicon	0.1		4.8	4.7	4.9	5.8	5.3	3.1	3.0	9.85	6.3	5.1	6.1	10.1	6.0	4.4	3.0	5.15	4.5	5.6	5.1	4.6	4.4	5.7	4.1	5.9	-	-	-	-	4.4	<0.1	<0.1
Silver	0.000005	0.0001	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	0.000024	0.000018	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	*0.000127*	-	-	-	-	<0.000005	<0.000005	<0.000005
Strontium	0.00005		0.303	0.306	0.248	0.231	0.209	0.129	0.132	0.106	0.247	0.192	0.264	0.355	0.213	0.363	0.131	0.199	0.212	0.129	0.181	0.148	0.153	0.239	0.342	0.249	-	-	-	-	0.155	0.00006	<0.00005
Thallium	0.000002	0.0008	0.000003	0.000002	0.000002	0.000003	0.000003	0.000004	0.000004	<0.000002	0.000007	0.000003	0.000003	0.000085	0.000005	0.000003	0.000004	0.000003	0.000002	0.000004	<0.000002	<0.000002	<0.000002	0.000002	0.000003	0.000024	-	-	-	-	<0.000002	<0.000002	<0.000002
Tin	0.00001		0.00009	0.00008	0.00004	<0.00001	0.00006	0.00005	0.00004	0.000045	0.00008	<0.00001	<0.00001	0.00007	<0.00001	0.00006	0.00007	<0.00001	0.00007	<0.00001	<0.00001	<0.00001	<0.00001	0.00005	0.00007	0.00012	-	-	-	-	<0.00001	0.00010	0.00008
Titanium	0.0005		<0.0005	0.0010	<0.0005	0.0028	0.0007	0.0021	0.0021	0.0009	<0.0005	0.0013	0.0022	0.0016	0.0088	0.0008	0.0034	0.0022	<0.0005	0.0043	0.0022	0.0017	0.0014	<0.0005	0.0006	<0.0005	-	-	-	-	0.0010	<0.0005	<0.0005
Uranium	0.000002		0.0182	0.0190	0.0152	0.0102	0.00857	0.00107	0.00111	0.000042	0.00263	0.00783	0.0130	0.0132	0.0101	0.0128	0.00120	0.007565	0.00303	0.00417	0.00580	0.000351	0.00135	0.00844	0.0141	0.00110	-	-	-	-	0.00394	<0.000002	<0.000002
Vanadium	0.0002		0.0003	0.0003	<0.0002	0.0005	0.0004	0.0006	0.0005	0.0002	<0.0002	0.0005	0.0004	0.0007	0.0007	0.0004	0.0006	0.0006	0.0003	0.0006	0.0011	0.0006	0.0006	0.0002	0.0003	<0.0002	-	-	-	-	0.0003	<0.0002	<0.0002
Zinc	0.0001	0.03	0.0008	0.0005	0.0007	0.0025	0.0010	0.0051	0.0051	0.01345	0.0148	0.0005	0.0053	*0.211*	0.0059	0.0008	0.0053	0.00155	0.0007	0.0008	0.0005	0.0005	0.0004	0.0003	0.0004	*2.53*	-	-	-	-	0.0006	0.0010	0.0002
Zirconium	0.0001		0.0002	0.0002	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	0.0001	0.0001	<0.0001	0.0002	0.0001	0.0002	<0.0001	0.0002	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001
Calcium	0.05		46.5	41.1	39.6	34.2	28.0	27.1	26.9	15.7	31.8	22.8	39.9	116	32.6	42.3	26.8	27.5	31.6	22.1	25.9	17.8	18.5	27.0	47.6	27.4	-	-	-	-	17.4	<0.05	<0.05
Magnesium	0.05		16.8	15.8	13.1	11.5	9.04	8.07	8.02	3.215	7.08	8.22	12.5	24.0	9.14	17.9	8.04	9.92	12.0	7.00	9.73	6.85	7.38	8.39	16.6	7.57	-	-	-	-	7.35	<0.05	<0.05
Potassium	0.05		2.14	2.03	1.97	1.16	0.86	0.73	0.70	0.53	0.84	0.77	1.07	2.01	1.15	1.99	0.72	0.99	1.26	1.08	1.07	0.72	0.80	0.88	1.91	1.38	-	-	-	-	0.63	<0.05	<0.05
Sodium	0.05		4.39	4.59	4.06	4.61	4.11	1.80	1.73	4.43	3.73	4.01	3.99	6.97	3.61	5.02	1.77	4.455	3.94	3.47	5.19	3.28	3.67	3.85	3.86	3.12	-	-	-	-	2.89	<0.05	<0.05
Sulphur	10		33	28	26	18	10	10	11	17.5	28	<10	25	183	<10	29	10	12	16	11	11	<10	<10	<10	32	15	-	-	-	-	<10	<10	<10

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20ºC for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic — Results exceed CCME Aquatic Life Guidelines

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A1. Surface Water Quality Data, Casino Project, October 2011

Station	Detection Limits	Water Quality Guidelines	W1 - Mouth of Canadian Creek	W2 - Britannia Creek D/S of Canadian Creek	W3 - Canadian Creek U/S of Britannia Creek	W4 - Mouth of Casino Creek	W5 - Dip Creek D/S Casino	W6a - Yukon River Downstream of Britannia Creek	W6b - Yukon River Upstream of Britannia Creek	W7 - Upper Canadian Creek*	W8 - Upper Casino Creek	W9 - Dip Creek U/S of Casino Creek	W11 - Casino Creek (proposed dam)	W12 - Proctor Gulch	W13 - Meloy Creek	W14 - Mouth of Britannia Creek	W15 - Island on Yukon River U/S of Excelsior Creek	W16 - Lower Reach of Dip Creek*	W17 - Sunshine Creek	W18 - Brynelsen Creek	W19 - Dip Creek at Klotassin River	W20 - Klotassin River U/S of Dip Creek	W21 - Klotassin River D/S of Dip Creek	W22 - Upper Dip Creek	W23 - Excelsior Creek	W43 - Adit	PG1 - Casino Creek U/S of Proctor Gulch	PG2 - Proctor Gulch, 10m D/S of Casino Creek	PG3 - Proctor Gulch, 30m D/S of Casino Creek	PG4 - Proctor Gulch U/S of W12	R2 - Victor Creek	FIELD BLANK	TRAVEL BLANK
Date		CCME[1]	6-Oct-11	6-Oct-11	6-Oct-11	4-Oct-11	5-Oct-11	5-Oct-11	5-Oct-11	6-Oct-11	10-Oct-11	4-Oct-11	4-Oct-11	7-Oct-11	4-Oct-11	6-Oct-11	5-Oct-11	4-Oct-11	5-Oct-11	3-Oct-11	4-Oct-11	4-Oct-11	4-Oct-11	5-Oct-11	5-Oct-11	7-Oct-11	7-Oct-11	7-Oct-11	7-Oct-11	7-Oct-11	4-Oct-11	7-Oct-11	6-Oct-11
Dissolved Metals																																	
Aluminum	0.0002		0.0202	0.0233	0.0138	0.0187	0.0157	0.0210	0.0198	0.0142	0.0508	0.0166	0.0257	10.4	0.0054	0.0321	0.0224	0.0201	0.0181	0.0186	0.0189	0.0144	0.0135	0.0107	0.0356	0.0055	-	-	-	-	0.0225	0.0016	0.0011
Antimony	0.00002		0.00027	0.00027	0.00030	0.00016	0.00009	0.00010	0.00010	0.00004	0.00008	0.00007	0.00014	0.00017	0.00017	0.00020	0.00010	0.00008	0.00024	0.00014	0.00008	0.00003	0.00004	0.00006	0.00035	0.00238	-	-	-	-	0.00003	<0.00002	<0.00002
Arsenic	0.00002		0.00047	0.00055	0.00057	0.00048	0.00034	0.00042	0.00039	0.000145	0.00018	0.00029	0.00072	0.00049	0.00099	0.00051	0.00040	0.00043	0.00050	0.00037	0.00075	0.00031	0.00040	0.00025	0.00071	0.00034	-	-	-	-	0.00020	<0.00002	<0.00002
Barium	0.00002		0.0850	0.0806	0.0715	0.0705	0.0637	0.0459	0.0460	0.05285	0.0615	0.0583	0.0746	0.0109	0.0896	0.103	0.0472	0.06095	0.0882	0.0490	0.0632	0.0382	0.0425	0.0822	0.0701	0.0550	-	-	-	-	0.0501	0.00003	0.00002
Beryllium	0.00001		<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00052	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.00001	<0.00001	<0.00001
Bismuth	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	-	-	-	-	<0.000005	<0.000005	<0.000005
Boron	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	<0.05	<0.05	<0.05
Cadmium	0.000005		0.000015	0.000022	0.000021	0.000027	0.000013	0.000035	0.000034	0.000159	0.000164	0.000006	0.000062	0.00284	0.000048	0.000010	0.000029	0.0000075	0.000011	0.000006	0.000010	0.000008	0.000010	0.000005	0.000011	0.0411	-	-	-	-	<0.000005	<0.000005	<0.000005
Chromium	0.0001		0.0001	0.0001	0.0002	0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	0.0001	<0.0001	0.0007	<0.0001	0.0002	<0.0001	0.0001	<0.0001	0.0002	0.0002	0.0002	0.0002	<0.0001	0.0002	0.0003	-	-	-	-	0.0005	<0.0001	<0.0001
Cobalt	0.000005		0.000047	0.000049	0.000045	0.000149	0.000075	0.000022	0.000022	0.000022	0.00230	0.000045	0.000488	0.0493	0.000017	0.000055	0.000027	0.0000915	0.000038	.000031 (2)	0.000160	0.000083	0.000085	0.000061	0.000050	0.000226	-	-	-	-	0.000037	<0.000005	<0.000005
Copper	0.00005		0.00194	0.00187	0.00209	0.00412	0.00209	0.00078	0.00097	0.00144	0.0166	0.00081	0.00768	0.945	0.00047	0.00155	0.00083	0.0017	0.00121	0.00070	0.00140	0.00121	0.00117	0.00043	0.00155	0.0515	-	-	-	-	0.00093	<0.00005	0.00005
Iron	0.001		0.015	0.018	0.013	0.043	0.040	0.027	0.027	0.0055	0.118	0.043	0.077	31.9	0.008	0.029	0.028	0.1175	0.021	0.014	0.585	0.123	0.191	0.058	0.021	0.034	-	-	-	-	0.024	<0.001	<0.001
Lead	0.000005		0.000055	0.000013	0.000005	0.000049	0.000018	0.000018	0.000020	0.000011	0.000093	<0.000005	0.000249	0.00105	0.000131	0.000008	0.000022	0.000021	0.000010	0.000007	0.000021	0.000026	0.000314	0.000021	0.000005	0.0118	-	-	-	-	0.000019	0.000007	0.000007
Lithium	0.0005		0.0009	0.0008	<0.0005	0.0014	0.0019	0.0018	0.0018	0.00075	0.0009	0.0025	0.0014	0.0059	0.0011	0.0008	0.0017	0.0016	0.0009	0.0007	0.0012	<0.0005	0.0005	0.0027	0.0006	0.0021	-	-	-	-	0.0011	<0.0005	<0.0005
Manganese	0.00005		0.00211	0.00482	0.00529	0.0233	0.0201	0.00240	0.00246	0.000915	0.0621	0.0238	0.0468	1.23	0.0211	0.00492	0.00256	0.03525	0.00448	0.00476	0.0829	0.0340	0.0438	0.0539	0.00339	0.368	-	-	-	-	0.00497	<0.00005	<0.00005
Molybdenum	0.00005		0.00086	0.00088	0.00093	0.00124	0.00093	0.00116	0.00109	0.000285	0.00026	0.00084	0.00062	0.00031	0.00058	0.00060	0.00107	0.000975	0.00045	0.00136	0.00104	0.00066	0.00070	0.00049	0.00042	0.00009	-	-	-	-	0.00095	<0.00005	<0.00005
Nickel	0.00002		0.00066	0.00059	0.00068	0.00033	0.00024	0.00185	0.00186	0.000745	0.00077	0.00030	0.00038	0.00780	0.00015	0.00055	0.00181	0.000375	0.00052	0.00019	0.00056	0.00061	0.00062	0.00022	0.00064	0.00058	-	-	-	-	0.00058	<0.00002	<0.00002
Selenium	0.00004		0.00015	0.00010	0.00007	0.00004	<0.00004	0.00047	0.00050	<0.00004	<0.00004	<0.00004	0.00013	0.00026	<0.00004	0.00010	0.00047	<0.00004	<0.00004	<0.00004	<0.00004	0.00008	0.00006	<0.00004	0.00018	<0.00004	-	-	-	-	<0.00004	<0.00004	<0.00004
Silicon	0.1		4.8	5.0	5.3	5.8	5.3	3.2	3.1	10.25	6.7	4.8	5.8	10.4	5.4	5.0	3.0	5.05	4.5	5.7	4.9	4.3	4.5	5.7	4.4	5.9	-	-	-	-	4.5	<0.1	<0.1
Silver	0.000005		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000022	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000023	-	-	-	-	<0.000005	<0.000005	<0.000005
Strontium	0.00005		0.323	0.305	0.258	0.232	0.207	0.130	0.132	0.1095	0.249	0.197	0.268	0.357	0.205	0.371	0.132	0.197	0.219	0.131	0.185	0.149	0.153	0.245	0.349	0.255	-	-	-	-	0.159	<0.00005	<0.00005
Thallium	0.000002		0.000002	<0.000002	0.000002	0.000003	<0.000002	0.000002	0.000002	0.000003	0.000005	<0.000002	0.000003	0.000092	<0.000002	0.000003	0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000002	0.000027	-	-	-	-	<0.000002	<0.000002	<0.000002
Tin	0.00001		0.00008	0.00006	0.00005	<0.00001	0.00006	0.00008	0.00006	0.00007	0.00008	<0.00001	<0.00001	0.00007	<0.00001	0.0001	0.00008	<0.00001	0.00008	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00006	0.00008	-	-	-	-	0.00002	0.00005	0.00009
Titanium	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	<0.0005	<0.0005	<0.0005
Uranium	0.000002		0.0192	0.0192	0.0157	0.0101	0.00858	0.00108	0.00107	0.0000455	0.00210	0.00816	0.0131	0.0136	0.00933	0.0134	0.00113	0.00749	0.00308	0.00419	0.00580	0.000341	0.00131	0.00868	0.0141	0.00127	-	-	-	-	0.00396	<0.000002	<0.000002
Vanadium	0.0002		0.0003	0.0003	0.0002	0.0004	0.0004	0.0002	0.0002	0.0003	<0.0002	0.0004	0.0002	0.0006	<0.0002	0.0005	0.0003	0.0005	0.0003	0.0004	0.0008	0.0005	0.0005	0.0002	0.0003	<0.0002	-	-	-	-	0.0003	<0.0002	<0.0002
Zinc	0.0001		0.0023	0.0007	0.0005	0.0022	0.0007	0.0017	0.0019	0.01315	0.0105	0.0002	0.0044	0.213	0.0030	0.0003	0.0020	0.00045	0.0005	0.0002	0.0003	0.0004	0.0005	0.0009	0.0003	2.45	-	-	-	-	0.0005	0.0002	0.0002
Zirconium	0.0001		0.0002	0.0002	0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	0.0001	0.0002	<0.0001	0.0002	0.0001	0.0001	<0.0001	0.0003	<0.0001	-	-	-	-	0.0001	<0.0001	<0.0001
Calcium	0.05		45.4	42.8	41.2	34.7	27.8	28.1	28.4	15.75	34.7	21.9	38.8	117	31.1	45.5	26.5	27.1	31.5	23.5	25.4	16.9	18.6	26.4	49.3	27.3	-	-	-	-	17.4	<0.05	<0.05
Magnesium	0.05		17.4	16.9	14.5	11.5	9.57	8.37	8.41	3.445	7.47	8.28	12.5	25.9	9.17	19.4	8.52	10.06	12.2	7.02	9.67	7.33	7.59	9.03	17.6	7.80	-	-	-	-	7.49	<0.05	<0.05
Potassium	0.05		2.36	2.29	2.26	1.18	0.95	0.78	0.78	0.59	0.92	0.77	1.10	2.31	1.15	2.27	0.78	0.99	1.36	1.11	1.05	0.75	0.80	0.97	2.10	1.49	-	-	-	-	0.64	<0.05	<0.05
Sodium	0.05		4.57	4.89	4.31	4.71	4.22	1.82	1.80	4.675	3.83	4.09	4.17	7.45	3.67	5.35	1.84	4.52	4.04	3.54	5.14	3.40	3.70	4.01	4.10	3.26	-	-	-	-	2.97	<0.05	<0.05
Sulphur	10		35	33	29	19	11	12	13	20	30	<10	26	210	10	33	12	12	17	11	<10	<10	<10	<10	36	17	-	-	-	-	<10	<10	<10
Misc. Inorganics																																	
Acidity (pH 4.5)	0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	75.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	79.4	<0.5	<0.5	<0.5
Acidity (pH 8.3)	0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.3	<0.5	<0.5	<0.5	133	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.6	<0.5	<0.5	<0.5	4.6	2.9	28.8	27.3	147	0.9	<0.5	<0.5
Bromide	0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Fluoride	0.01		0.09	0.09	0.09	0.06	0.05	0.10	0.11	0.06	0.09	0.05	0.07	0.30	0.05	0.09	0.11	0.05	0.06	0.04	0.06	0.15	0.11	0.04	0.07	0.08	0.19	0.23	0.23	0.33	0.05	<0.01	<0.01
Weak Acid Dissoc. Cyanide	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	<0.0005	<0.0005	<0.0005
Cyanide + Thiocyanate	0.0005		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	<0.0005	<0.0005	<0.0005
Dissolved Hardness	0.5		185	176	162	134	109	105	105	53.5	117	88.8	148	397	115	193	101	109.5	129	87.7	103	72.3	77.7	103	196	100	-	-	-	-	74.4	<0.5	<0.5
Dissolved Organic Carbon	0.5		8.6	8.0	6.8	4.1	4.3	2.7	2.6	1.8	2.3	5.0	4.5	1.7	2.7	10.3	2.7	5.45	6.8	3.6	6.6	5.5	5.8	3.0	11.2	1.0	-	-	-	-	5.4	<0.5	<0.5
Alkalinity	0.5		100	97	89	98	89	79	80	8.7	46	83	94	<0.5	100	110	80	90.5	92	65	86	66	68	100	100	69	12	<0.5	<0.5	<0.5	68	0.6	0.6
Total Organic Carbon	0.5		8.3	8.0	6.4	4.5	4.2	2.9	3.2	1.85	2.1	5.2	4.8	2.0	2.6	10.7	2.4	5.6	7.7	3.7	6.7	4.9	6.2	4.1	10.2	1.0	-	-	-	-	5.7	<0.5	<0.5

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Guideline based on pH=8.5 and temperature=20ºC for total ammonia-N

b) 0.005 mg/L at pH < 6.5, $[Ca^{2+}]$ < 4 mg/L, DOC < 2 mg/L: 0.1 mg/L at pH ≥ 6.5, $[Ca^{2+}]$ ≥ 4 mg/L, DOC ≥ 2 mg/L

c) $10^{(0.86[\log(hardness)]-3.2)}$

d) 0.002 mg/L at $[CaCO_3]$ = 0 - 120 mg/L; 0.003 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.004 mg/L at $[CaCO_3]$ > 180 mg/L

e) 0.001 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.002 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.004 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.007 mg/L at $[CaCO_3]$ > 180 mg/L

f) 0.025 mg/L at $[CaCO_3]$ = 0 - 60 mg/L; 0.065 mg/L at $[CaCO_3]$ = 60 - 120 mg/L; 0.110 mg/L at $[CaCO_3]$ = 120 - 180 mg/L; 0.150 mg/L at $[CaCO_3]$ > 180 mg/L

Italic Results exceed CCME Aquatic Life Guidelines

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A2. QA/QC: Field Replicates, March 2011

Surface Water Analysis Result (mg/L)							
Station	**W16**		**RPD**	**Station**	**W16**		**RPD**
Sampling Date	**29-Mar-11**		**%**	**Sampling Date**	**29-Mar-11**		**%**
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Conductivity (uS/cm)	284	281	1.1	Ammonia	0.009	0.009	0.0
pH	7.45	7.36	1.2	Total Kjeldahl Nitrogen	0.10	0.09	10.5
Total Suspended Solids	2	2	0.0	Nitrate plus Nitrite	0.274	0.271	1.1
Total Dissolved Solids	150	160	6.5	Nitrite	<0.002	<0.002	n/c
Turbidity	0.8	0.7	13.3	Total Nitrogen	0.38	0.36	5.4
Filter and HNO3 Preservation	FIELD	FIELD	n/c	Acidity (pH 4.5)	<0.5	<0.5	n/c
Total Hardness	133	134	0.7	Acidity (pH 8.3)	6.0	4.8	22.2
Ion Balance	1.1	1.1	0.0	Bromide	<0.4	<0.4	n/c
Nitrate	0.274	0.271	1.1	Fluoride	0.07	0.06	15.4
Orthophosphate	<0.001	<0.001	n/c	Weak Acid Dissoc. Cyanide	0.0012	0.0010	18.2
Dissolved Sulphate	30	29	3.4	Cyanide + Thiocyanate	0.0017	0.0014	19.4
Dissolved Chloride	0.8	0.9	11.8	Dissolved Hardness	136	136	0.0
Total Organic Carbon	3.6	3.7	2.7	Dissolved Organic Carbon	3.5	3.6	2.8
				Alkalinity	110	110	0.0
Total Metals				**Dissolved Metals**			
Aluminum	0.0207	0.0180	14.0	Aluminum	0.0062	0.0066	6.3
Antimony	0.00008	0.00008	0.0	Antimony	0.00007	0.00007	0.0
Arsenic	0.00044	0.00041	7.1	Arsenic	0.00034	0.00038	11.1
Barium	0.0846	0.0837	1.1	Barium	0.0822	0.0818	0.5
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000007	0.000012	**52.6**	Cadmium	0.000012	0.000016	**28.6**
Chromium	<0.0001	<0.0001	n/c	Chromium	<0.0001	<0.0001	n/c
Cobalt	0.000109	0.000112	2.7	Cobalt	0.000087	0.000091	4.5
Copper	0.00085	0.00085	0.0	Copper	0.00096	0.00083	14.5
Iron	0.193	0.184	4.8	Iron	0.108	0.104	3.8
Lead	0.000042	0.000042	0.0	Lead	0.000034	0.000006	**140.0**
Lithium	0.0014	0.0012	15.4	Lithium	0.0013	0.0013	0.0
Manganese	0.0538	0.0528	1.9	Manganese	0.0528	0.0517	2.1
Molybdenum	0.00085	0.00084	1.2	Molybdenum	0.00092	0.00088	4.4
Nickel	0.00046	0.00033	**32.9**	Nickel	0.00030	0.00030	0.0
Selenium	0.00005	0.00007	**33.3**	Selenium	0.00005	0.00005	0.0
Silicon	5.5	5.6	1.8	Silicon	5.5	5.6	1.8
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.240	0.233	3.0	Strontium	0.236	0.236	0.0
Thallium	<0.000002	<0.000002	n/c	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	<0.0005	<0.0005	n/c	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00770	0.00757	1.7	Uranium	0.00771	0.00765	0.8
Vanadium	0.0002	<0.0002	n/c	Vanadium	<0.0002	<0.0002	n/c
Zinc	0.0016	0.0015	6.5	Zinc	0.0011	0.0011	0.0
Zirconium	0.0001	0.0001	0.0	Zirconium	<0.0001	<0.0001	n/c
Calcium	33.6	33.6	0.0	Calcium	34.2	34.5	0.9
Magnesium	11.9	12.0	0.8	Magnesium	12.2	12.0	1.7
Potassium	1.13	1.11	1.8	Potassium	1.13	1.09	3.6
Sodium	5.61	5.62	0.2	Sodium	5.59	5.43	2.9
Sulphur	13	14	7.4	Sulphur	13	12	8.0

Notes:

Bold	Exceedes Data Quality objective of 25%.
Bold	Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.
RPD	Relative Percent Difference.
"n/c"	Not able to be calculated because one or both values not precisely known.
"<"	Less than detection limit.

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A2. QA/QC: Field Replicates, April 2011 W16

Surface Water Analysis Result (mg/L)							
Station	**W16**		**RPD**	**Station**	**W16**		**RPD**
Sampling Date	**29-Apr-11**		**%**	**Sampling Date**	**29-Apr-11**		**%**
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Conductivity (uS/cm)	293	291	0.7	Ammonia	0.006	0.007	15.4
pH	7.97	7.93	0.5	Total Kjeldahl Nitrogen	0.15	0.19	23.5
Total Suspended Solids	2	8	**120.0**	Nitrate plus Nitrite	0.124	0.126	1.6
Total Dissolved Solids	170	190	11.1	Nitrite	0.002	<0.002	n/c
Turbidity	2.4	2.1	13.3	Total Nitrogen	0.28	0.31	10.2
Filter and HNO3 Preservation	FIELD	FIELD	n/c	Acidity (pH 4.5)	<0.5	<0.5	n/c
Total Hardness	129	128	0.8	Acidity (pH 8.3)	<0.5	<0.5	n/c
Nitrate	0.122	0.126	3.2	Bromide	<0.4	<0.4	n/c
Orthophosphate	0.002	<0.001	n/c	Fluoride	0.06	0.06	0.0
Dissolved Sulphate	52	53	1.9	Weak Acid Dissoc. Cyanide	0.0010	0.0011	9.5
Dissolved Chloride	<0.5	0.5	n/c	Cyanide + Thiocyanate	0.0007	0.0006	15.4
Alkalinity	96	97	1.0	Dissolved Hardness	129	131	1.5
Total Organic Carbon	6.9	6.2	10.7	Dissolved Organic Carbon	6.5	5.9	9.7
Total Metals				**Dissolved Metals**			
Aluminum	0.135	0.0847	**45.8**	Aluminum	0.0098	0.0099	1.0
Antimony	0.00006	0.00006	0.0	Antimony	0.00005	0.00006	18.2
Arsenic	0.00060	0.00057	5.1	Arsenic	0.00035	0.00035	0.0
Barium	0.0688	0.0655	4.9	Barium	0.0628	0.0633	0.8
Beryllium	0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000043	0.000027	**45.7**	Cadmium	0.000022	0.000017	**25.6**
Chromium	0.0003	0.0002	**40.0**	Chromium	<0.0001	<0.0001	n/c
Cobalt	0.000213	0.000160	**28.4**	Cobalt	0.000075	0.000072	4.1
Copper	0.00167	0.00139	18.3	Copper	0.00095	0.00096	1.0
Iron	0.350	0.264	**28.0**	Iron	0.092	0.092	0.0
Lead	0.000450	0.000259	**53.9**	Lead	0.000009	0.000006	40.0
Lithium	0.0014	0.0013	7.4	Lithium	0.0014	0.0013	7.4
Manganese	0.0572	0.0523	8.9	Manganese	0.0445	0.0447	0.4
Molybdenum	0.00085	0.00083	2.4	Molybdenum	0.00089	0.00087	2.3
Nickel	0.00063	0.00054	15.4	Nickel	0.00037	0.00038	2.7
Selenium	0.00006	0.00006	0.0	Selenium	0.00006	0.00006	0.0
Silicon	4.4	4.4	0.0	Silicon	4.3	4.4	2.3
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.208	0.206	1.0	Strontium	0.209	0.211	1.0
Thallium	0.000003	<0.000002	n/c	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0055	0.0039	**34.0**	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00721	0.00692	4.1	Uranium	0.00692	0.00698	0.9
Vanadium	0.0009	0.0006	**40.0**	Vanadium	<0.0002	0.0002	n/c
Zinc	0.0025	0.0027	7.7	Zinc	0.0009	0.0009	0.0
Zirconium	0.0002	0.0001	**66.7**	Zirconium	<0.0001	<0.0001	n/c
Calcium	29.7	29.3	1.4	Calcium	29.4	29.9	1.7
Magnesium	13.3	13.4	0.7	Magnesium	13.5	13.7	1.5
Potassium	1.27	1.30	2.3	Potassium	1.31	1.34	2.3
Sodium	4.76	4.87	2.3	Sodium	4.90	4.94	0.8
Sulphur	18	20	10.5	Sulphur	19	19	0.0

Notes:

Bold	Exceedes Data Quality objective of 25%.
Bold	Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.
RPD	Relative Percent Difference.
"n/c"	Not able to be calculated because one or both values not precisely known.
"<"	Less than detection limit.

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A2. QA/QC: Field Replicates, April 2011 W18

Surface Water Analysis Result (mg/L)							
Station	**W18**		**RPD**	**Station**	**W18**		**RPD**
Sampling Date	**30-Apr-11**		**%**	**Sampling Date**	**30-Apr-11**		**%**
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Conductivity (uS/cm)	257	257	0.0	Ammonia	0.027	0.015	**57.1**
pH	7.84	7.86	0.3	Total Kjeldahl Nitrogen	0.29	0.30	3.4
Total Suspended Solids	1	1	0.0	Nitrate plus Nitrite	0.136	0.135	0.7
Total Dissolved Solids	170	170	0.0	Nitrite	<0.002	<0.002	n/c
Turbidity	1.1	1.0	9.5	Total Nitrogen	0.43	0.43	0.0
Filter and HNO3 Preservatio	FIELD	FIELD	n/c	Acidity (pH 4.5)	<0.5	<0.5	n/c
Total Hardness	116	115	0.9	Acidity (pH 8.3)	1.1	2.3	**70.6**
Nitrate	0.136	0.135	0.7	Bromide	<0.4	<0.4	n/c
Orthophosphate	0.001	0.002	**66.7**	Fluoride	0.06	0.06	0.0
Dissolved Sulphate	49	48	2.1	Weak Acid Dissoc. Cyanide	0.0006	0.0006	0.0
Dissolved Chloride	0.7	0.7	0.0	Cyanide + Thiocyanate	0.0007	0.0007	0.0
Alkalinity	84	83	1.2	Dissolved Hardness	124	125	0.8
Total Organic Carbon	10.2	10.3	1.0	Dissolved Organic Carbon	10.8	10.2	5.7
Total Metals				**Dissolved Metals**			
Aluminum	0.0676	0.0683	1.0	Aluminum	0.0363	0.0359	1.1
Antimony	0.00013	0.00013	0.0	Antimony	0.00011	0.00012	8.7
Arsenic	0.00059	0.00060	1.7	Arsenic	0.00059	0.00049	18.5
Barium	0.0529	0.0526	0.6	Barium	0.0556	0.0562	1.1
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000064	0.000071	10.4	Cadmium	0.000063	0.000063	0.0
Chromium	0.0001	0.0001	0.0	Chromium	0.0001	0.0001	0.0
Cobalt	0.000087	0.000084	3.5	Cobalt	0.000076	0.000073	4.0
Copper	0.00794	0.00804	1.3	Copper	0.00781	0.00730	6.8
Iron	0.056	0.055	1.8	Iron	0.044	0.042	4.7
Lead	0.000711	0.000706	0.7	Lead	0.000206	0.000188	9.1
Lithium	0.0013	0.0012	8.0	Lithium	0.0012	0.0014	15.4
Manganese	0.0269	0.0270	0.4	Manganese	0.0241	0.0231	4.2
Molybdenum	0.00090	0.00087	3.4	Molybdenum	0.00084	0.00088	4.7
Nickel	0.00046	0.00044	4.4	Nickel	0.00049	0.00044	10.8
Selenium	0.00009	0.00009	0.0	Selenium	0.00012	0.00010	18.2
Silicon	4.8	4.6	4.3	Silicon	4.6	5.0	8.3
Silver	0.000005	0.000006	18.2	Silver	0.000007	0.000007	0.0
Strontium	0.191	0.194	1.6	Strontium	0.195	0.198	1.5
Thallium	0.000004	0.000003	**28.6**	Thallium	0.000002	0.000002	0.0
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0007	0.0006	15.4	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00826	0.00830	0.5	Uranium	0.00863	0.00867	0.5
Vanadium	0.0002	<0.0002	n/c	Vanadium	<0.0002	0.0002	n/c
Zinc	0.0040	0.0043	7.2	Zinc	0.0052	0.0035	**39.1**
Zirconium	0.0001	0.0001	0.0	Zirconium	0.0001	0.0001	0.0
Calcium	30.4	29.8	2.0	Calcium	32.9	34.0	3.3
Magnesium	9.78	9.76	0.2	Magnesium	10.1	9.79	3.1
Potassium	1.50	1.50	0.0	Potassium	1.53	1.48	3.3
Sodium	3.47	3.53	1.7	Sodium	3.61	3.49	3.4
Sulphur	17	17	0.0	Sulphur	16	15	6.5

Notes:

Bold	Exceedes Data Quality objective of 25%.
Bold	Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.
RPD	Relative Percent Difference.
"n/c"	Not able to be calculated because one or both values not precisely known.
"<"	Less than detection limit.

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A2. QA/QC: Field Replicates, August 2011 W4

Surface Water Analysis Result (mg/L)							
Station	**W4**		**RPD**	**Station**	**W4**		**RPD**
Sampling Date	**23-Aug-2011**		**%**	**Sampling Date**	**23-Aug-2011**		**%**
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Conductivity (uS/cm)	232	232	0.0	Ammonia	0.063	0.055	13.6
pH	7.93	7.75	2.3	Total Kjeldahl Nitrogen	<0.02	0.04	n/c
Total Suspended Solids	22	23	4.4	Nitrate plus Nitrite	0.155	0.144	7.4
Total Dissolved Solids	130	150	14.3	Nitrite	<0.002	<0.002	n/c
Turbidity	3.6	3.4	5.7	Total Nitrogen	0.16	0.18	11.8
Filter and HNO3 Preservation	LAB	LAB	n/c	Acidity (pH 4.5)	<0.5	<0.5	n/c
Total Hardness	104	103	1.0	Acidity (pH 8.3)	1.8	1.5	18.2
Nitrate	0.155	0.144	7.4	Bromide	<0.4	<0.4	n/c
Orthophosphate	0.010	0.002	**133.3**	Fluoride	0.07	0.07	0.0
Dissolved Sulphate	32	35	9.0	Weak Acid Dissoc. Cyanide	<0.0005	<0.0005	n/c
Dissolved Chloride	<0.5	<0.5	n/c	Cyanide + Thiocyanate	<0.0005	<0.0005	n/c
Alkalinity	78	77	1.3	Dissolved Hardness	104	106	1.9
Total Organic Carbon	6.2	6.5	4.7	Dissolved Organic Carbon	6.3	6.3	0.0
Total Metals				**Dissolved Metals**			
Aluminum	0.264	0.265	0.4	Aluminum	0.0617	0.0645	4.4
Antimony	0.00014	0.00013	7.4	Antimony	0.00013	0.00014	7.4
Arsenic	0.00089	0.00083	7.0	Arsenic	0.00052	0.00051	1.9
Barium	0.0595	0.0578	2.9	Barium	0.0510	0.0507	0.6
Beryllium	0.00001	0.00002	**66.7**	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000057	0.000049	15.1	Cadmium	0.000019	0.000012	**45.2**
Chromium	0.0005	0.0004	22.2	Chromium	0.0001	0.0001	0.0
Cobalt	0.000468	0.000462	1.3	Cobalt	0.000124	0.000090	**31.8**
Copper	0.0105	0.0107	1.9	Copper	0.00629	0.00579	8.3
Iron	0.494	0.477	3.5	Iron	0.060	0.058	3.4
Lead	0.00117	0.00120	2.5	Lead	0.000126	0.000100	23.0
Lithium	0.0014	0.0014	0.0	Lithium	0.0012	0.0012	0.0
Manganese	0.0335	0.0335	0.0	Manganese	0.00891	0.00501	**56.0**
Mercury	<0.00001	<0.00001	n/c	Molybdenum	0.00108	0.00112	3.6
Molybdenum	0.00080	0.00104	**26.1**	Nickel	0.00031	0.00034	9.2
Nickel	0.00070	0.00069	1.4	Selenium	0.00009	0.00010	10.5
Phosphorus	0.015	0.014	6.9	Silicon	5.4	5.4	0.0
Selenium	0.00010	0.00010	0.0	Silver	<0.000005	<0.000005	n/c
Silicon	5.6	5.7	1.8	Strontium	0.172	0.173	0.6
Silver	<0.000005	<0.000005	n/c	Thallium	0.000003	0.000002	**40.0**
Strontium	0.174	0.171	1.7	Tin	<0.00001	<0.00001	n/c
Thallium	0.000004	0.000006	**40.0**	Titanium	0.0007	<0.0005	n/c
Tin	<0.00001	<0.00001	n/c	Uranium	0.00733	0.00728	0.7
Titanium	0.0099	0.0114	14.1	Vanadium	0.0008	0.0008	0.0
Uranium	0.00698	0.00677	3.1	Zinc	0.0008	0.0007	13.3
Vanadium	0.0013	0.0013	0.0	Zirconium	0.0002	0.0002	0.0
Zinc	0.0038	0.0042	10.0	Calcium	27.7	28.4	2.5
Zirconium	0.0002	0.0002	0.0	Magnesium	8.41	8.55	1.7
Calcium	27.7	27.0	2.6	Potassium	0.91	0.92	1.1
Magnesium	8.57	8.55	0.2	Sodium	3.56	3.58	0.6
Potassium	0.91	0.90	1.1	Sulphur	12	12	0.0
Sodium	3.52	3.50	0.6				
Sulphur	13	13	0.0				

Notes:

Bold	Exceedes Data Quality objective of 25%.
Bold	Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.
RPD	Relative Percent Difference.
"n/c"	Not able to be calculated because one or both values not precisely known.
"<"	Less than detection limit.

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A2. QA/QC: Field Replicates, August 2011 W7

Surface Water Analysis Result (mg/L)							
Station	**W7**		**RPD**	**Station**	**W7**		**RPD**
Sampling Date	**23-Aug-2011**		**%**	**Sampling Date**	**23-Aug-2011**		**%**
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Conductivity (uS/cm)	139	139	0.0	Ammonia	0.040	0.037	7.8
pH	6.73	6.96	3.4	Total Kjeldahl Nitrogen	0.15	0.20	**28.6**
Total Suspended Solids	<1	<1	n/c	Nitrate plus Nitrite	0.011	0.011	0.0
Total Dissolved Solids	110	110	0.0	Nitrite	<0.002	<0.002	n/c
Turbidity	0.6	0.8	**28.6**	Total Nitrogen	0.16	0.22	**31.6**
Filter and HNO3 Preservation	LAB	LAB	n/c	Acidity (pH 4.5)	<0.5	<0.5	n/c
Total Hardness	51	51	0.0	Acidity (pH 8.3)	0.7	1.3	**60.0**
Nitrate	0.011	0.011	0.0	Bromide	<0.4	<0.4	n/c
Orthophosphate	0.002	0.001	**66.7**	Fluoride	0.07	0.07	0.0
Dissolved Sulphate	54	48	11.8	Weak Acid Dissoc. Cyanide	<0.0005	<0.0005	n/c
Dissolved Chloride	0.7	<0.5	n/c	Cyanide + Thiocyanate	<0.0005	<0.0005	n/c
Alkalinity	5.7	6.3	10.0	Dissolved Hardness	49	50	2.0
Total Organic Carbon	3.2	3.1	3.2	Dissolved Organic Carbon	3.1	3.0	3.3
Total Metals				**Dissolved Metals**			
Aluminum	0.0570	0.0574	0.7	Aluminum	0.0318	0.0330	3.7
Antimony	0.00005	0.00006	18.2	Antimony	0.00006	0.00006	0.0
Arsenic	0.00019	0.00024	**23.3**	Arsenic	0.00018	0.00026	**36.4**
Barium	0.0523	0.0534	2.1	Barium	0.0485	0.0496	2.2
Beryllium	0.00001	0.00002	**66.7**	Beryllium	0.00001	0.00001	0.0
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000223	0.000228	2.2	Cadmium	0.000189	0.000186	1.6
Chromium	0.0001	0.0002	**66.7**	Chromium	0.0002	0.0001	**66.7**
Cobalt	0.000083	0.000088	5.8	Cobalt	0.000063	0.000062	1.6
Copper	0.00214	0.00220	2.8	Copper	0.00198	0.00212	6.8
Iron	0.047	0.050	6.2	Iron	0.013	0.013	0.0
Lead	0.000087	0.000108	21.5	Lead	0.000015	0.000013	14.3
Lithium	0.0008	0.0008	0.0	Lithium	0.0006	0.0006	0.0
Manganese	0.00526	0.00548	4.1	Manganese	0.00421	0.00434	3.0
Mercury	<0.00001	<0.00001	n/c	Molybdenum	0.00018	0.00017	5.7
Molybdenum	0.00017	0.00017	0.0	Nickel	0.00109	0.00106	2.8
Nickel	0.00110	0.00153	**32.7**	Selenium	0.00008	0.00009	11.8
Phosphorus	0.004	0.004	0.0	Silicon	8.8	9.0	2.2
Selenium	0.00006	0.00005	18.2	Silver	<0.000005	<0.000005	n/c
Silicon	9.6	9.5	1.0	Strontium	0.0930	0.0945	1.6
Silver	<0.000005	0.000006	n/c	Thallium	0.000002	0.000003	**40.0**
Strontium	0.0942	0.0948	0.6	Tin	<0.00001	0.00001	n/c
Thallium	0.000003	0.000002	**40.0**	Titanium	0.0008	0.0006	**28.6**
Tin	<0.00001	<0.00001	n/c	Uranium	0.000048	0.000050	4.1
Titanium	0.0013	0.0012	8.0	Vanadium	0.0005	0.0007	**33.3**
Uranium	0.000056	0.000054	3.6	Zinc	0.0130	0.0126	3.1
Vanadium	0.0002	0.0002	0.0	Zirconium	<0.0001	<0.0001	n/c
Zinc	0.0154	0.0172	11.0	Calcium	14.3	15.0	4.8
Zirconium	<0.0001	<0.0001	n/c	Magnesium	3.15	3.07	2.6
Calcium	15.4	15.3	0.7	Potassium	0.49	0.49	0.0
Magnesium	3.04	3.15	3.6	Sodium	4.28	4.14	3.3
Potassium	0.48	0.50	4.1	Sulphur	18	17	5.7
Sodium	4.12	4.25	3.1				
Sulphur	17	18	5.7				

Notes:

Bold	Exceedes Data Quality objective of 25%.
Bold	Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.
RPD	Relative Percent Difference.
"n/c"	Not able to be calculated because one or both values not precisely known.
"<"	Less than detection limit.

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A2. QA/QC: Field Replicates, August 2011 W14

Surface Water Analysis Result (mg/L)							
Station	**W14**		**RPD**	**Station**	**W14**		**RPD**
Sampling Date	**22-Aug-2011**		**%**	**Sampling Date**	**22-Aug-2011**		**%**
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Conductivity (uS/cm)	209	214	2.4	Ammonia	0.041	0.041	0.0
pH	7.87	7.83	0.5	Total Kjeldahl Nitrogen	0.12	0.13	8.0
Total Suspended Solids	5	4	22.2	Nitrate plus Nitrite	0.295	0.285	3.4
Total Dissolved Solids	170	140	19.4	Nitrite	<0.002	<0.002	n/c
Turbidity	0.6	1.1	**58.8**	Total Nitrogen	0.42	0.41	2.4
Filter and HNO3 Preservation	LAB	LAB	n/c	Acidity (pH 4.5)	<0.5	<0.5	n/c
Total Hardness	95	95	0.0	Acidity (pH 8.3)	1.1	2.5	**77.8**
Nitrate	0.295	0.285	3.4	Bromide	<0.4	<0.4	n/c
Orthophosphate	0.001	0.001	0.0	Fluoride	0.08	0.08	0.0
Dissolved Sulphate	35	35	0.0	Weak Acid Dissoc. Cyanide	0.0011	0.0013	16.7
Dissolved Chloride	0.9	0.8	11.8	Cyanide + Thiocyanate	0.0007	0.0007	0.0
Alkalinity	66	65	1.5	Dissolved Hardness	94	94	0.0
Total Organic Carbon	14.7	14.7	0.0	Dissolved Organic Carbon	12.5	13.9	10.6
Total Metals				**Dissolved Metals**			
Aluminum	0.173	0.151	13.6	Aluminum	0.109	0.106	2.8
Antimony	0.00028	0.00027	3.6	Antimony	0.00027	0.00027	0.0
Arsenic	0.00068	0.00059	14.2	Arsenic	0.00058	0.00063	8.3
Barium	0.0700	0.0684	2.3	Barium	0.0653	0.0645	1.2
Beryllium	0.00002	0.00002	0.0	Beryllium	0.00001	0.00001	0.0
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000014	0.000025	**56.4**	Cadmium	0.000012	0.000008	**40.0**
Chromium	0.0004	0.0004	0.0	Chromium	0.0004	0.0004	0.0
Cobalt	0.000125	0.000118	5.8	Cobalt	0.000085	0.000078	8.6
Copper	0.00198	0.00192	3.1	Copper	0.00186	0.00191	2.7
Iron	0.182	0.157	14.7	Iron	0.076	0.076	0.0
Lead	0.000082	0.000058	**34.3**	Lead	0.000019	0.000018	5.4
Lithium	0.0008	0.0007	13.3	Lithium	0.0006	0.0006	0.0
Manganese	0.00921	0.00829	10.5	Manganese	0.00207	0.00189	9.1
Mercury	<0.00001	<0.00001	n/c	Molybdenum	0.00037	0.00037	0.0
Molybdenum	0.00030	0.00027	10.5	Nickel	0.00062	0.00064	3.2
Nickel	0.00070	0.00064	9.0	Selenium	0.00010	0.00011	9.5
Phosphorus	0.008	0.008	0.0	Silicon	4.1	4.2	2.4
Selenium	0.00010	0.00009	10.5	Silver	<0.000005	<0.000005	n/c
Silicon	4.6	4.5	2.2	Strontium	0.180	0.178	1.1
Silver	<0.000005	<0.000005	n/c	Thallium	0.000005	0.000004	22.2
Strontium	0.179	0.179	0.0	Tin	<0.00001	<0.00001	n/c
Thallium	0.000004	0.000003	**28.6**	Titanium	0.0017	0.0016	6.1
Tin	<0.00001	<0.00001	n/c	Uranium	0.00421	0.00415	1.4
Titanium	0.0050	0.0047	6.2	Vanadium	0.0008	0.0008	0.0
Uranium	0.00372	0.00363	2.4	Zinc	0.0007	0.0003	**80.0**
Vanadium	0.0006	0.0005	18.2	Zirconium	0.0005	0.0005	0.0
Zinc	0.0010	0.0009	10.5	Calcium	22.2	22.2	0.0
Zirconium	0.0005	0.0004	22.2	Magnesium	9.38	9.35	0.3
Calcium	23.3	23.0	1.3	Potassium	1.31	1.29	1.5
Magnesium	8.98	9.18	2.2	Sodium	2.88	2.87	0.3
Potassium	1.20	1.24	3.3	Sulphur	13	12	8.0
Sodium	2.77	2.80	1.1				
Sulphur	12	13	8.0				

Notes:

Bold	Exceedes Data Quality objective of 25%.
Bold	Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.
RPD	Relative Percent Difference.
"n/c"	Not able to be calculated because one or both values not precisely known.
"<"	Less than detection limit.

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix A2. QA/QC: Field Replicates, October 2011 W7

Surface Water Analysis Result (mg/L)							
Station	**W7**		**RPD**	**Station**	**W7**		**RPD**
Sampling Date	**6-Oct-11**		**%**	**Sampling Date**	**6-Oct-11**		**%**
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Conductivity (uS/cm)	151	152	0.7	Ammonia	0.024	0.016	**40.0**
pH	7.06	6.92	2.0	Total Kjeldahl Nitrogen	0.10	0.10	0.0
Total Suspended Solids	1	2	**66.7**	Nitrate plus Nitrite	<0.002	<0.002	n/c
Total Dissolved Solids	94	88	6.6	Nitrite	<0.002	<0.002	n/c
Turbidity	0.1	0.2	**66.7**	Total Nitrogen	0.10	0.10	0.0
Filter and HNO3 Preservation	FIELD	FIELD	n/c	Acidity (pH 4.5)	<0.5	<0.5	n/c
Total Hardness (CaCO3)	53.8	51.1	5.1	Acidity (pH 8.3)	<0.5	1.3	n/c
Ion Balance	1.0	1.1	9.5	Bromide	<0.4	<0.4	n/c
Nitrate	<0.002	<0.002	n/c	Fluoride	0.06	0.06	0.0
Orthophosphate	0.004	0.004	0.0	Weak Acid Dissoc. Cyanide	<0.0005	<0.0005	n/c
Dissolved Sulphate	52	51	1.9	Cyanide + Thiocyanate	<0.0005	<0.0005	n/c
Dissolved Chloride	<0.5	<0.5	n/c	Dissolved Hardness	53.8	53.2	1.1
Total Organic Carbon	1.9	1.8	5.4	Dissolved Organic Carbon	1.7	1.9	11.1
				Alkalinity	9.2	8.2	11.5
Total Metals				**Dissolved Metals**			
Aluminum	0.0262	0.0272	3.7	Aluminum	0.0149	0.0135	9.9
Antimony	0.00004	0.00004	0.0	Antimony	0.00004	0.00004	0.0
Arsenic	0.00018	0.00015	18.2	Arsenic	0.00015	0.00014	6.9
Barium	0.0485	0.0512	5.4	Barium	0.0528	0.0529	-0.2
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000155	0.000160	3.2	Cadmium	0.000155	0.000163	5.0
Chromium	<0.0001	<0.0001	n/c	Chromium	0.0003	<0.0001	n/c
Cobalt	0.000028	0.000029	3.5	Cobalt	0.000024	0.000020	18.2
Copper	0.00144	0.00127	12.5	Copper	0.00159	0.00129	20.8
Iron	0.029	0.028	3.5	Iron	0.006	0.005	18.2
Lead	0.000042	0.000036	15.4	Lead	0.000011	<0.000005	n/c
Lithium	0.0005	0.0006	18.2	Lithium	0.0008	0.0007	13.3
Manganese	0.00141	0.00119	16.9	Manganese	0.00117	0.00066	**55.7**
Molybdenum	0.00026	0.00026	0.0	Molybdenum	0.00028	0.00029	3.5
Nickel	0.00080	0.00067	17.7	Nickel	0.00075	0.00074	1.3
Selenium	<0.00004	<0.00004	n/c	Selenium	<0.00004	<0.00004	n/c
Silicon	10.0	9.7	3.0	Silicon	10.3	10.2	1.0
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.104	0.108	3.8	Strontium	0.110	0.109	0.9
Thallium	<0.000002	<0.000002	n/c	Thallium	<0.000002	0.000003	n/c
Tin	0.00004	0.00005	22.2	Tin	0.00009	0.00005	**57.1**
Titanium	0.0010	0.0008	22.2	Titanium	<0.0005	<0.0005	n/c
Uranium	0.000047	0.000037	23.8	Uranium	0.000052	0.000039	**28.6**
Vanadium	0.0002	0.0002	0.0	Vanadium	0.0003	0.0003	0.0
Zinc	0.0137	0.0132	3.7	Zinc	0.0136	0.0127	6.8
Zirconium	<0.0001	<0.0001	n/c	Zirconium	<0.0001	<0.0001	n/c
Calcium	16.1	15.3	5.1	Calcium	15.8	15.7	0.6
Magnesium	3.32	3.11	6.5	Magnesium	3.49	3.40	2.6
Potassium	0.54	0.52	3.8	Potassium	0.60	0.58	3.4
Sodium	4.54	4.32	5.0	Sodium	4.70	4.65	1.1
Sulphur	18	17	5.7	Sulphur	20	20	0.0

Notes:

Bold	Exceedes Data Quality objective of 25%.
Bold	Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.
RPD	Relative Percent Difference.
"n/c"	Not able to be calculated because one or both values not precisely known.
"<"	Less than detection limit.

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Appendix A2. QA/QC: Field Replicates, October 2011 W16

Surface Water Analysis Result (mg/L)							
Station	**W16**		**RPD**	**Station**	**W16**		**RPD**
Sampling Date	**4-Oct-11**		**%**	**Sampling Date**	**4-Oct-11**		**%**
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Conductivity (uS/cm)	235	233	0.9	Ammonia	0.041	0.013	**103.7**
pH	7.94	7.90	0.5	Total Kjeldahl Nitrogen	0.34	0.28	19.4
Total Suspended Solids	2	2	0.0	Nitrate plus Nitrite	0.166	0.1	**49.6**
Total Dissolved Solids	140	140	0.0	Nitrite	<0.002	<0.002	n/c
Turbidity	0.6	0.5	18.2	Total Nitrogen	0.51	0.39	**26.7**
Filter and HNO3 Preservation	FIELD	FIELD	n/c	Acidity (pH 4.5)	<0.5	<0.5	n/c
Total Hardness (CaCO3)	109	110	0.9	Acidity (pH 8.3)	<0.5	<0.5	n/c
Ion Balance	1.0	0.96	4.1	Bromide	<0.4	<0.4	n/c
Nitrate	0.166	0.10	**49.6**	Fluoride	0.05	0.05	0.0
Orthophosphate	0.004	0.003	**28.6**	Weak Acid Dissoc. Cyanide	<0.0005	<0.0005	n/c
Dissolved Sulphate	28	29	3.5	Cyanide + Thiocyanate	<0.0005	<0.0005	n/c
Dissolved Chloride	<0.5	<0.5	n/c	Dissolved Hardness	112	107	4.6
Total Organic Carbon	5.1	6.1	17.9	Dissolved Organic Carbon	5.1	5.8	12.8
				Alkalinity	89	92	3.3
Total Metals				**Dissolved Metals**			
Aluminum	0.0533	0.0509	4.6	Aluminum	0.0188	0.0214	12.9
Antimony	0.00008	0.00008	0.0	Antimony	0.00008	0.00008	0.0
Arsenic	0.00046	0.00051	10.3	Arsenic	0.00043	0.00043	0.0
Barium	0.0634	0.0626	1.3	Barium	0.0610	0.0609	0.2
Beryllium	<0.00001	<0.00001	n/c	Beryllium	<0.00001	<0.00001	n/c
Bismuth	<0.000005	<0.000005	n/c	Bismuth	<0.000005	<0.000005	n/c
Boron	<0.05	<0.05	n/c	Boron	<0.05	<0.05	n/c
Cadmium	0.000012	0.000009	**28.6**	Cadmium	0.000006	0.000009	**40.0**
Chromium	0.0002	0.0002	0.0	Chromium	0.0001	<0.0001	n/c
Cobalt	0.000120	0.000127	5.7	Cobalt	0.000086	0.000097	12.0
Copper	0.00209	0.00212	1.4	Copper	0.00173	0.00167	3.5
Iron	0.195	0.201	3.0	Iron	0.117	0.118	0.9
Lead	0.000096	0.000097	1.0	Lead	0.000014	0.000028	**66.7**
Lithium	0.0016	0.0016	0.0	Lithium	0.0016	0.0016	0.0
Manganese	0.0383	0.0380	0.8	Manganese	0.0354	0.0351	0.9
Molybdenum	0.00100	0.00090	10.5	Molybdenum	0.00097	0.00098	1.0
Nickel	0.00042	0.00044	4.7	Nickel	0.00039	0.00036	8.0
Selenium	<0.00004	<0.00004	n/c	Selenium	<0.00004	<0.00004	n/c
Silicon	5.1	5.2	1.9	Silicon	5.2	4.9	5.9
Silver	<0.000005	<0.000005	n/c	Silver	<0.000005	<0.000005	n/c
Strontium	0.197	0.201	2.0	Strontium	0.197	0.197	0.0
Thallium	<0.000002	0.000003	n/c	Thallium	<0.000002	<0.000002	n/c
Tin	<0.00001	<0.00001	n/c	Tin	<0.00001	<0.00001	n/c
Titanium	0.0020	0.0024	18.2	Titanium	<0.0005	<0.0005	n/c
Uranium	0.00765	0.00748	2.2	Uranium	0.00738	0.00760	2.9
Vanadium	0.0006	0.0006	0.0	Vanadium	0.0005	0.0005	0.0
Zinc	0.0010	0.0021	**71.0**	Zinc	0.0004	0.0005	22.2
Zirconium	0.0001	0.0001	0.0	Zirconium	0.0001	0.0001	0.0
Calcium	27.3	27.7	1.5	Calcium	27.9	26.3	5.9
Magnesium	9.91	9.93	0.2	Magnesium	10.2	9.92	2.8
Potassium	0.99	0.99	0.0	Potassium	1.00	0.98	2.0
Sodium	4.44	4.47	0.7	Sodium	4.51	4.53	0.4
Sulphur	11	13	16.7	Sulphur	12	12	0.0

Notes:

Bold	Exceedes Data Quality objective of 25%.
Bold	Exceedes Data Quality objective of 25%, but does not meet Practical Quantitation Limit.
RPD	Relative Percent Difference.
"n/c"	Not able to be calculated because one or both values not precisely known.
"<"	Less than detection limit.

Appendix B – Sediment Quality Data

Sediment Quality Data, Casino Project, August 2011

Appendix B. Sediment Quality Data, August 2011

Sediment Parameters	Detection Limits	CCME Sediment		W15	W15-1	W15-2	W16	W16-1	W16-2	W16-3	W21	W21-1	W21-2	W21-3	W24	W24-1	W24-2	W24-3
		ISQG[d]	PEL[c]	22-Aug-11	22-Aug-11	22-Aug-11	23-Aug-11	22-Aug-11	22-Aug-11	22-Aug-11	23-Aug-11	22-Aug-11	22-Aug-11	22-Aug-11	23-Aug-11	22-Aug-11	22-Aug-11	22-Aug-11
Physical Properties																		
Moisture (%)	0.3			41	-	31	20	19	17	15	18	24	23	22	75	36	53	34
pH	0.01			7.96	7.39	7.92	7.30	7.45	7.41	7.35	7.39	7.07	7.24	7.36	6.48	5.91	6.61	6.35
Total Metals																		
Aluminum	100			11500	4680	8070	7270	8990	7900	9440	6150	4830	5140	4720	12600	8450	6910	5880
Antimony	0.1			1.6	0.5	1.1	0.6	0.5	0.4	0.4	0.2	0.2	0.2	0.2	1.4	2.2	2.1	3.1
Arsenic	0.5	5.9	17	*14.3*	4.4	*8.4*	*8.5*	*6.9*	*6.1*	*6.6*	5.1	4.8	4.6	4.5	***37.2***	***45.8***	***42.3***	***44.3***
Barium	0.1			558	262	400	115	115	110	121	69.6	65.5	64.3	59.4	231	134	115	88.3
Beryllium	0.4			0.6	<0.4	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.8	0.6	0.5	<0.4
Bismuth	0.1			0.2	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.2	0.6	0.2	0.2
Cadmium	0.05	0.6	3.5	*2.05*	*0.69*	*1.20*	0.16	0.13	0.14	0.14	0.08	<0.05	0.05	<0.05	*0.77*	0.41	0.34	0.29
Calcium	100			15600	4980	11600	3050	3230	2850	3400	2690	2030	2130	1910	13600	3840	2720	2320
Chromium	1	37.3	90	31	13	21	15	11	10	12	17	12	13	11	24	17	16	12
Cobalt	0.3			13.1	5.3	8.8	6.8	7.2	6.8	7.5	5.8	4.7	5.0	4.6	8.9	8.1	6.8	6.7
Copper	0.5	35.7	197	*42.0*	13.4	24.5	10.3	10.6	11.4	11.4	7.1	5.9	6.3	6.0	23.6	17.1	15.7	18.4
Iron	100			27600	13200	20300	25100	18700	17800	19500	16300	12500	13600	12800	19800	19600	17200	19000
Lead	0.1	35	91.3	15.9	4.4	8.2	8.1	7.7	6.7	7.1	3.5	3.0	3.1	2.9	16.2	13.0	11.1	11.3
Magnesium	100			9850	3860	7320	3230	4050	3550	4110	4120	3050	3390	2950	4920	2830	2340	2040
Manganese	0.2			701	320	444	431	356	383	361	219	196	205	206	594	432	274	245
Mercury	0.05	0.17	0.486	0.12	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.10	0.06	0.05	<0.05
Molybdenum	0.1			1.9	0.7	1.3	0.7	0.6	0.6	0.6	0.7	0.5	0.5	0.5	1.0	0.9	0.9	1.1
Nickel	0.8			55.9	21.7	36.7	8.2	9.1	8.6	9.9	13.4	10.4	11.8	10.5	17.8	14.9	13.6	12.7
Phosphorus	10			1040	664	835	556	492	467	509	569	464	497	445	786	537	452	473
Potassium	100			1230	448	793	826	1030	879	1020	491	385	415	400	1120	784	685	616
Selenium	0.5			1.7	<0.5	0.8	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	2.4	1.0	<0.5	0.8
Silver	0.05			0.30	0.08	0.17	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.27	0.13	0.09	0.08
Sodium	100			193	<100	131	153	182	169	193	163	144	148	141	175	120	<100	<100
Strontium	0.1			73.4	29.1	52.9	20.3	21.7	19.7	22.6	17.7	14.2	15.0	13.1	51.6	17.6	13.1	10.2
Thallium	0.05			0.18	0.05	0.12	0.10	0.12	0.11	0.12	<0.05	<0.05	<0.05	<0.05	0.30	0.29	0.23	0.19
Tin	0.1			0.7	1.8	0.5	0.4	0.4	0.5	0.5	0.3	0.3	0.3	0.3	1.3	0.6	0.5	0.6
Titanium	1			387	218	274	520	630	546	650	404	282	310	284	550	395	309	260
Vanadium	2			52	24	36	64	36	35	39	36	25	27	23	44	37	32	32
Zinc	1	123	315	*212*	70	*154*	45	55	51	57	36	32	34	32	73	70	60	64
Zirconium	0.5			2.1	1.3	1.7	1.1	1.2	1.2	1.3	1.8	2.0	2.0	1.8	3.4	1.0	0.8	<0.5

Notes

All units mg/kg unless otherwise noted

a) Canadian sediment quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2002.

b) ISQG: Interim Freshwater Sediment Quality Guidelines

c) PEL: Probable Effects Levels

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Appendix C

Periphyton Taxonomy, Casino Project, 2011

Appendix C. Periphyton Taxonomy Data, August 2011

			Excelsior Creek					Sunshine Creek					Brynelson Creek					Casino Creek					Dip Creek				
		Sample Site	**P9-1**	**P9-2**	**P9-3**	**P9-4**	**P9-5**	**P10-1**	**P10-2**	**P10-3**	**P10-4**	**P10-5**	**P11-1**	**P11-2**	**P11-3**	**P11-4**	**P11-5**	**P12-1**	**P12-2**	**P12-3**	**P12-4**	**P12-5**	**P14-1**	**P14-2**	**P14-3**	**P14-4**	**P14-5**
		Sampling Date	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**
Phylum	**Order**	**Genera and Species**																									
Bacillariophycae	Centrales	*Melosira sp.*	<15.7	<66.7																							
	Pennales	*Achnanthes flexella*	<15.7																				285.6				282.6
		Achnanthes lanceolata									<6.8					<5.1	<9.7						<95.2		<100.0		
		Achnanthes minutissima	935.2	1,292.0	1,175.2	2,811.0	540.6	508.8	40,845.0	5,608.6	6,705.6	7,340.8	1,769.3	33.9	831.0	25.5	3,625.0	261.0	155.2	2,808.0	495.2	1,753.5	151,993.5	53,032.0	46,236.5	65,529.6	248,626.0
		Achnanthes spp.	243.2	775.2	881.4	420.8	270.3	169.6	2,334.0	290.1	406.4	355.2	408.3	<11.3	27.7	19.6	1,160.0	217.5	77.6	1,296.0	31.9	467.6	18,466.5	5,682.0	32,813.0	13,310.7	46,354.0
		Amphora spp.										<7.9											<95.2				
		Caloneis spp.		<66.7									18.2	<11.3	<7.1	<5.1	9.7		<10.0			30.2	<95.2	<31.8	<100.0		141.3
		Ceratoneis arcus	<15.7			<18.9		132.6	403.0	75.3	47.6	150.1	283.2	22.6	415.5	411.6	1,885.0	134.4	260.0	261.0	861.3	241.6	14,205.0	7,102.5	10,440.5	18,430.2	23,177.0
		Cocconeis placentula		<66.7	75.8	<18.9	<90.1	17.1	32.0	26.0	34.0	15.8	9.1				38.8							<31.8			
		Cymbella cf. cestaii													<7.1								385.6	31.8	200.0	68.7	141.3
		Cymbella cistula	<15.7	<66.7	<75.8					<6.5					<7.1												<141.3
		Cymbella minuta		<66.7		<18.9			8.0				<9.1		7.1	5.1	113.1	11.2	<10.0		<31.9	<30.2	6,643.8	1,599.0	4,263.6	4,523.7	8,212.5
		Cymbella sinuata	304.0	516.8	587.6	140.2	90.1	424.0	1,116.0	50.2	422.4	184.8	9.1	22.6	<7.1	117.6	75.4	<11.2	<10.0	14.5		30.2		<31.8	<100.0		
		Cymbella spp.		<66.7						<6.5			<9.1		<7.1	<5.1								<31.8	<100.0		<141.3
		Diatoma elongatum	78.5	1,033.6	1,469.0	280.4	720.8	45.6	124.0	225.9	27.2	154.0	212.4	<11.3	193.9		1,015.0						49,717.5	31,251.0	41,762.0	83,959.8	29,498.0
		Diatoma mesodon						<5.7	<8.0		<6.8				<7.1		48.5	11.2	<10.0	<14.5			190.4	31.8	100.0	137.4	
		Diatoma moniliformis?	<15.7		<75.8			<5.7																			
		Diatomella sp.																<11.2									
		Didymosphenia geminata													184.6		<9.7						<95.2				<141.3
		Diploneis spp.	<15.7													<5.1											
		Eunotia spp.		<66.7	<75.8	<18.9		<5.7				<7.9	<9.1	<11.3	<7.1	5.1	<9.7	<11.2			<31.9	<30.2			<100.0		141.3
		Fragilaria capucina						<5.7	<8.0			<7.9	<9.1				<9.7	<11.2					<95.2			<68.7	
		Fragilaria construens																				<30.2					
		Fragilaria crotonensis			<75.8																						
		Fragilaria vaucheriae	243.2	400.2	758.0	718.2	1,081.2	88.4	651.0	376.5	52.8	831.6	708.0	11.3	332.4	20.4	11,020.0	391.5	504.4	87.0	223.3	271.8	90,912.0	36,933.0	38,779.0	110,581.2	61,103.0
		Fragilaria spp.	31.4	66.7	75.8	37.8	270.3		31.0	25.1		30.8	141.6		55.4	5.1	870.0	56.0	698.4	245.6	127.6	332.2	11,364.0	3,314.5	4,474.5	9,215.1	8,428.0
		Frustulia sp.						<5.7															<95.2			<68.7	<141.3
		Gomphonema agustatum / parvulum	182.4	2,982.9	4,522.0	70.1	<90.1	<5.7	62.0	75.3	105.6	30.8		<11.3	7.1	5.1	75.4	<11.2	<10.0	<14.5	<31.9	<30.2	2,214.6	861.0	1,938.0	1,330.5	2,190.0
		Gomphonema olivaceum	3,507.0	23,863.2	14,696.5	6,465.3	540.6	1,187.2	93.0	25.1	26.4		18.2	33.9			150.8	<11.2									
		Gomphonema olivaceum?																							100.0		
		Gomphonema spp.	364.8	13,920.2	11,305.0	2,529.9	360.4	198.9	372.0	175.7	290.4	92.4	106.2	22.6	35.5	<5.1	188.5	<11.2	<10.0	14.5	<31.9	30.2	28,410.0	1,968.0	14,915.0	8,515.2	16,856.0
		Hantzschia sp. ?		<66.7	<75.8								<9.1														
		Meridion circulare	15.7	66.7	75.8	37.8	90.1	<5.7	16.0	6.5	<6.8	15.8	9.1	<11.3	7.1	10.2	164.9	1,044.0	1,086.4	203.0	63.8	181.2	666.4	159.0	300.0	137.4	847.8
		Navicula radiosa											<9.1		<7.1								95.2	<31.8	<100.0	<68.7	<141.3
		Navicula spp.							<8.0	<6.5	6.8	<7.9	<9.1										380.8	63.6	400.0	68.7	141.3
		Nitzschia dissipata															<9.7						190.4	31.8	100.0	68.7	
		Nitzschia spp.		<66.7	<75.8	<18.9	<90.1	<5.7		6.5	<6.8				14.2		38.8				<31.9		4,060.1	369.0	1,550.4	1,064.4	3,832.5
		Pinnularia spp.	<15.7		<75.8	<18.9	<90.1	<5.7				<7.9	<9.1		<7.1		<9.7			<14.5		<30.2	95.2		100.0	<68.7	282.6
		Synedra ulna	<15.7			<18.9		<5.7	<8.0	<6.5			<9.1	<11.3	21.3	<5.1	9.7						190.4	<31.8	<100.0		<141.3
		Synedra spp.	15.7	133.4	151.6	94.5	360.4	5.7	24.0	<6.5		7.9	54.6	<11.3	28.4	10.2	725.0	22.4	<10.0	29.0	31.9	<30.2	9,943.5	246.0	3,876.0	1,330.5	2,737.5
		Tabellaria fenestrata											<9.1	<11.3		<5.1	<9.7							<31.8			
		Tabellaria flocculosa		<66.7	<75.8	<18.9	<90.1				<6.8				<7.1		<9.7	<11.2			<31.9	<30.2	<95.2		<100.0	<68.7	<141.3
		UID girdle view		<66.7	<75.8		<90.1		<8.0	6.5			<9.1	<11.3												<68.7	
		Deformed Diatoms	15.7			<18.9	<90.1											78.4	40.0	29.0		30.2		<31.8	<100.0	137.4	

Notes:

UID = unidentified

cf. = (confertim = close together) = possibly for species

? = possibly for genus

unit = cells/cm^2

Area Sampled (cm^2) 100.0

Synonyms:

Diatoma elongatum = Diatoma tenue var. elongatum

Diatoma mesodon = Diatoma hiemale var. mesodon

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Appendix C. Periphyton Taxonomy Data, August 2011

			Excelsior Creek					Sunshine Creek					Brynelson Creek					Casino Creek					Dip Creek				
		Sample Site	**P9-1**	**P9-2**	**P9-3**	**P9-4**	**P9-5**	**P10-1**	**P10-2**	**P10-3**	**P10-4**	**P10-5**	**P11-1**	**P11-2**	**P11-3**	**P11-4**	**P11-5**	**P12-1**	**P12-2**	**P12-3**	**P12-4**	**P12-5**	**P14-1**	**P14-2**	**P14-3**	**P14-4**	**P14-5**
		Sampling Date	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**22-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**	**21-Aug-11**
Chlorophyta	Chaetophorales	*Microthamnion sp.*																	<10.0								
		UID Chaetophorales																33.6	<10.0	<14.5	<31.9	3,039.4					
	Ulothricales	*Microspora sp.*									<6.8				<7.1												
	Zygnematales	*Closterium spp.*																					<95.2				
		Cosmarium spp.																							<100.0		
Chlorophyta		UID Chlorophyta colonial							<8.0																		
		UID Chlorophyta filamentous																					<95.2				
		UID Chlorophyta flagellate											<9.1										<95.2				
		UID Chlorophyta unicellular	<15.7									7.9													<100.0	<68.7	
Chrysophyta	Chromulinales	*Chromulina sp.*		2,584.0	49,742.0	16,303.8	38,961.5																				
		Chrysamoeba sp.	2,104.2	16,903.1	9,044.0	3,935.4	6,982.0				26.4		247.8			5.1	1,305.0	14,880.8	747.5			116.9	1,107.3	492.0	6,976.8	6,386.4	2,190.0
		Hydrurus sp.											<9.1				<9.7										
	Tribonematales	*Tribonema spp.*																							<100.0		
Chrysophyta		UID Chrysophyta colonial	1,870.4	5,943.2	13,566.0	2,248.8	6,982.0		806.0	200.8	79.2	862.4					3,625.0	<11.2	40.0			233.8	<95.2		<100.0	1,236.6	565.2
		UID Chrysophyta cyst	15.7	133.4	75.8	<18.9	90.1				<6.8				<7.1			304.5	116.4	<14.5	<31.9	116.9	<95.2				
		UID Chrysophyta unicellular	<15.7	15,908.8	9,044.0	2,248.8	8,061.0	5.7	93.0		105.6	61.6	141.6		83.1		1,450.0			<14.5	31.9		369.1	246.0	2,325.6	2,128.8	1,642.5
Cyanophyta	Chamaesiphonales	*Chamaesiphon spp.*	<15.7	258.4			270.3	116,345.6	172,716.0	151,236.0	183,692.8	364,195.2	282,177.3	2,699.2	91,164.0	31,106.0	120,992.0	3,678.4	68,770.0	15,552.0	120,078.0	226,699.2	32,671.5	25,569.0	262,504.0	75,768.6	535,178.0
		Clastidium setigerum	121.6					1,950.4	56,016.0	47,891.4	15,240.0	86,419.2	44,367.5	674.8	4,792.5		68,058.0	21,736.0	179,400.0	132,192.0	308,772.0	680,097.6	14,205.0	5,682.0	92,473.0	19,454.1	77,959.0
	Chroococcales	*Aphanothece sp.*																					9,596.6	2,460.0			41,062.5
		Gloeocapsa sp.?																	320.0								
		UID Chrooccocales																									
	Nostocales	*Anabaena sp. ?*											<9.1														
		UID Nostocales						<5.7																			
	Oscillatoriales	*Homoeothrix varians*	2,736.0	4,651.2	4,994.6	2,383.4	<90.1	22,387.2	120,355.2	32,878.0	104,444.8	68,908.8	106,702.4	1,349.6	7,561.5	450.8	29,870.0	3,784.5	1,707.2	25,056.0	35,737.5	4,676.0	1,292,655.0	1,146,817.0	2,786,122.0	1,693,530.6	6,632,836.0
		Lyngbya spp.															<9.7						6,643.8	12,915.0	29,457.6	22,618.5	26,827.5
		Oscillatoria cf. agardhii	<15.7	<66.7		<18.9	<90.1	1,060.8	22,089.0	90,898.0	1,082.4	2,926.0			21,300.0	<5.1	17,110.0			<14.5			176,142.0	6,273.0	26,744.4	5,322.0	51,465.0
		Oscillatoria spp.	<15.7	<66.7				<5.7			<6.8												186,085.5	10,332.0	11,628.0	4,257.6	43,252.5
		Phormidium sp.																					42,077.4				
		Pseudoanabaena spp.	282.6	533.6	909.6	<18.9			<8.0	351.4	61.2							134.4		58.0	<31.9	271.8			500.0	1,064.4	
		Spirulina sp.		266.8					<8.0			<7.9			<7.1												
		UID Oscillatoriales	<15.7	933.8		<18.9	<90.1	243.1	<8.0		<6.8				<7.1			<11.2			<31.9	<30.2	13,287.6	7,380.0	16,666.8	15,433.8	33,397.5
Euglenophyta	Euglenales	UID																									
Rhodophyta	Nemalionales	*Audouinella sp.*	204.1	<66.7	<75.8	<18.9		136.8	1,767.0	903.6	1,056.0	2,618.0	814.2	<11.3	1,523.5	<5.1	97.0						119,322.0	181,350.5	265,487.0	204,780.0	726,915.0
		Batrachospermum sp.							<8.0																		
		UID flagellate	60.8	<66.7	<75.8																						
		UID colonial						<5.7																			
		UID filamentous		<66.7																<14.5							
		UID unicellular	121.6	258.4	293.8					25.1	52.8	30.8	9.1		83.1	<5.1	150.8	43.5	38.8	56.1	247.6	116.9	1,107.3	246.0	387.6	532.2	141.3

Notes:

UID = unidentified

cf. = (confertim = close together) = possibly for species

? = possibly for genus

unit = cells/cm^2

Area Sampled (cm^2) 100.0

Synonyms:

Diatoma elongatum = Diatoma tenue var. elongatum

Diatoma mesodon = Diatoma hiemale var. mesodon

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix D

Benthic Invertebrate Taxonomy, Casino Project, 2011

Appendix D. Benthic Invertebrate Taxonomy, Casino Project, 2011

	Excelsior Creek					Sunshine Creek					Brynelson Creek					Casino Creek					Meloy Creek					Dip Creek				
Site:	**B9**	**B9**	**B9**	**B9**	**B9**	**B10**	**B10**	**B10**	**B10**	**B10**	**B11**	**B11**	**B11**	**B11**	**B11**	**B12**	**B12**	**B12**	**B12**	**B12**	**B13**	**B13**	**B13**	**B13**	**B13**	**B14**	**B14**	**B14**	**B14**	**B14**
Sample:	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**
CC#:	**CC120114**	**CC120115**	**CC120116**	**CC120117**	**CC120118**	**CC120119**	**CC120120**	**CC120121**	**CC120122**	**CC120123**	**CC120124**	**CC120125**	**CC120126**	**CC120127**	**CC120128**	**CC120129**	**CC120130**	**CC120131**	**CC120132**	**CC120133**	**CC120134**	**CC120135**	**CC120136**	**CC120137**	**CC120138**	**CC120139**	**CC120140**	**CC120141**	**CC120142**	**CC120143**
Phylum: Arthropoda																														
Subphylum: Hexapoda																														
| Class: Insecta																														
| Order: Ephemeroptera		1		1																										
| Family: Ameletidae																														
Ameletus sp.			1			2		1	1		10	30	4	26	17	3	6	1	1	2	5	7	2		1	2	1	11	1	
| Family: Baetidae																														
Baetis bicaudatus	132	106	111	127	107		1	3	2	1	1	1	3	3	6	2	1	2	1	3						14	4	9	1	3
Baetis sp.	53	25	39	34	58	2	2	4	4		1	3	1	1	1	1			2	2						10	2	11		3
| Family: Ephemerellidae						1																								
Drunella coloradensis							3		1																					
Drunella doddsi							1	1	2	1																2				
| Family: Heptageniidae	13	7	11	11	8	2	4	1	4	2	1	5	1		2	1		1												1
Cinygmula sp.	64	19	27	27	42	33	38	36	46	19	4	9	3		4	8	7	4	3	9						4	1	2		
Epeorus sp.	36	12	30	27	33	49	114	65	34	23	1	15	5		12											1				
| Order: Plecoptera																														
| Family: Capniidae	16	3	12	9	18	1			4			1				1	1			2						1	1			
Capnia sp.	2	1		1	1																									
| Family: Chloroperlidae																														
Suwallia sp.			3			2	6	4	3	5	1	7	5	3	12	2		1	5	3						1				
Sweltsa sp.											1	4			3											3				
| Family: Leuctridae	1																													
| Family: Nemouridae	25	11	14	33	19									1		1		2	3	1										
Nemoura	2		2		1													1												
Podmosta sp.				1																										
Zapada sp.											4	5		8	15	1		1			2	2				3		2	1	
| Family: Perlodidae												3				6	5	3	4	9	1									
Skwala sp.																			1		1									
| Order: Trichoptera										1					4															
| Family: Limnephilidae	7	4	7		3	3	2	1	2	2				2	2		7		2									1	1	
Ecclisomyia sp.									1			5	1		1		2													
| Family: Uenoidae																														
Neothremma sp.																				1										
| Order: Coleoptera								2																						
| Family: Dytiscidae																														1
| Family: Staphylinidae																	1				1									
| Order: Diptera	2	1	1	3	1							1			4	2					2	3	3		8	14	8	21	10	6
| Family: Ceratopogonidae																														
Culicoides sp.																										1				
Monohelea sp.																		1												
| Family: Chironomidae																														
| Subfamily: Diamesinae																														
| Tribe: Diamesini																														
Diamesa sp.	57	19	13	61	22		37	20	5	6	13	18	11	18	37	78	75	102	110	83	27	18	12		20	179	41	82	31	27
Pagastia sp.																										2		2		
| Subfamily: Orthocladiinae																														
Eukiefferiella sp.	15	21	34	23	13	12	16	11	7	2											2									
Orthocladius complex		6		6	1	1	9	3	3												3	2				6			2	
Pseudosmittia sp.												1																		
Tvetenia sp.	24	20	16	16	19	8	8	27	41	12																				
| Family: Empididae																														
Chelifera/ Metachela	1			1		2		4	8	1		6	6	1	4											4		2		
Oreogeton sp.											1	1	2	1	3															
| Family: Muscidae																														
Limnophora sp.																	1													
| Family: Psychodidae													3													2				2
| Family: Simuliidae	1	1		1	1				1	1	1			2	2				1											
Prosimulium sp.		1	2	5	3	9	65	66	40	1	3	6		5	23	1	1		1	2	1					38	1	2	4	2
Simulium sp.	8	11	11	10	27		1								1															
| Family: Tipulidae		1					1																							
Dicranota sp.				1		10	1		1																					
Tipula sp.		1				1	1	2	1	2	1	1			2													1	1	

Appendix D. Benthic Invertebrate Taxonomy, Casino Project, 2011

	Excelsior Creek					Sunshine Creek					Brynelson Creek					Casino Creek					Meloy Creek					Dip Creek				
Site:	B9	B9	B9	B9	B9	B10	B10	B10	B10	B10	B11	B11	B11	B11	B11	B12	B12	B12	B12	B12	B13	B13	B13	B13	B13	B14	B14	B14	B14	B14
Sample:	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
CC#:	CC120114	CC120115	CC120116	CC120117	CC120118	CC120119	CC120120	CC120121	CC120122	CC120123	CC120124	CC120125	CC120126	CC120127	CC120128	CC120129	CC120130	CC120131	CC120132	CC120133	CC120134	CC120135	CC120136	CC120137	CC120138	CC120139	CC120140	CC120141	CC120142	CC120143
| Order: Lepidoptera				1	1				1		2				1		1	1	1		3				1	9	4	5	9	3
| Class: Entognatha																														
| Order: Collembola					1																									
Subphylum: Crustacea																														
| Class: Copepoda								1																						
| Class: Malacostraca																														
| Order: Amphipoda			1																							1				
Subphylum: Chelicerata																														
| Class: Arachnida																														
| Order: Trombidiformes																														
| Family: Feltriidae																														
Feltria sp.					1																									
| Family: Lebertiidae																														
Lebertia sp.												1																		
| Family: Sperchontidae																														
Sperchon sp.	3										1																			
| Order: Oribatei																														
| Family: Hydrozetidae	1				1		1						1		1					2	3	1	1		3	1	1	1		
Phylum: Mollusca																														
| Class: Gastropoda																														
| Order: Heterostropha																														
| Family: Valvatidae							1																							
Valvata sincera				1																										
| Order: Hypsogastropoda																														
| Family: Hydrobiidae			1					1							1						2									
Phylum: Annelida																														
Subphylum: Clitellata																														
| Class: Oligochaeta	1																													
| Order: Lumbriculida																														
| Family: Lumbriculidae					1	1	4	11	5	2	1	12		8	1	7	7	1		3	4	1			10	7	3	2	2	7
Rhynchelmis sp.																		1	5		1					1				
| Order: Tubificida																														
| Family: Enchytraeidae																														
Enchytraeus													13	8	4						5		1					1		
| Family: Naididae																										1				
| Family: Tubificidae							1																							
Phylum: Nemata	4						3	2	1			1		1	1			1			2	2	1		3	6				
Phylum: Platyhelminthes																														
| Class: Turbellaria																									4		1			1
Phylum: Tardigrada			1																											
Totals:	**468**	**271**	**337**	**400**	**382**	**139**	**320**	**266**	**218**	**81**	**47**	**136**	**59**	**88**	**164**	**114**	**115**	**123**	**140**	**122**	**65**	**36**	**20**	**0**	**50**	**313**	**68**	**155**	**63**	**56**

Appendix E

- **E1. Electrofishing Catch Per Unit Effort, Casino Project, 2011**
- **E2. Fish Biological Characteristics Casino Project, 2011**
- **E3. Fish Tissue Metals Concentrations, Casino Project, 2011**

Appendix E1: Electrofishing Effort, Catch and CPUE, Casino Project, 2011

Date	Site	Pass	Votage (V)	Effort (sec)	Catch				CPUE (number/100 sec)		
					AG	CCG	CH	Total	AG	CCG	CH
11-Aug-11	F15	1	500	314	1	12	10	23	0.32	3.82	3.18
11-Aug-11	F08	1	500	361	1	0	0	1	0.28	0.00	0.00
07-Sep-11	F08	1	400	1188	2	0	0	2	0.17	0.00	0.00
07-Sep-11	F08	2	350	1032	1	0	0	1	0.10	0.00	0.00
07-Sep-11	F08	3	350	1132	0	0	0	0	0.00	0.00	0.00
08-Sep-11	F16	1	350	822	0	0	0	0	0.00	0.00	0.00
08-Sep-11	F16	2	350	820	0	0	0	0	0.00	0.00	0.00
08-Sep-11	F16	3	350	728	0	0	0	0	0.00	0.00	0.00
08-Sep-11	W13	1	350	533	0	0	0	0	0.00	0.00	0.00
08-Sep-11	R2	1	350	971	0	9	0	9	0.00	0.93	0.00
09-Sep-11	F17	1	350	583	0	0	0	0	0.00	0.00	0.00
09-Sep-11	F17	2	400	541	0	0	0	0	0.00	0.00	0.00
09-Sep-11	F17	3	500	659	0	0	0	0	0.00	0.00	0.00
09-Sep-11	F13	1	350	1692	0	10	0	10	0.00	0.59	0.00

Notes:

AG: Arctic grayling
CCG: Slimy sculpin
CH: Chinook salmon
BB: Burbot
RW: Round Whitefish

Appendix E2. Fish Biological Characteristics, Casino Project, 2011

Date	Watershed	Site	Method	Pass	Number	Species	Length (mm)	Weight (g)	Age (year)
09-Aug-11	Britannia Creek	F15	EF	1	1	CH	73	5.3	-
09-Aug-11	Britannia Creek	F15	EF	1	2	AG	185	77.4	-
09-Aug-11	Britannia Creek	F15	EF	1	3	CH	53	2.7	-
09-Aug-11	Britannia Creek	F15	EF	1	4	CH	57	2.5	-
09-Aug-11	Britannia Creek	F15	EF	1	5	CH	66	3.0	-
09-Aug-11	Britannia Creek	F15	EF	1	6	CCG	60	2.9	2+
09-Aug-11	Britannia Creek	F15	EF	1	7	CH	60	2.6	-
09-Aug-11	Britannia Creek	F15	EF	1	8	CH	63	3.2	-
09-Aug-11	Britannia Creek	F15	EF	1	9	CH	48	1.7	-
09-Aug-11	Britannia Creek	F15	EF	1	10	CH	70	5.3	-
09-Aug-11	Britannia Creek	F15	EF	1	11	CH	53	1.9	-
09-Aug-11	Britannia Creek	F15	EF	1	12	CH	55	2.4	-
09-Aug-11	Britannia Creek	F15	EF	1	13	CCG	73	4.4	3+
09-Aug-11	Britannia Creek	F15	EF	1	14	CCG	51	2.0	1+
09-Aug-11	Britannia Creek	F15	EF	1	15	CCG	45	1.3	1+
09-Aug-11	Britannia Creek	F15	EF	1	16	CCG	36	0.7	1+
09-Aug-11	Britannia Creek	F15	EF	1	17	CCG	59	2.6	-
09-Aug-11	Britannia Creek	F15	EF	1	18	CCG	65	3.1	-
09-Aug-11	Britannia Creek	F15	EF	1	19	CCG	51	1.7	-
09-Aug-11	Britannia Creek	F15	EF	1	20	CCG	43	1.1	-
09-Aug-11	Britannia Creek	F15	EF	1	21	CCG	42	1.0	-
09-Aug-11	Britannia Creek	F15	EF	1	22	CCG	49	1.4	-
09-Aug-11	Britannia Creek	F15	EF	1	23	CCG	36	1.0	-
10-Aug-11	Britannia Creek	F15	MT	NA	24	CH	61	2.5	-
10-Aug-11	Britannia Creek	F15	MT	NA	25	CH	54	2.0	-
10-Aug-11	Britannia Creek	F15	MT	NA	26	CH	63	2.2	-
10-Aug-11	Britannia Creek	F15	MT	NA	27	CCG	53	1.5	-
10-Aug-11	Britannia Creek	F15	MT	NA	28	CH	73	3.5	-
10-Aug-11	Britannia Creek	F15	MT	NA	29	CCG	65	2.4	-
10-Aug-11	Britannia Creek	F15	MT	NA	30	CCG	74	4.0	-
10-Aug-11	Britannia Creek	F15	MT	NA	31	CH	73	3.5	-
10-Aug-11	Britannia Creek	F15	MT	NA	32	CCG	68	3.2	-
10-Aug-11	Britannia Creek	F15	MT	NA	33	CH	69	3.6	-
10-Aug-11	Britannia Creek	F15	MT	NA	34	CCG	66	3.0	-
10-Aug-11	Britannia Creek	F15	MT	NA	35	CCG	80	4.4	-
10-Aug-11	Britannia Creek	F15	MT	NA	36	CCG	79	4.3	-
10-Aug-11	Britannia Creek	F15	MT	NA	37	CCG	76	4.2	-
10-Aug-11	Britannia Creek	F15	MT	NA	38	CH	66	3.3	-
10-Aug-11	Britannia Creek	F15	MT	NA	39	CCG	70	3.0	-
10-Aug-11	Britannia Creek	F15	MT	NA	40	CCG	66	3.0	-
10-Aug-11	Britannia Creek	F15	MT	NA	41	CCG	65	2.6	-
10-Aug-11	Britannia Creek	F15	MT	NA	42	CH	66	2.0	-
10-Aug-11	Britannia Creek	F15	MT	NA	43	CH	65	2.5	-
10-Aug-11	Britannia Creek	F15	MT	NA	44	CCG	85	6.4	-
10-Aug-11	Britannia Creek	F15	MT	NA	45	CH	72	3.7	-
10-Aug-11	Britannia Creek	F15	MT	NA	46	CCG	75	4.7	-
10-Aug-11	Britannia Creek	F15	MT	NA	47	CH	66	2.9	-
10-Aug-11	Britannia Creek	F15	MT	NA	48	CH	69	3.5	-
10-Aug-11	Britannia Creek	F15	MT	NA	49	CH	69	2.9	-
10-Aug-11	Britannia Creek	F15	MT	NA	50	CCG	70	3.2	-
10-Aug-11	Britannia Creek	F16	MT	NA	51	CCG	63	2.5	-
10-Aug-11	Britannia Creek	F17	MT	NA	52	CH	67	2.9	-
10-Aug-11	Britannia Creek	F18	MT	NA	53	CH	71	3.6	-
10-Aug-11	Britannia Creek	F19	MT	NA	54	CH	61	2.6	-
10-Aug-11	Britannia Creek	F20	MT	NA	55	CH	65	3.6	-
10-Aug-11	Britannia Creek	F21	MT	NA	56	CH	62	3.0	-

Date	Watershed	Site	Method	Pass	Number	Species	Length (mm)	Weight (g)	Age (year)
10-Aug-11	Britannia Creek	F22	MT	NA	57	CH	60	2.4	-
10-Aug-11	Britannia Creek	F23	MT	NA	58	CH	56	2.5	-
10-Aug-11	Britannia Creek	F24	MT	NA	59	CCG	63	2.8	-
10-Aug-11	Britannia Creek	F25	MT	NA	60	CCG	63	3.5	-
10-Aug-11	Britannia Creek	F26	MT	NA	61	CCG	46	1.1	-
10-Aug-11	Britannia Creek	F27	MT	NA	62	CH	72	4.9	-
10-Aug-11	Britannia Creek	F28	MT	NA	63	CH	70	4.8	-
07-Sep-11	Casino Creek	F08	EF	1	101	AG	327	NA	11+
07-Sep-11	Casino Creek	F08	EF	1	102	AG	206	96.1	4+
07-Sep-11	Casino Creek	F08	EF	2	103	AG	255	193.7	-
08-Sep-11	Victor Creek	R2	EF	1	104	CCG	98	10.5	-
08-Sep-11	Victor Creek	R2	EF	1	105	CCG	89	7.3	-
08-Sep-11	Victor Creek	R2	EF	1	106	CCG	76	4.1	-
08-Sep-11	Victor Creek	R2	EF	1	107	CCG	74	4.1	-
08-Sep-11	Victor Creek	R2	EF	1	108	CCG	41	0.8	-
08-Sep-11	Victor Creek	R2	EF	1	109	CCG	39	0.6	-
08-Sep-11	Victor Creek	R2	EF	1	110	CCG	35	0.4	-
08-Sep-11	Victor Creek	R2	EF	1	111	CCG	38	0.4	-
08-Sep-11	Victor Creek	R2	EF	1	112	CCG	29	0.2	-
09-Sep-11	Casino Creek	F13	EF	1	113	CCG	83	5.7	-
09-Sep-11	Casino Creek	F13	EF	1	114	CCG	70	3.5	-
09-Sep-11	Casino Creek	F13	EF	1	115	CCG	82	4.6	-
09-Sep-11	Casino Creek	F13	EF	1	116	CCG	69	2.7	-
09-Sep-11	Casino Creek	F13	EF	1	117	CCG	69	2.7	-
09-Sep-11	Casino Creek	F13	EF	1	118	CCG	88	6.0	-
09-Sep-11	Casino Creek	F13	EF	1	119	CCG	62	2.3	-
09-Sep-11	Casino Creek	F13	EF	1	120	CCG	90	6.6	-
09-Sep-11	Casino Creek	F13	EF	1	121	CCG	70	3.5	-
09-Sep-11	Casino Creek	F13	EF	1	122	CCG	56	1.9	-

Notes:

AG: Arctic grayling
CCG: Slimy sculpin
CH: Chinook salmon
EF: Electrofishing
MT: Minnow Trap (Gee Trap)
NA: Not Applicable

Maxxam

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Your P.O. #: TASK 8.1
Your Project #: P1103 CASINO
Your C.O.C. #: 12986809, 129868-09-01, 1298681001, 1298681101

Attention: May Quach
PALMER ENVIRONMENTAL CONSULTING GROUP (PECG)
1199 West Hastings Street
Suite 800
Vancouver, BC
CANADA V6E 3T5

Report Date: 2012/03/30
This report supersedes all previous reports with the same Maxxam job number

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B192436
Received: 2011/09/28, 14:22

Sample Matrix: TISSUE
Samples Received: 22

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Elements by CRC ICPMS - Tissue Wet Wt	22	2011/10/25	2011/11/06	BBY7SOP-00002	EPA 6020A

* Results relate only to the items tested.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Kelly Janda, B.Sc, Burnaby Project Manager
Email: KJanda@maxxam.ca
Phone# (604) 638-5019

==========
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam

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Maxxam Job #: B192436
Report Date: 2012/03/30

PALMER ENVIRONMENTAL CONSULTING GROUP (PECG)
Client Project #: P1103 CASINO

Your P.O. #: TASK 8.1

ELEMENTS BY ATOMIC SPECTROSCOPY - WET WT (TISSUE)

Maxxam ID		BQ8797	BQ8798	BQ8799	BQ8800	BQ8801		BQ8802		BQ8825		
Sampling Date		2011/08/10	2011/08/10	2011/08/09	2011/08/09	2011/08/09		2011/08/09		2011/08/11		
	Units	**BRIT CREEK 62**	**BRIT CREEK 6**	**BRIT CREEK 13**	**BRIT CREEK 14**	**BRIT CREEK 15**	**RDL**	**BRIT CREEK 16**	**RDL**	**#101 (F08)**	**RDL**	**QC Batch**
Total Metals by ICPMS												
Total Aluminum (Al)	mg/kg	13.9	28.1	46.3	52.5	76.9	0.2	43.7	0.4	0.9	0.2	5298575
Total Antimony (Sb)	mg/kg	0.002	0.014	0.009	0.013	0.015	0.001	0.011	0.002	<0.001	0.001	5298575
Total Arsenic (As)	mg/kg	0.05	0.13	0.19	0.26	0.36	0.01	0.19	0.02	0.02	0.01	5298575
Total Barium (Ba)	mg/kg	1.29	4.32	6.14	3.34	5.72	0.02	3.83	0.04	0.12(1)	0.02	5298575
Total Beryllium (Be)	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.04	0.04	<0.02	0.02	5298575
Total Bismuth (Bi)	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.04	0.04	<0.02	0.02	5298575
Total Boron (B)	mg/kg	1.5	1.5	1.3	1.1	1.2	0.4	1.9	0.8	3.0	0.4	5298575
Total Cadmium (Cd)	mg/kg	0.028	0.169	0.485	0.155	0.264	0.002	0.117	0.004	0.004	0.002	5298575
Total Calcium (Ca)	mg/kg	3620	11600	16200	9370	11000	2	8420	4	573(1)	2	5298575
Total Chromium (Cr)	mg/kg	0.04	0.09	0.20	0.15	0.22	0.04	0.08	0.08	<0.04	0.04	5298575
Total Cobalt (Co)	mg/kg	0.037	0.047	0.079	0.095	0.161	0.004	0.055	0.008	0.042	0.004	5298575
Total Copper (Cu)	mg/kg	0.75	1.06	1.29	1.25	1.91	0.01	1.14	0.02	0.79	0.01	5298575
Total Iron (Fe)	mg/kg	40	65	117	123	194	2	90	4	7	2	5298575
Total Lead (Pb)	mg/kg	0.028	0.137	0.214	0.281	0.203	0.002	0.153	0.004	0.012	0.002	5298575
Total Magnesium (Mg)	mg/kg	280	347	423	349	410	2	318	4	262	2	5298575
Total Manganese (Mn)	mg/kg	1.20	13.3	17.0	12.4	9.26	0.02	6.45	0.04	0.30	0.02	5298575
Total Mercury (Hg)	mg/kg	0.021	0.054	0.054	0.050	0.038	0.002	0.036	0.004	0.072	0.002	5298575
Total Molybdenum (Mo)	mg/kg	0.02	0.03	0.04	0.04	0.07	0.01	0.04	0.02	<0.01	0.01	5298575
Total Nickel (Ni)	mg/kg	0.03	0.12	0.24	0.17	0.23	0.01	0.19	0.02	0.02	0.01	5298575
Total Phosphorus (P)	mg/kg	3470	7790	9870	6870	8060	2	6150	4	2610	2	5298575
Total Potassium (K)	mg/kg	2380	1870	1940	2110	2590	2	1890	4	3850	2	5298575
Total Selenium (Se)	mg/kg	0.59	0.96	1.35	1.38	1.70	0.01	1.50	0.02	0.19	0.01	5298575
Total Silver (Ag)	mg/kg	<0.004	<0.004	<0.004	<0.004	0.005	0.004	<0.008	0.008	<0.004	0.004	5298575
Total Sodium (Na)	mg/kg	275	779	1110	753	1020	2	651	4	481	2	5298575
Total Strontium (Sr)	mg/kg	5.29	18.2	24.0	12.8	15.6	0.02	14.7	0.04	0.83(1)	0.02	5298575
Total Thallium (Tl)	mg/kg	0.0039	0.0041	0.0047	0.0046	0.0049	0.0004	0.0062	0.0008	0.0103	0.0004	5298575
Total Tin (Sn)	mg/kg	<0.02	0.03	0.04	0.02	0.04	0.02	<0.04	0.04	0.07	0.02	5298575
Total Titanium (Ti)	mg/kg	1.5	2.1	3.8	3.1	5.0	0.2	2.7	0.4	<0.2	0.2	5298575
Total Uranium (U)	mg/kg	0.0196	0.0314	0.0661	0.0698	0.0732	0.0004	0.0396	0.0008	0.0016	0.0004	5298575
Total Vanadium (V)	mg/kg	0.06	0.26	0.52	0.27	0.47	0.04	0.20	0.08	<0.04	0.04	5298575
Total Zinc (Zn)	mg/kg	22.7	31.4	42.3	21.4	27.0	0.04	24.4	0.08	8.16	0.04	5298575

RDL = Reportable Detection Limit
(1) - Duplicate RPD above control limit - (10% of analytes failure allowed).

Maxxam

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Maxxam Job #: B192436
Report Date: 2012/03/30

PALMER ENVIRONMENTAL CONSULTING GROUP (PECG)
Client Project #: P1103 CASINO

Your P.O. #: TASK 8.1

ELEMENTS BY ATOMIC SPECTROSCOPY - WET WT (TISSUE)

Maxxam ID		BQ8826	BQ8827	BQ8828	BQ8829	BQ8830	BQ8831	BQ8832	BQ8833	BQ8834		
Sampling Date		2011/08/11	2011/08/09	2011/08/09	2011/08/09	2011/08/09	2011/09/09	2011/09/09	2011/09/09	2011/09/09		
	Units	**#102 (F08)**	**#103(R2)**	**#104 (R2)**	**#105 (R2)**	**#106 (R2)**	**#107 (F13)**	**#108 (F13)**	**#109 (F13)**	**#110 (F13)**	**RDL**	**QC Batch**
Total Metals by ICPMS												
Total Aluminum (Al)	mg/kg	1.6	15.6	0.9(1)	9.8	13.3	17.8	15.7	16.4	17.0	0.2	5298575
Total Antimony (Sb)	mg/kg	<0.001	0.001	<0.001	0.002	0.001	0.003	0.003	0.003	0.002	0.001	5298575
Total Arsenic (As)	mg/kg	0.02	0.07	0.04	0.08	0.05	0.10	0.10	0.08	0.09	0.01	5298575
Total Barium (Ba)	mg/kg	0.08	3.47	3.66	2.70	4.48	2.34	4.62	3.76	4.37	0.02	5298575
Total Beryllium (Be)	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	5298575
Total Bismuth (Bi)	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	5298575
Total Boron (B)	mg/kg	0.9	0.9	1.9	0.8	0.8	0.7	0.5	0.6	0.6	0.4	5298575
Total Cadmium (Cd)	mg/kg	0.003	0.020	0.014	0.026	0.016	0.077	0.080	0.123	0.097	0.002	5298575
Total Calcium (Ca)	mg/kg	260	11500	12000	6930	11000	9360	12500	11400	9550	2	5298575
Total Chromium (Cr)	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	0.10	0.05	0.06	0.04	5298575
Total Cobalt (Co)	mg/kg	0.046	0.024	0.013	0.023	0.028	0.088	0.069	0.086	0.073	0.004	5298575
Total Copper (Cu)	mg/kg	1.01	0.99	0.82	0.99	1.29	1.95	1.87	1.55	1.58	0.01	5298575
Total Iron (Fe)	mg/kg	10	36	14	30	41	42	44	37	39	2	5298575
Total Lead (Pb)	mg/kg	0.015	0.055	0.021	0.088	0.081	0.168	0.236	0.201	0.234	0.002	5298575
Total Magnesium (Mg)	mg/kg	203	382	321	317	324	329	381	353	376	2	5298575
Total Manganese (Mn)	mg/kg	0.30	6.00	4.82	4.91	7.92	7.91	10.5	7.92	11.1	0.02	5298575
Total Mercury (Hg)	mg/kg	0.063	0.057	0.102	0.085	0.048	0.050	0.045	0.061	0.071	0.002	5298575
Total Molybdenum (Mo)	mg/kg	<0.01	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.01	5298575
Total Nickel (Ni)	mg/kg	0.04	0.04	0.02	0.03	0.03	0.03	0.05	0.05	0.04	0.01	5298575
Total Phosphorus (P)	mg/kg	1960	8120	7590	5440	7720	6780	8950	8340	7450	2	5298575
Total Potassium (K)	mg/kg	3550	2890	2440	2910	2330	2490	2860	2650	2580	2	5298575
Total Selenium (Se)	mg/kg	0.28	1.88	0.58	1.12	1.92	0.81	0.76	0.83	0.54	0.01	5298575
Total Silver (Ag)	mg/kg	<0.004	<0.004	<0.004	<0.004	0.006	<0.004	<0.004	<0.004	<0.004	0.004	5298575
Total Sodium (Na)	mg/kg	513	1090	1350	1030	1030	1020	1180	1150	1010	2	5298575
Total Strontium (Sr)	mg/kg	0.32	26.6	25.1	13.8	25.8	16.5	26.0	20.0	21.3	0.02	5298575
Total Thallium (Tl)	mg/kg	0.0019	0.0063	0.0069	0.0062	0.0073	0.0089	0.0066	0.0101	0.0089	0.0004	5298575
Total Tin (Sn)	mg/kg	0.11	0.06	<0.02	0.06	0.04	0.03	0.26	0.04	0.06	0.02	5298575
Total Titanium (Ti)	mg/kg	<0.2	1.4	0.4	0.9	1.9	1.2	1.1	1.2	1.2	0.2	5298575
Total Uranium (U)	mg/kg	0.0013	0.0738	0.0789	0.0750	0.0644	0.0314	0.0534	0.0858	0.0684	0.0004	5298575
Total Vanadium (V)	mg/kg	<0.04	0.18	0.08	0.28	0.21	0.19	0.22	0.28	0.27	0.04	5298575
Total Zinc (Zn)	mg/kg	8.69	24.7	35.7	22.3	23.5	26.2	33.3	26.0	30.9	0.04	5298575

RDL = Reportable Detection Limit
(1) - Duplicate RPD above control limit - (10% of analytes failure allowed).

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Maxxam Job #: B192436
Report Date: 2012/03/30

PALMER ENVIRONMENTAL CONSULTING GROUP (PECG)
Client Project #: P1103 CASINO

Your P.O. #: TASK 8.1

ELEMENTS BY ATOMIC SPECTROSCOPY - WET WT (TISSUE)

Maxxam ID		BQ8835	BQ8836	BQ8837	BQ8838	BQ8839	BQ8840		
Sampling Date		2011/09/09	2011/09/09	2011/09/09	2011/09/09	2011/09/09	2011/09/09		
	Units	**#111 (F13)**	**#112 (F13)**	**#113 (F13)**	**#114 (F13)**	**#115 (F13)**	**#116 (F13)**	**RDL**	**QC Batch**
Total Metals by ICPMS									
Total Aluminum (Al)	mg/kg	25.4	5.2	23.6	15.8	7.1	16.0	0.2	5298575
Total Antimony (Sb)	mg/kg	0.004	0.002	0.003	0.003	0.002	0.003	0.001	5298575
Total Arsenic (As)	mg/kg	0.13	0.11	0.13	0.11	0.11	0.09	0.01	5298575
Total Barium (Ba)	mg/kg	2.82	3.60	4.35	2.36	3.49	3.19	0.02	5298575
Total Beryllium (Be)	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	5298575
Total Bismuth (Bi)	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	5298575
Total Boron (B)	mg/kg	0.5	<0.4	0.4	<0.4	<0.4	<0.4	0.4	5298575
Total Cadmium (Cd)	mg/kg	0.127	0.054	0.113	0.090	0.052	0.076	0.002	5298575
Total Calcium (Ca)	mg/kg	12700	11600	11200	9160	11500	10400	2	5298575
Total Chromium (Cr)	mg/kg	0.09	0.04	0.06	<0.04	<0.04	<0.04	0.04	5298575
Total Cobalt (Co)	mg/kg	0.106	0.072	0.090	0.073	0.049	0.068	0.004	5298575
Total Copper (Cu)	mg/kg	2.01	2.06	2.07	1.73	1.48	1.61	0.01	5298575
Total Iron (Fe)	mg/kg	58	21	53	41	22	39	2	5298575
Total Lead (Pb)	mg/kg	0.296	0.118	0.187	0.151	0.190	0.189	0.002	5298575
Total Magnesium (Mg)	mg/kg	362	340	382	311	353	313	2	5298575
Total Manganese (Mn)	mg/kg	8.11	8.38	9.00	6.20	8.29	8.27	0.02	5298575
Total Mercury (Hg)	mg/kg	0.063	0.038	0.087	0.032	0.043	0.036	0.002	5298575
Total Molybdenum (Mo)	mg/kg	0.02	0.02	0.03	0.02	0.01	0.03	0.01	5298575
Total Nickel (Ni)	mg/kg	0.07	0.08	0.07	0.03	0.02	0.04	0.01	5298575
Total Phosphorus (P)	mg/kg	8490	8670	7970	6960	8110	7330	2	5298575
Total Potassium (K)	mg/kg	2650	2550	2680	2360	2400	2150	2	5298575
Total Selenium (Se)	mg/kg	0.65	1.05	0.68	1.16	0.89	0.69	0.01	5298575
Total Silver (Ag)	mg/kg	<0.004	0.005	<0.004	<0.004	<0.004	<0.004	0.004	5298575
Total Sodium (Na)	mg/kg	1310	1090	1230	841	902	861	2	5298575
Total Strontium (Sr)	mg/kg	18.4	22.3	23.8	15.0	21.8	19.4	0.02	5298575
Total Thallium (Tl)	mg/kg	0.0104	0.0076	0.0079	0.0095	0.0084	0.0072	0.0004	5298575
Total Tin (Sn)	mg/kg	0.22	0.04	0.05	<0.02	<0.02	0.03	0.02	5298575
Total Titanium (Ti)	mg/kg	1.8	0.6	1.5	1.1	0.6	1.2	0.2	5298575
Total Uranium (U)	mg/kg	0.0640	0.0457	0.116	0.0384	0.0416	0.0702	0.0004	5298575
Total Vanadium (V)	mg/kg	0.20	0.18	0.30	0.18	0.19	0.20	0.04	5298575
Total Zinc (Zn)	mg/kg	33.0	27.0	26.9	21.9	25.6	22.5	0.04	5298575

RDL = Reportable Detection Limit

Maxxam Job #: B192436
Report Date: 2012/03/30

PALMER ENVIRONMENTAL CONSULTING GROUP (PECG)
Client Project #: P1103 CASINO

Your P.O. #: TASK 8.1

ELEMENTS BY ATOMIC SPECTROSCOPY - WET WT (TISSUE) Comments

Sample BQ8802-01 Elements by CRC ICPMS - Tissue Wet Wt: Detection limit raised based on sample volume used for analysis.

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Maxxam Job #: B192436
Report Date: 2012/03/30

PALMER ENVIRONMENTAL CONSULTING GROUP (PECG)
Client Project #: P1103 CASINO

Your P.O. #: TASK 8.1

QUALITY ASSURANCE REPORT

			Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
5298575	Total Arsenic (As)	2011/11/06	<0.01	mg/kg	NC	35	82	75 - 125
5298575	Total Cadmium (Cd)	2011/11/06	<0.002	mg/kg	30.6	35	90	75 - 125
5298575	Total Copper (Cu)	2011/11/06	<0.01	mg/kg	2.8	35	93	75 - 125
5298575	Total Iron (Fe)	2011/11/06	<2	mg/kg	13.6	35	90	75 - 125
5298575	Total Mercury (Hg)	2011/11/07	<0.002	mg/kg			87	75 - 125
5298575	Total Selenium (Se)	2011/11/06	<0.01	mg/kg	14.0	35	97	75 - 125
5298575	Total Silver (Ag)	2011/11/06	<0.004	mg/kg	NC	35	87	75 - 125
5298575	Total Zinc (Zn)	2011/11/06	<0.04	mg/kg	3.4	35	96	75 - 125
5298575	Total Aluminum (Al)	2011/11/06	<0.2	mg/kg	NC	35		
5298575	Total Antimony (Sb)	2011/11/06	<0.001	mg/kg	NC	35		
5298575	Total Barium (Ba)	2011/11/06	<0.02	mg/kg	31.8	35		
5298575	Total Beryllium (Be)	2011/11/06	<0.02	mg/kg	NC	35		
5298575	Total Bismuth (Bi)	2011/11/06	<0.02	mg/kg	NC	35		
5298575	Total Boron (B)	2011/11/06	<0.4	mg/kg	NC	35		
5298575	Total Calcium (Ca)	2011/11/06	<2	mg/kg	24.1(1)	35		
5298575	Total Chromium (Cr)	2011/11/06	<0.04	mg/kg	NC	35		
5298575	Total Cobalt (Co)	2011/11/06	<0.004	mg/kg	NC	35		
5298575	Total Lead (Pb)	2011/11/06	<0.002	mg/kg	30.0	35		
5298575	Total Magnesium (Mg)	2011/11/06	<2	mg/kg	9.4	35		
5298575	Total Manganese (Mn)	2011/11/06	<0.02	mg/kg	22.7	35		
5298575	Total Molybdenum (Mo)	2011/11/06	<0.01	mg/kg	NC	35		
5298575	Total Nickel (Ni)	2011/11/06	<0.01	mg/kg	NC	35		
5298575	Total Phosphorus (P)	2011/11/06	<2	mg/kg	23.6	35		
5298575	Total Potassium (K)	2011/11/06	<2	mg/kg	9.8	35		
5298575	Total Sodium (Na)	2011/11/06	<2	mg/kg	4.3	35		
5298575	Total Strontium (Sr)	2011/11/06	<0.02	mg/kg	29.1(1)	35		
5298575	Total Thallium (Tl)	2011/11/06	<0.0004	mg/kg	3.2	35		
5298575	Total Tin (Sn)	2011/11/06	<0.02	mg/kg	NC	35		
5298575	Total Titanium (Ti)	2011/11/06	<0.2	mg/kg	NC	35		
5298575	Total Uranium (U)	2011/11/06	<0.0004	mg/kg	33.0	35		
5298575	Total Vanadium (V)	2011/11/06	<0.04	mg/kg	NC	35		

N/A = Not Applicable
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.
(1) - Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Maxxam

Maxxam Analytics International Corporation o/a Maxxam Analytics
4606 Canada Way, Burnaby, British Columbia Canada V5G 1K5 Tel:(604) 734 7276 Toll-free:(604) 734 7276 Fax:(604) 731 2386 www.maxxam.ca

CHAIN OF CUSTODY RECORD

INVOICE INFORMATION:		REPORT INFORMATION (if differs from invoice):		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#4012 WESTERN COPPER CORPORATION	Company Name:	#18675 PALMER$ ENVIRONMENTAL CONSUL	Quotation #:	B00507	MAXXAM JOB #:	BOTTLE ORDER #:
Contact Name:	AP-Julien Francois (Casino)	Contact Name:	May Quach / Eric Cleveland	P.O. #:	Task # ~~8284~~ 8.1	B192436	129868
Address:	2050 - 1111 GEORGIA STREET WES	Address:	1199 West Hastings Street Suite 800	Project #:	P1103 Casino ~~Water Quality~~	CHAIN OF CUSTODY #:	PROJECT MANAGER:
	VANCOUVER BC V6E 4M3		Vancouver BC V6E 3T5	Project Name:		C#129868-09-01	Kelly Janda
Phone:	(604)684-9497 Fax: (604)669-2926	Phone:	(604)834-1858 Fax:	Site #:			
Email:	jfrancois@westerncoppercorp.com, may@pecgroup	Email:	may@pecgroup.ca eric@pecgroup.ca	Sampled By:			

REGULATORY CRITERIA:

SPECIAL INSTRUCTIONS

Note: For regulated drinking water samples - please use the Drinking Water Chain of Custody Form

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

ANALYSIS REQUESTED (Please be specific):

TURNAROUND TIME (TAT) REQUIRED:

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Regular (Standard) TAT: ☑
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission) ☐
Date Required: _____ Time Required: _____
Rush Confirmation Number: _____ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y/N)	Metals Field Filtered ? (Y/N)	Total Metals (Ultra Low)	Dissolved Metals (Ultra Low)	General Chem	NH4/TOC	Carbon (POC)	TSS	Cyanide (Total & WAD)	Metals			# of Bottles	Comments
1		Brit. Creek	10/8/11		Tissue										X				
2	BQ8797	Brit Creek 62	10/8/11																
3	798	Brit Creek 6	9/8/11																
4	799	Brit Creek 13																	
5	800	Brit Creek 14																	
6	801	Brit Creek 15																	
7	802	Brit Creek 16																	
8																			
9																			
10																			

B192436

*RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	# Jars Used and Not Submitted	Laboratory Use Only: Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact on Cooler?
E. Cleveland	11/9/28	12:00	Nahed Amer	11/09/20	14:22		☐	3,3,3	☐ Yes ☐ No

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Write: Maxxam Know: Client

NA

Maxxam

Maxxam Analytics International Corporation o/a Maxxam Analytics
4606 Canada Way, Burnaby, British Columbia Canada V5G 1K5 Tel:(604) 734 7276 Toll-free:(604) 734 7276 Fax:(604) 731 2386 www.maxxam.ca

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Company Name:	#4012 WESTERN COPPER CORPORATION	Company Name:	#18675 PALMER ENVIRONMENTAL CONSUL	Quotation #:	B00507	MAXXAM JOB #:	BOTTLE ORDER #:
Contact Name:	AP-Julien Francois (Casino)	Contact Name:	May Quach / Eric Cleveland.	P.O. #:	Task # ~~5.2.8~~ 8.1		129868
Address:	2050 - 1111 GEORGIA STREET WES	Address:	1199 West Hastings Street Suite 800	Project #:	P1103 Casino ~~Water Quality~~		
	VANCOUVER BC V6E 4M3		Vancouver BC V6E 3T5	Project Name:		CHAIN OF CUSTODY #:	PROJECT MANAGER:
Phone:	(604)684-9497 Fax: (604)669-2926	Phone:	(604)834-1858 Fax:	Site #:		C#129868-10-01	Kelly Janda
Email:	jfrancois@westerncoppercorp.com, may@pecgroup	Email:	may@pecgroup.ca eric@pecgroup.ca	Sampled By:	E. Cleveland		

REGULATORY CRITERIA:

SPECIAL INSTRUCTIONS

Note: For regulated drinking water samples - please use the Drinking Water Chain of Custody Form

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Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: _____ Time Required: _____ ☐
Rush Confirmation Number: _____ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y / N)	Metals Field Filtered ? (Y / N)	Total Metals (Ultra Low)	Dissolved Metals (Ultra Low)	General Chem	NH3/D96	Carbon (DOC)	TSS	Cyanide (Total & WAD)	Metals			# of Bottles	Comments
1	BQ 8825	#101 (F08)	7/9/11		Tissue										X				
2	826	#102 (F08)	"																
3	827	#103 (R2)	8/9/11																
4	828	#104 (R2)																	
5	829	#105 (R2)																	
6	830	#106 (R2)	✓																
7	831	#107 (F13)	9/9/11																
8	832	#108 (F13)																	
9	833	#109 (F13)																	
10	834	#110 (F13)	✓												✓				

B192436

*RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	# Jars Used and Not Submitted	Laboratory Use Only: Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact or Cooler?
E. Cleveland	11/9/28	12:00	Nahed Amer	11/09/28	14:22		☐	3,3,3	☐ Yes ☐ No

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

NA

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Company Name:	#4012 WESTERN COPPER CORPORATION	Company Name:	#18675 PALMERS ENVIRONMENTAL CONSUL	Quotation #:	B00507	MAXXAM JOB #:	BOTTLE ORDER #:
Contact Name:	AP-Julien Francois (Casino)	Contact Name:	May Quach / Eric Cleveland	P.O. #:	Task # ~~5.2~~ 8.1		129868
Address:	2050 - 1111 GEORGIA STREET WES	Address:	1199 West Hastings Street Suite 800	Project #:	P1103 Casino ~~Water Quality~~	CHAIN OF CUSTODY #:	PROJECT MANAGER:
	VANCOUVER BC V6E 4M3		Vancouver BC V6E 3T5	Project Name:		C#129868-11-01	Kelly Janda
Phone:	(604)684-9497 Fax: (604)669-2926	Phone:	(604)834-1858 Fax:	Site #:			
Email:	jfrancois@westerncoppercorp.com, may@pecgroup	Email:	may@pecgroup.ca eric@pecgroup.ca	Sampled By:	E. Cleveland		

REGULATORY CRITERIA:

SPECIAL INSTRUCTIONS

Note: For regulated drinking water samples - please use the Drinking Water Chain of Custody Form

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Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission) ☐
Date Required: _____ Time Required: _____
Rush Confirmation Number: _____ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y / N)	Metals Field Filtered ? (Y / N)	~~Total Metals (Ultra Low)~~	~~Dissolved Metals (Ultra Low)~~	~~General Chem~~	~~NH4/NO2~~	~~Carbon (DOC)~~	~~TSS~~	~~Cyanide (Total & WAD)~~	Metals			# of Bottles	Comments
1	BQ8835	#111 (F13)	9/9/11		Tissue										X				
2	836	#112 (F13)	↓		↓										↓				
3	837	#113 (F13)																	
4	838	#114 (F13)																	
5	839	#115 (F13)																	
6	840	#116 (F13)																	
7																			
8																			
9																			
10																			

B192436

*RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time:	# Jars Used and Not Submitted	Laboratory Use Only: Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact on Cooler?
E. Cleveland	11/09/28	12:00	Nahed Amer	11/09/28	14:22		☐	3,3,3	☐ Yes ☐ No

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White: Maxxam Yellow: Client

NA

Appendix F

Environment Canada Water Quality and Toxicity Testing Results, 2011

Pacific and Yukon Laboratory for Environmental Testing (PYLET)
2645 Dollarton Highway
North Vancouver, BC. Canada V7H - 1B1

Environment Canada Environnement Canada

Wednesday September 7, 2011 At 12:37PM

Final Analytical Results with QC data

FOLDER # : 201100565

Location:	CASINO MINE- HISTORICAL ADIT (W43)
Type of Sample:	Waste Water / Other (WWOT)
Submitted By:	Denis Lacroix Environment Canada 91782 Alaska Hwy Whitehorse, YT Canada Y1A 5B7 Phone: 867-667-4592 Fax: 867-667-7962
Logged In:	Thursday July 14, 2011
Completed:	Wednesday September 7, 2011 (118 results)
Client Code:	2561-101 2561-101 EP YUKON ENV ASSESSMENT
Sample Priority:	Normal

Authorized by: Richard Strub
QA Officer

Notes:

METALS FIELD ACIDIFIED

The samples associated with this report will be discarded 30 days after the final report is generated unless other arrangements for storage and / or pick-up have been made with the lab.

Results relate only to the samples tested.Test analysis date provided upon client request.
An asterix (*) indicates that the corresponding method may be accredited by CALA for some or all of the parameters listed. For our current Scope of Accreditation please see www.cala.ca/scopes/1578.pdf .

This test report shall not be reproduced except in full, without written approval of the laboratory.

CALA Testing Accreditation No. A 1578

TEST DESCRIPTION	MATRIX	RESULT	MDL	UNITS
PYLET Order No: 231569 - Client Sample ID: CASINO MINE W43 NUTRIENTS				**Arrival Temperature: 6.2°C**
Sampling Date: 7/13/2011				
General				
***Acidity Tot.&pH4.5**				
Acidity, Total	WWOT	8.2	1	mg CaCO3 / L
***AlkalinityTotpH4.5**				
Alkalinity to pH 4.5	WWOT	69.8	0.5	mg CaCO3 / L
***Color True**				
Colour, True	WWOT	5	5	Col. unit
***ICA (Cl F SO4)**				
Chloride (Cl)	WWOT	0.3	0.1	mg/L
Fluoride (F)	WWOT	0.11	0.01	mg/L
Sulphate (SO4)	WWOT	42	3	mg/L
***pH**				
pH	WWOT	7.05	0.01	pH Units
***Residue Filterable**				
Solids, Total Dissolved (FR)	WWOT	150	10	mg/L
***Residue Nonfilt.**				
Solids, Total Suspended (NFR)	WWOT	< 5	5	mg/L
***SpecificConductance**				
Conductivity (25C)	WWOT	226	2	uS/cm
Non-Halogenated				
DOC				
Carbon, Dissolved Organic	WWOT	1.2	0.5	mg/L
Nutrients				
***Nitrogen Ammonia**				
Nitrogen, Ammonia as N	WWOT	< 0.002	0.002	mg/L
***Nitrogen NO 2**				
Nitrogen, Nitrite as N	WWOT	< 0.002	0.002	mg/L
***Nitrogen NO 23**				
Nitrogen, Nitrate + Nitrite as N	WWOT	0.416	0.002	mg/L
***Nitrogen. Total**				
Nitrogen, Total as N	WWOT	0.46	0.02	mg/L
***Phosphorus Total**				
Phosphorus, Total as P	WWOT	0.003	0.002	mg/L
PYLET Order No: 231570 - Client Sample ID: CASINO MINEW43 DAPNIA				
Sampling Date: 7/13/2011				

TEST DESCRIPTION	MATRIX	RESULT	MDL	UNITS

PYLET Order No: 231570 - Client Sample ID: CASINO MINEW43 DAPNIA
Sampling Date: 7/13/2011

Aquatic

Daphnia LT50 48h

Daphnia Magna, 48-hour LT50 Bioassay	WWOT	>1<3.5	0.0	hr

At 100% concentration, the 48 hour LT50 was > 1 hour but < 3.5 hours of exposure for daphnia magna. At 100% concentration, the sample had 100% mortality to daphnia magna after 3.5 hours of exposure.

PYLET Order No: 231571 - Client Sample ID: CASINO MINE W43 T. METALS
Sampling Date: 7/13/2011

Metals

*ICP Total

Aluminum (Al)	WWOT	< 0.06	0.06	mg/L
Antimony (Sb)	WWOT	< 0.06	0.06	mg/L
Arsenic (As)	WWOT	< 0.06	0.06	mg/L
Barium (Ba)	WWOT	0.058	0.001	mg/L
Beryllium (Be)	WWOT	< 0.001	0.001	mg/L
Boron (B)	WWOT	< 0.01	0.01	mg/L
Cadmium (Cd)	WWOT	0.045	0.006	mg/L
Calcium (Ca)	WWOT	26.8	0.1	mg/L
Chromium (Cr)	WWOT	< 0.006	0.006	mg/L
Cobalt (Co)	WWOT	< 0.006	0.006	mg/L
Copper (Cu)	WWOT	0.09	0.02	mg/L
Iron (Fe)	WWOT	0.10	0.05	mg/L
Lead (Pb)	WWOT	< 0.06	0.06	mg/L
Magnesium (Mg)	WWOT	7.8	0.1	mg/L
Manganese (Mn)	WWOT	0.783	0.001	mg/L
Molybdenum (Mo)	WWOT	< 0.01	0.01	mg/L
Nickel (Ni)	WWOT	< 0.02	0.02	mg/L
Phosphorus (P)	WWOT	< 0.1	0.1	mg/L
Potassium (K)	WWOT	1.5	0.1	mg/L
Selenium (Se)	WWOT	< 0.06	0.06	mg/L
Silicon (Si)	WWOT	5.48	0.06	mg/L
Silver (Ag)	WWOT	< 0.01	0.01	mg/L
Sodium (Na)	WWOT	3.1	0.1	mg/L
Strontium (Sr)	WWOT	0.253	0.001	mg/L

TEST DESCRIPTION	MATRIX	RESULT	MDL	UNITS
PYLET Order No: 231571 - Client Sample ID: CASINO MINE W43 T. METALS				
Sampling Date: 7/13/2011				
Sulfur (S)	WWOT	14.7	0.06	mg/L
Tin (Sn)	WWOT	< 0.06	0.06	mg/L
Titanium (Ti)	WWOT	< 0.002	0.002	mg/L
Vanadium (V)	WWOT	< 0.01	0.01	mg/L
Zinc (Zn)	WWOT	2.50	0.05	mg/L
***ICPMS Total**				
Aluminum (Al)	WWOT	33.8	0.2	ug/L
Antimony (Sb)	WWOT	2.34	0.005	ug/L
Arsenic (As)	WWOT	0.8	0.1	ug/L
Barium (Ba)	WWOT	53.6	0.02	ug/L
Beryllium (Be)	WWOT	0.013	0.002	ug/L
Bismuth (Bi)	WWOT	0.14	0.02	ug/L
Cadmium (Cd)	WWOT	42.5	0.01	ug/L
Chromium (Cr)	WWOT	5.4	0.2	ug/L
Cobalt (Co)	WWOT	0.393	0.005	ug/L
Copper (Cu)	WWOT	75.2	0.05	ug/L
Lead (Pb)	WWOT	17	0.01	ug/L
Lithium (Li)	WWOT	2.14	0.05	ug/L
Manganese (Mn)	WWOT	763	0.005	ug/L
Molybdenum (Mo)	WWOT	0.08	0.05	ug/L
Nickel (Ni)	WWOT	1.69	0.05	ug/L
Selenium (Se)	WWOT	< 0.2	0.2	ug/L
Silver (Ag)	WWOT	0.20	0.02	ug/L
Strontium (Sr)	WWOT	243	0.005	ug/L
Thallium (Tl)	WWOT	0.031	0.002	ug/L
Tin (Sn)	WWOT	0.39	0.01	ug/L
Uranium (U)	WWOT	1.35	0.002	ug/L
Vanadium (V)	WWOT	0.06	0.05	ug/L
Zinc (Zn)	WWOT	2480	0.2	ug/L
***Mercury total**				
Mercury (Hg)	WWOT	< 0.02	0.02	ug/L
PYLET Order No: 231572 - Client Sample ID: CASINO MINE W43 D. METALS				
Sampling Date: 7/13/2011				

Metals

***ICP Dissolved**				
Aluminum (Al)	WWOT	< 0.05	0.05	mg/L
Antimony (Sb)	WWOT	< 0.05	0.05	mg/L

TEST DESCRIPTION	MATRIX	RESULT	MDL	UNITS
PYLET Order No: 231572 - Client Sample ID: CASINO MINE W43 D. METALS				
Sampling Date: 7/13/2011				
Arsenic (As)	WWOT	< 0.05	0.05	mg/L
Barium (Ba)	WWOT	0.055	0.001	mg/L
Beryllium (Be)	WWOT	< 0.001	0.001	mg/L
Boron (B)	WWOT	< 0.01	0.01	mg/L
Cadmium (Cd)	WWOT	0.047	0.005	mg/L
Calcium (Ca)	WWOT	27.4	0.1	mg/L
Chromium (Cr)	WWOT	0.006	0.005	mg/L
Cobalt (Co)	WWOT	< 0.005	0.005	mg/L
Copper (Cu)	WWOT	0.086	0.005	mg/L
Iron (Fe)	WWOT	0.023	0.005	mg/L
Lead (Pb)	WWOT	< 0.05	0.05	mg/L
Magnesium (Mg)	WWOT	7.8	0.1	mg/L
Manganese (Mn)	WWOT	0.775	0.001	mg/L
Molybdenum (Mo)	WWOT	< 0.01	0.01	mg/L
Nickel (Ni)	WWOT	< 0.02	0.02	mg/L
Phosphorus (P)	WWOT	< 0.1	0.1	mg/L
Potassium (K)	WWOT	1.5	0.1	mg/L
Selenium (Se)	WWOT	< 0.05	0.05	mg/L
Silicon (Si)	WWOT	5.57	0.05	mg/L
Silver (Ag)	WWOT	< 0.01	0.01	mg/L
Sodium (Na)	WWOT	3.1	0.1	mg/L
Strontium (Sr)	WWOT	0.242	0.001	mg/L
Sulfur (S)	WWOT	15.3	0.05	mg/L
Tin (Sn)	WWOT	< 0.05	0.05	mg/L
Titanium (Ti)	WWOT	< 0.002	0.002	mg/L
Vanadium (V)	WWOT	< 0.01	0.01	mg/L
Zinc (Zn)	WWOT	2.62	0.05	mg/L
***ICPMS Dissolved**				
Aluminum (Al)	WWOT	1.3	0.2	ug/L
Antimony (Sb)	WWOT	2.28	0.005	ug/L
Arsenic (As)	WWOT	0.5	0.1	ug/L
Barium (Ba)	WWOT	55.7	0.02	ug/L
Beryllium (Be)	WWOT	0.008	0.002	ug/L
Bismuth (Bi)	WWOT	< 0.02	0.02	ug/L
Cadmium (Cd)	WWOT	45.2	0.01	ug/L
Chromium (Cr)	WWOT	5.6	0.2	ug/L
Cobalt (Co)	WWOT	0.365	0.005	ug/L
Copper (Cu)	WWOT	76.7	0.05	ug/L
Lead (Pb)	WWOT	8.01	0.01	ug/L
Lithium (Li)	WWOT	2.24	0.05	ug/L
Manganese (Mn)	WWOT	728	0.005	ug/L
Molybdenum (Mo)	WWOT	< 0.05	0.05	ug/L
Nickel (Ni)	WWOT	1.16	0.05	ug/L

TEST DESCRIPTION	MATRIX	RESULT	MDL	UNITS
PYLET Order No: 231572 - Client Sample ID: CASINO MINE W43 D. METALS				
Sampling Date: 7/13/2011				
Selenium (Se)	WWOT	< 0.2	0.2	ug/L
Silver (Ag)	WWOT	0.10	0.02	ug/L
Strontium (Sr)	WWOT	254	0.005	ug/L
Thallium (Tl)	WWOT	0.024	0.002	ug/L
Tin (Sn)	WWOT	0.03	0.01	ug/L
Uranium (U)	WWOT	1.12	0.002	ug/L
Vanadium (V)	WWOT	< 0.05	0.05	ug/L
Zinc (Zn)	WWOT	2679	0.2	ug/L
***Mercury dissolved**				
Mercury (Hg)	WWOT	< 0.02	0.02	ug/L
Hardness Diss. CaMg				
Hardness, Dissolved Calcium+Magnesium - calc.	WWOT	101	0.4	mg CaCO3 / L
Hardness Diss.Total				
Hardness, Dissolved Total - calc.	WWOT	107	0.4	mg CaCO3 / L

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE

***Acidity Tot.&pH4.5 UNITS:** mg CaCO3 / L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Acidity, Total	231678-1	< MDL	< 1		1	1	BLE
Acidity, Total	231681-1	25.2295096	25	99.7	1	1	REF
Acidity, Total	231682-1	50.2925323	49	97.8	1	1	REF
Acidity, Total	231680-1	8.2	8.8	107.6	1	1	REP

***AlkalinityTotpH4.5 UNITS:** mg CaCO3 / L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Alkalinity to pH 4.5	231673-1	77.7072307	78.4	100.9	1	0.5	REF
Alkalinity to pH 4.5	231677-1	69.9	69.9	100.1	1	0.5	REP
Alkalinity, Total	231657-1	10.2490878	< 0.5		1	0.5	BLE

***Color True UNITS:** Col. unit **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Colour, True	231581-1	< MDL	< 2.5		1	2.5	BLE
Colour, True	231582-1	20	20	100.0	1	2.5	REF
Colour, True	231583-1	5	5	100.0	1	2.5	REP

***ICA (Cl F SO4) UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Chloride (Cl)	231604-1	< MDL	< 0.1		1	0.1	BLE
Chloride (Cl)	231609-1	2.62477758	2.4	93.9	1	0.1	REF
Chloride (Cl)	231613-1	<0.1	0.1	137.1	1	0.1	REP
Fluoride (F)	231604-1	< MDL	0.02		1	0.01	BLE
Fluoride (F)	231609-1	0.35385454	0.40	115.0	1	0.01	REF
Fluoride (F)	231613-1	0.08	0.09	119.4	1	0.01	REP
Sulphate (SO4)	231604-1	< MDL	< 0.5		1	0.5	BLE
Sulphate (SO4)	231608-1	19.6243750	19.0	96.6	1	0.5	REF
Sulphate (SO4)	231613-1	24.5	24.7	100.7	1	0.5	REP

***ICP Dissolved UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Aluminum (Al)	231744-1	< MDL	< 0.05		1	0.05	BLE
Aluminum (Al)	231754-1	0.36091111	0.36	98.9	1	0.05	REF
Aluminum (Al)	231757-1		< 0.05		1	0.05	REP
Aluminum (Al)	231758-1	0.32	0.32	101.0	1	0.05	REP
Aluminum (Al)	231759-1		< 0.05		1	0.05	REP
Antimony (Sb)	231744-1	< MDL	< 0.05		1	0.05	BLE
Antimony (Sb)	231754-1	0.52092222	0.50	95.4	1	0.05	REF
Antimony (Sb)	231757-1		< 0.05		1	0.05	REP
Antimony (Sb)	231758-1		< 0.05		1	0.05	REP
Antimony (Sb)	231759-1		< 0.05		1	0.05	REP
Arsenic (As)	231744-1	< MDL	< 0.05		1	0.05	BLE
Arsenic (As)	231754-1	0.68630000	0.66	96.2	1	0.05	REF
Arsenic (As)	231757-1		< 0.05		1	0.05	REP
Arsenic (As)	231758-1		< 0.05		1	0.05	REP
Arsenic (As)	231759-1		< 0.05		1	0.05	REP

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Barium (Ba)	231744-1	< MDL	< 0.001		1	0.001	BLE
Barium (Ba)	231754-1	0.34563333	0.331	95.8	1	0.001	REF
Barium (Ba)	231757-1	0.055	0.055	100.5	1	0.001	REP
Barium (Ba)	231758-1	0.010	0.010	97.3	1	0.001	REP
Barium (Ba)	231759-1	0.016	0.016	100.6	1	0.001	REP
Beryllium (Be)	231744-1	< MDL	< 0.001		1	0.001	BLE
Beryllium (Be)	231754-1	0.60306666	0.590	97.8	1	0.001	REF
Beryllium (Be)	231757-1		< 0.001		1	0.001	REP
Beryllium (Be)	231758-1		< 0.001		1	0.001	REP
Beryllium (Be)	231759-1		< 0.001		1	0.001	REP
Boron (B)	231744-1	< MDL	< 0.01		1	0.01	BLE
Boron (B)	231754-1	1.56577777	1.49	95.2	1	0.01	REF
Boron (B)	231757-1		< 0.01		1	0.01	REP
Boron (B)	231758-1	0.04	0.04	100.0	1	0.01	REP
Boron (B)	231759-1	0.02	0.02	99.4	1	0.01	REP
Cadmium (Cd)	231744-1	< MDL	< 0.005		1	0.005	BLE
Cadmium (Cd)	231754-1	0.23944444	0.227	94.6	1	0.005	REF
Cadmium (Cd)	231757-1	0.047	0.047	99.9	1	0.005	REP
Cadmium (Cd)	231758-1		< 0.005		1	0.005	REP
Cadmium (Cd)	231759-1		< 0.005		1	0.005	REP
Calcium (Ca)	231744-1	< MDL	< 0.1		1	0.1	BLE
Calcium (Ca)	231746-1	88.7555555	88.9	100.1	1	0.1	REF
Calcium (Ca)	231757-1	27.4	27.3	99.5	1	0.1	REP
Calcium (Ca)	231758-1	85.2	86.4	101.4	1	0.1	REP
Calcium (Ca)	231759-1	32.3	32.1	99.5	1	0.1	REP
Chromium (Cr)	231744-1	< MDL	< 0.005		1	0.005	BLE
Chromium (Cr)	231754-1	0.43412222	0.415	95.7	1	0.005	REF
Chromium (Cr)	231757-1	0.006	0.006	100.0	1	0.005	REP
Chromium (Cr)	231758-1		< 0.005		1	0.005	REP
Chromium (Cr)	231759-1		< 0.005		1	0.005	REP
Cobalt (Co)	231744-1	< MDL	< 0.005		1	0.005	BLE
Cobalt (Co)	231754-1	0.73388888	0.708	96.5	1	0.005	REF
Cobalt (Co)	231757-1		< 0.005		1	0.005	REP
Cobalt (Co)	231758-1		< 0.005		1	0.005	REP
Cobalt (Co)	231759-1		< 0.005		1	0.005	REP
Copper (Cu)	231744-1	< MDL	< 0.005		1	0.005	BLE
Copper (Cu)	231754-1	0.90426666	0.906	100.2	1	0.005	REF
Copper (Cu)	231757-1	0.086	0.085	99.3	1	0.005	REP
Copper (Cu)	231758-1	0.678	0.685	101.1	1	0.005	REP
Copper (Cu)	231759-1		< 0.005		1	0.005	REP
Iron (Fe)	231744-1	< MDL	< 0.005		1	0.005	BLE
Iron (Fe)	231754-1	0.79790444	0.801	100.3	1	0.005	REF
Iron (Fe)	231757-1	0.023	0.023	98.8	1	0.005	REP
Iron (Fe)	231758-1		< 0.005		1	0.005	REP
Iron (Fe)	231759-1	0.008	0.008	99.6	1	0.005	REP
Lead (Pb)	231744-1	< MDL	< 0.05		1	0.05	BLE
Lead (Pb)	231754-1	1.86400000	1.84	98.7	1	0.05	REF
Lead (Pb)	231757-1		< 0.05		1	0.05	REP
Lead (Pb)	231758-1		< 0.05		1	0.05	REP
Lead (Pb)	231759-1		< 0.05		1	0.05	REP
Magnesium (Mg)	231744-1	< MDL	< 0.1		1	0.1	BLE
Magnesium (Mg)	231746-1	25.9366666	25.5	98.5	1	0.1	REF

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Magnesium (Mg)	231757-1	7.8	7.7	98.9	1	0.1	REP
Magnesium (Mg)	231758-1	9.1	9.0	99.3	1	0.1	REP
Magnesium (Mg)	231759-1	9.3	9.4	100.9	1	0.1	REP
Manganese (Mn)	231744-1	< MDL	< 0.001		1	0.001	BLE
Manganese (Mn)	231754-1	0.64556666	0.633	98.1	1	0.001	REF
Manganese (Mn)	231757-1	0.775	0.764	98.6	1	0.001	REP
Manganese (Mn)	231758-1	0.027	0.027	101.3	1	0.001	REP
Manganese (Mn)	231759-1		< 0.001		1	0.001	REP
Molybdenum (Mo)	231744-1	< MDL	< 0.01		1	0.01	BLE
Molybdenum (Mo)	231754-1	0.52988888	0.51	97.0	1	0.01	REF
Molybdenum (Mo)	231757-1		< 0.01		1	0.01	REP
Molybdenum (Mo)	231758-1		< 0.01		1	0.01	REP
Molybdenum (Mo)	231759-1		< 0.01		1	0.01	REP
Nickel (Ni)	231744-1	< MDL	< 0.02		1	0.02	BLE
Nickel (Ni)	231754-1	0.74666666	0.73	98.3	1	0.02	REF
Nickel (Ni)	231757-1		< 0.02		1	0.02	REP
Nickel (Ni)	231758-1		< 0.02		1	0.02	REP
Nickel (Ni)	231759-1		< 0.02		1	0.02	REP
Phosphorus (P)	231744-1	< MDL	< 0.1		1	0.1	BLE
Phosphorus (P)	231757-1		< 0.1		1	0.1	REP
Phosphorus (P)	231758-1		< 0.1		1	0.1	REP
Phosphorus (P)	231759-1		< 0.1		1	0.1	REP
Potassium (K)	231744-1	< MDL	< 0.1		1	0.1	BLE
Potassium (K)	231746-1	4.17122222	4.0	96.2	1	0.1	REF
Potassium (K)	231757-1	1.5	1.5	99.9	1	0.1	REP
Potassium (K)	231758-1	6.7	6.5	97.2	1	0.1	REP
Potassium (K)	231759-1	1.4	1.4	99.8	1	0.1	REP
Selenium (Se)	231744-1	< MDL	< 0.05		1	0.05	BLE
Selenium (Se)	231754-1	0.71785555	0.70	97.7	1	0.05	REF
Selenium (Se)	231757-1		< 0.05		1	0.05	REP
Selenium (Se)	231758-1		< 0.05		1	0.05	REP
Selenium (Se)	231759-1		< 0.05		1	0.05	REP
Silicon (Si)	231744-1	< MDL	< 0.05		1	0.05	BLE
Silicon (Si)	231746-1	1.09294444	1.10	100.2	1	0.05	REF
Silicon (Si)	231757-1	5.57	5.55	99.6	1	0.05	REP
Silicon (Si)	231758-1	9.49	9.42	99.2	1	0.05	REP
Silicon (Si)	231759-1	10.2	10.3	100.5	1	0.05	REP
Silver (Ag)	231744-1	< MDL	< 0.01		1	0.01	BLE
Silver (Ag)	231757-1		< 0.01		1	0.01	REP
Silver (Ag)	231758-1		< 0.01		1	0.01	REP
Silver (Ag)	231759-1		< 0.01		1	0.01	REP
Sodium (Na)	231744-1	< MDL	< 0.1		1	0.1	BLE
Sodium (Na)	231746-1	49.8788888	49.1	98.5	1	0.1	REF
Sodium (Na)	231757-1	3.1	3.1	99.5	1	0.1	REP
Sodium (Na)	231758-1	11.2	11.2	100.3	1	0.1	REP
Sodium (Na)	231759-1	6.1	6.1	99.3	1	0.1	REP
Strontium (Sr)	231744-1	< MDL	< 0.001		1	0.001	BLE
Strontium (Sr)	231754-1	0.08649111	0.082	94.3	1	0.001	REF
Strontium (Sr)	231757-1	0.243	0.240	98.9	1	0.001	REP
Strontium (Sr)	231758-1	0.407	0.402	98.8	1	0.001	REP
Strontium (Sr)	231759-1	0.126	0.127	100.5	1	0.001	REP
Sulfur (S)	231744-1	< MDL	< 0.05		1	0.05	BLE

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Sulfur (S)	231746-1	38.3836666	37.8	98.4	1	0.05	REF
Sulfur (S)	231757-1	15.3	15.1	99.0	1	0.05	REP
Sulfur (S)	231758-1	80.0	79.8	99.7	1	0.05	REP
Sulfur (S)	231759-1	9.85	9.72	98.7	1	0.05	REP
Tin (Sn)	231744-1	< MDL	< 0.05		1	0.05	BLE
Tin (Sn)	231752-1	3.61542857	3.60	100.7	1	0.05	REF
Tin (Sn)	231757-1		< 0.05		1	0.05	REP
Tin (Sn)	231758-1		< 0.05		1	0.05	REP
Tin (Sn)	231759-1		< 0.05		1	0.05	REP
Titanium (Ti)	231744-1	< MDL	< 0.002		1	0.002	BLE
Titanium (Ti)	231752-1	0.21574285	0.212	103.8	1	0.002	REF
Titanium (Ti)	231757-1		< 0.002		1	0.002	REP
Titanium (Ti)	231758-1		< 0.002		1	0.002	REP
Titanium (Ti)	231759-1		< 0.002		1	0.002	REP
Vanadium (V)	231744-1	< MDL	< 0.01		1	0.01	BLE
Vanadium (V)	231754-1	1.36733333	1.33	97.0	1	0.01	REF
Vanadium (V)	231757-1		< 0.01		1	0.01	REP
Vanadium (V)	231758-1		< 0.01		1	0.01	REP
Vanadium (V)	231759-1		< 0.01		1	0.01	REP
Zinc (Zn)	231744-1	< MDL	< 0.05		1	0.05	BLE
Zinc (Zn)	231754-1	0.91475555	0.89	97.5	1	0.05	REF
Zinc (Zn)	231757-1	2.62	2.63	100.2	1	0.05	REP
Zinc (Zn)	231758-1	0.51	0.51	99.5	1	0.05	REP
Zinc (Zn)	231759-1		< 0.05		1	0.05	REP

***ICP Total UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Aluminum (Al)	232268-1	< MDL	< 0.06		1	0.06	BLL
Aluminum (Al)	232273-1	0.37997500	0.45	118.4	1	0.06	REF
Aluminum (Al)	232274-1	0.24	0.21	89.3	1	0.06	REP
Aluminum (Al)	232275-1	0.22	0.22	98.9	1	0.06	REP
Aluminum (Al)	232276-1		< 0.06		1	0.06	REP
Antimony (Sb)	232268-1	< MDL	< 0.06		1	0.06	BLL
Antimony (Sb)	232273-1	0.52062500	0.52	99.2	1	0.06	REF
Antimony (Sb)	232274-1		< 0.06		1	0.06	REP
Antimony (Sb)	232275-1		< 0.06		1	0.06	REP
Antimony (Sb)	232276-1		< 0.06		1	0.06	REP
Arsenic (As)	232268-1	< MDL	< 0.06		1	0.06	BLL
Arsenic (As)	232273-1	0.70917500	0.71	99.7	1	0.06	REF
Arsenic (As)	232274-1		< 0.06		1	0.06	REP
Arsenic (As)	232275-1		< 0.06		1	0.06	REP
Arsenic (As)	232276-1		< 0.06		1	0.06	REP
Barium (Ba)	232268-1	< MDL	< 0.001		1	0.001	BLL
Barium (Ba)	232273-1	0.35345000	0.350	99.1	1	0.001	REF
Barium (Ba)	232274-1	0.017	0.017	98.5	1	0.001	REP
Barium (Ba)	232275-1	0.007	0.007	101.2	1	0.001	REP
Barium (Ba)	232276-1	0.058	0.059	100.9	1	0.001	REP
Beryllium (Be)	232268-1	< MDL	< 0.001		1	0.001	BLL
Beryllium (Be)	232273-1	0.59197500	0.594	100.4	1	0.001	REF
Beryllium (Be)	232274-1		< 0.001		1	0.001	REP
Beryllium (Be)	232275-1		< 0.001		1	0.001	REP
Beryllium (Be)	232276-1		< 0.001		1	0.001	REP

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Boron (B)	232268-1	< MDL	< 0.01		1	0.01	BLL
Boron (B)	232273-1	1.55625000	1.58	101.5	1	0.01	REF
Boron (B)	232274-1		< 0.01		1	0.01	REP
Boron (B)	232275-1		< 0.01		1	0.01	REP
Boron (B)	232276-1		< 0.01		1	0.01	REP
Cadmium (Cd)	232268-1	< MDL	< 0.006		1	0.006	BLL
Cadmium (Cd)	232273-1	0.23385000	0.232	99.0	1	0.006	REF
Cadmium (Cd)	232274-1	0.031	0.028	90.7	1	0.006	REP
Cadmium (Cd)	232275-1		< 0.006		1	0.006	REP
Cadmium (Cd)	232276-1	0.046	0.046	100.3	1	0.006	REP
Calcium (Ca)	232268-1	< MDL	0.1		1	0.1	BLL
Calcium (Ca)	232269-1	92.3070519	95.7	103.7	1	0.1	REF
Calcium (Ca)	232274-1	0.5	0.5	94.2	1	0.1	REP
Calcium (Ca)	232275-1	0.5	0.5	102.0	1	0.1	REP
Calcium (Ca)	232276-1	26.8	26.8	100.0	1	0.1	REP
Chromium (Cr)	232268-1	< MDL	< 0.006		1	0.006	BLL
Chromium (Cr)	232273-1	0.43735000	0.440	100.7	1	0.006	REF
Chromium (Cr)	232274-1		< 0.006		1	0.006	REP
Chromium (Cr)	232275-1		< 0.006		1	0.006	REP
Chromium (Cr)	232276-1		< 0.006		1	0.006	REP
Cobalt (Co)	232268-1	< MDL	< 0.006		1	0.006	BLL
Cobalt (Co)	232273-1	0.73560000	0.746	101.4	1	0.006	REF
Cobalt (Co)	232274-1		< 0.006		1	0.006	REP
Cobalt (Co)	232275-1		< 0.006		1	0.006	REP
Cobalt (Co)	232276-1		< 0.006		1	0.006	REP
Copper (Cu)	232268-1	< MDL	< 0.02		1	0.02	BLL
Copper (Cu)	232273-1	0.93977500	0.93	98.9	1	0.02	REF
Copper (Cu)	232274-1	1.21	1.09	90.4	1	0.02	REP
Copper (Cu)	232275-1	0.58	0.55	94.8	1	0.02	REP
Copper (Cu)	232276-1	0.09	0.09	98.9	1	0.02	REP
Iron (Fe)	232268-1	< MDL	< 0.05		1	0.05	BLL
Iron (Fe)	232273-1	0.82587500	0.81	98.4	1	0.05	REF
Iron (Fe)	232274-1	2.07	1.83	88.3	1	0.006	REP
Iron (Fe)	232275-1	0.489	0.444	90.8	1	0.006	REP
Iron (Fe)	232276-1	0.10	0.10	100.6	1	0.05	REP
Lead (Pb)	232268-1	< MDL	< 0.06		1	0.06	BLL
Lead (Pb)	232273-1	1.87275000	1.88	100.4	1	0.06	REF
Lead (Pb)	232274-1	1.69	1.63	96.7	1	0.06	REP
Lead (Pb)	232275-1	0.16	0.15	96.1	1	0.06	REP
Lead (Pb)	232276-1		< 0.06		1	0.06	REP
Magnesium (Mg)	232268-1	< MDL	< 0.1		1	0.1	BLL
Magnesium (Mg)	232269-1	26.1042500	27.1	103.8	1	0.1	REF
Magnesium (Mg)	232274-1		< 0.1		1	0.1	REP
Magnesium (Mg)	232275-1		< 0.1		1	0.1	REP
Magnesium (Mg)	232276-1	7.8	7.8	100.4	1	0.1	REP
Manganese (Mn)	232268-1	< MDL	< 0.001		1	0.001	BLL
Manganese (Mn)	232273-1	0.65535000	0.661	100.9	1	0.001	REF
Manganese (Mn)	232274-1	0.067	0.063	93.4	1	0.001	REP
Manganese (Mn)	232275-1	0.012	0.012	98.0	1	0.001	REP
Manganese (Mn)	232276-1	0.783	0.787	100.5	1	0.001	REP
Molybdenum (Mo)	232268-1	< MDL	< 0.01		1	0.01	BLL
Molybdenum (Mo)	232273-1	0.56895000	0.56	98.4	1	0.01	REF

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Molybdenum (Mo)	232274-1		< 0.01		1	0.01	REP
Molybdenum (Mo)	232275-1		< 0.01		1	0.01	REP
Molybdenum (Mo)	232276-1		< 0.01		1	0.01	REP
Nickel (Ni)	232268-1	< MDL	< 0.02		1	0.02	BLL
Nickel (Ni)	232273-1	0.77057500	0.78	101.2	1	0.02	REF
Nickel (Ni)	232274-1		< 0.02		1	0.02	REP
Nickel (Ni)	232275-1		< 0.02		1	0.02	REP
Nickel (Ni)	232276-1		< 0.02		1	0.02	REP
Phosphorus (P)	232268-1	< MDL	< 0.1		1	0.1	BLL
Phosphorus (P)	232274-1		< 0.1		1	0.1	REP
Phosphorus (P)	232275-1		< 0.1		1	0.1	REP
Phosphorus (P)	232276-1		< 0.1		1	0.1	REP
Potassium (K)	232268-1	< MDL	< 0.1		1	0.1	BLL
Potassium (K)	232269-1	4.03501333	4.1	101.1	1	0.1	REF
Potassium (K)	232274-1	0.2	0.2	97.8	1	0.1	REP
Potassium (K)	232275-1	0.2	0.2	94.0	1	0.1	REP
Potassium (K)	232276-1	1.5	1.5	98.7	1	0.1	REP
Selenium (Se)	232268-1	< MDL	< 0.06		1	0.06	BLL
Selenium (Se)	232273-1	0.74505000	0.74	99.6	1	0.06	REF
Selenium (Se)	232274-1		< 0.06		1	0.06	REP
Selenium (Se)	232275-1		< 0.06		1	0.06	REP
Selenium (Se)	232276-1		< 0.06		1	0.06	REP
Silicon (Si)	232268-1	< MDL	< 0.06		1	0.06	BLL
Silicon (Si)	232269-1	1.17518266	1.09	92.8	1	0.06	REF
Silicon (Si)	232274-1	0.47	0.45	95.4	1	0.06	REP
Silicon (Si)	232275-1	0.52	0.50	95.5	1	0.06	REP
Silicon (Si)	232276-1	5.48	5.48	100.0	1	0.06	REP
Silver (Ag)	232268-1	< MDL	< 0.01		1	0.01	BLL
Silver (Ag)	232274-1	0.06	0.05	80.7	1	0.01	REP
Silver (Ag)	232275-1		< 0.01		1	0.01	REP
Silver (Ag)	232276-1		< 0.01		1	0.01	REP
Sodium (Na)	232268-1	< MDL	< 0.1		1	0.1	BLL
Sodium (Na)	232269-1	49.915333	52.0	104.3	1	0.1	REF
Sodium (Na)	232274-1	0.1	0.1	84.4	1	0.1	REP
Sodium (Na)	232275-1	<0.1	0.1	100.3	1	0.1	REP
Sodium (Na)	232276-1	3.0	3.0	99.6	1	0.1	REP
Strontium (Sr)	232268-1	< MDL	0.001		1	0.001	BLL
Strontium (Sr)	232273-1	0.08878250	0.091	102.7	1	0.001	REF
Strontium (Sr)	232274-1	0.003	0.003	87.6	1	0.001	REP
Strontium (Sr)	232275-1	0.003	0.003	103.3	1	0.001	REP
Strontium (Sr)	232276-1	0.253	0.249	98.5	1	0.001	REP
Sulfur (S)	232268-1	< MDL	< 0.06		1	0.06	BLL
Sulfur (S)	232269-1	38.1126025	39.4	103.4	1	0.06	REF
Sulfur (S)	232274-1	4.34	3.98	91.7	1	0.06	REP
Sulfur (S)	232275-1	1.57	1.54	97.9	1	0.06	REP
Sulfur (S)	232276-1	14.7	14.7	100.1	1	0.06	REP
Tin (Sn)	232268-1	< MDL	< 0.06		1	0.06	BLL
Tin (Sn)	232272-1	3.63940000	3.73	102.5	1	0.06	REF
Tin (Sn)	232274-1		< 0.06		1	0.06	REP
Tin (Sn)	232275-1		< 0.06		1	0.06	REP
Tin (Sn)	232276-1		< 0.06		1	0.06	REP
Titanium (Ti)	232268-1	< MDL	< 0.002		1	0.002	BLL

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Titanium (Ti)	232272-1	0.21102000	0.194	91.8	1	0.002	REF
Titanium (Ti)	232274-1	0.011	0.010	92.1	1	0.002	REP
Titanium (Ti)	232275-1	0.012	0.011	92.6	1	0.002	REP
Titanium (Ti)	232276-1		< 0.002		1	0.002	REP
Vanadium (V)	232268-1	< MDL	< 0.01		1	0.01	BLL
Vanadium (V)	232273-1	1.41475000	1.42	100.6	1	0.01	REF
Vanadium (V)	232274-1		< 0.01		1	0.01	REP
Vanadium (V)	232275-1		< 0.01		1	0.01	REP
Vanadium (V)	232276-1		< 0.01		1	0.01	REP
Zinc (Zn)	232268-1	< MDL	< 0.05		1	0.05	BLL
Zinc (Zn)	232273-1	0.90227500	0.89	98.4	1	0.05	REF
Zinc (Zn)	232274-1	4.93	4.50	91.2	1	0.05	REP
Zinc (Zn)	232275-1	0.48	0.47	98.3	1	0.05	REP
Zinc (Zn)	232276-1	2.50	2.52	100.8	1	0.05	REP

***ICPMS Dissolved** **UNITS:** ug/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Aluminum (Al)	232353-1	< MDL	< 0.2		1	0.2	BLL
Aluminum (Al)	232354-1	54.3643221	57.3	105.4	1	0.2	REF
Aluminum (Al)	232355-1	23.9	23.8	99.6	1	0.2	REP
Aluminum (Al)	232356-1	54.7	55.0	100.5	1	0.2	REP
Antimony (Sb)	232353-1	0.00688562	0.013		1	0.005	BLL
Antimony (Sb)	232354-1		31.6		1	0.005	REF
Antimony (Sb)	231700-1	0.013	0.012	95.6	1	0.005	REP
Antimony (Sb)	231770-1	0.175	0.175	99.8	1	0.005	REP
Antimony (Sb)	232355-1	0.013	0.013	99.5	1	0.005	REP
Antimony (Sb)	232356-1	0.175	0.176	100.5	1	0.005	REP
Arsenic (As)	232353-1	< MDL	< 0.1		1	0.1	BLL
Arsenic (As)	232354-1	35.0005842	33.6	95.9	1	0.1	REF
Arsenic (As)	232355-1	<0.1	0.1	108.5	1	0.1	REP
Arsenic (As)	232356-1	0.3	0.3	97.4	1	0.1	REP
Barium (Ba)	232353-1	< MDL	< 0.02		1	0.02	BLL
Barium (Ba)	232354-1	62.1316108	62.7	100.9	1	0.02	REF
Barium (Ba)	231700-1	2.14	2.12	99.2	1	0.02	REP
Barium (Ba)	231770-1	11.1	11.3	101.5	1	0.02	REP
Barium (Ba)	232355-1	2.14	2.12	99.1	1	0.02	REP
Barium (Ba)	232356-1	11.2	11.3	100.8	1	0.02	REP
Beryllium (Be)	232353-1	0.00224543	0.005		1	0.002	BLL
Beryllium (Be)	232354-1	36.3986985	38.6	106.2	1	0.002	REF
Beryllium (Be)	232355-1	0.004	0.003	68.1	1	0.002	REP
Beryllium (Be)	232356-1	0.009	0.011	119.5	1	0.002	REP
Bismuth (Bi)	232353-1	< MDL	< 0.02		1	0.02	BLL
Bismuth (Bi)	232354-1	15.5389535	7.73	49.8	1	0.02	REF
Bismuth (Bi)	232355-1		< 0.02		1	0.02	REP
Bismuth (Bi)	232356-1		< 0.02		1	0.02	REP
Cadmium (Cd)	232353-1	< MDL	< 0.01		1	0.01	BLL
Cadmium (Cd)	232354-1	60.2564490	58.9	97.8	1	0.01	REF
Cadmium (Cd)	231700-1	0.03	0.03	88.2	1	0.01	REP
Cadmium (Cd)	231770-1	0.10	0.10	99.4	1	0.01	REP
Cadmium (Cd)	232355-1	0.03	0.03	96.3	1	0.01	REP
Cadmium (Cd)	232356-1	0.10	0.10	101.3	1	0.01	REP
Chromium (Cr)	232353-1	< MDL	< 0.2		1	0.2	BLL

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Chromium (Cr)	232354-1	67.0757531	62.2	92.8	1	0.2	REF
Chromium (Cr)	231700-1	1.2	1.8	150.8	1	0.2	REP
Chromium (Cr)	231770-1	1.6	2.5	159.5	1	0.2	REP
Chromium (Cr)	232355-1	1.2	1.2	100.2	1	0.2	REP
Chromium (Cr)	232356-1	1.5	1.5	97.9	1	0.2	REP
Cobalt (Co)	232353-1	< MDL	0.015		1	0.005	BLL
Cobalt (Co)	232354-1	62.8803782	57.7	91.8	1	0.005	REF
Cobalt (Co)	232355-1	0.074	0.072	97.0	1	0.005	REP
Cobalt (Co)	232356-1	0.231	0.233	101.0	1	0.005	REP
Copper (Cu)	232353-1	< MDL	< 0.05		1	0.05	BLL
Copper (Cu)	232354-1	62.2043843	62.7	100.7	1	0.05	REF
Copper (Cu)	231700-1	0.57	0.38	67.0	1	0.05	REP
Copper (Cu)	231770-1	3.54	3.31	93.5	1	0.05	REP
Copper (Cu)	232355-1	0.57	0.45	78.9	1	0.05	REP
Copper (Cu)	232356-1	3.53	3.43	97.1	1	0.05	REP
Lead (Pb)	232353-1	< MDL	< 0.01		1	0.01	BLL
Lead (Pb)	232354-1	62.9929221	55.8	88.6	1	0.01	REF
Lead (Pb)	232355-1	0.03	0.03	90.5	1	0.01	REP
Lead (Pb)	232356-1	0.07	0.07	101.3	1	0.01	REP
Lithium (Li)	232353-1	< MDL	< 0.05		1	0.05	BLL
Lithium (Li)	232354-1	32.3199228	35.5	109.7	1	0.05	REF
Lithium (Li)	232355-1	2.63	2.56	97.3	1	0.05	REP
Lithium (Li)	232356-1	13.1	13.3	101.5	1	0.05	REP
Manganese (Mn)	232353-1	0.01069498	0.015		1	0.005	BLL
Manganese (Mn)	232354-1	75.7573885	75.9	100.2	1	0.005	REF
Manganese (Mn)	232355-1	6.01	5.95	99.0	1	0.005	REP
Manganese (Mn)	232356-1	8.61	8.88	103.1	1	0.005	REP
Molybdenum (Mo)	232353-1	< MDL	< 0.05		1	0.05	BLL
Molybdenum (Mo)	232354-1	74.8778395	72.4	96.7	1	0.05	REF
Molybdenum (Mo)	232355-1	0.07	0.07	97.4	1	0.05	REP
Molybdenum (Mo)	232356-1	0.76	0.76	100.4	1	0.05	REP
Nickel (Ni)	232353-1	< MDL	< 0.05		1	0.05	BLL
Nickel (Ni)	232354-1	57.1707753	59.1	103.3	1	0.05	REF
Nickel (Ni)	232355-1	0.87	0.87	99.5	1	0.05	REP
Nickel (Ni)	232356-1	3.23	3.27	101.2	1	0.05	REP
Selenium (Se)	232353-1	< MDL	< 0.2		1	0.2	BLL
Selenium (Se)	232354-1	41.7205339	40.5	97.2	1	0.2	REF
Selenium (Se)	232355-1	0.4	0.4	111.6	1	0.2	REP
Selenium (Se)	232356-1	0.7	0.7	98.4	1	0.2	REP
Silver (Ag)	232353-1	< MDL	< 0.02		1	0.02	BLL
Silver (Ag)	232355-1		< 0.02		1	0.02	REP
Silver (Ag)	232356-1		< 0.02		1	0.02	REP
Strontium (Sr)	232353-1	0.01977173	0.013		1	0.005	BLL
Strontium (Sr)	232354-1	109.610868	116	106.1	1	0.005	REF
Strontium (Sr)	232355-1	134	134	100.0	1	0.005	REP
Strontium (Sr)	232356-1	132	131	99.2	1	0.005	REP
Thallium (Tl)	232353-1	0.00341025	0.004		1	0.002	BLL
Thallium (Tl)	232354-1	38.2040492	33.2	86.9	1	0.002	REF
Thallium (Tl)	232355-1	0.004	0.005	113.6	1	0.002	REP
Thallium (Tl)	232356-1	0.014	0.013	94.8	1	0.002	REP
Tin (Sn)	232353-1	0.01406443	0.01		1	0.01	BLL
Tin (Sn)	232354-1	58.2414567	52.7	90.4	1	0.01	REF

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Tin (Sn)	232355-1	0.01	0.01	89.7	1	0.01	REP
Tin (Sn)	232356-1	0.03	0.02	76.2	1	0.01	REP
Uranium (U)	232353-1	< MDL	< 0.002		1	0.002	BLL
Uranium (U)	232354-1	38.1002192	33.5	88.0	1	0.002	REF
Uranium (U)	232355-1	0.064	0.063	98.4	1	0.002	REP
Uranium (U)	232356-1	0.160	0.165	103.1	1	0.002	REP
Vanadium (V)	232353-1	< MDL	< 0.05		1	0.05	BLL
Vanadium (V)	232354-1	72.3718975	69.3	95.8	1	0.05	REF
Vanadium (V)	232355-1	0.41	0.41	100.2	1	0.05	REP
Vanadium (V)	232356-1	0.65	0.65	99.8	1	0.05	REP
Zinc (Zn)	232353-1	< MDL	< 0.2		1	0.2	BLL
Zinc (Zn)	232354-1	73.2518067	73.6	100.5	1	0.2	REF
Zinc (Zn)	231700-1	3.2	3.2	98.9	1	0.2	REP
Zinc (Zn)	231770-1	55.0	55.2	100.4	1	0.2	REP
Zinc (Zn)	232355-1	3.2	3.0	95.0	1	0.2	REP
Zinc (Zn)	232356-1	54.9	55.9	101.7	1	0.2	REP

***Mercury dissolved UNITS:** ug/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Mercury (Hg)	231877-1	< MDL	< 0.02		1	0.02	BLL
Mercury (Hg)	231879-1	1.50770731	1.58	104.5	1	0.02	REF
Mercury (Hg)	231882-1		< 0.02		1	0.02	REP
Mercury (Hg)	231883-1		< 0.02		1	0.02	REP
Mercury (Hg)	231884-1		< 0.02		1	0.02	REP
Mercury (Hg)	231885-1		< 0.02		1	0.02	REP

***Mercury total UNITS:** ug/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Mercury (Hg)	231780-1	< MDL	< 0.02		1	0.02	BLL
Mercury (Hg)	231781-1	1.51738709	1.51	99.2	1	0.02	REF
Mercury (Hg)	231782-1	0.02	0.02	88.6	1	0.02	REP
Mercury (Hg)	231783-1		< 0.02		1	0.02	REP

***Nitrogen Ammonia UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Nitrogen, Ammonia as N	231686-1	< MDL	< 0.002		1	0.002	BLE
Nitrogen, Ammonia as N	231689-1	17.1248888	17.3	100.9	25	0.05	REF
Nitrogen, Ammonia as N	231692-1		< 0.002		1	0.002	REP

***Nitrogen NO 2 UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Nitrogen, Nitrite as N	231688-1	< MDL	< 0.002		1	0.002	BLE
Nitrogen, Nitrite as N	231691-1	1.01799322	0.999	98.1	1	0.002	REF
Nitrogen, Nitrite as N	231694-1		< 0.002		1	0.002	REP

***Nitrogen NO 23 UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Nitrogen, Nitrate + Nitrite as N	231687-1	< MDL	< 0.002		1	0.002	BLE

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Nitrogen, Nitrate + Nitrite as N	231690-1	6.65	6.59	99.6	5	0.01	REF
Nitrogen, Nitrate + Nitrite as N	231693-1	0.416	0.417	100.2	1	0.002	REP

***Nitrogen. Total UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Nitrogen, Total as N	231627-1	< MDL	< 0.02		1	0.02	BLL
Nitrogen, Total as N	231629-1	5.01270000	5.39	107.5	1	0.02	REF
Nitrogen, Total as N	231631-1	0.08	0.06	79.7	1	0.02	REP
Nitrogen, Total as N	231633-1	0.11	0.10	91.8	1	0.02	REP
Nitrogen, Total as N	231634-1	0.08	0.08	105.4	1	0.02	REP
Nitrogen, Total as N	231636-1	0.14	0.12	83.8	1	0.02	REP

***pH UNITS:** pH Units **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
pH	231637-1	6.00	6.02	100.3	1	0.01	REF
pH	231675-1	7.05	7.07	100.3	1	0.01	REP

***Phosphorus Total UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Phosphorus, Total as P	231619-1	< MDL	< 0.002		1	0.002	BLL
Phosphorus, Total as P	231620-1	4.25789090	4.2	97.9	50	0.1	REF
Phosphorus, Total as P	231621-1	0.005	0.005	97.9	1	0.002	REP

***Residue Filterable UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Solids, Total Dissolved (FR)	231799-1	< MDL	< 10		1	10	BLE
Solids, Total Dissolved (FR)	231800-1	1900	1820	95.5	1	10	REF
Solids, Total Dissolved (FR)	231801-1	294	305	103.7	1	10	REP
Solids, Total Dissolved (FR)	231802-1	16,200	16300	100.6	1	10	REP

***Residue Nonfilt. UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Solids, Total Suspended (NFR)	231731-1	< MDL	< 5		1	5	BLE
Solids, Total Suspended (NFR)	231732-1	451.284430	443	98.1	1	5	REF
Solids, Total Suspended (NFR)	231733-1		< 5		1	5	REP

***SpecificConductance UNITS:** uS/cm **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Conductivity (25C)	231659-1	< MDL	< 2		1	2	BLE
Conductivity (25C)	231661-1	15.4075000	15	97.2	1	2	REF
Conductivity (25C)	231662-1	712.024000	719	101.0	1	2	REF
Conductivity (25C)	231674-1	373.973571	370	98.9	1	2	REF
Conductivity (25C)	231676-1	226	226	100.0	1	2	REP

DOC UNITS: mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Carbon, Dissolved Organic	231563-1	< MDL	< 0.5		1	0.5	BLL
Carbon, Dissolved Organic	231564-1	9.97540000	9.4	94.4	1	0.5	REF
Carbon, Dissolved Organic	231565-1	10.0	9.8	98.1	1	0.5	REF
Carbon, Dissolved Organic	231588-1	1.0	1.0	103.8	1	0.5	REP
Carbon, Dissolved Organic	231589-1		< 0.5		1	0.5	REP
Carbon, Dissolved Organic	231596-1	1.7	1.8	106.4	1	0.5	REP
Carbon, Dissolved Organic	231590-1	5.0	6.0	100.4	1	0.5	SPK
Carbon, Dissolved Organic	231591-1	5.0	5.2	100.9	1	0.5	SPK
Carbon, Dissolved Organic	231599-1	5.0	5.4	106.7	1	0.5	SPK

Hardness Diss. CaMg **UNITS:** mg CaCO3 / L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Hardness, Dissolved Calcium+Magnes	231744-1		< 0.4		1	0.4	BLE
Hardness, Dissolved Calcium+Magnes	231757-1		200		1	0.4	REP
Hardness, Dissolved Calcium+Magnes	231758-1		506		1	0.4	REP
Hardness, Dissolved Calcium+Magnes	231759-1		238		1	0.4	REP

Hardness Diss.Total **UNITS:** mg CaCO3 / L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Hardness, Dissolved Total - calc.	231744-1		< 0.4		1	0.4	BLE
Hardness, Dissolved Total - calc.	231757-1		212		1	0.4	REP
Hardness, Dissolved Total - calc.	231758-1		513		1	0.4	REP
Hardness, Dissolved Total - calc.	231759-1		238		1	0.4	REP

Note: **All QC information is batch associated. Duplicate analysis are not necessarily those of this report. Percent recovery for duplicate analysis represents the percent recovery of REP2 as compared to REP1 of a sample duplicate.**

BLE - Blank, Equipment
BLL - Blank, Method
BLX - Blank, Extraction
REA - Replicate Spike, Known Addition
REF - Reference Material
REG - Regular Sample
RRF - Replicate Reference Material
REK - Replicate, Spike
REP - Replicate, Regular
RTS - Replicate Test Sample
SPA - Spike, Known Addition
SPK - Spike
TST - Test Sample 1=Present 2=Absent
MDL - Method Detection Limit

Environment Canada Environnement Canada

Billing Estimate

PYLET FOLDER # : 201100565

Invoice: 114889

------- Not an Invoice Do not Pay -------

EP YUKON ENV ASSESSMENT

Location: CASINO MINE- HISTORICAL ADIT (W43)

TEST DESCRIPTION	MATRIX	QTY	UNITPRICE	PENALTY	SURCHARGE	NETPRICE
PESC - Environmental Toxicology						
Daphnia LT50 48h	WWOT	1	$290.00			$290.00
				PESC - Environmental Toxicology Charges		**$290.00**
PESC - Inorganics						
*Acidity Tot.&pH4.5	WWOT	1	$12.00			$12.00
*AlkalinityTotpH4.5	WWOT	1	$12.00			$12.00
*Color True	WWOT	1	$9.00			$9.00
*ICA (Cl F SO4)	WWOT	1	$15.00			$15.00
*ICP Dissolved	WWOT	1	$22.50			$22.50
*ICP Total	WWOT	1	$30.00			$30.00
*ICPMS Dissolved	WWOT	1	$60.00			$60.00
*ICPMS Total	WWOT	1	$60.00			$60.00
*Mercury dissolved	WWOT	1	$40.50			$40.50
*Mercury total	WWOT	1	$40.50			$40.50
*Nitrogen Ammonia	WWOT	1	$13.50			$13.50
*Nitrogen NO 2	WWOT	1	$10.50			$10.50
*Nitrogen NO 23	WWOT	1	$10.50			$10.50
*Nitrogen. Total	WWOT	1	$24.00			$24.00
*pH	WWOT	1	$4.50			$4.50
*Phosphorus Total	WWOT	1	$16.50			$16.50
*Residue Filterable	WWOT	1	$18.00			$18.00
*Residue Nonfilt.	WWOT	1	$18.00			$18.00
*SpecificConductance	WWOT	1	$4.50			$4.50
Hardness Diss. CaMg	WWOT	1	$0.00			$0.00
Hardness Diss.Total	WWOT	1	$0.00			$0.00
					PESC - Inorganics Charges	**$421.50**
PESC - Organics						
DOC	WWOT	1	$30.00			$30.00
					PESC - Organics Charges	**$30.00**

Total Charged To: 2561-101 EP YUKON ENV ASSESSMENT **$741.50**

Penalty - A charge that removed from the price due to a test performed after a certian penalty time.
Surcharge - A service charge that is applied when tests are performed by a contract Lab.

Printed On: 7-Sep-2011

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Casino Project: 2012 Aquatic Studies Report

Prepared for

Casino Mining Corporation

May 9, 2013

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

*475 Howe Street, Suite 1030, Vancouver, BC V6C 2B3 **t** 604-629-9075*

May 9, 2013

Jesse Duke
Project Director
Casino Mining Corporation
2050-1111 West Georgia Street
Vancouver, BC V6E 4M3

Dear Mr. Duke,

Re: Casino Project: 2012 Aquatic Studies Report

Palmer Environmental Consulting Group Inc. is pleased to submit the attached draft report describing the studies conducted in 2012 on the aquatic environment of the Casino Project area. If there are any questions or comments on this report, then please contact the undersigned.

Thank you for the opportunity to work with you on this project.

Yours truly,

Palmer Environmental Consulting Group Inc.

R. Palmer

Rick Palmer, M.Sc. R.P. Bio
President, Senior Fisheries Biologist

Distribution List

# of Hard Copies	PDF Required	Association / Company Name
1	Yes	Casino Mining Corporation
1	Yes	Palmer Environmental Consulting Group

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	Rick Palmer	April 21, 2013	Senior Review
2			

Signatures

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Alyssa Murdoch, M.Sc.
Palmer Environmental Consulting Group
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Report Reviewed By:

_____

Rick Palmer, M.Sc., R.P. Bio
Palmer Environmental Consulting Group
President, Senior Fisheries Biologist

Executive Summary

This report describes the studies conducted in 2012 on the aquatic environment of the Casino Project area. Casino Mining Corporation, formerly Western Copper Corporation, has 100% ownership of the Casino property. The Casino Project is a proposed open-pit porphyry copper-gold-molybdenum mine located at 611379E 6956218N in west-central Yukon, approximately 380 km northwest of the territorial capital of Whitehorse.

Surveys of the aquatic environment in 2012 were completed on March 25-31, May 22-29, July 1-5, and September 4-14. The objectives were to sample water quality and fish communities to further characterize the pre-development aquatic environment of the Project area, and to address gaps in the established datasets.

A total of 16 sites were chosen for water quality sampling. Water samples were collected from each site in March and May, and from W43 only in July and September, and analyzed for the full suite of physical parameters, anions, nutrients and total and dissolved metals. Exceedances of the Canadian Council of Ministers of the Environment (CCME) guidelines for protection of freshwater aquatic life were observed for ten parameters. The number of exceedances was highest for cadmium, aluminum, iron and copper. Exceedances were lower in March (n=29) in comparison to May (n=65), revealing that water quality generally decreased following the spring freshet in May. Water quality was poorest in the upper Casino Creek watershed, particularly in Proctor Gulch (W12) and Meloy Creek (W13).

Fish communities at 11 stream sites were sampled in July and September either with an electrofisher or with minnow traps. A total of 9 fish from two species were captured from the Project study area, including Arctic grayling (*Thymallus arcticus*) and slimy sculpin (*Cottus cognatus*). Fisheries sampling and spawning surveying in Dip Creek demonstrated that there was no evidence of Chinook salmon spawning or juvenile rearing, similar to results from recent field sampling (2008-2011).

Coffee Creek was added as an additional fish reference site for the Project. The fish community in Coffee Creek was similar to communities in the local study area, with 7 Arctic grayling captured at a rate of 0.80 fish/100s of electrofishing.

Acknowledgements

The studies described in this report were carried out by the following PECG staff:

Aquatic Resources Discipline Lead:

- Rick Palmer, M.Sc., R.P. Bio., Senior Fisheries Biologist

Field Studies:

- Eric Cleveland, Environmental Technician
- Alyssa Murdoch, M.Sc., Aquatic Biologist

Report Preparation:

- May Quach, M.Sc., R.P. Bio., Aquatic Ecologist
- Alyssa Murdoch, M. Sc., Aquatic Biologist

Senior Review:

- Rick Palmer, M.Sc., R.P. Bio., Senior Fisheries Biologist

Acronyms and Abbreviations

ARD	Acid Rock Drainage
BC MOE	British Columbia Ministry of Environment
CCME	Canadian Council of Ministers of the Environment
CPUE	Catch-per-unit-effort
DFO	Fisheries and Oceans Canada
DIAND	Department of Indian Affairs and Northern Development
DOC	Dissolved Organic Carbon
EEM	Environmental Effects Monitoring
FISS	Fisheries Information Summary System
GPS	Global Positioning System
HKP	Hallam Knight Piésold Ltd.
INAC	Indian and Northern Affairs Canada
ISQG	Interim Sediment Quality Guideline
LSA	Local Study Area
LT_{50}	Lethal Time for 50% of the test organisms
MMER	Metal Mining Effluent Regulations
µS	micro-Siemens
NA	Not applicable
NAN	Not a Number
NS	Not sampled
NTU	Nephelometric unit
PEL	Probable Effects Level
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
RDL	Reported Detection Limit
RPD	Relative Percent Difference
RSA	Regional Study Area
SE	Standard error
TDS	Total Dissolved Solids
TIA	Tailings Impoundment Area
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TSS	Total Suspended Solids
U.S. EPA	United States Environmental Protection Agency
YESAB	Yukon Environmental and Socio-Economic Assessment Board

Table of Contents

Letter
Executive Summary
Acknowledgements
Acronyms and Abbreviations

1 Introduction 1
1.1 Overview 1
1.2 Study Areas 2
1.3 Study Objectives 5

2 Methods 7
2.1 Dates and Locations of Sampling Surveying 7
2.1.1 General 7
2.1.2 Water Quality 7
2.1.3 Fish Assessment 9
2.2 Sample Collection 10
2.2.1 Water Quality 10
2.2.2 Fish Assessment 11
2.3 QA/QC 12
2.3.1 Water Quality 12
2.3.2 Fish Assessment 13
2.4 Data Analysis 13
2.4.1 Water Quality 13
2.4.2 Fish Assessment 14

3 Results and Discussion 14
3.1 Water Quality 14
3.1.1 Statistical Summary 14
3.1.2 Exceedances of Water Quality Guidelines 18
3.2 Fish Assessment 19

4 Summary 20

5 References 22

List of Figures

Figure 1. Aquatic RSA in Relation to the Yukon River 3
Figure 2. Proposed Casino Project General Arrangement 4
Figure 3. Aquatic RSA with Sampling Sites 6
Figure 4. Percentage of Water Quality Exceedances of CCME Guidelines, Casino Project, 2012. 19

List of Tables

Table 1. Sampling Events, Aquatic Environment, Casino Project, 2012 7
Table 2. Summary of Water Quality Sampling Sites, Casino Project, 2012 7
Table 3. Summary of Fish Sampling Sites, Casino Project, 2012 9
Table 4. Water Quality Parameters and Detection Limits 10
Table 5. Water Quality Summary Statistics, Casino Creek Watershed, 2012 15
Table 6. Water Quality Summary Statistics, Dip Creek Watershed, 2012 16
Table 7. Water Quality Summary Statistics, Britannia Creek and Yukon River Watersheds, 2012 17
Table 8. Water Quality Parameters Exceeding CCME Guidelines, Casino Project, 2012 18
Table 9. Fish Catch, Casino Project, 2012 19

List of Appendices

Appendix A. Surface Water Quality Data and Replicate Data, Casino Project, 2012
Appendix B. Fisheries Data, Casino Project, 2012

1 Introduction

1.1 Overview

This report describes the studies conducted in 2012 by Palmer Environmental Consulting Group Inc. (PECG) on the aquatic environments of the Casino Project (Project), which specifically includes water quality and fisheries assessments. The purpose of these studies was to characterize the pre-development environment in support of the project proposal to the Yukon Environmental and Socio-economic Assessment Board (YESAB). The results from 2012 studies will be included with those from previous surveys to describe the complete environmental baseline for the project in a future report.

The Project is owned by the Casino Mining Corporation (CMC). It is a proposed porphyry copper-gold-molybdenum mine located in west-central Yukon, at 611379E 6956218N, approximately 380 km northwest of the territorial capital of Whitehorse. The location of the Project is shown in Figure 1, surrounded by the aquatic Regional Study Area (RSA), in relation to the Yukon River – to which all of the streams in the Project area eventually discharge.

In August 2008, a pre-feasibility study of the Project was completed (M3 Engineering, 2008). It envisioned a conventional truck-shovel, open pit mine. Heap leach, ore stockpile and oxide waste will be stored in the interior of the impoundment (Figure 2). Tailings, process water, treated sewage effluent, leachate from the waste rock dumps and surface runoff from the mine site will be directed to the Tailings Impoundment Area (TIA) located in the headwaters of Casino Creek.

Limited historical data are available on the aquatic environmental of the Project area. Historical studies on the aquatic ecosystem of the Project property were first conducted from 1993 to 1995 (Hallam Knight Piésold, 1997). In 1994, Fisheries and Oceans Canada (DFO) and Indian and Northern Affairs Canada (INAC), then known as the Department of Fisheries and Oceans Canada and Department of Indian Affairs and Northern Development (DIAND), conducted an overview investigation of waters that may be affected by the Project (DFO, 1994). This included the Klotassin River, Dip Creek, Britannia Creek, Selwyn River and Hayes Creek. In 1998, White River First Nation commissioned a study to identify areas of the Lower Donjek River drainage utilized by Chinook salmon (Otto, 1998). This was conducted in order to serve as a pilot study to develop a strategic plan for future Chinook salmon restoration and enhancement work in the lower Donjek. In 2001, on behalf of Selkirk First Nation, studies were conducted on selected Yukon River tributaries between McGregor Creek and Coffee Creek by Laberge Environmental Services (Laberge, 2001). Basic data on flow, water quality, benthic invertebrate and fish were collected.

For the purposes of managing Pacific salmon fisheries in the Yukon River Watershed and for classifying fish habitat in support of the Yukon Placer Authorization, DFO previously conducted surveys of fish and fish habitat in watersheds near the study area (Government of Canada, 2000). DFO surveys were conducted in reaches of the Yukon River adjacent to the Project property and the lower reaches of Dip Creek and the Klotassin, Donjek and White rivers. The results of the DFO surveys are reported in Appendix B10 of AECOM (2009).

Recent studies of the aquatic ecosystem of the RSA began in 2008 with sampling trips in May, July, September and October. Study components included stream flows, water quality, sediment quality, periphyton, benthic invertebrates, fish and fish habitat. The results of those surveys were reported in "*Casino Project: 2008 Environmental Studies Report*" (AECOM, 2009). The continuation of these studies was carried out in 2009 with monthly water quality sampling completed between May and December and sediment quality, periphyton, benthic invertebrates, fish and fish habitat sampling completed in August. The results of these surveys are reported in "*Casino Project: 2009 Aquatic Studies Report*" (PECG, 2011a). Monthly water quality sampling continued in 2010 and 2011, with some sediment, periphyton, benthic invertebrate and fish sampling to fill in data gaps (PECG, 2011b; PECG, 2012). The studies conducted in 2012 and reported herein are continuations of the 2008 program. All data from 2008-2012 will be compiled into a separate future report describing the baseline aquatic environment of the Project Area.

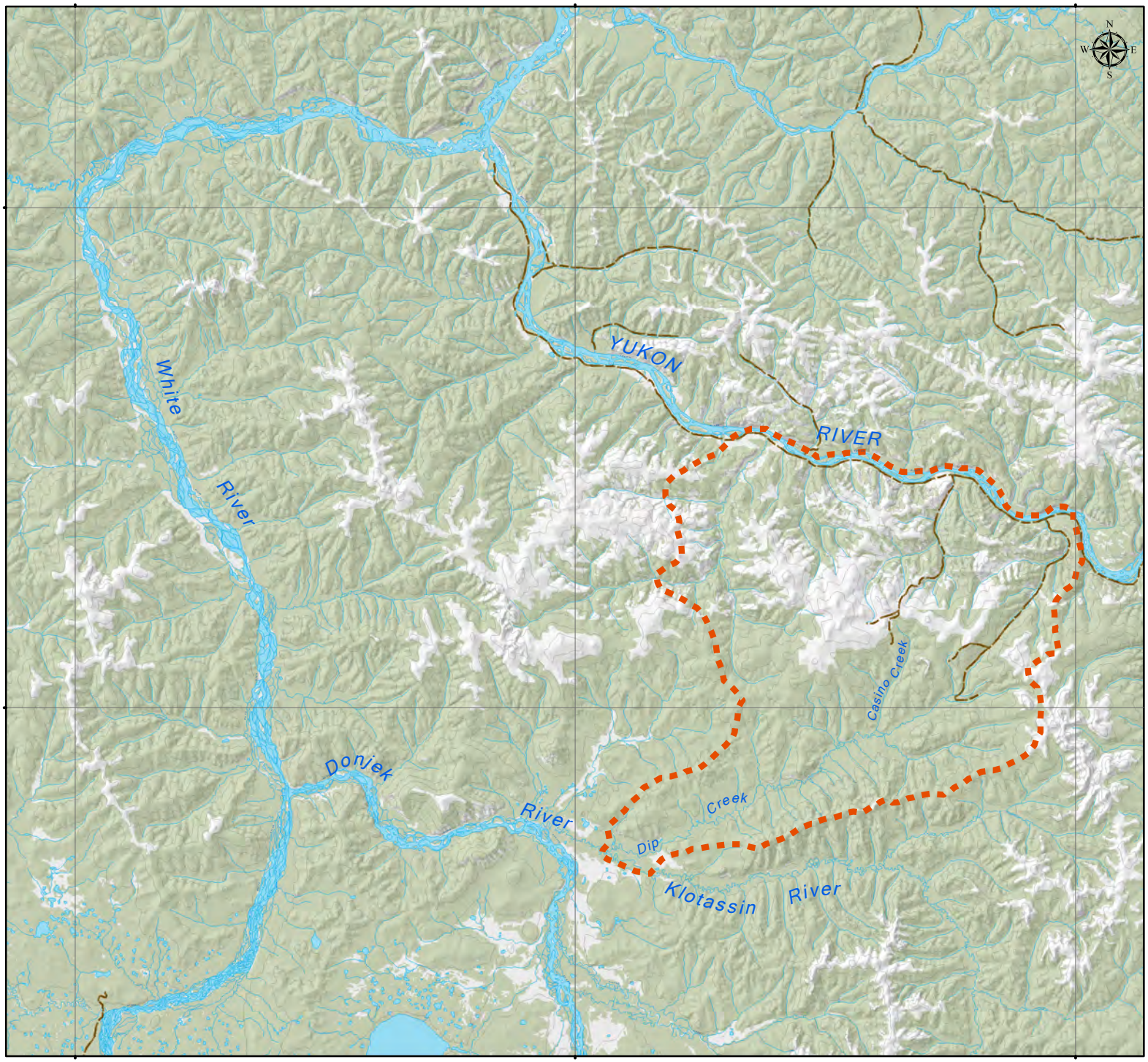
1.2 Study Areas

The Local Study Area (LSA) for the aquatic ecosystem of the Project is defined by the boundaries of the two watersheds surrounding the Project deposit: the Britannia Creek Watershed to the north and the Casino Creek Watershed to the south. This area includes the direct footprint of the proposed Project mine and near-field affected areas. The boundaries of the LSA are shown within the RSA in Figure 3.

Most of the proposed mine infrastructure will be in the Casino Creek Watershed, with some (e.g., the northern corner of the open pit) found within the Britannia Creek Watershed. The northern part of the LSA is drained by Britannia Creek and one of its tributaries, Canadian Creek. Britannia Creek flows north into the Yukon River. The northern edge of the LSA includes a 2 km-long reach of the Yukon River. The southern part of the property is drained by Casino Creek which flows south to Dip Creek and thence to the Yukon River via the Klotassin, Donjek and White rivers. The southern edge of the LSA includes a 2 km-long reach of Dip Creek.

The aquatics Regional Study Area (RSA) was defined as the LSA plus five adjacent areas (Figure 3). It includes water bodies which are not directly impacted, but are either indirectly affected or are suitable for providing references sites (mid-to-far field effects) to compare to the near-field effects within Coffee Creek and Canadian Creek. The following provides a summary of the reference sites and watersheds:

- **Dip Creek Watershed**. The headwaters of Dip Creek are not expected to be affected by Project activities, but the reaches of Dip Creek downstream of the confluence of Dip and Casino creeks may be affected by a reduction in stream flow from Casino Creek caused by the impoundment of its headwaters within the TIA. The effects of flow reductions may decrease with downstream distance from the confluence of Dip and Casino creeks. Reference site R2 (Figure 3) was established in 2009 on Victor Creek, which is a tributary of Dip Creek located upstream of the Project, for water quality sampling, benthos, periphyton and fish communities.
- **Sunshine Creek Watershed**. This watershed, located to the east of the Britannia Creek Watershed, is not expected to be affected by Project activities. Reference water quality station W17 was located on Sunshine Creek upstream of its confluence with the Yukon River.



Legend

- Regional Study Area
- Watercourse
- Waterbody
- Access Road
- Contours

0 2.5 5 10 15
Km

Map scale 1:550,000 (printed at 8.5x11)

Figure 1. Aquatic Regional Study Area

Drawn By:	D. Turner
Checked By:	A. Murdoch
Date:	9 April 2013
Projection:	North American Datum

1:250,000 Topographic Spatial Data: Canvec; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Digital Elevation Model provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

This document is not an official land survey and the spatial data presented is subject to change without any notice.

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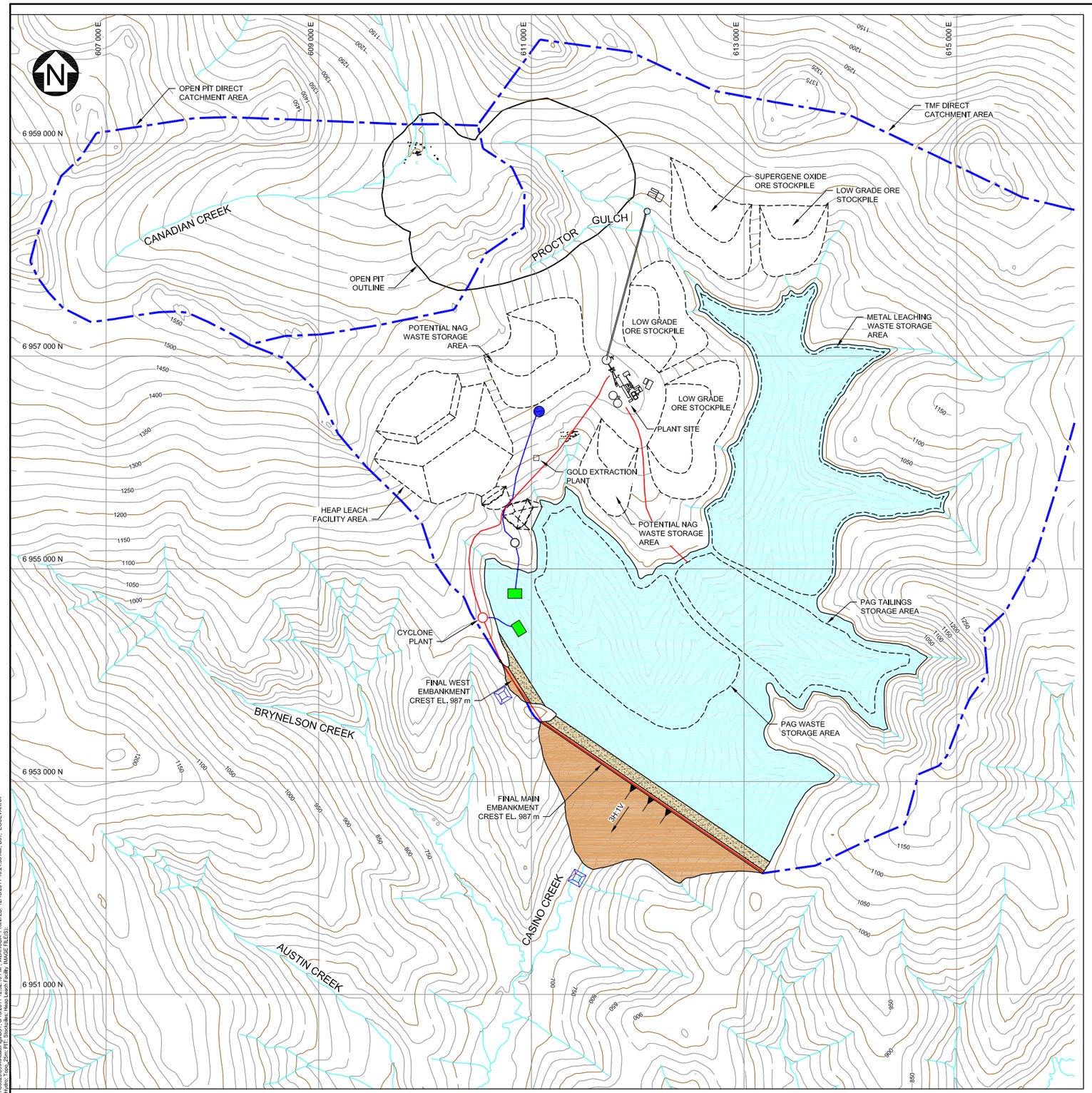

NOTES:

1. COORDINATE GRID IS UTM (WGS84/NAD83) ZONE 7 (m).
2. CONTOUR INTERVAL IS 25 METRES.
3. DIMENSIONS ARE IN METRES UNLESS NOTED.
4. PLANT SITE AND CRUSHER LAYOUT PROVIDED BY M3ENGINEERING AND TECHNOLOGY CORPORATION (APRIL 9, 2008).
5. ORE STOCKPILES ARE SHOWN AT THEIR MAXIMUM SIZE DURING OPERATIONS.

LEGEND:

- TAILINGS PIPELINES
- RECLAIM PIPELINES
- SUPERNATANT POND
- TAILINGS BEACH
- RECLAIM BOOSTER PUMP STATION
- RECLAIM WATER HEAD TANK
- RECLAIM BARGE
- SEDIMENT AND SEEPAGE COLLECTION PONDS

SCALE A 400 200 0 400 800 1200 1600 2000 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	07JUN'11	ISSUED WITH REPORT	AG	ELG	GRG	KJB

WESTERN COPPER CORPORATION

CASINO COPPER-GOLD PROJECT

PROJECT GENERAL ARRANGEMENT

Knight Piésold CONSULTING

P/A NO. VA101-325/3

REF NO. 5

FIGURE 2

REV 0

SAVED: M:\101\00325\03\A\Acad\Figs\B31, 01/5/2011 12:42:10 PM , VILAHUDA , PRINTED: 12/16/2011 10:21:33 AM , B31 , EQUEVIARRA
XREF FILE(S): Hydro; Topo_25m; PIT; Stockpiles; Heap Leach Facility; IMAGE FILE(S):

- **Coffee Creek Watershed**. Coffee Creek is located west of the Excelsior Creek watershed and approximately 15 km west of the Britannia Creek watershed. Coffee Creek is not expected to be affected by Project activities, and thus a new fisheries reference site was added on Coffee Creek in 2012 (F19), upstream of the main drilling activities of the Kaminak Coffee Gold Project (SRK, 2013).
- **Yukon River**. This river will be the receiving environment for flows from Britannia Creek. Therefore, water quality sampling stations were placed upstream (W6b – reference site) and downstream (W6a and W15 – non-reference sites) of the confluence of Britannia Creek and the Yukon River. In 2012, only W6b was sampled as sufficient data had previously been collected at sites W6a and W15 (not shown on Figure 3).
- **Klotassin River**. In September 2009, the RSA was extended in a south-western direction to include the confluence of Dip Creek and the Klotassin River. Two water sampling stations (W20 and W21) were established in the Klotassin River. Site W20 (non-reference site) was placed downstream of the Dip Creek confluence and site W21 (reference site) was placed upstream of the confluence. In 2012, only W20 was sampled as there was sufficient reference data collected in previous years for W21 (not shown on Figure 3).

1.3 Study Objectives

As in 2008 to 2011, the overall objective of the 2012 aquatic studies was to collect information that will be used to characterize the pre-development aquatic environment of the Project area. A significant amount of aquatic baseline data has previously been collected, therefore the 2012 studies focused on continued monitoring and filling in gaps in the established data sets.

The specific objectives for the 2012 aquatic studies were the following:

- Complete baseline water quality sampling at all sites in the LSA and RSA on a seasonal basis;
- Complete fish assessments at established sites within the LSA and RSA to further develop understanding of species distribution, fish abundance and habitat utilization;
- Investigate the potential usage of Dip Creek by juvenile Chinook salmon for rearing, as documented for lower Dip Creek in previous reports (DFO 1994; Otto 1998), but remains unsupported during more recent sampling (e.g., 2008-2011 period);
- Conduct a salmonid spawning assessment of Dip Creek between its confluences with Casino Creek and the Klotassin River; and
- Establish a new fisheries reference site within the RSA.

No sediment quality, periphyton, or benthic invertebrate samples were collected as part of the 2012 aquatic studies.

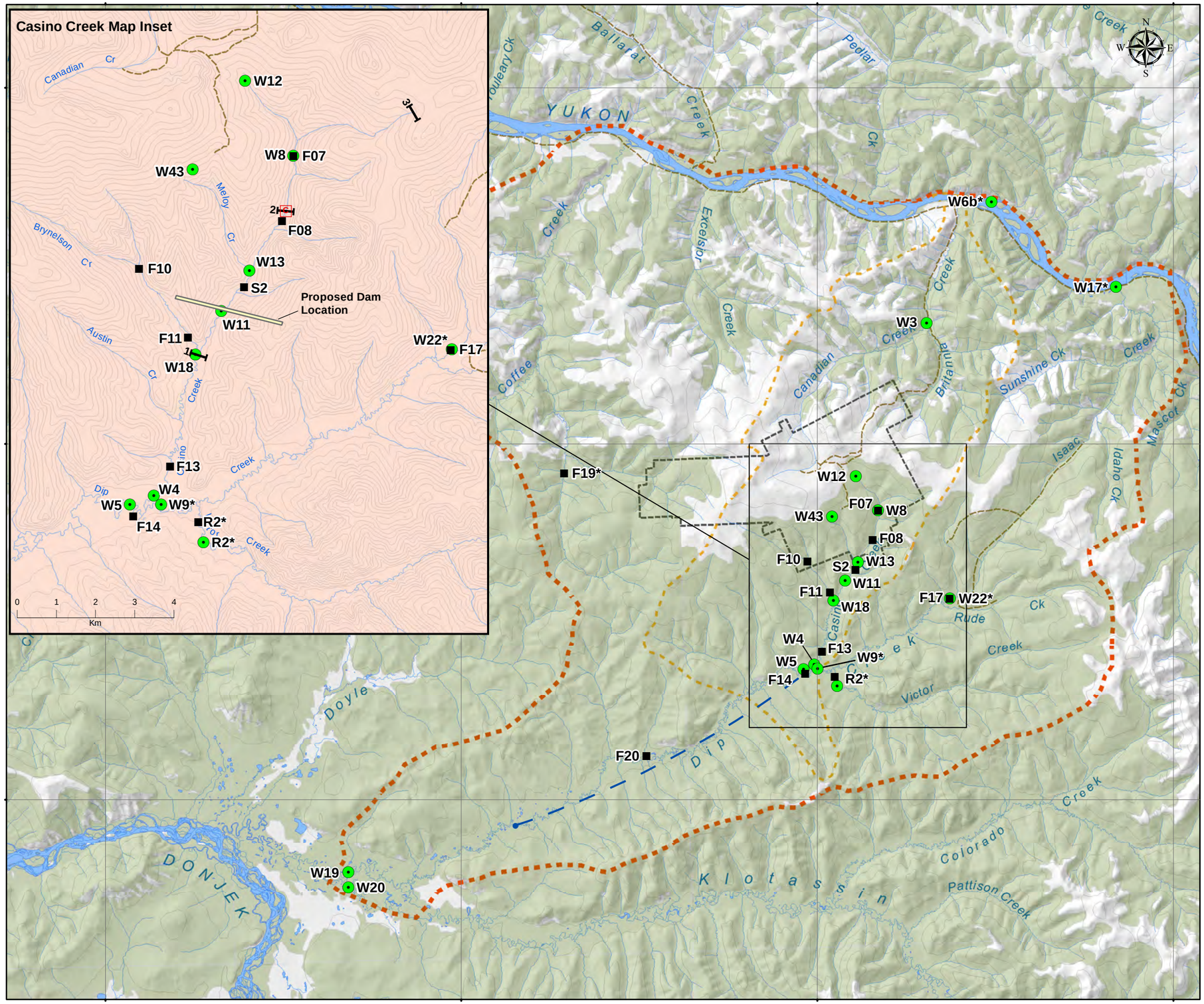

Figure 3. 2012 Casino Aquatic Sampling Sites

Drawn By: D. Turner
Checked By: A. Murdoch
Date: 9 April 2013
Projection: North American Datum 1983 UTM Zone 7

1:50,000 Topographic Spatial Data: Canvec; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Digital Elevation Model provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

This document is not an official land survey and the spatial data presented is subject to change without any notice.

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2 Methods

2.1 Dates and Locations of Sampling Surveying

2.1.1 General

The study design for the 2012 aquatics work was a reduced version of the study design used in 2008-2011. The same sampling techniques were employed, although fewer sites were sampled overall. Four sampling trips were made from March to September (Table 1). For each trip during the spring, summer and fall, a fixed-wing aircraft was chartered from Alkan Air to fly from Whitehorse to the Casino property. While on the property, PECG aquatic biologists travelled to sampling sites by helicopter, by all-terrain vehicles or by foot, depending on weather and trail conditions.

Table 1. Sampling Events, Aquatic Environment, Casino Project, 2012

Date	Water Quality	Fish Assessment
March 25 – 31	X	-
May 22 – 29	X	-
July 1 – 5	X	X
September 4 – 14	X	X

Note: Dashes indicate no data collection.

2.1.2 Water Quality

A total of 16 sites were chosen for water quality sampling in 2012 (Figure 3). A description of each of these sites is provided in Table 2. Water samples were collected from each site in March and May, and from W43 only in July and September, and analyzed for the full suite of physical parameters, anions, nutrients, and total and dissolved metals. Results were compared to the Canadian Council of Ministers of the Environment (CCME) guidelines for protection of freshwater aquatic life.

Table 2. Summary of Water Quality Sampling Sites, Casino Project, 2012

Watershed	Creek/River	Site	UTM Co-ordinates	
			Easting	Northing
Casino Creek	Procter Gulch (Casino Tributary)	W12	612,163	6,958,175
	Casino (Reach 3)	W8	613,398	6,956,258
	Casino (Reach 2)	W11	611,557	6,952,289
	Casino (Reach 1)	W4	609,833	6,947,575
	Adit	W43	610,823	6,955,906
	Meloy	W13	612,275	6,953,326
	Brynelson	W18	610,893	6,951,180

Dip Creek	Dip	W22*	617,447	6,951,308
	Dip	W9*	610,018	6,947,352
	Dip	W5	609,219	6,947,348
	Dip	W19	583,657	6,935,916
	Victor	R2*	611,102	6,946,387
Klotassin River	Klotassin	W20	583,656	6,935,082
Britannia Creek	Canadian	W3	616,141	6,966,789
Yukon River	Yukon	W6b*	619,781	6,973,576
Sunshine Creek	Sunshine	W17*	626,775	6,968,802

Notes: Dashes indicate no data was available.
****reference site***

Seven sites were sampled in the Casino Creek Watershed:

- W12 in Proctor Gulch, a tributary to reach 3 of Casino Creek;
- W8 in the upper reach of Casino Creek, upstream of the confluence of Meloy Creek;
- W43 on the adit discharge pipe of the lower camp (which discharges to surface about 1 km from upper Meloy Creek);
- W13 on Meloy Creek upstream of its confluence with Casino Creek;
- W11 in reach 2 of Casino Creek outside of the southern edge of the proposed TIA;
- W18 on Brynelson Creek upstream of its confluence with reach 1 of Casino Creek; and
- W4 on reach 1 of Casino Creek upstream of its confluence with Dip Creek.

Five sites were sampled in the Dip Creek Watershed:

- W9 on Dip Creek upstream of its confluence with Casino Creek;
- W22 on upper Dip Creek, upstream of R2 and the placer mining operation;
- W5 on Dip Creek downstream of its confluence with Casino Creek;
- W19 on Dip Creek just upstream of Klotassin River; and
- R2 on a tributary, Victor Creek, to Dip Creek upstream of its confluence with Casino Creek.

Water quality samples were also acquired in several proximate watersheds, and included:

- W3 on Canadian Creek upstream of the confluence of Canadian and Britannia creeks;
- W6b on the Yukon River upstream of the outflow of Britannia Creek;
- W20 on the Klotassin River upstream from its confluence with Dip Creek – a far-field site; and
- W17 on Sunshine Creek upstream of its confluence with the Yukon River.

Of these 16 sites, five are reference sites, nine sites are potentially affected by future mine activities, and one – W43 – has already been disturbed by the adit discharge pipe[1] releasing groundwater, a source of natural Acid Rock Drainage (ARD).

[1] The pipe drains from a historical underground mine entrance

2.1.3 Fish Assessment

Fish communities within Dip, Casino, and Coffee Creeks were sampled using minnow traps and electrofishing from July 3rd to 4th and from September 8th to 13th, in 2012. The location of each fish sampling site is shown on Figure 3.

Prior to the 2012 field program, fisheries data from previous years of sampling was analyzed to identify any outstanding data gaps for the Casino baseline assessment. Sites requiring additional sampling were identified on the basis of having only one or two years of previous sampling, and/or only one previous sampling method employed. Thus, fisheries abundance, distribution and life history use at these sites was available but each location would benefit from additional baseline information. Furthermore, sites that were located within the TIA (upper Casino Creek), or that may contain regionally important species such as juvenile Chinook salmon (mid-lower Dip Creek), were re-sampled to strengthen previous datasets. Finally, a secondary fish reference site was established in Coffee Creek

In addition to fish sampling, a Chinook spawning survey was conducted on September 13th, 2012 by helicopter on Dip Creek (Figure 3). The survey began at the confluence with Casino Creek and stopped at approximately three-quarters of the length to the Klotassin River (i.e., approximately 24 km downstream from Casino Creek).

A total of eleven sites were sampled in 2012 for fish (Table 3):

- F07, F08 and S2 on Casino Creek, above the proposed tailing management facility;
- F10 and F11 on upper and lower Brynelson Creek, respectively;
- F13 on lower Casino Creek near the confluence with Dip Creek;
- F17 on upper Dip Creek;
- R2 on Victor Creek (reference site);
- F14 on Dip Creek downstream of the confluence with Casino Creek;
- F20 on middle Dip Creek; and
- F19 on Coffee Creek (reference site).

Table 3. Summary of Fish Sampling Sites, Casino Project, 2012

Creek/River	Site	Minnow Trapping	Electrofishing	UTM Co-ordinates	
				Easting	Northing
Casino	F07	03-Jul and 08-Sep	08-Sep	613,401	6,956,248
Casino	F08	08-Sep	08-Sep	613,105	6,954,586
Casino	S2	08-Sep	08-Sep	612,135	6,952,897
Brynelson	F10	12-Sep	-	609,456	6,953,369
Brynelson	F11	12-Sep	-	610,705	6,951,610
Casino	F13	12-Sep	-	610,250	6,948,309
Dip	F17	-	08-Sep	617,420	6,951,285
Victor	R2	08-Sep	08-Sep	610,969	6,946,892

Dip	F14	13-Sep	-	609,308	6,947,048
Dip	F20	13-Sep	-	600,395	6,942,437
Coffee	F19	12-Sep	12-Sep	595,767	6,958,310

Note: Dashes indicate no sampling at that site and date.
****reference site***

2.2 Sample Collection

2.2.1 Water Quality

All surface water samples were grab samples, collected in mid-stream approximately 20 cm under the surface with the bottle mouth facing upstream. Water quality samples for general chemical parameters were collected in two pre-cleaned 1 L plastic bottles supplied by Maxxam Analytics. Samples for total metals were collected in 120 mL acid-washed plastic bottles supplied by the laboratory and preserved in the field with laboratory-supplied nitric acid. Samples for dissolved metals were filtered in the field through 0.45-micron disposable filterware and preserved with laboratory-supplied nitric acid immediately after filtration. Samples for nutrients – ammonia, total Kjeldhal nitrogen (TKN), Total Organic Carbon (TOC), and dissolved orthophosphate – were collected in 120 mL bottles and preserved in the field with laboratory-supplied sulphuric acid. Total cyanide was collected in 120 mL bottles and preserved in the field with laboratory-supplied sodium hydroxide.

Field measurements of pH, temperature, dissolved oxygen and specific electrical conductivity were made at each site using a HI 9828 Hanna Meter.

All samples were kept cold and were not allowed to freeze. They were shipped via air cargo from Whitehorse to Maxxam Analytics in Burnaby, BC. Maxxam Analytics is accredited by the Canadian Association for Environmental Analytical Laboratories. Chain of Custody forms accompanied all samples. Table 4 shows the water quality variables that were measured and their Reported Detection Limits (RDL).

Table 4. Water Quality Parameters and Detection Limits

Parameter	Units	RDL	Parameter	Units	RDL
Physical			**Total and Dissolved Metals Continued**		
Conductivity	µS/cm	1	Boron	mg/L	0.05-0.3
pH	pH units	n/a	Cadmium	mg/L	0.000005-0.00003
Hardness	mg/L	0.5	Calcium	mg/L	0.05-0.3
Total Dissolved Solids (TDS)	mg/L	10	Chromium	mg/L	0.0001-0.0005
Total Suspended Solids (TSS)	mg/L	1	Cobalt	mg/L	0.000005-0.00003
Turbidity	NTU	0.1	Copper	mg/L	0.00005-0.0003
Anions			Iron	mg/L	0.001-0.005
Alkalinity	mg/L	0.5	Lead	mg/L	0.000005-0.00003
Acidity (pH 8.3)	mg/L	0.5	Lithium	mg/L	0.0005-0.003
Bromide	mg/L	0.01-0.05	Magnesium	mg/L	0.05-0.3
Chloride	mg/L	0.5	Manganese	mg/L	0.00005-0.0003
Fluoride	mg/L	0.01	Mercury	mg/L	0.00001-0.00005

Sulphate	mg/L	0.5-5	Molybdenum	mg/L	0.00005-0.0003
Cyanide (Total)	mg/L	0.0005	Nickel	mg/L	0.00002-0.0001
Cyanide (Weak Acid Dissociable)	mg/L	0.0005	Phosphorus	mg/L	0.002-0.01
Nutrients			Potassium	mg/L	0.05-0.3
Ammonia (as N)	mg/L	0.005	Selenium	mg/L	0.00004-0.0002
Nitrate (as N)	mg/L	0.002	Silicon	mg/L	0.1-0.5
Nitrite (as N)	mg/L	0.002	Silver	mg/L	0.000005-0.00003
Total Kjeldahl Nitrogen (TKN)	mg/L	0.02	Sodium	mg/L	0.05-0.3
Ortho-phosphate (as P)	mg/L	0.001	Strontium	mg/L	0.00005-0.0003
Total Phosphorus (as P)	mg/L	0.002	Thallium	mg/L	0.000002-0.00001
Total and Dissolved Metals			Tin	mg/L	0.0002-0.001
Aluminum	mg/L	0.0002-0.001	Titanium	mg/L	0.0005-0.003
Antimony	mg/L	0.00002-0.0001	Uranium	mg/L	0.000002-0.00001
Arsenic	mg/L	0.00002-0.0001	Vanadium	mg/L	0.0002-0.001
Barium	mg/L	0.00002-0.0001	Zinc	mg/L	0.0001-0.0005
Beryllium	mg/L	0.00001-0.00005	Zirconium	mg/L	0.0001-0.0005
Bismuth	mg/L	0.000005-0.00003			

2.2.2 Fish Assessment

Fish sampling was carried out under Permit XR 47 2012, issued by DFO. Electrofishing and minnow trapping were both used in 2012 for sampling fish communities. Between three and five minnow traps were installed at ten of the eleven sites in July and/or September, 2012 (Table 3). Minnow traps were made of galvanized steel wire and were conical in shape with a length of 42 cm, a width of 23 cm and a mesh size of 0.6 cm. Minnow traps were placed at each site in deep pools or among large woody debris or in slow-moving eddies. They were anchored to large woody debris or rocks, and rocks were placed within the traps to weigh them down. The traps were marked with red or yellow fluorescent flagging tape. Each trap was baited with salmon roe placed in a small perforated bag. Traps were soaked for approximately 24 hours.

Electrofishing was conducted using a two-person crew and a backpack electrofishing unit. Single-pass fishing methods were used, while walking the stream in an upstream direction repeatedly sweeping the stream from bank to bank with the wand (anode) of the electrofishing unit. Fish were captured with a dip net and stored in a bucket of freshwater.

All fish captured were identified to species level and counted. Fork length was measured to the nearest 1 mm with a measuring board (total length was measured for slimy sculpin), and wet weight was measured to the nearest 0.1 g or 1.0 g with a balance (depending on size of fish).

The Dip Creek Chinook spawning survey was conducted by two qualified PECG fisheries biologists, using a Bell Jet Ranger helicopter hovering just above the tree line and travelling at a slow enough speed to allow observers seated on both sides of the helicopter to observe spawning habitat and activity. The water was clear in Dip Creek during the time of the survey, and there were no rain events 72 hours prior to conducting the survey.

2.3 QA/QC

2.3.1 Water Quality

All field equipment was maintained in good working condition and measuring instruments were calibrated both in the field and in the office prior to travelling to the site. The HI 9828 Hanna Meter was calibrated for pH prior to each field trip using prepared solutions with pH of 4, 7 and 10, and conductivity was checked prior to each field trip using the standard 1,413 µS/cm conductivity solution. In the field, the Hanna Meter was re-calibrated using the quick calibration option which calibrates dissolved oxygen, pH and conductivity using a single point procedure. In addition, dissolved oxygen was re-calibrated at each site as required when changes in temperature or atmospheric pressure were noted.

Water quality samples were collected by a qualified PECG aquatic biologist and were carried out by the same individual at each sampling site to insure consistency. All water samples were collected using industry standard sampling protocols. Appropriate measures were taken by staff to reduce potential for sample contamination. Field staff wore disposable nitrile gloves when sampling and used bottles and preservative supplied by the analytical laboratory. All samples were collected with the mouth of the sampling bottle facing upstream. Care was taken to insure that no upstream disturbances occurred as the result of walking within the creek bed prior to sampling.

Approximately six percent of the number of water quality samples were replicated, hence a total of two replicate samples were collected: one in March, 2012 and one in May, 2012. Replicate sample locations were chosen randomly. Appendix A5 shows the analysis results of replicate samples. Relative Percent Difference (RPD) was used to assess analytical variability. RPD was defined as:

$$\%RPD = \frac{2(X_1 - X_2)}{(X_1 + X_2)} \times 100$$

where X_1 = the concentration of a parameter in the first sample and X_2 = the concentration of the same parameter in the second sample (i.e., the replicate). An RPD less than 25% is considered an acceptable difference and an RPD greater than 25% warrants further examination to ensure that the result was not due to sampling or analytical error. RPD is only relevant when both values are greater than the Practical Quantitation Limit (PQL), which was defined for this project as three times the detection limit. The PQL is considered the lowest concentration that can be accurately measured, as opposed to just detected.

As shown in Appendix A5, five of the 95 parameters that were measured from each sample had RPDs greater than 25% and met PQL restrictions. This was equivalent to 5% of all parameters, which is considered to be an acceptable level of variability.

The sites, dates and parameters for which RPD was greater than 25% were as follows:

- W3 – March: total cadmium, total iron, total Kjeldahl nitrogen, dissolved zinc, and total zinc; and
- R2 – May: acidity (pH 8.3), dissolved cadmium, nitrate, dissolved lead, and dissolved zinc.

The results of the field and travel blanks are shown for each sampling event in Appendices A1 to A4. A total of two field blanks and three travel blanks were collected. The recommended alert criterion for potential blank contamination was set as two times the detection limit for each parameter. Exceeding these criteria were:

- Nitrate, dissolved lead, total aluminum and total uranium in the March travel blank;
- Nitrate, total aluminum, total cadmium, total copper, total tin, and total zinc in the March field blank;
- Dissolved sulfate in the May travel blank;
- Total organic carbon, dissolved aluminum, dissolved barium, dissolved lead, and total aluminum in the May field blank; and
- Ammonium, ion balance, dissolved copper, dissolved tin, total aluminum and total copper in the September travel blank.

The reported exceedances for the field and travel blank samples indicate that there may have been minor contamination associated with either the field or lab techniques and are not considered significant enough to affect the overall sample results or consultations.

Maxxam Analytics, which conducted the analyses of water and sediment samples, is a certified member of the Canadian Association of Environmental Analytical Laboratories. Maxxam split several samples into duplicates and analyzed each one separately to provide a measure of their laboratories analytical precision. Duplicates were chosen randomly by Maxxam. The results, which are not reported herein, met Maxxam's standards for QA/QC (QC limits of 80%-100%).

2.3.2 Fish Assessment

All fisheries field data were recorded on waterproof paper field notes and then transferred to electronic spreadsheets in the office. The spreadsheets were compared with the field notes to identify and correct transcription errors. A variety of other measures were taken to further ensure the validity of the data. For example, fish weights were plotted against fish lengths for each species separately to identify outliers that may have been due to errors in recording or transcription. In the 2012 dataset, no outliers were observed.

2.4 Data Analysis

2.4.1 Water Quality

The minimum, median and maximum concentrations of selected water quality parameters were calculated for each site sampled in 2012. The median, rather than the arithmetic mean, was determined to yield the best estimate of the central tendency of the data because many water quality variables tend not to be normally distributed. To calculate statistics, all data for each site were pooled over the March-September sampling period and values below detection limits were replaced with one-half the detection limit. Where replicate samples were collected, average values of each parameter were used in water quality analyses.

Concentrations of water quality parameters were compared to guidelines for the protection of freshwater aquatic life issued by the Canadian Council of the Ministers of the Environment (CCME) (CCME, 2007), and parameters exceeding the guidelines were identified.

2.4.2 Fish Assessment

There was no data analysis conducted for the 2012 field data, as too few fish were captured to produce meaningful results (described in Section 3.2). Fish data from 2012 will be combined with data from previous years in a separate baseline report.

3 Results and Discussion

3.1 Water Quality

3.1.1 Statistical Summary

The surface water quality data for the months of March, May, July and September of 2012 are reported in Appendix A. Tables 5, 6, and 7 show the minimum, median and maximum values for selected water quality parameters for sites in Casino Creek, Dip Creek, and the Britannia Creek and Yukon River watersheds, respectively.

Table 5. Water Quality Summary Statistics, Casino Creek Watershed, 2012

Station	Conductivity (µS/cm)	pH	Total Suspended Solids	Total Hardness ($CaCO_3$)	Dissolved Sulphate	Ammonia as NH3	Total Aluminum	Total Arsenic	Total Cadmium	Cadmium guideline	Total Chromium	Total Copper	Copper guideline	Total Iron	Total Lead	Lead guideline	Total Molybdenum	Total Nickel	Nickel guideline	Total Selenium	Total Silver	Total Zinc	Total Alkalinity (mg/L $CaCO_3$)
CCME[1]		**6.5-9.0**				**0.499[a]**	**0.005-0.1[b]**	**0.005**	**equation[c]**		**0.001**	**equation[d]**		**0.3**	**equation[e]**		**0.073**	**equation[f]**		**0.001**	**0.0001**	**0.03**	
W12 - Proctor Gulch																							
Min	209	**3.06**	6.9	56.2	79.2	0.025	**2.26**	0.001	**0.00052**	0.000020	0.0007	**0.179**	0.00200	**12.4**	**0.00155**	0.00153	0.00015	0.00176	0.061681	0.000136	0.000015	**0.0412**	0.25
Median	909.5	**3.655**	42.25	288.6	449.6	0.055	**9.43**	0.001675	**0.00256**	0.000082	0.00072	**0.8045**	0.00585	**25.75**	0.001685	0.01226	0.0002455	0.00703	0.2138835	0.000268	0.0000554	**0.2091**	0.25
Max	1610	**4.25**	77.6	521	820	0.085	**16.6**	0.00235	**0.0046**	0.000137	0.00074	**1.43**	0.00969	**39.1**	0.00182	0.02601	0.000341	0.0123	0.3350802	0.0004	0.0000958	**0.377**	0.25
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W8 - Lower Casino Creek																							
Min	71.8	7.08	8	30.4	18.9	0.014	**0.847**	0.00028	**0.000153**	0.000012	0.00005	**0.0528**	0.00200	**1.16**	0.000289	0.00100	0.00027	0.000877	0.0386666	0.00002	0.0000025	0.0124	8.19
Median	222.4	7.42	19.45	92.7	72.45	0.014	**0.917**	0.0005875	**0.0002675**	0.000031	0.00028	**0.0725**	0.00222	**1.405**	0.0007345	0.00289	0.000523	0.0010335	0.0902262	0.000055	0.0000327	0.022	29.495
Max	373	7.76	30.9	155	126	0.014	**0.987**	0.000895	**0.000382**	0.000048	0.00051	**0.0922**	0.00344	**1.65**	0.00118	0.00556	0.000776	0.00119	0.1333534	0.00009	0.0000629	**0.0316**	50.8
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W13 - Meloy Creek																							
Min	76.1	7.46	6.6	41	0.25	0.0082	0.051	0.00139	**0.000153**	0.000015	0.0001	0.00069	0.00200	0.079	**0.00486**	0.00102	0.000352	0.00032	0.0485364	0.000044	0.00002	0.0065	28.8
Median	220.55	7.595	49.05	105.5	32.725	0.0156	**0.385**	0.00164	**0.000336**	0.000035	0.000775	**0.003755**	0.00248	**0.4925**	**0.03893**	0.00341	0.000616	0.00089	0.099546	0.000077	0.000086	0.0197	84.9
Max	365	7.73	91.5	170	65.2	0.023	**0.719**	0.00189	**0.000519**	0.000052	**0.00145**	**0.00682**	0.00372	**0.906**	**0.073**	0.00625	0.00088	0.00146	0.1430518	0.00011	**0.000152**	**0.0329**	141
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W11 - Casino Creek (proposed dam outflow)																							
Min	104	7.52	3.2	45.8	20.3	0.0025	**0.185**	0.00076	**0.00015**	0.000017	0.00005	**0.0151**	0.00200	**0.31**	0.00106	0.00118	0.000257	0.00048	0.0527971	0.000069	0.0000025	0.0075	27.6
Median	277	7.82	16.5	124.9	63.65	0.01875	**0.333**	0.00089	**0.0001545**	0.000040	0.000285	**0.02055**	0.00286	**0.5055**	**0.00553**	0.00422	0.0006335	0.000755	0.1131722	0.0001745	0.00002335	0.00965	77.3
Max	450	8.12	29.8	204	107	0.035	**0.481**	0.00102	**0.000159**	0.000061	0.00052	**0.026**	0.00435	**0.701**	**0.01**	0.00789	0.00101	0.00103	0.1643127	0.00028	0.0000442	0.0118	127
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W18 - Brynelson Creek																							
Min	53.3	7.33	0.5	24.8	0.25	0.0025	0.006	0.00038	**0.00001**	0.000010	0.00005	0.00044	0.00200	0.004	0.0000025	0.00100	0.000579	0.00011	0.0331234	0.000044	0.0000025	0.0016	15.5
Median	160.15	7.65	10.65	69.4	19.925	0.02175	**0.1675**	0.0005265	**0.00002545**	0.000024	0.000245	0.001295	0.00200	0.1905	0.0001208	0.00200	0.0014845	0.000414	0.0724078	0.000062	0.0000061	0.00197	53.7
Max	267	7.97	20.8	114	39.6	0.041	**0.329**	0.000673	**0.0000409**	0.000037	0.00044	0.00215	0.00264	**0.377**	0.000239	0.00376	0.00239	0.000718	0.1055844	0.00008	0.0000097	0.00234	91.9
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W4 - Mouth of Casino Creek																							
Min	71.3	7.43	1	36.9	7.16	0.0025	0.0467	0.00043	**0.000046**	0.000014	0.00005	**0.00342**	0.00200	0.074	0.00016	0.00100	0.0004	0.0002	0.0448015	0.000072	0.0000025	0.0019	22
Median	229.15	7.745	53.5	102.45	38.83	0.01625	**0.49585**	0.00143	**0.000146**	0.000034	0.000655	**0.01501**	0.00241	**1.002**	**0.00543**	0.00328	0.000885	0.000955	0.0973512	0.000111	0.00002955	0.00935	73.5
Max	387	8.06	106	168	70.5	0.03	**0.945**	0.00243	**0.000246**	0.000052	**0.00126**	**0.0266**	0.00368	**1.93**	**0.0107**	0.00616	0.00137	0.00171	0.1417709	0.00015	0.0000566	0.0168	125
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W43 - Adit																							
Min	208	7.39		88.4	34		0.0024	0.000429	**0.0421**	0.000030	0.00005	**0.0571**	0.00213	0.0205	**0.00658**	0.00272	0.000025	0.000433	0.0870274	0.00002	0.000085	**2.35**	66.5
Median	218.5	7.515		94.7	35.25		0.0084	0.000455	**0.04395**	0.000032	0.00005	**0.06645**	0.00226	0.02475	**0.008245**	0.00297	0.000025	0.00046	0.0917019	0.00002	**0.0001075**	**2.48**	69.9
Max	229	7.64		101	36.5		0.0144	0.000481	**0.0458**	0.000033	0.00005	**0.0758**	0.00238	0.029	**0.00991**	0.00322	0.000025	0.000487	0.0963022	0.00002	**0.00013**	**2.61**	73.3
n	2	2	0	2	2	0	2	2	2		2	2		2	2		2	2		2	2	2	2

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Ammonia (NH3) guideline based on ph=8 and temp=20

b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5

c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000

d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness

e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness

f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

Bold Results exceed CCME Aquatic Life Guidelines

Table 6. Water Quality Summary Statistics, Dip Creek Watershed, 2012

Station	Conductivity (µS/cm)	pH	Total Suspended Solids	Total Hardness ($CaCO_3$)	Dissolved Sulphate	Ammonia as NH3	Total Aluminum	Total Arsenic	Total Cadmium	Cadmium guideline	Total Chromium	Total Copper	Copper guideline	Total Iron	Total Lead	Lead guideline	Total Molybdenum	Total Nickel	Nickel guideline	Total Selenium	Total Silver	Total Zinc	Total Alkalinity (mg/L $CaCO_3$)
CCME[1]		**6.5-9.0**				**0.499[a]**	**0.005-0.1[b]**	**0.005**	**equation[c]**		**0.001**	**equation[d]**		**0.3**	**equation[e]**		**0.073**	**equation[f]**		**0.001**	**0.0001**	**0.03**	
W22 - Upper Dip Creek																							
Min	77.6	7.44	0.5	40.4	9.86	0.01	0.0098	0.00031	0.000014	0.000015	0.00005	0.00033	0.00200	0.094	0.000027	0.00100	0.000226	0.00021	0.0479957	0.00002	0.0000025	0.00096	35.4
Median	183.3	7.72	5.25	86.2	11.63	0.012	**0.1039**	0.000426	0.00001805	0.000029	0.00017	0.00085	0.00208	0.2325	0.000074	0.00263	0.000373	0.000389	0.0853764	0.00002	0.0000045	0.00228	86.2
Max	289	8	10	132	13.4	0.014	**0.198**	0.000542	0.0000221	0.000042	0.00029	0.00137	0.00300	**0.371**	0.000121	0.00453	0.00052	0.000568	0.1180289	0.00002	0.0000065	0.0036	137
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
R2 - Victor Creek																							
Min	51.35	7.38	0.5	26.25	0.25	0.0025	0.0093	0.00015	0.000006	0.000010	0.00005	0.00048	0.00200	0.007	0.000007	0.00100	0.000282	0.0002	0.0345852	0.0000855	0.0000025	0.0002	20.65
Median	136.675	7.615	15.45	61.575	11.625	0.0185	**0.19065**	0.0003203	**0.0000235**	0.000022	0.000295	0.001485	0.00200	**0.316**	0.0001343	0.00172	0.000631	0.000665	0.0661149	9.275E-05	0.00000525	0.0014775	54.325
Max	222	7.85	30.4	96.9	23	0.0345	**0.372**	0.0004905	**0.000041**	0.000032	0.00054	**0.00249**	0.00230	**0.625**	0.0002615	0.00306	0.00098	0.00113	0.0933165	0.0001	0.000008	0.002755	88
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W9 - Dip Creek us of confluence with Casino Creek																							
Min	65.2	7.51	0.5	32.6	0.25	0.0054	0.0105	0.00029	0.000008	0.000013	0.00005	0.00054	0.00200	0.053	0.000012	0.00100	0.000278	0.00023	0.0407753	0.00004	0.0000025	0.0004	25.7
Median	164.1	7.705	29.7	76.3	11.075	0.0152	**0.23925**	0.000602	**0.0000325**	0.000026	0.00035	0.00163	0.00200	**0.4835**	0.0003615	0.00225	0.000414	0.00072	0.0778163	0.0000535	0.00000605	0.00188	69.35
Max	263	7.9	58.9	120	21.9	0.025	**0.468**	0.000914	**0.000057**	0.000039	0.00065	0.00272	0.00276	**0.914**	0.000711	0.00401	0.00055	0.00121	0.1097817	0.000067	0.0000096	0.00336	113
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W5 - Dip Creek ds of confluence with Casino Creek																							
Min	68.2	7.5	0.5	32.5	0.25	0.0025	0.0189	0.00029	0.000019	0.000013	0.00005	0.00139	0.00200	0.047	0.00005	0.00100	0.000469	0.00022	0.0406802	0.00007	0.0000025	0.0012	27.2
Median	186.6	7.7	34.75	86.25	18.875	0.01575	**0.29395**	0.000675	0.00006	0.000029	0.00042	**0.00534**	0.00208	**0.51**	0.002085	0.00264	0.0006595	0.0007	0.085414	0.00008	0.00001255	0.00427	71.1
Max	305	7.9	69	140	37.5	0.029	**0.569**	0.00106	0.000101	0.000044	0.00079	**0.00929**	0.00315	**0.973**	0.00412	0.00488	0.00085	0.00118	0.1234268	0.00009	0.0000226	0.00734	115
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W19 - Dip Creek at Klotassin																							
Min	108	7.59	1.1	55.4	12.5	0.018	0.0111	0.00112	0.000018	0.000020	0.0001	0.00079	0.00200	**1.21**	0.000015	0.00150	0.000548	0.00065	0.0610126	0.00005	0.0000025	0.0005	45.5
Median	178	7.69	62.05	80.2	21.75	0.0275	**0.39605**	0.00171	**0.00005435**	0.000027	0.000635	**0.004525**	0.00200	**1.945**	0.0011175	0.00240	0.000599	0.001245	0.0808211	0.0000755	0.0000128	0.00345	69.1
Max	248	7.79	123	105	31	0.037	**0.781**	0.0023	**0.0000907**	0.000035	**0.00117**	**0.00826**	0.00247	**2.68**	0.00222	0.00339	0.00065	0.00184	0.0991873	0.000101	0.0000231	0.0064	92.7
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W20 - Klotassin River us of Dip Creek																							
Min	106	7.68	0.5	53.7	8.01	0.012	0.0081	0.000751	0.00001	0.000019	0.00005	0.0007	0.00200	**0.563**	0.000006	0.00144	0.000465	0.00045	0.0595844	0.000153	0.0000025	0.0002	42.7
Median	143.5	7.75	30	64.5	13.905	0.013	**0.24755**	0.0007805	**0.00003175**	0.000023	0.000775	0.00176	0.00200	**0.7785**	0.000218	0.00182	0.0004825	0.00114	0.0684885	0.0001615	0.00000675	0.001755	55.7
Max	181	7.82	59.5	75.3	19.8	0.014	**0.487**	0.00081	**0.0000535**	0.000026	**0.0015**	**0.00282**	0.00200	**0.994**	0.00043	0.00222	0.0005	0.00183	0.07704	0.00017	0.000011	0.00331	68.7
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Ammonia (NH3) guideline based on ph=8 and temp=20

b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5

c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000

d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness

e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness

f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

Bold Results exceed CCME Aquatic Life Guidelines

Table 7. Water Quality Summary Statistics, Britannia Creek and Yukon River Watersheds, 2012

Station	Conductivity (µS/cm)	pH	Total Suspended Solids	Total Hardness ($CaCO_3$)	Dissolved Sulphate	Ammonia as NH3	Total Aluminum	Total Arsenic	Total Cadmium	Cadmium guideline	Total Chromium	Total Copper	Copper guideline	Total Iron	Total Lead	Lead guideline	Total Molybdenum	Total Nickel	Nickel guideline	Total Selenium	Total Silver	Total Zinc	Total Alkalinity (mg/L $CaCO_3$)
CCME[1]		6.5-9.0				0.499[a]	0.005-0.1[b]	0.005	equation[c]		0.001	equation[d]		0.3	equation[e]		0.073	equation[f]		0.001	0.0001	0.03	
W3 - Canadian Creek us of confluence with Britannia Creek																							
Min	111	7.45	0.5	48.7	21	0.023	0.00755	0.00043	**0.000021**	0.000018	0.00005	0.001325	0.00200	0.007	0.0000095	0.00127	0.00042	0.00051	0.055319	0.00008	0.0000025	0.00085	25.9
Median	274.25	7.7475	9.05	120.1	71	0.023	**0.158275**	0.000905	**0.00005**	0.000039	0.00032	**0.0039125**	0.00277	0.2565	0.0001813	0.00402	0.00092	0.000915	0.1098512	0.00013	0.00000805	0.002745	67.7
Max	437.5	8.045	17.6	191.5	121	0.023	**0.309**	0.00138	**0.000079**	0.000058	0.00059	**0.0065**	0.00412	**0.506**	0.000353	0.00728	0.00142	0.00132	0.1566031	0.00018	0.0000136	0.00464	109.5
n	2	2	2	2	2	1	2	2	2		2	2		2	2		2	2		2	2	2	2
W17 - Sunshine Creek																							
Min	96.6	7.56	7.3	46.6	7.62	0.0025	0.0217	0.00044	**0.000019**	0.000017	0.00005	0.00089	0.00200	0.03	0.000022	0.00120	0.000195	0.00039	0.0534965	0.000076	0.0000025	0.0008	33
Median	213.3	7.75	22.5	95.8	34.71	0.01525	**0.23985**	0.00077	**0.0000531**	0.000032	0.00028	0.00177	0.00228	**0.3095**	0.0002115	0.00301	0.0002675	0.000965	0.0925103	0.000093	0.00000735	0.003015	69
Max	330	7.94	37.7	145	61.8	0.028	**0.458**	0.0011	**0.0000872**	0.000046	0.00051	0.00265	0.00325	**0.589**	0.000401	0.00511	0.00034	0.00154	0.1267628	0.00011	0.0000122	0.00523	105
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2
W6B - Yukon River us of Britannia Creek																							
Min	220	8.08	0.5	103	27.9	0.0025	0.0107	0.00033	0.000033	0.000034	0.00005	0.00046	0.00243	0.021	0.000009	0.00330	0.00104	0.0008	0.0977481	0.00053	0.0000025	0.0024	79.9
Median	231.5	8.085	17	106	28.8	0.00975	**0.17735**	0.000644	**0.000111**	0.000035	0.000305	0.001625	0.00249	**0.351**	0.000263	0.00343	0.00115	0.00255	0.0999044	0.000547	0.00000735	0.0078	86.9
Max	243	8.09	33.5	109	29.7	0.017	**0.344**	0.000958	**0.000189**	0.000036	0.00056	**0.00279**	0.00255	**0.681**	0.000517	0.00355	0.00126	0.0043	0.1020461	0.000564	0.0000122	0.0132	93.9
n	2	2	2	2	2	2	2	2	2		2	2		2	2		2	2		2	2	2	2

Note:

All units mg/L unless otherwise noted

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007

a) Ammonia (NH3) guideline based on ph=8 and temp=20

b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5

c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000

d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness

e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness

f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

Bold Results exceed CCME Aquatic Life Guidelines

3.1.2 Exceedances of Water Quality Guidelines

As shown in Table 8, CCME water quality guidelines for protection of freshwater aquatic life were exceeded at all sample locations in 2012 for pH and/or total metals, including: aluminum (Al), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), silver (Ag), uranium (U), and zinc (Zn).. CCME guidelines were exceeded for at least one parameter at all sites. The number of exceedances was highest for cadmium, aluminum, iron and copper, and least for silver (Figure 4). Exceedances of aluminum, cadmium, copper and iron often occurred together at the same sites. Exceedances were lower in March (n=29) in comparison to May (n=65), revealing that water quality generally decreased following the spring freshet in May. Water quality was poorest in the upper Casino Creek watershed, particularly in Proctor Gulch (W12) and Meloy Creek (W13).

Table 8. Water Quality Parameters Exceeding CCME Guidelines, Casino Project, 2012

Site	March	May	July	September
R2*	*No Exceedances*	Al, Cd, Cu, Fe	-	-
W3	Cd, U	Al, Cd, Cu, Fe	-	-
W4	Cd, Cu, U	Al, Cd, Cr, Cu, Fe, Pb	-	-
W5	*No Exceedances*	Al, Cu, Fe	-	-
W6b*	*No Exceedances*	Al, Cd, Cu, Fe	-	-
W8	Al, Cd, Cu, Fe, Zn	Al, Cd, Cu, Fe	-	-
W9	*No Exceedances*	Al, Cd, Fe	-	-
W11	Al, Cd, Cu, Fe, U	Al, Cd, Cu, Fe, Pb	-	-
W12	pH, Al, Cd, Cu, Fe, Pb, U, Zn	pH, Al, Cd, Cu, Fe, Zn	-	-
W13	Cd, Pb, U	Al, Cd, Cr, Cu, Fe, Pb, Ag, Zn	-	-
W17*	Cd	Al, Cd, Fe	-	-
W18	Cd	Al, Cd, Fe	-	-
W19	*No Exceedances*	Al, Cd, Cr, Cu, Fe	-	-
W20	*No Exceedances*	Al, Cd, Cr, Cu, Fe	-	-
W22*	U	Al, Fe	-	-
W43	-	-	Cd, Cu, Pb, Ag, Zn	Cd, Cu, Pb, Zn

Note: Dashes indicate site not sampled.
****reference site***

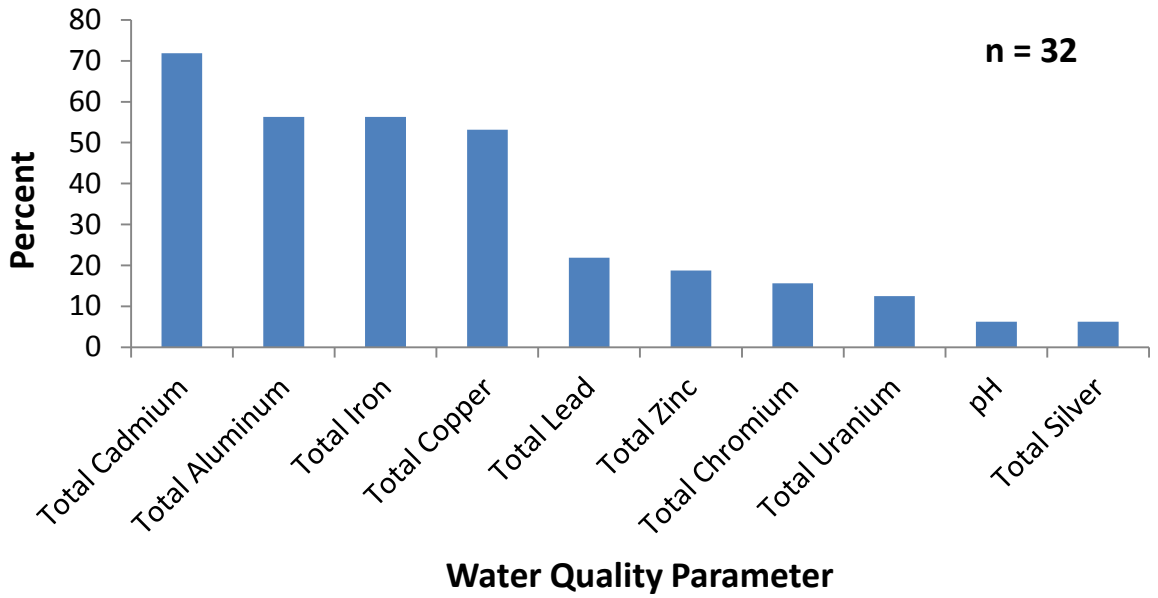

Figure 4. Percentage of Water Quality Exceedances of CCME Guidelines, Casino Project, 2012.

3.2 Fish Assessment

A total of eleven sites were sampled in 2012 for fish (Figure 3 and Table 3). Appendices B1 and B2 show the fish catch, effort and catch per unit effort (CPUE) for electrofishing and minnow trapping. Minnow trapping was completed at all sites except F17, and electrofishing was conducted at six of the eleven sites. Electrofishing effort ranged from 431 to 1031 seconds with a mean of 755 seconds.

A total of nine fish from two species were captured from the Project LSA in September of 2012 (Table 9 and Appendix B). Fish were only captured at sites S2, F14 and F19. The two species captured were Arctic grayling (*Thymallus arcticus*) and slimy sculpin (*Cottus cognatus*). Sampling at all other sites did not yield any fish.

Site F07 was also sampled in July, 2012, but no fish were captured during this sampling event.

Table 9. Fish Catch, Casino Project, 2012

Site	Creek	Arctic Grayling	Slimy Sculpin	Total
S2	Casino	1	-	1
F14	Dip	-	1	1
F19*	Coffee	7	-	7
Totals		8	1	

Note: Dashes indicate no fish captured

****reference site***

Fish sampling in upper Casino Creek yielded one adult Arctic grayling at site S2, but no fish were caught at sites F08 or F07 despite employing both electrofishing and minnow trapping efforts. Minnow trapping was conducted at sites on Brynelson Creek and lower Casino Creek to supplement previous electrofishing efforts, however, no fish were caught.

Site F17 was established in 2011 in upper Dip Creek (Figure 3) with the aim of using this location as a second reference site (R2 is the other established reference site within the Dip Creek watershed). However, for the second year in a row, no fish were captured at this location and thus the site was removed as a potential fish-bearing reference. To replace this location, site F19 was established in Coffee Creek, located approximately 15 km west of the Britannia Creek watershed. Sampling in 2012 confirmed a similar fish community to the Project LSA, with 7 Arctic grayling captured at a rate of 0.80 fish/100s of electrofishing. Arctic grayling lengths varied from 153-235mm, which suggests that the site generally supports sub-adult and adult rearing, but no young-of-the-year. Site R2 in Victor Creek was re-assessed in 2012 using electrofishing and minnow trapping, yet no fish were caught. The absence of fish was unexpected, as the CPUE for slimy sculpin was 1.4 and 0.9 sculpins/100s of electrofishing in 2009 and 2011, respectively, and sculpins tend to exhibit high site fidelity (Gray *et al.*, 2004).

Minnow traps were deployed in Dip Creek, below the confluence with Casino Creek (site F14) and approximately mid-way between Casino Creek and the Klotassin River (site F20) (Figure 3). The purpose of sampling within Dip Creek was to gain additional insight into the potential use by juvenile Chinook salmon for rearing, as documented for lower Dip Creek in previous reports (DFO, 1994; Otto, 1998). No Chinook salmon were caught in 2012, or in any of the previous years of the Casino baseline program (AECOM, 2009; PECG, 2011a, 2011b, 2012). The only fish caught in Dip Creek in 2012 was a single slimy sculpin captured at F14.

An aerial spawning survey was performed starting at the confluence of Dip and Casino Creeks, moving downstream on Dip Creek towards the Klotassin River (Figure 3). Around the mid-way point, the creek bed material changed drastically from being gravel-dominated to dominated by finer grained materials (e.g., sand). The spawning survey ended at approximately 24 km or three-quarters the distance to the Klotassin River from Casino Creek, with no evidence of adult Chinook salmon or redds (nesting sites) observed. In addition, the substrate in lower Dip Creek was consistently fine and thus not conducive to salmon spawning which requires gravel substrate (Healey, 1991). Evidence from two years of Dip Creek spawning surveys, conducted in 2010 (PECG, 2011b) and 2012, both indicate that no Chinook spawning occurs in Dip Creek.

4 Summary

The goal of the 2012 aquatic sampling program was to collect information that will be used to characterize the pre-development aquatic environment of the Project area. A significant amount of aquatic baseline data has previously been collected between 2008 and 2011, and therefore the 2012 studies focused on continued monitoring and addressing identified gaps in the established data sets. Surveys of the aquatic environment in 2012 were completed on March 25-31, May 22-29, July 1-5, and September 4-14.

A summary of the objectives for the 2012 aquatic studies included:

- Completion of baseline water quality sampling at all sites in the LSA and RSA;
- Completion of fish assessments using minnow trapping and electrofishing at established sites within the LSA and RSA, with focus on the sites within the TIA (i.e., upper Casino Creek);
- To investigate the potential usage of Dip Creek downstream of the confluence with Casino Creek by Chinook salmon for spawning and rearing habitat; and
- Establishment of a new fisheries reference site within the RSA.

A total of 16 sites were chosen for water quality sampling. Water samples were collected from each site in March and May, and from site W43 only in July and September. Each sample was analyzed for physical parameters, anions, nutrients and total and dissolved metals. Analyses of the water quality results showed similar trends as previous studies (AECOM, 2009; PECG 2011a, 2011b, 2012). CCME guidelines were regularly exceeded for pH, copper, aluminum, iron, and cadmium at various sample locations and generally occurred together at the same sites. A greater number of exceedances occurred following the spring freshet in May (N=65) compared to the winter sampling event in March (N=29). Water quality was poorest in the upper Casino Creek watershed, particularly in Proctor Gulch (W12) and Meloy Creek (W13).

Fish communities at 11 stream sites were sampled in July and September either with an electrofisher or with minnow traps. A total of 9 fish from two species were captured from the Project study area, including Arctic grayling (*Thymallus arcticus*) and slimy sculpin (*Cottus cognatus*). Results from the 2012 fisheries sampling program supported the conclusions of the 2008-2011 programs. Only one adult Arctic grayling individual was caught within the proposed project footprint (TIA) in upper Casino Creek despite considerable minnow trapping and electrofishing efforts at three sites (S2, F08, F07). No fish were caught using minnow traps in Brynelson Creek or lower Casino Creek, indicating that previous electrofishing methods were more critical for determining fish presence and life history use.

Fisheries sampling and spawning surveying in Dip Creek demonstrated that there was no evidence of Chinook salmon spawning or juvenile rearing, similar to results from recent field sampling (2008-2011). Changes in substrate from coarse gravels to fine sand occurred approximately half way along Dip Creek and further indicate that Dip Creek does not provide suitable salmon spawning habitat.

One additional reference site was established in Coffee Creek (site F19) to replace site F17 located in upper Dip Creek, since no fish were captured at this location for the second year in a row. The fish community in Coffee Creek was comparable to sites within the LSA and will aid in providing reference conditions alongside site R2 in Victor Creek. Seven Arctic grayling were captured at this located at a rate of 0.80 fish/100s of electrofishing.

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Appendix A

Surface Water Quality and Replicate Data

- **A1. Surface Water Quality Data, Casino Project, March 2012**
- **A2. Surface Water Quality Data, Casino Project, May 2012**
- **A3. Surface Water Quality Data, Casino Project, July 2012**
- **A4. Surface Water Quality Data, Casino Project, September 2012**
- **A5. Surface Water Quality Replicate Data, Casino Project**

Appendix A1. Surface Water Quality Data, Casino Project, March 2012

Date	CCME[1] Water Quality Guidelines	W20 - Klotassin River us of Dip Creek 29/03/2012	W19 - Dip Creek at Klotassin 29/03/2012	W22 - Upper Dip Creek 29/03/2012	W13 - Meloy Creek 29/03/2012	W8 - Lower Casino Creek 29/03/2012	Trip Blank 29/03/2012	Field Blank 29/03/2012	W4 - Mouth of Casino Creek 29/03/2012	W9 - Dip Creek us of confluence with Casino Creek 29/03/2012	R2 - Victor Creek 29/03/2012	W5 - Dip Creek ds of confluence with Casino Creek 29/03/2012	W3 - Canadian Creek us of confluence with Britannia Creek 29/03/2012	W3 - Canadian Creek us of confluence with Britannia Creek (Repeat) 29/03/2012	W6B - Yukon River us of Britannia Creek 29/03/2012	W17 - Sunshine Creek 29/03/2012	W11 - Casino Creek (proposed dam outflow) 29/03/2012	W18 - Brynelson Creek 29/03/2012	Detection Limits	W12 - Proctor Gulch 29/03/2012	W12 Detection Limits
Physical Properties																					
In Situ Field Data																					
Temperature (°C)		0	-0.08	-0.12	-0.1	-0.09			-0.08	-0.1	-0.1	-0.11	-0.06		-0.04	0.42	-0.11	-0.1		-0.09	
Conductivity (µS/cm)		168	230	273	368	354			368	245	206	286	413		223	311	429	250		1446	
pH		7.95	7.88	7.4	7.31	7.25			7.8	7.35	7.5	7.7	7.91		8.4	7.8	7.8	7.9		3.4	
Dissolved oxygen (mg/L)		6.23	0	9.83	9.74	11.11			9.56	7.05	7.78	8.47	11.73		8.4	0	11.52	9.87		9.25	
Laboratory Data																					
Conductivity (µS/cm)		181	248	289	365	373	1.2	1.1	387	263	222	305	435	440	243	330	450	267	1.0	1610	1.0
pH	6.5-9.0	7.82	7.79	8.00	7.73	7.76	**5.66**	**5.59**	8.06	7.90	7.85	7.90	8.02	8.07	8.08	7.94	8.12	7.97		**3.06**	
Total Suspended Solids		<1.0	1.1	<1.0	6.6	8.0	<1.0	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.3	3.2	<1.0	1.0	6.9	1.0
Total Dissolved Solids		110	158	164	228	238	<10	<10	232	144	138	180	306	290	132	200	278	168	10	1120	10
Turbidity (NTU)		1.08	5.14	1.09	0.53	8.16	<0.10	<0.10	0.44	0.21	<0.10	0.24	0.14	0.13	0.55	0.47	2.13	0.1	0.10	10	0.10
Calculated Parameters																					
Total Hardness (CaCO3)		75.3	105	132	170	155	<0.50	<0.50	168	120	96.9	140	183	200	109	145	204	114	0.50	521	0.50
Ion Balance		0.94	0.95	0.92	0.87	0.89	<0.010	<0.010	0.93	0.88	0.91	0.91	0.89	0.86	0.88	0.88	0.84	0.98	0.010	0.87	0.010
Nitrate (N)	13	0.154	0.0808	0.296	0.419	0.158	0.0051	0.0069	0.250	0.301	0.359	0.291	0.487	0.516	0.117	0.601	0.289	0.283	0.0020	0.0194	0.0020
Dissolved Anions and Nutrients																					
Orthophosphate (P)		0.008	0.005	0.002	0.002	0.001	<0.001	<0.001	<0.001	0.002	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.001	0.004	0.001
Dissolved Sulphate (SO4)		19.8	31.0	13.4	65.2	126	<0.50	<0.50	70.5	21.9	23.0	37.5	121	121	27.9	61.8	107	39.6	0.50	820	5.0
Dissolved Chloride (Cl)		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	0.8	0.6	<0.5	<0.5	<0.5	0.5	0.5	<0.5	<0.5	0.5
Ammonia (N)	0.499[a]	0.014	0.037	0.010	0.0082	0.014	<0.0050	<0.0050	<0.0050	0.0054	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	0.085	0.0050
Total Total Kjeldahl Nitrogen (Calc)		0.127	0.228	0.086	0.049	0.049	<0.020	<0.020	0.095	0.093	0.090	0.086	0.134	0.103	0.053	0.125	0.049	0.076	0.020	0.129	0.020
Nitrate plus Nitrite (N)		0.154	0.0808	0.296	0.419	0.158	0.0051	0.0069	0.25	0.301	0.359	0.291	0.487	0.516	0.117	0.611	0.289	0.283	0.0020	0.0291	0.0020
Nitrite (N)	0.06	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.01	<0.002	<0.002	0.002	0.01	0.002
Total Nitrogen (N)		0.281	0.308	0.382	0.468	0.207	<0.020	<0.020	0.346	0.394	0.449	0.376	0.621	0.619	0.170	0.736	0.338	0.359	0.020	0.158	0.020
Misc. Inorganics																					
Acidity (pH 4.5)		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	130	0.5
Acidity (pH 8.3)		4.9	12.1	7.5	5.4	2.1	<0.5	<0.5	2.8	5.2	7.3	4.3	3.2	2.7	1.3	5.5	1.7	2.3	0.5	229	0.5
Bromide (Br)		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.05	0.05
Fluoride (F)	0.12	0.120	0.064	0.062	0.081	**0.140**	<0.010	<0.010	0.076	0.054	0.057	0.060	0.120	0.120	0.120	0.067	0.100	0.054	0.010	**0.410**	0.010
Weak Acid Dissoc. Cyanide (CN)	0.005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00050	<0.00050	0.00050
Cyanide + Thiocyanate	0.005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00050	<0.00050	0.00050
Dissolved Hardness (CaCO3)		75.6	105	128	169	151	<0.5	<0.5	170	109	93.4	129	197	189	103	140	190	120	0.5	589	0.5
Dissolved Organic Carbon (C)		3.46	5.44	2.04	1.31	1.64	<0.50	<0.50	2.21	2.62	2.24	2.83	3.70	4.40	1.92	4.22	1.44	1.84	0.50	1.76	0.50
Alkalinity (Total as CaCO3)		68.7	92.7	137	141	50.8	<0.50	<0.50	125	113	88.0	115	110	109	93.9	105	127	91.9	0.50	<0.50	0.50
Total Organic Carbon (C)		3.61	5.58	2.00	1.20	1.64	<0.50	<0.50	2.29	2.92	2.51	3.03	4.09	3.89	2.31	4.42	1.72	2.17	0.50	2.03	0.50
Total Metals																					
Total Aluminum (Al)	0.005-0.1[b]	0.0081	0.0111	0.0098	0.0510	**0.987**	0.0005	0.0013	0.0467	0.0105	0.0093	0.0189	0.0071	0.0080	0.0107	0.0217	**0.185**	0.0060	0.0002	**16.6**	0.001
Total Antimony (Sb)		0.00003	0.00005	0.00005	0.00019	0.00007	<0.00002	<0.00002	0.00012	0.00006	0.00002	0.00008	0.00023	0.00025	0.00009	0.00020	0.00012	0.00014	0.00002	0.0001	0.0001
Total Arsenic (As)	0.005	0.00081	0.00112	0.00031	0.00189	0.00028	<0.00002	<0.00002	0.00043	0.00029	0.00015	0.00029	0.00044	0.00042	0.00033	0.00044	0.00076	0.00038	0.00002	0.0010	0.0001
Total Barium (Ba)		0.0541	0.0873	0.101	0.110	0.0779	0.00002	<0.00002	0.0985	0.0860	0.0674	0.0897	0.0909	0.0894	0.0590	0.120	0.0906	0.0623	0.00002	0.0086	0.0001
Total Beryllium (Be)		<0.00001	<0.00001	<0.00001	<0.00001	0.00004	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	0.00001	0.00070	0.00005
Total Bismuth (Bi)		<0.000005	<0.000005	<0.000005	0.000006	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	<0.00003	0.00003
Total Boron (B)		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.3	0.3
Total Cadmium (Cd)	equation[c]	0.000010	0.000018	0.000014	**0.000153**	**0.000382**	<0.000005	0.000026	**0.000046**	0.000008	0.000006	0.000019	**0.000018**	**0.000024**	0.000033	**0.000019**	**0.000150**	**0.000010**	0.000005	**0.00460**	0.00003
Total Chromium (Cr)	0.001	<0.0001	0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0007	0.0005
Total Cobalt (Co)		0.000146	0.000411	0.000071	0.000066	0.00502	<0.000005	<0.000005	0.000075	0.000049	0.000018	0.000056	0.000031	0.000026	0.000014	0.000046	0.000565	0.000009	0.000005	0.0797	0.00003
Total Copper (Cu)	equation[d]	0.00070	0.00079	0.00033	0.00069	**0.0922**	<0.00005	0.00012	**0.00342**	0.00054	0.00048	0.00139	0.00129	0.00136	0.00046	0.00089	**0.0151**	0.00044	0.00005	**1.43**	0.0003
Total Iron (Fe)	0.3	0.563	1.21	0.094	0.079	**1.65**	<0.001	<0.001	0.074	0.053	0.007	0.047	0.006	0.008	0.021	0.030	**0.310**	0.004	0.001	**39.1**	0.005
Total Lead (Pb)	equation[e]	0.000006	0.000015	0.000027	**0.00486**	0.000289	<0.000005	0.000008	0.000160	0.000012	0.000007	0.000050	0.000010	0.000009	0.000009	0.000022	0.00106	<0.000005	0.000005	**0.00155**	0.00003
Total Lithium (Li)		<0.0005	0.0006	0.0047	0.0024	0.0014	<0.0005	<0.0005	0.0015	0.0031	0.0013	0.0025	0.0006	0.0007	0.0017	0.0006	0.0026	0.0012	0.0005	0.008	0.003
Total Manganese (Mn)		0.101	0.275	0.0771	0.130	0.157	<0.00005	<0.00005	0.0248	0.0403	0.00554	0.0316	0.00057	0.00059	0.00476	0.00299	0.121	0.00403	0.00005	1.97	0.0003
Total Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00005	0.00005
Total Molybdenum (Mo)	0.073	0.00050	0.00065	0.00052	0.00088	0.00027	<0.00005	<0.00005	0.00137	0.00055	0.00098	0.00085	0.00143	0.00141	0.00126	0.00034	0.00101	0.00239	0.00005	<0.0003	0.0003
Total Nickel (Ni)	equation[f]	0.00045	0.00065	0.00021	0.00032	0.00119	<0.00002	<0.00002	0.00020	0.00023	0.00020	0.00022	0.00049	0.00053	0.00080	0.00039	0.00048	0.00011	0.00002	0.0123	0.0001
Total Phosphorus (P)		0.010	0.012	0.003	0.010	0.004	<0.002	<0.002	0.003	0.004	0.002	0.003	0.003	0.004	0.002	0.003	0.005	<0.002	0.002	0.01	0.01
Total Selenium (Se)	0.001	0.00017	0.00005	<0.00004	0.00011	0.00009	<0.00004	<0.00004	0.00015	0.00004	0.00010	0.00009	0.00019	0.00017	0.00053	0.00011	0.00028	0.00008	0.00004	0.0004	0.0002
Total Silicon (Si)		4.4	4.8	5.8	4.7	6.0	<0.1	<0.1	5.0	5.3	4.4	5.3	3.9	4.2	2.8	3.8	5.2	5.1	0.1	9.1	0.5
Total Silver (Ag)	0.0001	<0.000005	<0.000005	<0.000005	0.000020	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	<0.00003	0.00003
Total Strontium (Sr)		0.168	0.190	0.339	0.322	0.361	<0.00005	<0.00005	0.309	0.263	0.222	0.281	0.345	0.341	0.147	0.239	0.367	0.181	0.00005	0.457	0.0003
Total Thallium (Tl)	0.0008	<0.000002	<0.000002	<0.000002	0.000002	0.000009	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000003	<0.000002	0.000002	0.00012	0.00001
Total Tin (Sn)		<0.0002	<0.0002	0.0003	0.0003	<0.0002	<0.0002	0.0007	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0005	0.0002	<0.001	0.001
Total Titanium (Ti)		<0.0005	<0.0005	<0.0005	0.0040	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.0009	<0.0005	0.0005	<0.003	0.003
Total Uranium (U)	0.015	0.000181	0.00227	**0.0144**	**0.0244**	0.00429	0.000008	<0.000002	**0.0185**	0.0114	0.00569	0.0132	**0.0351**	**0.0343**	0.00144	0.00373	**0.0240**	0.00805	0.000002	**0.0177**	0.00001
Total Vanadium (V)		0.0005	0.0006	<0.0002	0.0003	<0.0002	<0.0002	<0.0002	0.0003	0.0003	0.0003	0.0003	<0.0002	<0.0002	0.0002	0.0003	0.0002	0.0004	0.0002	<0.001	0.001
Total Zinc (Zn)	0.03	0.0002	0.0005	0.0036	0.0065	**0.0316**	0.0001	0.0007	0.0019	0.0004	0.0002	0.0012	0.0010	0.0007	0.0024	0.0008	0.0075	0.0016	0.0001	**0.377**	0.0005
Total Zirconium (Zr)		0.0001	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	<0.0005	0.0005
Total Calcium (Ca)		17.3	25.4	34.5	41.9	45.1	<0.05	<0.05	42.3	30.9	21.9	36.1	44.9	50.6	29.4	33.9	51.3	29.5	0.05	147	0.3
Total Magnesium (Mg)		7.82	10.1	11.3	15.8	10.3	<0.05	<0.05	15.1	10.4	10.2	12.1	17.3	18.0	8.61	14.7	18.6	9.81	0.05	37.2	0.3
Total Potassium (K)		0.81	1.22	1.16	1.41	1.07	<0.05	<0.05	1.30	0.93	0.78	1.08	2.41	2.56	0.92	1.43	1.28	1.33	0.05	2.5	0.3
Total Sodium (Na)		3.60	5.09	5.07	5.59	4.88	<0.05	<0.05	6.02	5.08	3.97	5.52	5.65	5.97	2.21	4.58	5.53	4.92	0.05	10.4	0.3
Total Sulphur (S)		<10	12	<10	23	45	<10	<10	26	<10	<10	14	40	41	10	21	39	15	10	280	50

Note:
All units mg/L unless otherwise noted
NS= Not Sampled
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5; 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

Bold	Results exceed CCME Aquatic Life Guidelines

Appendix A1. Surface Water Quality Data, Casino Project, March 2012

	CCME[1] Water Quality Guidelines	W20 - Klotassin River us of Dip Creek	W19 - Dip Creek at Klotassin	W22 - Upper Dip Creek	W13 - Meloy Creek	W8 - Lower Casino Creek	Trip Blank	Field Blank	W4 - Mouth of Casino Creek	W9 - Dip Creek us of confluence with Casino Creek	R2 - Victor Creek	W5 - Dip Creek ds of confluence with Casino Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W3 - Canadian Creek us of confluence with Britannia Creek (Repeat)	W6B - Yukon River us of Britannia Creek	W17 - Sunshine Creek	W11 - Casino Creek (proposed dam outflow)	W18 - Brynelson Creek	Detection Limits	W12 - Proctor Gulch	W12 Detection Limits
Date		**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**	**29/03/2012**		**29/03/2012**	
Dissolved Metals																					
Dissolved Aluminum (Al)		0.0057	0.0078	0.0035	0.0023	0.0275	0.0002	<0.0002	0.0139	0.0070	0.0079	0.0077	0.0059	0.0055	0.0021	0.0113	0.0240	0.0048	0.0002	17.4	0.0002
Dissolved Antimony (Sb)		0.00003	0.00005	0.00005	0.00016	0.00006	<0.00002	<0.00002	0.00013	0.00006	0.00002	0.00008	0.00023	0.00024	0.00009	0.00019	0.00012	0.00015	0.00002	<0.0001	0.0001
Dissolved Arsenic (As)		0.00064	0.00082	0.00020	0.00163	0.00007	<0.00002	<0.00002	0.00032	0.00024	0.00019	0.00024	0.00048	0.00039	0.00035	0.00045	0.00035	0.00039	0.00002	0.0006	0.0001
Dissolved Barium (Ba)		0.0511	0.0877	0.104	0.107	0.0678	0.00003	<0.00002	0.0987	0.0872	0.0685	0.0891	0.0896	0.0872	0.0590	0.121	0.0917	0.0819	0.00002	0.0079	0.0001
Dissolved Beryllium (Be)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00074	0.00005
Dissolved Bismuth (Bi)		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	<0.00003	0.00003
Dissolved Boron (B)		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.3	0.3
Dissolved Cadmium (Cd)		0.000009	0.000014	0.000010	0.000120	0.000316	<0.000005	<0.000005	0.000040	0.000008	0.000012	0.000018	0.000018	0.000023	0.000026	0.000018	0.000127	0.000011	0.000005	0.00462	0.00003
Dissolved Chromium (Cr)		<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0005	0.0005
Dissolved Cobalt (Co)		0.000159	0.000414	0.000059	0.000010	0.00476	<0.000005	<0.000005	0.000065	0.000048	0.000023	0.000041	0.000030	0.000028	0.000007	0.000028	0.000483	0.000013	0.000005	0.0761	0.00003
Dissolved Copper (Cu)		0.00066	0.00064	0.00020	0.00028	0.00968	0.00006	<0.00005	0.00258	0.00055	0.00042	0.00119	0.00134	0.00124	0.00046	0.00087	0.00593	0.00039	0.00005	1.21	0.00005
Dissolved Iron (Fe)		0.336	0.582	0.013	0.001	0.001	<0.001	<0.001	0.003	0.028	0.004	0.013	0.003	0.003	0.004	0.011	0.002	0.002	0.001	13.7	0.001
Dissolved Lead (Pb)		<0.000005	0.000012	<0.000005	0.000112	<0.000005	0.000013	<0.000005	0.000007	0.000006	<0.000005	0.000007	0.000005	<0.000005	0.000007	0.000005	0.000009	0.000007	0.000005	0.00150	0.00003
Dissolved Lithium (Li)		<0.0005	0.0006	0.0047	0.0023	0.0015	<0.0005	<0.0005	0.0015	0.0031	0.0012	0.0024	0.0007	0.0007	0.0018	<0.0005	0.0024	0.0012	0.0005	0.008	0.003
Dissolved Manganese (Mn)		0.0983	0.265	0.0704	0.0939	0.151	<0.00005	<0.00005	0.0230	0.0389	0.00523	0.0291	0.00058	0.00052	0.00413	0.00228	0.111	0.00350	0.00005	1.88	0.00005
Dissolved Mercury (Hg)		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00005	0.00005
Dissolved Molybdenum (Mo)		0.00051	0.00064	0.00049	0.00099	0.00027	0.00009	<0.00005	0.00141	0.00060	0.00101	0.00085	0.00143	0.00139	0.00126	0.00035	0.00099	0.00239	0.00005	<0.0003	0.0003
Dissolved Nickel (Ni)		0.00052	0.00070	0.00019	0.00026	0.00110	<0.00002	<0.00002	0.00023	0.00023	0.00020	0.00020	0.00047	0.00046	0.00076	0.00030	0.00042	0.00010	0.00002	0.0116	0.00002
Dissolved Phosphorus (P)		0.007	0.006	0.002	0.003	0.003	<0.002	<0.002	0.003	0.003	0.003	0.003	0.003	0.003	<0.002	0.002	<0.002	<0.002	0.002	<0.01	0.01
Dissolved Selenium (Se)		0.00019	<0.00004	<0.00004	0.00012	0.00007	<0.00004	<0.00004	0.00015	0.00005	0.00012	0.00007	0.00019	0.00016	0.00057	0.00010	0.00028	0.00009	0.00004	0.0005	0.0002
Dissolved Silicon (Si)		4.4	4.9	5.5	4.8	5.4	<0.1	<0.1	4.9	4.6	4.3	4.9	4.2	3.9	2.7	3.7	4.9	5.3	0.1	8.9	0.5
Dissolved Silver (Ag)		<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	0.00003	0.00003
Dissolved Strontium (Sr)		0.165	0.185	0.330	0.314	0.350	<0.00005	<0.00005	0.299	0.270	0.221	0.270	0.345	0.330	0.145	0.238	0.365	0.179	0.00005	0.444	0.0003
Dissolved Thallium (Tl)		<0.000002	<0.000002	<0.000002	<0.000002	0.000008	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000003	<0.000002	0.000002	0.00010	0.00001
Dissolved Tin (Sn)		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.001	0.001
Dissolved Titanium (Ti)		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.003	0.003
Dissolved Uranium (U)		0.000181	0.00226	0.0146	0.0239	0.00213	<0.000002	<0.000002	0.0182	0.0119	0.00601	0.0130	0.0356	0.0340	0.00144	0.00379	0.0237	0.00798	0.000002	0.0176	0.00001
Dissolved Vanadium (V)		0.0005	0.0005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.0002	0.0003	0.0002	<0.0002	<0.0002	0.0003	0.0003	<0.0002	0.0003	0.0002	<0.001	0.001
Dissolved Zinc (Zn)		0.0004	0.0006	0.0012	0.0036	0.0173	<0.0001	0.0002	0.0016	0.0006	0.0006	0.0014	0.0006	0.0012	0.0024	0.0006	0.0059	0.0005	0.0001	0.328	0.0001
Dissolved Zirconium (Zr)		0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	<0.0005	0.0005
Dissolved Calcium (Ca)		17.5	25.8	32.8	42.7	43.9	<0.05	<0.05	42.8	26.4	21.4	32.8	49.9	47.4	27.2	32.9	47.1	32.0	0.05	175	0.05
Dissolved Magnesium (Mg)		7.71	9.75	11.2	15.1	10.1	<0.05	<0.05	15.3	10.5	9.73	11.4	17.5	17.1	8.55	14.2	17.6	9.75	0.05	37.2	0.05
Dissolved Potassium (K)		0.80	1.16	1.11	1.38	1.04	<0.05	<0.05	1.29	0.95	0.74	1.00	2.45	2.37	0.88	1.37	1.20	1.32	0.05	2.60	0.05
Dissolved Sodium (Na)		3.51	4.98	5.01	5.39	4.78	<0.05	<0.05	6.16	5.22	3.82	5.20	5.81	5.62	2.16	4.33	5.22	4.95	0.05	10.3	0.05
Dissolved Sulphur (S)		<10	11	<10	23	44	<10	<10	27	<10	<10	13	40	42	<10	22	40	13	10	278	10

Note:
All units mg/L unless otherwise noted
NS= Not Sampled
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e*0.76[ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

Bold	Results exceed CCME Aquatic Life Guidelines

Appendix A2. Surface Water Quality Data, Casino Project, May 2012

Date	CCME[1] Water Quality Guidelines	W20 - Klotassin River us of Dip Creek 25/05/2012	W19 - Dip Creek at Klotassin 25/05/2012	W22 - Upper Dip Creek 25/05/2012	W13 - Meloy Creek 25/05/2012	W8 - Lower Casino Creek 25/05/2012	W12 - Proctor Gulch 25/05/2012	Trip Blank	Field Blank	W4 - Mouth of Casino Creek 24/05/2012	W9 - Dip Creek us of confluence with Casino Creek 24/05/2012	R2 - Victor Creek 24/05/2012	R2 - Victor Creek (Repeat) 24/05/2012	W5 - Dip Creek ds of confluence with Casino Creek 24/05/2012	W3 - Canadian Creek us of confluence with Britannia Creek 23/05/2012	W6B - Yukon River us of Britannia Creek 23/05/2012	W17 - Sunshine Creek 23/05/2012	W11 - Casino Creek (proposed dam outflow) 23/05/2012	W18 - Brynelson Creek 23/05/2012	Detection Limits
Physical Properties																				
In Situ Field Data																				
Temperature (°C)		5.2	5	3.88	NS	2.98	1.53			1.3	1.4	1.4		2.3	3.7	11.4	2.7	3.3	3.8	
Conductivity (µS/cm)		121.2	122.2	121	118	99	293			70.5	64.8	50.4		71	117.9	288.7	101.4	111.7	58.8	
pH		7.38	7.31	7.4	6.82	6.54	3.86			7.28	7.26	7.23		7.55	7.57	8.11	7.82	7.71	7.46	
Dissolved oxygen (mg/L)		10.48	10.44	9.66	10.13	12.65	10.93			13.22	12.88	12.77		12.35	11.92	9.27	12.61	12.51	12.21	
Laboratory Data																				
Conductivity (µS/cm)		106	108	77.6	76.1	71.8	209	<1.0	<1.0	71.3	65.2	50.7	52.0	68.2	111	220	96.6	104	53.3	1.0
pH	6.5-9.0	7.68	7.59	7.44	7.46	7.08	**4.25**	**5.32**	**5.42**	7.43	7.51	7.37	7.39	7.50	7.45	8.09	7.56	7.52	7.33	-
Total Suspended Solids		59.5	123	10.0	91.5	30.9	77.6	<1.0	<1.0	106	58.9	31.1	29.7	69.0	17.6	33.5	37.7	29.8	20.8	1.0
Total Dissolved Solids		80	84	70	70	54	120	<10	<10	72	66	72	62	68	98	140	96	90	54	10
Turbidity (NTU)		6.26	15.2	1.63	13.3	13.4	40.8	<0.10	<0.10	12.6	8.45	3.1	3.28	7.82	3.03	18.5	5.19	3.07	1.78	0.10
Calculated Parameters																				
Total Hardness (CaCO3)		53.7	55.4	40.4	41.0	30.4	56.2	<0.50	<0.50	36.9	32.6	26.8	25.7	32.5	48.7	103	46.6	45.8	24.8	0.50
Ion Balance		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Nitrate (N)	13	0.0721	0.0439	0.102	0.0816	0.0289	0.0139	<0.0020	<0.0020	0.0490	0.0342	0.0089	0.0117	0.0437	0.109	0.0211	0.0990	0.0595	0.105	0.0020
Dissolved Anions and Nutrients																				
Orthophosphate (P)		0.0012	0.0019	<0.0010	0.0014	0.0011	0.0024	<0.0010	<0.0010	0.0018	0.0013	0.0014	0.0012	0.0012	0.0011	0.0022	0.0017	0.001	0.001	0.0010
Dissolved Sulphate (SO4)		8.01	12.5	9.86	<0.50	18.9	79.2	1.39	<0.50	7.16	<0.50	<0.50	<0.50	<0.50	21.0	29.7	7.62	20.3	<0.50	0.50
Dissolved Chloride (Cl)		0.73	0.90	0.80	1.1	0.83	0.65	<0.50	<0.50	1.1	1.3	1.1	1.2	1.0	1.5	1.2	1.3	1.2	1.3	0.50
Ammonia (N)	0.499[a]	0.012	0.018	0.014	0.023	0.014	0.025	<0.0050	<0.0050	0.030	0.025	0.026	0.043	0.029	0.023	0.017	0.028	0.035	0.041	0.0050
Total Total Kjeldahl Nitrogen (Calc)		0.486	0.692	0.436	0.655	0.567	0.563	0.025	<0.020	0.685	0.576	0.594	0.576	0.511	0.564	0.248	0.598	0.505	0.517	0.020
Nitrate plus Nitrite (N)		0.0755	0.0461	0.104	0.0836	0.0324	0.0139	<0.0020	<0.0020	0.0521	0.037	0.011	0.0141	0.0461	0.111	0.0256	0.099	0.062	0.105	0.0020
Nitrite (N)	0.06	0.0034	0.0022	0.0024	0.002	0.0035	<0.0020	<0.0020	<0.0020	0.0031	0.0028	0.0021	0.0024	0.0024	0.002	0.0045	<0.0020	0.0025	<0.0020	0.0020
Total Nitrogen (N)		0.561	0.738	0.540	0.739	0.600	0.577	0.025	<0.020	0.737	0.613	0.605	0.590	0.557	0.675	0.274	0.697	0.567	0.622	0.020
Misc. Inorganics																				
Acidity (pH 4.5)		<0.50	<0.50	<0.50	<0.50	<0.50	2.43	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Acidity (pH 8.3)		1.09	1.75	2.25	1.60	1.51	22.2	<0.50	<0.50	1.11	1.39	2.50	1.73	1.57	1.39	1.03	1.17	1.41	1.42	0.50
Bromide (Br)		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010
Fluoride (F)	0.12	0.120	0.059	0.038	0.034	0.049	0.066	<0.010	<0.010	0.040	0.041	0.037	0.037	0.040	0.059	0.110	0.047	0.055	0.028	0.010
Weak Acid Dissoc. Cyanide (CN)	0.005	<0.00050	0.00061	0.00070	0.00114	0.00060	<0.00050	<0.00050	<0.00050	0.00061	0.00075	0.00066	0.00079	0.00055	0.00067	<0.00050	0.00059	<0.00050	0.00057	0.00050
Cyanide + Thiocyanate	0.005	0.00070	0.00055	0.00135	0.00143	0.00089	<0.00050	<0.00050	0.00055	0.00076	0.00119	0.00098	0.00075	0.00072	0.00107	<0.00050	0.00059	0.00083	0.00058	0.00050
Dissolved Hardness (CaCO3)		50.7	50.2	39.5	38.0	30.6	56.9	<0.50	<0.50	32.7	30.8	25.7	25.7	33.4	48.4	103	46.2	46.7	25.8	0.50
Dissolved Organic Carbon (C)		7.1 (2)	14.4 (2)	7.4 (2)	11.5 (2)	7.5 (2)	6.0 (2)	0.94	<0.50	13.4	14.1	15.7	17.8	14.1	15.3	9.26	16.8	13.6	14.9	0.50
Alkalinity (Total as CaCO3)		42.7	45.5	35.4	28.8	8.19	<0.50	<0.50	<0.50	22.0	25.7	21.3	20.0	27.2	25.9	79.9	33.0	27.6	15.5	0.50
Total Organic Carbon (C)		<5.0 (2)	15.9 (2)	<5.0 (2)	10.8 (2)	18.2 (2)	12.6 (2)	0.91	1.02	17.7	17.3	19.5	18.8	16.4	17.4	10.0	19.7	16.0	17.1	0.50
Total Metals																				
Total Aluminum (Al)	0.005-0.1[b]	**0.487**	**0.781**	**0.198**	**0.719**	**0.847**	**2.26**	0.00036	0.00141	**0.945**	**0.468**	**0.370**	**0.374**	**0.569**	**0.309**	**0.344**	**0.458**	**0.481**	**0.329**	0.00020
Total Antimony (Sb)		0.000041	0.000086	0.000064	0.000296	0.000112	0.000239	<0.000020	<0.000020	0.000132	0.000069	0.000032	0.000025	0.000088	0.000225	0.000141	0.000145	0.000121	0.000068	0.000020
Total Arsenic (As)	0.005	0.000751	0.00230	0.000542	0.00139	0.000895	0.00235	<0.000020	<0.000020	0.00243	0.000914	0.000475	0.000506	0.00106	0.00138	0.000958	0.00110	0.00102	0.000673	0.000020
Total Barium (Ba)		0.0390	0.0708	0.0421	0.0816	0.0394	0.0315	<0.000020	0.000022	0.0626	0.0452	0.0356	0.0365	0.0472	0.0395	0.0735	0.0614	0.0449	0.0308	0.000020
Total Beryllium (Be)		0.000045	0.000052	0.000017	0.000047	0.000042	0.000096	<0.000010	<0.000010	0.000073	0.000037	0.000032	0.000034	0.000045	0.000027	0.000028	0.000034	0.000039	0.000020	0.000010
Total Bismuth (Bi)		0.0000050	0.0000103	<0.0000050	0.0000131	0.0000307	0.0000820	<0.0000050	<0.0000050	0.0000177	0.0000085	0.0000077	0.0000155	0.0000123	0.0000071	0.0000058	<0.0000050	0.0000284	<0.0000050	0.0000050
Total Boron (B)		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.050
Total Cadmium (Cd)	equation[c]	**0.0000535**	**0.0000907**	0.0000221	**0.000519**	**0.000153**	**0.000520**	<0.0000050	<0.0000050	**0.000246**	**0.0000570**	**0.0000377**	**0.0000443**	0.000101	**0.0000790**	**0.000189**	**0.0000872**	**0.000159**	**0.0000409**	0.0000050
Total Chromium (Cr)	0.001	**0.00150**	**0.00117**	0.00029	**0.00145**	0.00051	0.00074	<0.00010	<0.00010	**0.00126**	0.00065	0.00055	0.000053	0.00079	0.00059	0.00056	0.00051	0.00052	0.00044	0.00010
Total Cobalt (Co)		0.000604	0.00100	0.000149	0.000645	0.00122	0.00720	<0.0000050	<0.0000050	0.00170	0.000473	0.000319	0.000348	0.000645	0.000375	0.000391	0.000342	0.000764	0.000198	0.0000050
Total Copper (Cu)	equation[d]	**0.00282**	**0.00826**	0.00137	0.00682	0.0528	0.179	<0.000050	0.000064	**0.0266**	0.00272	**0.00228**	**0.00270**	**0.00929**	**0.00650**	**0.00279**	0.00265	**0.0260**	0.00215	0.000050
Total Iron (Fe)	0.3	**0.994**	**2.68**	**0.371**	**0.906**	**1.16**	**12.4**	<0.0010	0.0011	**1.93**	**0.914**	**0.625**	**0.625**	**0.973**	**0.506**	**0.681**	**0.589**	**0.701**	**0.377**	0.0010
Total Lead (Pb)	equation[e]	0.000430	0.00222	0.000121	**0.0730**	0.00118	0.00182	<0.0000050	<0.0000050	**0.0107**	0.000711	0.000232	0.000291	0.00412	0.000353	0.000517	0.000401	**0.0100**	0.000239	0.0000050
Total Lithium (Li)		0.00058	0.00126	0.00107	0.00071	<0.00050	0.00093	<0.00050	<0.00050	0.00086	0.00145	0.00075	0.00079	0.00130	<0.00050	0.00262	0.00072	0.00076	<0.00050	0.00050
Total Manganese (Mn)		0.0733	0.216	0.0419	0.173	0.0565	0.243	<0.000050	<0.000050	0.132	0.0780	0.0371	0.0390	0.0760	0.0299	0.0453	0.0410	0.0640	0.0153	0.000050
Total Mercury (Hg)		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.010 (2)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000010
Total Molybdenum (Mo)	0.073	0.000465	0.000548	0.000226	0.000352	0.000776	0.000341	<0.000050	<0.000050	0.000400	0.000278	0.000292	0.000272	0.000469	0.000420	0.00104	0.000195	0.000257	0.000579	0.000050
Total Nickel (Ni)	equation[f]	0.00183	0.00184	0.000568	0.00146	0.000877	0.00176	<0.000020	<0.000020	0.00171	0.00121	0.00108	0.00118	0.00118	0.00132	0.00430	0.00154	0.00103	0.000718	0.000020
Total Phosphorus (P)		0.0573	0.0817	0.0208	0.0647	0.0293	0.111	<0.0020	<0.0020	0.0910	0.0521	0.0400	0.0463	0.0530	0.0296	0.0437	0.0326	0.0289	0.0227	0.0020
Total Selenium (Se)	0.001	0.000153	0.000101	<0.000040	0.000044	<0.000040	0.000136	<0.000040	<0.000040	0.000072	0.000067	0.000077	0.000094	0.000070	0.000080	0.000564	0.000076	0.000069	0.000044	0.000040
Total Silicon (Si)		3.94	3.80	3.09	3.02	2.84	2.78	<0.10	<0.10	3.07	2.58	2.20	2.15	2.63	2.62	3.42	2.51	2.83	2.30	0.10
Total Silver (Ag)	0.0001	0.0000110	0.0000231	0.0000065	**0.000152**	0.0000629	0.0000958	<0.0000050	<0.0000050	0.0000566	0.0000096	0.0000070	0.0000090	0.0000226	0.0000136	0.0000122	0.0000122	0.0000442	0.0000097	0.0000050
Total Strontium (Sr)		0.104	0.0925	0.0896	0.0720	0.0589	0.0514	<0.000050	<0.000050	0.0646	0.0693	0.0523	0.0523	0.0679	0.0835	0.137	0.0829	0.0864	0.0405	0.000050
Total Thallium (Tl)	0.0008	0.0000033	0.0000083	0.0000038	0.0000249	0.0000098	0.0000226	<0.0000020	<0.0000020	0.0000179	0.0000068	0.0000058	0.0000051	0.0000104	0.0000069	0.0000104	0.0000052	0.0000100	0.0000070	0.0000020
Total Tin (Sn)		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00028	0.00020
Total Titanium (Ti)		0.0177	0.0250	0.00692	0.0269	0.0126	0.0105	<0.000050	<0.000050	0.0313	0.0186	0.0112	0.0125	0.0219	0.00983	0.00898	0.0163	0.0133	0.0110	0.00050
Total Uranium (U)	0.015	0.000499	0.00265	0.00223	0.00369	0.000984	0.00397	<0.0000020	<0.0000020	0.00295	0.00232	0.00155	0.00138	0.00236	0.00437	0.000965	0.00130	0.00287	0.00121	0.0000020
Total Vanadium (V)		0.00262	0.00437	0.00078	0.00231	0.00094	0.00127	<0.00020	<0.00020	0.00389	0.00198	0.00131	0.00140	0.00216	0.00085	0.00150	0.00169	0.00108	0.00120	0.00020
Total Zinc (Zn)	0.03	0.00331	0.00640	0.00096	**0.0329**	0.0124	**0.0412**	<0.00010	<0.00010	0.0168	0.00336	0.00244	0.00307	0.00734	0.00464	0.0132	0.00523	0.0118	0.00234	0.00010
Total Zirconium (Zr)		0.00049	0.00059	0.00021	0.00029	0.00042	0.00040	<0.00010	<0.00010	0.00043	0.00040	0.00037	0.00038	0.00040	0.00034	0.00050	0.00039	0.00029	0.00028	0.00010
Total Calcium (Ca)		13.6	14.4	11.2	11.4	9.08	16.5	<0.050	<0.050	10.1	8.38	6.74	6.24	8.44	12.4	27.4	11.8	12.5	6.71	0.050
Total Magnesium (Mg)		4.78	4.71	3.02	3.07	1.87	3.67	<0.050	<0.050	2.85	2.83	2.43	2.45	2.77	4.29	8.29	4.18	3.52	1.95	0.050
Total Potassium (K)		0.665	0.819	0.690	0.894	0.733	1.05	<0.050	<0.050	0.807	0.582	0.550	0.552	0.649	1.12	1.03	0.950	0.763	0.800	0.050
Total Sodium (Na)		2.43	2.19	1.56	1.17	1.01	1.24	<0.050	<0.050	1.22	1.31	0.894	0.904	1.25	1.40	2.00	1.54	1.33	1.07	0.050
Total Sulphur (S)		<10	<10	<10	<10	<10	27	<10	<10	<10	<10	<10	<10	<10	<10	11	<10	<10	<10	10

Note:
All units mg/L unless otherwise noted
NS= Not Sampled
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
2) RDL raised due to sample matrix interference; RDL for DOC was 5, for TOC was 5, and for total mercury was 0.01.
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

Bold	Results exceed CCME Aquatic Life Guidelines

Appendix A2. Surface Water Quality Data, Casino Project, May 2012

	CCME[1] Water Quality Guidelines	W20 - Klotassin River us of Dip Creek	W19 - Dip Creek at Klotassin	W22 - Upper Dip Creek	W13 - Meloy Creek	W8 - Lower Casino Creek	W12 - Proctor Gulch	Trip Blank	Field Blank	W4 - Mouth of Casino Creek	W9 - Dip Creek us of confluence with Casino Creek	R2 - Victor Creek	R2 - Victor Creek (Repeat)	W5 - Dip Creek ds of confluence with Casino Creek	W3 - Canadian Creek us of confluence with Britannia Creek	W6B - Yukon River us of Britannia Creek	W17 - Sunshine Creek	W11 - Casino Creek (proposed dam outflow)	W18 - Brynelson Creek	Detection Limits
Date		**25/05/2012**	**25/05/2012**	**25/05/2012**	**25/05/2012**	**25/05/2012**	**25/05/2012**			**24/05/2012**	**24/05/2012**	**24/05/2012**	**24/05/2012**	**24/05/2012**	**23/05/2012**	**23/05/2012**	**23/05/2012**	**23/05/2012**	**23/05/2012**	
Dissolved Metals																				
Dissolved Aluminum (Al)		0.0475	0.0823	0.112	0.133	0.283	1.78	<0.00020	0.00200	0.180	0.136	0.166	0.164	0.150	0.162	0.0308	0.160	0.228	0.182	0.00020
Dissolved Antimony (Sb)		0.000033	0.000069	0.000063	0.000166	0.000075	0.000078	<0.000020	<0.000020	0.000072	0.000048	0.000029	0.000032	0.000064	0.000184	0.000125	0.000117	0.000087	0.000057	0.000020
Dissolved Arsenic (As)		0.000315	0.000522	0.000339	0.000580	0.000297	0.000253	<0.000020	<0.000020	0.000393	0.000371	0.000288	0.000312	0.000428	0.000712	0.000501	0.000644	0.000433	0.000363	0.000020
Dissolved Barium (Ba)		0.0263	0.0373	0.0394	0.0398	0.0305	0.0219	<0.000020	0.000047	0.0270	0.0279	0.0264	0.0258	0.0285	0.0318	0.0499	0.0445	0.0367	0.0252	0.000020
Dissolved Beryllium (Be)		0.000015	0.000011	0.000013	0.000010	0.000022	0.000086	<0.000010	<0.000010	0.000012	0.000016	0.000017	0.000020	0.000014	0.000016	<0.000010	0.000015	0.000019	0.000013	0.000010
Dissolved Bismuth (Bi)		<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000084	<0.0000050	<0.0000050	0.0000050
Dissolved Boron (B)		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.050
Dissolved Cadmium (Cd)		0.0000157	0.0000153	0.0000141	0.0000898	0.000117	0.000494	<0.0000050	<0.0000050	0.0000470	0.0000156	0.0000235	0.0000352	0.0000348	0.0000534	0.0000796	0.0000288	0.0000905	0.0000382	0.0000050
Dissolved Chromium (Cr)		0.00019	0.00025	0.00018	0.00020	0.00019	0.00024	<0.00010	<0.00010	0.00018	0.00025	0.00028	0.00031	0.00024	0.00026	<0.00010	0.00022	0.00022	0.00022	0.00010
Dissolved Cobalt (Co)		0.0000726	0.000113	0.0000391	0.0000379	0.000920	0.00675	<0.0000050	<0.0000050	0.000127	0.0000916	0.000129	0.000126	0.000113	0.000126	0.0000356	0.0000855	0.000395	0.0000542	0.0000050
Dissolved Copper (Cu)		0.00155	0.00386	0.00120	0.00228	0.0278	0.154	<0.000050	<0.000050	0.0105	0.00166	0.00192	0.00187	0.00474	0.00559	0.00176	0.00195	0.0213	0.00194	0.000050
Dissolved Iron (Fe)		0.131	0.328	0.122	0.0846	0.403	4.79	<0.0010	0.0019	0.181	0.220	0.213	0.216	0.203	0.155	0.0897	0.157	0.257	0.125	0.0010
Dissolved Lead (Pb)		0.0000218	0.000126	0.0000149	0.00273	0.000114	0.000446	<0.0000050	0.0000138	0.000495	0.0000511	0.0000501	0.0000241	0.000219	0.0000619	0.0000402	0.0000615	0.000703	0.0000355	0.0000050
Dissolved Lithium (Li)		<0.00050	0.00077	0.00108	<0.00050	<0.00050	0.00089	<0.00050	<0.00050	<0.00050	0.00120	0.00058	0.00054	0.00092	<0.00050	0.00232	0.00051	0.00060	<0.00050	0.00050
Dissolved Manganese (Mn)		0.0154	0.0295	0.00903	0.00801	0.0374	0.237	<0.000050	<0.000050	0.00914	0.0128	0.0107	0.0104	0.0113	0.00875	0.00687	0.00726	0.0254	0.00326	0.000050
Dissolved Mercury (Hg)		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000010
Dissolved Molybdenum (Mo)		0.000506	0.000952	0.000329	0.000181	0.000190	<0.000050	<0.000050	<0.000050	0.000328	0.000288	0.000284	0.000274	0.000328	0.000416	0.000915	0.000206	0.000251	0.000445	0.000050
Dissolved Nickel (Ni)		0.000713	0.000849	0.000473	0.000562	0.000722	0.00171	<0.000020	<0.000020	0.000616	0.000694	0.000904	0.000893	0.000869	0.00119	0.00280	0.000837	0.000678	0.000706	0.000020
Dissolved Phosphorus (P)		0.0065	0.0121	0.0090	0.0110	0.0115	0.0122	<0.0020	<0.0020	0.0103	0.0099	0.0099	0.0096	0.0111	0.0106	0.0048	0.0107	0.0098	0.0094	0.0020
Dissolved Selenium (Se)		0.000123	0.000049	<0.000040	<0.000040	<0.000040	0.000090	<0.000040	<0.000040	0.000049	0.000057	0.000062	0.000054	0.000057	0.000071	0.000564	0.000056	0.000067	<0.000040	0.000040
Dissolved Silicon (Si)		3.41	2.93	2.98	2.49	2.69	2.79	<0.10	<0.10	2.24	2.22	1.98	2.01	2.34	2.49	2.96	2.16	2.74	2.34	0.10
Dissolved Silver (Ag)		<0.0000050	<0.0000050	<0.0000050	0.0000200	0.0000178	0.0000133	<0.0000050	<0.0000050	0.0000068	<0.0000050	<0.0000050	<0.0000050	0.0000081	0.0000091	<0.0000050	<0.0000050	0.0000109	0.0000052	0.0000050
Dissolved Strontium (Sr)		0.101	0.0843	0.0877	0.0646	0.0564	0.0497	<0.000050	<0.000050	0.0570	0.0661	0.0506	0.0506	0.0650	0.0817	0.135	0.0809	0.0860	0.0408	0.000050
Dissolved Thallium (Tl)		<0.0000020	<0.0000020	<0.0000020	<0.0000020	0.0000045	0.0000164	<0.0000020	<0.0000020	0.0000034	0.0000027	<0.0000020	<0.0000020	0.0000026	0.0000037	0.0000054	<0.0000020	0.0000045	0.0000029	0.0000020
Dissolved Tin (Sn)		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00020
Dissolved Titanium (Ti)		0.00073	0.00137	0.00122	0.00144	0.00128	0.00117	<0.00050	<0.00050	0.00150	0.00173	0.00164	0.00159	0.00166	0.00164	<0.00050	0.00191	0.00154	0.00164	0.00050
Dissolved Uranium (U)		0.000273	0.00142	0.00200	0.00243	0.000642	0.00193	<0.0000020	<0.0000020	0.00150	0.00161	0.00104	0.00106	0.00163	0.00412	0.000906	0.00110	0.00259	0.00107	0.0000020
Dissolved Vanadium (V)		0.00070	0.00071	0.00043	0.00035	0.00035	<0.00020	0.00037	<0.00020	0.00059	0.00066	0.00063	0.00061	0.00063	0.00039	0.00021	0.00053	0.00032	0.00055	0.00020
Dissolved Zinc (Zn)		0.00035	0.00079	0.00052	0.00644	0.00783	0.0387	<0.00010	0.00016	0.00244	0.00083	0.00296	0.00110	0.00266	0.00317	0.00289	0.00203	0.00575	0.00122	0.00010
Dissolved Zirconium (Zr)		0.00015	0.00025	0.00016	0.00015	0.00021	0.00021	<0.00010	<0.00010	0.00016	0.00022	0.00024	0.00024	0.00025	0.00026	<0.00010	0.00022	0.00019	0.00021	0.00010
Dissolved Calcium (Ca)		12.8	12.9	10.7	10.6	9.38	17.0	<0.050	<0.050	8.91	7.81	6.24	6.32	8.82	12.0	27.8	11.7	13.0	7.21	0.050
Dissolved Magnesium (Mg)		4.53	4.34	3.12	2.80	1.74	3.53	<0.050	<0.050	2.54	2.75	2.46	2.42	2.77	4.45	8.08	4.12	3.49	1.89	0.050
Dissolved Potassium (K)		0.617	0.754	0.673	0.800	0.657	0.988	<0.050	<0.050	0.715	0.553	0.538	0.534	0.631	1.12	0.948	0.914	0.728	0.773	0.050
Dissolved Sodium (Na)		2.39	2.14	1.57	1.16	0.992	1.19	<0.050	<0.050	1.19	1.34	0.958	0.939	1.34	1.50	2.01	1.55	1.37	1.10	0.050
Dissolved Sulphur (S)		<10	<10	<10	<10	<10	26	<10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	10

Note:
All units mg/L unless otherwise noted
NS= Not Sampled
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
2) RDL raised due to sample matrix interference; RDL for DOC was 5, for TOC was 5, and for total mercury was 0.01.
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

Bold	Results exceed CCME Aquatic Life Guidelines

Appendix A3. Surface Water Quality Data, Casino Project, July 2012

	CCME[1] Water Quality Guidelines	W43 - Adit	Detection Limits
Date		**04/07/2012**	
Physical Properties			
In Situ Field Data			
Temperature (°C)		2.69	
Conductivity (µS/cm)		184	
pH		6.84	
Dissolved oxygen (mg/L)		NS	
Laboratory Data			
Conductivity (µS/cm)		208	1.0
pH	6.5-9.0	7.64	
Total Suspended Solids		NS	1.0
Total Dissolved Solids		126	10
Turbidity (NTU)		0.47	0.10
Calculated Parameters			
Total Hardness (CaCO3)		88.4	0.50
Ion Balance		NS	
Nitrate (N)	13	0.183	0.0020
Dissolved Anions and Nutrients			
Orthophosphate (P)		0.0053	0.0010
Dissolved Sulphate (SO4)		34.0	0.50
Dissolved Chloride (Cl)		0.69	0.50
Ammonia (N)	0.499[a]	NS	0.0050
Total Total Kjeldahl Nitrogen (Calc)		0.068	0.020
Nitrate plus Nitrite (N)		0.183	0.0020
Nitrite (N)	0.06	<0.0020	0.0020
Total Nitrogen (N)		0.251	0.020
Misc. Inorganics			
Acidity (pH 4.5)		<0.50	0.50
Acidity (pH 8.3)		5.42	0.50
Bromide (Br)		<0.010	0.010
Fluoride (F)	0.12	0.089	0.010
Weak Acid Dissoc. Cyanide (CN)	0.005	NS	0.00050
Cyanide + Thiocyanate	0.005	NS	0.00050
Dissolved Hardness (CaCO3)		NS	
Dissolved Organic Carbon (C)		NS	
Alkalinity (Total as CaCO3)		66.5	0.50
Total Organic Carbon (C)		NS	0.50
Total Metals			
Total Aluminum (Al)	0.005-0.1[b]	0.0144	0.00020
Total Antimony (Sb)		0.00305	0.000020
Total Arsenic (As)	0.005	0.000481	0.000020
Total Barium (Ba)		0.0452	0.000020
Total Beryllium (Be)		<0.000010	0.000010
Total Bismuth (Bi)		<0.0000050	0.0000050
Total Boron (B)		<0.050	0.050
Total Cadmium (Cd)	equation[c]	**0.0421**	0.0000050
Total Chromium (Cr)	0.001	<0.00010	0.00010
Total Cobalt (Co)		0.000187	0.0000050
Total Copper (Cu)	equation[d]	**0.0758**	0.000050
Total Iron (Fe)	0.3	0.0290	0.0010
Total Lead (Pb)	equation[e]	**0.00991**	0.0000050
Total Lithium (Li)		0.00210	0.00050
Total Manganese (Mn)		0.317	0.000050
Total Mercury (Hg)		<0.000010	0.000010
Total Molybdenum (Mo)	0.073	<0.000050	0.000050
Total Nickel (Ni)	equation[f]	0.000433	0.000020
Total Phosphorus (P)		0.0036	0.0020
Total Selenium (Se)	0.001	<0.000040	0.000040
Total Silicon (Si)		5.70	0.10
Total Silver (Ag)	0.0001	**0.000130**	0.0000050
Total Strontium (Sr)		0.217	0.000050
Total Thallium (Tl)	0.0008	0.0000293	0.0000020
Total Tin (Sn)		<0.00020	0.00020
Total Titanium (Ti)		<0.00050	0.00050
Total Uranium (U)	0.015	0.000996	0.0000020
Total Vanadium (V)		0.00030	0.00020
Total Zinc (Zn)	0.03	**2.35**	0.00010
Total Zirconium (Zr)		<0.00010	0.00010
Total Calcium (Ca)		24.0	0.050
Total Magnesium (Mg)		6.92	0.050
Total Potassium (K)		1.20	0.050
Total Sodium (Na)		3.09	0.050
Total Sulphur (S)		11	10

Note:
All units mg/L unless otherwise noted
NS= Not Sampled
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

Bold	Results exceed CCME Aquatic Life Guidelines

Appendix A4. Surface Water Quality Data, Casino Project, September 2012

	CCME[1] Water Quality Guidelines	W43 - Adit	Trip Blank	Detection Limits
Date		**17/09/2012**	**17/09/2012**	
Physical Properties				
Conductivity (µS/cm)		229	1.2	1.0
pH	6.5-9.0	7.39	**5.77**	
Total Suspended Solids		NS	<1.0	1.0
Total Dissolved Solids		144	<10	10
Turbidity (NTU)		0.20	<0.10	0.10
Calculated Parameters				
Total Hardness (CaCO3)		101	<0.50	0.50
Ion Balance		NS	0.091	0.010
Nitrate (N)	13	0.138	<0.0020	0.0020
Dissolved Anions and Nutrients				
Orthophosphate (P)		0.0016	<0.0010	0.0010
Dissolved Sulphate (SO4)		36.5	0.90	0.50
Dissolved Chloride (Cl)		<0.50	<0.50	0.50
Ammonia (N)	0.499[a]	NS	0.022	0.0050
Total Total Kjeldahl Nitrogen (Calc)		0.040	0.037	0.020
Nitrate plus Nitrite (N)		0.138	<0.0020	0.0020
Nitrite (N)	0.06	<0.0020	<0.0020	0.0020
Total Nitrogen (N)		0.178	0.037	0.020
Misc. Inorganics				
Acidity (pH 4.5)		<0.50	<0.50	0.50
Acidity (pH 8.3)		8.28	<0.50	0.50
Bromide (Br)		<0.010	<0.010	0.010
Fluoride (F)	0.12	0.092	<0.010	0.010
Weak Acid Dissoc. Cyanide (CN)	0.005	NS	<0.00050	0.00050
Cyanide + Thiocyanate	0.005	NS	<0.00050	0.00050
Dissolved Hardness (CaCO3)		NS	<0.50	0.50
Dissolved Organic Carbon (C)		NS		0.50
Alkalinity (Total as CaCO3)		73.3	<0.50	0.50
Total Organic Carbon (C)		NS	<0.50	0.50
Total Metals				
Total Aluminum (Al)	0.005-0.1[b]	0.00240	0.00187	0.00020
Total Antimony (Sb)		0.00243	<0.000020	0.000020
Total Arsenic (As)	0.005	0.000429	<0.000020	0.000020
Total Barium (Ba)		0.0468	<0.000020	0.000020
Total Beryllium (Be)		<0.000010	<0.000010	0.000010
Total Bismuth (Bi)		<0.0000050	<0.0000050	0.0000050
Total Boron (B)		<0.050	<0.050	0.050
Total Cadmium (Cd)	equation[c]	**0.0458**	<0.0000050	0.0000050
Total Chromium (Cr)	0.001	<0.00010	<0.00010	0.00010
Total Cobalt (Co)		0.000199	<0.0000050	0.0000050
Total Copper (Cu)	equation[d]	**0.0571**	0.000122	0.000050
Total Iron (Fe)	0.3	0.0205	0.0015	0.0010
Total Lead (Pb)	equation[e]	**0.00658**	0.0000060	0.0000050
Total Lithium (Li)		0.00232	<0.00050	0.00050
Total Manganese (Mn)		0.317	<0.000050	0.000050
Total Mercury (Hg)		<0.000010	<0.000010	0.000010
Total Molybdenum (Mo)	0.073	<0.000050	<0.000050	0.000050
Total Nickel (Ni)	equation[f]	0.000487	<0.000020	0.000020
Total Phosphorus (P)		0.0039	0.0022	0.0020
Total Selenium (Se)	0.001	<0.000040	<0.000040	0.000040
Total Silicon (Si)		5.42	<0.10	0.10
Total Silver (Ag)	0.0001	0.0000850	<0.0000050	0.0000050
Total Strontium (Sr)		0.267	<0.000050	0.000050
Total Thallium (Tl)	0.0008	0.0000250	<0.0000020	0.0000020
Total Tin (Sn)		<0.00020	<0.00020	0.00020
Total Titanium (Ti)		<0.00050	<0.00050	0.00050
Total Uranium (U)	0.015	0.00125	<0.0000020	0.0000020
Total Vanadium (V)		<0.00020	<0.00020	0.00020
Total Zinc (Zn)	0.03	**2.61**	0.00013	0.00010
Total Zirconium (Zr)		<0.00010	<0.00010	0.00010
Total Calcium (Ca)		27.7	<0.050	0.050
Total Magnesium (Mg)		7.85	<0.050	0.050
Total Potassium (K)		1.40	<0.050	0.050
Total Sodium (Na)		3.40	<0.050	0.050
Total Sulphur (S)		14	<10	10

Note:
All units mg/L unless otherwise noted
NS= Not Sampled
1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

Bold	Results exceed CCME Aquatic Life Guidelines

Surface Water Analysis Result (mg/L)							
Station	**W3**			**Station**	**R2**		
Sampling Date	**29-Mar-12**			**Sampling Date**	**24-May-12**		
Parameter	**Sample 1**	**Sample 2**	**% RPD**	**Parameter**	**Sample 1**	**Sample 2**	**% RPD**
Physical Tests, Nutrients and Dissolved Anions				**Physical Tests, Nutrients and Dissolved Anions**			
Conductivity	435	440	1.1	Conductivity	50.7	52	2.5
pH	8.02	8.07	0.6	pH	7.37	7.39	0.3
Total Suspended Solids	<1	<1	n/c	Total Suspended Solids	29.7	31.1	4.6
Total Dissolved Solids	290	306	5.4	Total Dissolved Solids	62	72	14.9
Turbidity	0.14	0.14	0.0	Turbidity	3.1	3.28	5.6
Total Hardness	183	200	8.9	Total Hardness	25.7	26.8	4.2
Ion Balance	0.86	0.89	3.4	Ion Balance	NS	NS	NS
Nitrate	0.487	0.516	5.8	Nitrate	0.0089	0.0117	**27.2**
Orthophosphate	<0.001	<0.001	n/c	Orthophosphate	0.0012	0.0014	15.4
Dissolved Sulphate	121	121	0.0	Dissolved Sulphate	<0.5	<0.5	n/c
Dissolved Chloride	<0.5	0.6	n/c	Dissolved Chloride	1.1	1.2	8.7
Total Organic Carbon	3.89	4.09	5.0	Total Organic Carbon	18.8	19.5	3.7
Ammonia	NS	NS	NS	Ammonia	0.026	0.043	**49.3**
Total Kjeldahl Nitrogen	0.103	0.134	**26.2**	Total Kjeldahl Nitrogen	0.576	0.594	3.1
Nitrate plus Nitrite	0.487	0.487	0.0	Nitrate plus Nitrite	0.011	0.0141	24.7
Nitrite	<0.002	<0.002	n/c	Nitrite	0.0021	0.0024	13.3
Total Nitrogen	0.619	0.621	0.3	Total Nitrogen	0.59	0.605	2.5
Acidity (pH 4.5)	<0.5	<0.5	n/c	Acidity (pH 4.5)	<0.5	<0.5	n/c
Acidity (pH 8.3)	2.7	3.2	16.9	Acidity (pH 8.3)	1.73	2.5	**36.4**
Bromide	<0.01	<0.01	n/c	Bromide	<0.01	<0.01	n/c
Fluoride	0.12	0.12	0.0	Fluoride	0.037	0.037	0.0
Weak Acid Dissoc. Cyanide	<0.0005	<0.0005	n/c	Weak Acid Dissoc. Cyanide	0.00066	0.00079	17.9
Cyanide + Thiocyanate	<0.0005	<0.0005	n/c	Cyanide + Thiocyanate	0.00075	0.00098	**26.6**
Dissolved Hardness	189	197	4.1	Dissolved Hardness	25.7	25.7	0.0
Dissolved Organic Carbon	3.7	4.4	17.3	Dissolved Organic Carbon	15.7	17.8	12.5
Total Alkalinity	109	110	0.9	Total Alkalinity	20	21.3	6.3
Total Metals				**Total Metals**			
Total Aluminum	0.0071	0.008	11.9	Total Aluminum	0.37	0.374	1.1
Total Antimony	0.00023	0.00025	8.3	Total Antimony	0.000025	0.000032	24.6
Total Arsenic	0.00042	0.00044	4.7	Total Arsenic	0.000475	0.000506	6.3
Total Barium	0.0894	0.0909	1.7	Total Barium	0.0356	0.0365	2.5
Total Beryllium	<0.00001	<0.00001	n/c	Total Beryllium	0.000032	0.000034	6.1
Total Bismuth	<0.000005	<0.000005	n/c	Total Bismuth	0.0000077	0.0000155	**67.2**
Total Boron	<0.05	<0.05	n/c	Total Boron	<0.05	<0.05	n/c
Total Cadmium	0.000018	0.000024	**28.6**	Total Cadmium	0.0000377	0.0000443	16.1
Total Calcium	44.9	50.6	11.9	Total Calcium	6.24	6.74	7.7
Total Chromium	<0.0001	<0.0001	n/c	Total Chromium	0.00053	0.00055	3.7
Total Cobalt	0.000026	0.000031	17.5	Total Cobalt	0.000319	0.000348	8.7
Total Copper	0.00129	0.00136	5.3	Total Copper	0.00228	0.0027	16.9
Total Iron	0.006	0.008	**28.6**	Total Iron	0.625	0.625	0.0
Total Lead	0.000009	0.00001	10.5	Total Lead	0.000232	0.000291	22.6
Total Lithium	0.0006	0.0007	15.4	Total Lithium	0.00075	0.00079	5.2
Total Magnesium	17.3	18	4.0	Total Magnesium	2.43	2.45	0.8
Total Manganese	0.00057	0.00059	3.4	Total Manganese	0.0371	0.039	5.0
Total Mercury	<0.00001	<0.00001	n/c	Total Mercury	<0.00001	<0.00001	n/c
Total Molybdenum	0.00141	0.00143	1.4	Total Molybdenum	0.000272	0.000292	7.1
Total Nickel	0.00049	0.00053	7.8	Total Nickel	0.00108	0.00118	8.8
Total Phosphorus	0.003	0.004	**28.6**	Total Phosphorus	0.04	0.0463	14.6
Total Potassium	2.41	2.56	6.0	Total Potassium	0.55	0.552	0.4

Notes:	**Bold**	Exceeds Data Quality objective of 25%
	Bold	Exceeds Data Quality objective of 25%, but does not meet Practical Quantitation Limit
	RPD	Relative Percent Difference
	n/c	Not able to be calculated because one or both values not precisely known
	<	Less than detection limit
	NS	Not sampled

Surface Water Analysis Result (mg/L)							
Station	**W3**			**Station**	**R2**		
Sampling Date	**29-Mar-12**			**Sampling Date**	**24-May-12**		
Parameter	**Sample 1**	**Sample 2**	**% RPD**	**Parameter**	**Sample 1**	**Sample 2**	**% RPD**
Total Selenium	0.00017	0.00019	11.1	Total Selenium	0.000077	0.000094	19.9
Total Silicon	3.9	4.2	7.4	Total Silicon	2.15	2.2	2.3
Total Silver	<0.000005	<0.000005	n/c	Total Silver	0.000007	0.000009	**25.0**
Total Sodium	5.65	5.97	5.5	Total Sodium	0.894	0.904	1.1
Total Strontium	0.341	0.345	1.2	Total Strontium	0.0523	0.0523	0.0
Total Sulphur	40	41	2.5	Total Sulphur	<10	<10	n/c
Total Thallium	<0.000002	<0.000002	n/c	Total Thallium	0.0000051	0.0000058	12.8
Total Tin	<0.0002	<0.0002	n/c	Total Tin	<0.0002	<0.0002	n/c
Total Titanium	<0.0005	<0.0005	n/c	Total Titanium	0.0112	0.0125	11.0
Total Uranium	0.0343	0.0351	2.3	Total Uranium	0.00138	0.00155	11.6
Total Vanadium	<0.0002	<0.0002	n/c	Total Vanadium	0.00131	0.0014	6.6
Total Zinc	0.0007	0.001	**35.3**	Total Zinc	0.00244	0.00307	22.9
Total Zirconium	<0.0001	<0.0001	n/c	Total Zirconium	0.00037	0.00038	2.7
Dissolved Metals				**Dissolved Metals**			
Dissolved Aluminum	0.0055	0.0059	7.0	Dissolved Aluminum	0.164	0.166	1.2
Dissolved Antimony	0.00023	0.00024	4.3	Dissolved Antimony	0.000029	0.000032	9.8
Dissolved Arsenic	0.00039	0.00048	20.7	Dissolved Arsenic	0.000288	0.000312	8.0
Dissolved Barium	0.0872	0.0896	2.7	Dissolved Barium	0.0258	0.0264	2.3
Dissolved Beryllium	<0.00001	<0.00001	n/c	Dissolved Beryllium	0.000017	0.00002	16.2
Dissolved Bismuth	<0.000005	<0.000005	n/c	Dissolved Bismuth	<0.000005	<0.000005	n/c
Dissolved Boron	<0.05	<0.05	n/c	Dissolved Boron	<0.05	<0.05	n/c
Dissolved Cadmium	0.000018	0.000023	24.4	Dissolved Cadmium	0.0000235	0.0000352	**39.9**
Dissolved Calcium	47.4	49.9	5.1	Dissolved Calcium	6.24	6.32	1.3
Dissolved Chromium	<0.0001	<0.0001	n/c	Dissolved Chromium	0.00028	0.00031	10.2
Dissolved Cobalt	0.000028	0.00003	6.9	Dissolved Cobalt	0.000126	0.000129	2.4
Dissolved Copper	0.00124	0.00134	7.8	Dissolved Copper	0.00187	0.00192	2.6
Dissolved Iron	0.003	0.003	0.0	Dissolved Iron	0.213	0.216	1.4
Dissolved Lead	<0.000005	0.000005	n/c	Dissolved Lead	0.0000241	0.0000501	**70.1**
Dissolved Lithium	0.0007	0.0007	0.0	Dissolved Lithium	0.00054	0.00058	7.1
Dissolved Magnesium	17.1	17.5	2.3	Dissolved Magnesium	2.42	2.46	1.6
Dissolved Manganese	0.00052	0.00058	10.9	Dissolved Manganese	0.0104	0.0107	2.8
Dissolved Mercury	<0.00001	<0.00001	n/c	Dissolved Mercury	<0.00001	<0.00001	n/c
Dissolved Molybdenum	0.00139	0.00143	2.8	Dissolved Molybdenum	0.000274	0.000284	3.6
Dissolved Nickel	0.00046	0.00047	2.2	Dissolved Nickel	0.000893	0.000904	1.2
Dissolved Phosphorus	<0.003	<0.003	n/c	Dissolved Phosphorus	0.0096	0.0099	3.1
Dissolved Potassium	2.37	2.45	3.3	Dissolved Potassium	0.534	0.538	0.7
Dissolved Selenium	0.00016	0.00019	17.1	Dissolved Selenium	0.000054	0.000062	13.8
Dissolved Silicon	3.9	4.2	7.4	Dissolved Silicon	1.98	2.01	1.5
Dissolved Silver	<0.000005	<0.000005	n/c	Dissolved Silver	<0.000005	<0.000005	n/c
Dissolved Sodium	5.62	5.81	3.3	Dissolved Sodium	0.939	0.958	2.0
Dissolved Strontium	0.33	0.345	4.4	Dissolved Strontium	0.0506	0.0506	0.0
Dissolved Sulphur	40	42	4.9	Dissolved Sulphur	10	10	0.0
Dissolved Thallium	<0.000002	<0.000002	n/c	Dissolved Thallium	<0.000002	<0.000002	n/c
Dissolved Tin	<0.0002	<0.0002	n/c	Dissolved Tin	<0.0002	<0.0002	n/c
Dissolved Titanium	<0.0005	<0.0005	n/c	Dissolved Titanium	0.00159	0.00164	3.1
Dissolved Uranium	0.034	0.0356	4.6	Dissolved Uranium	0.00104	0.00106	1.9
Dissolved Vanadium	<0.0002	<0.0002	n/c	Dissolved Vanadium	0.00061	0.00063	3.2
Dissolved Zinc	0.0006	0.0012	**66.7**	Dissolved Zinc	0.0011	0.00296	**91.6**
Dissolved Zirconium	<0.0001	<0.0001	n/c	Dissolved Zirconium	0.00024	0.00024	0.0

Notes:	**Bold**	Exceeds Data Quality objective of 25%
	Bold	Exceeds Data Quality objective of 25%, but does not meet Practical Quantitation Limit
	RPD	Relative Percent Difference
	n/c	Not able to be calculated because one or both values not precisely known
	<	Less than detection limit
	NS	Not sampled

Appendix B

Fisheries Data

- **B1. Electrofishing Effort, Catch and CPUE, Casino Project, 2012**
- **B2. Minnow Trapping Effort and Catch, Casino Project, 2012**
- **B3. Fish Biological Characteristics, Casino Project, 2012**

Appendix B1. Electrofishing Effort, Catch, and CPUE, Casino Project, 2012

Date	Site	Section Length (m)	Voltage (V)	Effort (s)	Catch	CPUE (number/100s)
08-Sep-12	F07	120	250	932	0	0
08-Sep-12	F08	50	250	253	0	0
08-Sep-12	F08-b	150	250	560	0	0
08-Sep-12	F17	60	250	431	0	0
08-Sep-12	R2	90	250	1031	0	0
08-Sep-12	S2	180	250	451	1	0.22
12-Sep-12	F19	175	300	870	7	0.80

Notes:
Only Arctic grayling was captured.
F08 and F08b are located below and above the reach break, respectively.

Appendix B2. Minnow Trapping Effort and Catch, Casino Project, 2012

Date	Site	Trap number	Effort (hours)	Catch
03-Jul-12	F07	MT1	14.5	0
03-Jul-12	F07	MT2	14.5	0
03-Jul-12	F07	MT3	14.5	0
03-Jul-12	F07	MT4	14.5	0
03-Jul-12	F07	MT5	14.5	0
08-Sep-12	F07	MT1	70	0
08-Sep-12	F07	MT2	70	0
08-Sep-12	F07	MT3	70	0
08-Sep-12	F08	MT4	70	0
08-Sep-12	F08-b	MT5	70	0
08-Sep-12	F08-b	MT6	70	0
08-Sep-12	S2	MT7	70	0
08-Sep-12	S2	MT8	70	0
08-Sep-12	S2	MT9	70	0
08-Sep-12	R2	MT10	50	0
08-Sep-12	R2	MT11	50	0
08-Sep-12	R2	MT12	50	0
12-Sep-12	F10	MT1	31	0
12-Sep-12	F10	MT2	31	0
12-Sep-12	F10	MT3	31	0
12-Sep-12	F11	MT4	30.5	0
12-Sep-12	F11	MT5	30.5	0
12-Sep-12	F11	MT6	30.5	0
12-Sep-12	F13	MT7	30	0
12-Sep-12	F13	MT8	30	0
12-Sep-12	F13	MT9	30	0
12-Sep-12	F19	MT10	26	0
12-Sep-12	F19	MT11	26	0
12-Sep-12	F19	MT12	26	0
13-Sep-12	F14	MT1	26	1
13-Sep-12	F14	MT2	26	0
13-Sep-12	F14	MT3	26	0
13-Sep-12	F20	MT1	28	0
13-Sep-12	F20	MT2	28	0
13-Sep-12	F20	MT3	28	0

Notes:
Only slimy sculpin was captured.
F08 and F08b are located below and above the reach break, respectively.

Appendix B3. Fish Biological Characteristics, Casino Project, 2012

Sampling date	Watershed	Site	Method	Fish Number	Species	Length (mm)	Weight (g)
08-Sep-12	Casino Creek	S2	EF	1	AG	215	105.0
12-Sep-12	Coffee Creek	F19	EF	10	AG	164	54.4
12-Sep-12	Coffee Creek	F19	EF	11	AG	235	151.9
12-Sep-12	Coffee Creek	F19	EF	12	AG	215	116.3
12-Sep-12	Coffee Creek	F19	EF	13	AG	158	71.7
12-Sep-12	Coffee Creek	F19	EF	14	AG	157	45.3
12-Sep-12	Coffee Creek	F19	EF	15	AG	153	41.9
12-Sep-12	Coffee Creek	F19	EF	16	AG	158	50.2
13-Sep-12	Dip Creek	F14	MT	20	CCG	60	1.9

Notes:

AG: Arctic grayling
CCG: Slimy sculpin
EF: Electrofishing
MT: Minnow Trap (Gee Trap)

Appendix B

Surface Water Quality Analysis

- **B1. Environment Canada Toxicity Testing: Final Analytical Results with QC data (2011)**
- **B2. Surface Water Quality: Travel Blanks, Casino Project 2008-2012**
- **B3. Surface Water Quality: Field Blanks, Casino Project 2008-2012**
- **B4. Flagged Dissolved metals versus Total metals, Casino Project, 2008-2012**
- **B5. Surface Water Quality Statistics: all stations all parameters, Casino Project, 2008-2012**
- **B6. Surface Water Quality *In Situ* data, Casino Project, 2008-2012**

Pacific and Yukon Laboratory for Environmental Testing (PYLET)
2645 Dollarton Highway
North Vancouver, BC. Canada V7H - 1B1

Environment Canada Environnement Canada

Wednesday September 7, 2011 At 12:37PM

Final Analytical Results with QC data

FOLDER # : 201100565

Location:	CASINO MINE- HISTORICAL ADIT (W43)
Type of Sample:	Waste Water / Other (WWOT)
Submitted By:	Denis Lacroix Environment Canada 91782 Alaska Hwy Whitehorse, YT Canada Y1A 5B7 Phone: 867-667-4592 Fax: 867-667-7962
Logged In:	Thursday July 14, 2011
Completed:	Wednesday September 7, 2011 (118 results)
Client Code:	2561-101 2561-101 EP YUKON ENV ASSESSMENT
Sample Priority:	Normal

Authorized by: Richard Strub
QA Officer

Notes:

METALS FIELD ACIDIFIED

The samples associated with this report will be discarded 30 days after the final report is generated unless other arrangements for storage and / or pick-up have been made with the lab.

Results relate only to the samples tested.Test analysis date provided upon client request.
An asterix (*) indicates that the corresponding method may be accredited by CALA for some or all of the parameters listed. For our current Scope of Accreditation please see www.cala.ca/scopes/1578.pdf .

This test report shall not be reproduced except in full, without written approval of the laboratory.

CALA Testing Accreditation No. A 1578

TEST DESCRIPTION	MATRIX	RESULT	MDL	UNITS
PYLET Order No: 231569 - Client Sample ID: CASINO MINE W43 NUTRIENTS				**Arrival Temperature: 6.2°C**
Sampling Date: 7/13/2011				
General				
***Acidity Tot.&pH4.5**				
Acidity, Total	WWOT	8.2	1	mg CaCO3 / L
***AlkalinityTotpH4.5**				
Alkalinity to pH 4.5	WWOT	69.8	0.5	mg CaCO3 / L
***Color True**				
Colour, True	WWOT	5	5	Col. unit
***ICA (Cl F SO4)**				
Chloride (Cl)	WWOT	0.3	0.1	mg/L
Fluoride (F)	WWOT	0.11	0.01	mg/L
Sulphate (SO4)	WWOT	42	3	mg/L
***pH**				
pH	WWOT	7.05	0.01	pH Units
***Residue Filterable**				
Solids, Total Dissolved (FR)	WWOT	150	10	mg/L
***Residue Nonfilt.**				
Solids, Total Suspended (NFR)	WWOT	< 5	5	mg/L
***SpecificConductance**				
Conductivity (25C)	WWOT	226	2	uS/cm
Non-Halogenated				
DOC				
Carbon, Dissolved Organic	WWOT	1.2	0.5	mg/L
Nutrients				
***Nitrogen Ammonia**				
Nitrogen, Ammonia as N	WWOT	< 0.002	0.002	mg/L
***Nitrogen NO 2**				
Nitrogen, Nitrite as N	WWOT	< 0.002	0.002	mg/L
***Nitrogen NO 23**				
Nitrogen, Nitrate + Nitrite as N	WWOT	0.416	0.002	mg/L
***Nitrogen. Total**				
Nitrogen, Total as N	WWOT	0.46	0.02	mg/L
***Phosphorus Total**				
Phosphorus, Total as P	WWOT	0.003	0.002	mg/L
PYLET Order No: 231570 - Client Sample ID: CASINO MINEW43 DAPNIA				
Sampling Date: 7/13/2011				

TEST DESCRIPTION	MATRIX	RESULT	MDL	UNITS

PYLET Order No: 231570 - Client Sample ID: CASINO MINEW43 DAPNIA
Sampling Date: 7/13/2011

Aquatic

Daphnia LT50 48h

Daphnia Magna, 48-hour LT50 Bioassay	WWOT	>1<3.5	0.0	hr

At 100% concentration, the 48 hour LT50 was > 1 hour but < 3.5 hours of exposure for daphnia magna. At 100% concentration, the sample had 100% mortality to daphnia magna after 3.5 hours of exposure.

PYLET Order No: 231571 - Client Sample ID: CASINO MINE W43 T. METALS
Sampling Date: 7/13/2011

Metals

*ICP Total

Aluminum (Al)	WWOT	< 0.06	0.06	mg/L
Antimony (Sb)	WWOT	< 0.06	0.06	mg/L
Arsenic (As)	WWOT	< 0.06	0.06	mg/L
Barium (Ba)	WWOT	0.058	0.001	mg/L
Beryllium (Be)	WWOT	< 0.001	0.001	mg/L
Boron (B)	WWOT	< 0.01	0.01	mg/L
Cadmium (Cd)	WWOT	0.045	0.006	mg/L
Calcium (Ca)	WWOT	26.8	0.1	mg/L
Chromium (Cr)	WWOT	< 0.006	0.006	mg/L
Cobalt (Co)	WWOT	< 0.006	0.006	mg/L
Copper (Cu)	WWOT	0.09	0.02	mg/L
Iron (Fe)	WWOT	0.10	0.05	mg/L
Lead (Pb)	WWOT	< 0.06	0.06	mg/L
Magnesium (Mg)	WWOT	7.8	0.1	mg/L
Manganese (Mn)	WWOT	0.783	0.001	mg/L
Molybdenum (Mo)	WWOT	< 0.01	0.01	mg/L
Nickel (Ni)	WWOT	< 0.02	0.02	mg/L
Phosphorus (P)	WWOT	< 0.1	0.1	mg/L
Potassium (K)	WWOT	1.5	0.1	mg/L
Selenium (Se)	WWOT	< 0.06	0.06	mg/L
Silicon (Si)	WWOT	5.48	0.06	mg/L
Silver (Ag)	WWOT	< 0.01	0.01	mg/L
Sodium (Na)	WWOT	3.1	0.1	mg/L
Strontium (Sr)	WWOT	0.253	0.001	mg/L

TEST DESCRIPTION	MATRIX	RESULT	MDL	UNITS
PYLET Order No: 231571 - Client Sample ID: CASINO MINE W43 T. METALS				
Sampling Date: 7/13/2011				
Sulfur (S)	WWOT	14.7	0.06	mg/L
Tin (Sn)	WWOT	< 0.06	0.06	mg/L
Titanium (Ti)	WWOT	< 0.002	0.002	mg/L
Vanadium (V)	WWOT	< 0.01	0.01	mg/L
Zinc (Zn)	WWOT	2.50	0.05	mg/L
***ICPMS Total**				
Aluminum (Al)	WWOT	33.8	0.2	ug/L
Antimony (Sb)	WWOT	2.34	0.005	ug/L
Arsenic (As)	WWOT	0.8	0.1	ug/L
Barium (Ba)	WWOT	53.6	0.02	ug/L
Beryllium (Be)	WWOT	0.013	0.002	ug/L
Bismuth (Bi)	WWOT	0.14	0.02	ug/L
Cadmium (Cd)	WWOT	42.5	0.01	ug/L
Chromium (Cr)	WWOT	5.4	0.2	ug/L
Cobalt (Co)	WWOT	0.393	0.005	ug/L
Copper (Cu)	WWOT	75.2	0.05	ug/L
Lead (Pb)	WWOT	17	0.01	ug/L
Lithium (Li)	WWOT	2.14	0.05	ug/L
Manganese (Mn)	WWOT	763	0.005	ug/L
Molybdenum (Mo)	WWOT	0.08	0.05	ug/L
Nickel (Ni)	WWOT	1.69	0.05	ug/L
Selenium (Se)	WWOT	< 0.2	0.2	ug/L
Silver (Ag)	WWOT	0.20	0.02	ug/L
Strontium (Sr)	WWOT	243	0.005	ug/L
Thallium (Tl)	WWOT	0.031	0.002	ug/L
Tin (Sn)	WWOT	0.39	0.01	ug/L
Uranium (U)	WWOT	1.35	0.002	ug/L
Vanadium (V)	WWOT	0.06	0.05	ug/L
Zinc (Zn)	WWOT	2480	0.2	ug/L
***Mercury total**				
Mercury (Hg)	WWOT	< 0.02	0.02	ug/L
PYLET Order No: 231572 - Client Sample ID: CASINO MINE W43 D. METALS				
Sampling Date: 7/13/2011				

Metals

***ICP Dissolved**				
Aluminum (Al)	WWOT	< 0.05	0.05	mg/L
Antimony (Sb)	WWOT	< 0.05	0.05	mg/L

TEST DESCRIPTION	MATRIX	RESULT	MDL	UNITS
PYLET Order No: 231572 - Client Sample ID: CASINO MINE W43 D. METALS				
Sampling Date: 7/13/2011				
Arsenic (As)	WWOT	< 0.05	0.05	mg/L
Barium (Ba)	WWOT	0.055	0.001	mg/L
Beryllium (Be)	WWOT	< 0.001	0.001	mg/L
Boron (B)	WWOT	< 0.01	0.01	mg/L
Cadmium (Cd)	WWOT	0.047	0.005	mg/L
Calcium (Ca)	WWOT	27.4	0.1	mg/L
Chromium (Cr)	WWOT	0.006	0.005	mg/L
Cobalt (Co)	WWOT	< 0.005	0.005	mg/L
Copper (Cu)	WWOT	0.086	0.005	mg/L
Iron (Fe)	WWOT	0.023	0.005	mg/L
Lead (Pb)	WWOT	< 0.05	0.05	mg/L
Magnesium (Mg)	WWOT	7.8	0.1	mg/L
Manganese (Mn)	WWOT	0.775	0.001	mg/L
Molybdenum (Mo)	WWOT	< 0.01	0.01	mg/L
Nickel (Ni)	WWOT	< 0.02	0.02	mg/L
Phosphorus (P)	WWOT	< 0.1	0.1	mg/L
Potassium (K)	WWOT	1.5	0.1	mg/L
Selenium (Se)	WWOT	< 0.05	0.05	mg/L
Silicon (Si)	WWOT	5.57	0.05	mg/L
Silver (Ag)	WWOT	< 0.01	0.01	mg/L
Sodium (Na)	WWOT	3.1	0.1	mg/L
Strontium (Sr)	WWOT	0.242	0.001	mg/L
Sulfur (S)	WWOT	15.3	0.05	mg/L
Tin (Sn)	WWOT	< 0.05	0.05	mg/L
Titanium (Ti)	WWOT	< 0.002	0.002	mg/L
Vanadium (V)	WWOT	< 0.01	0.01	mg/L
Zinc (Zn)	WWOT	2.62	0.05	mg/L
***ICPMS Dissolved**				
Aluminum (Al)	WWOT	1.3	0.2	ug/L
Antimony (Sb)	WWOT	2.28	0.005	ug/L
Arsenic (As)	WWOT	0.5	0.1	ug/L
Barium (Ba)	WWOT	55.7	0.02	ug/L
Beryllium (Be)	WWOT	0.008	0.002	ug/L
Bismuth (Bi)	WWOT	< 0.02	0.02	ug/L
Cadmium (Cd)	WWOT	45.2	0.01	ug/L
Chromium (Cr)	WWOT	5.6	0.2	ug/L
Cobalt (Co)	WWOT	0.365	0.005	ug/L
Copper (Cu)	WWOT	76.7	0.05	ug/L
Lead (Pb)	WWOT	8.01	0.01	ug/L
Lithium (Li)	WWOT	2.24	0.05	ug/L
Manganese (Mn)	WWOT	728	0.005	ug/L
Molybdenum (Mo)	WWOT	< 0.05	0.05	ug/L
Nickel (Ni)	WWOT	1.16	0.05	ug/L

TEST DESCRIPTION	MATRIX	RESULT	MDL	UNITS
PYLET Order No: 231572 - Client Sample ID: CASINO MINE W43 D. METALS				
Sampling Date: 7/13/2011				
Selenium (Se)	WWOT	< 0.2	0.2	ug/L
Silver (Ag)	WWOT	0.10	0.02	ug/L
Strontium (Sr)	WWOT	254	0.005	ug/L
Thallium (Tl)	WWOT	0.024	0.002	ug/L
Tin (Sn)	WWOT	0.03	0.01	ug/L
Uranium (U)	WWOT	1.12	0.002	ug/L
Vanadium (V)	WWOT	< 0.05	0.05	ug/L
Zinc (Zn)	WWOT	2679	0.2	ug/L
***Mercury dissolved**				
Mercury (Hg)	WWOT	< 0.02	0.02	ug/L
Hardness Diss. CaMg				
Hardness, Dissolved Calcium+Magnesium - calc.	WWOT	101	0.4	mg CaCO3 / L
Hardness Diss.Total				
Hardness, Dissolved Total - calc.	WWOT	107	0.4	mg CaCO3 / L

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE

***Acidity Tot.&pH4.5 UNITS:** mg CaCO3 / L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Acidity, Total	231678-1	< MDL	< 1		1	1	BLE
Acidity, Total	231681-1	25.2295096	25	99.7	1	1	REF
Acidity, Total	231682-1	50.2925323	49	97.8	1	1	REF
Acidity, Total	231680-1	8.2	8.8	107.6	1	1	REP

***AlkalinityTotpH4.5 UNITS:** mg CaCO3 / L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Alkalinity to pH 4.5	231673-1	77.7072307	78.4	100.9	1	0.5	REF
Alkalinity to pH 4.5	231677-1	69.9	69.9	100.1	1	0.5	REP
Alkalinity, Total	231657-1	10.2490878	< 0.5		1	0.5	BLE

***Color True UNITS:** Col. unit **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Colour, True	231581-1	< MDL	< 2.5		1	2.5	BLE
Colour, True	231582-1	20	20	100.0	1	2.5	REF
Colour, True	231583-1	5	5	100.0	1	2.5	REP

***ICA (Cl F SO4) UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Chloride (Cl)	231604-1	< MDL	< 0.1		1	0.1	BLE
Chloride (Cl)	231609-1	2.62477758	2.4	93.9	1	0.1	REF
Chloride (Cl)	231613-1	<0.1	0.1	137.1	1	0.1	REP
Fluoride (F)	231604-1	< MDL	0.02		1	0.01	BLE
Fluoride (F)	231609-1	0.35385454	0.40	115.0	1	0.01	REF
Fluoride (F)	231613-1	0.08	0.09	119.4	1	0.01	REP
Sulphate (SO4)	231604-1	< MDL	< 0.5		1	0.5	BLE
Sulphate (SO4)	231608-1	19.6243750	19.0	96.6	1	0.5	REF
Sulphate (SO4)	231613-1	24.5	24.7	100.7	1	0.5	REP

***ICP Dissolved UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Aluminum (Al)	231744-1	< MDL	< 0.05		1	0.05	BLE
Aluminum (Al)	231754-1	0.36091111	0.36	98.9	1	0.05	REF
Aluminum (Al)	231757-1		< 0.05		1	0.05	REP
Aluminum (Al)	231758-1	0.32	0.32	101.0	1	0.05	REP
Aluminum (Al)	231759-1		< 0.05		1	0.05	REP
Antimony (Sb)	231744-1	< MDL	< 0.05		1	0.05	BLE
Antimony (Sb)	231754-1	0.52092222	0.50	95.4	1	0.05	REF
Antimony (Sb)	231757-1		< 0.05		1	0.05	REP
Antimony (Sb)	231758-1		< 0.05		1	0.05	REP
Antimony (Sb)	231759-1		< 0.05		1	0.05	REP
Arsenic (As)	231744-1	< MDL	< 0.05		1	0.05	BLE
Arsenic (As)	231754-1	0.68630000	0.66	96.2	1	0.05	REF
Arsenic (As)	231757-1		< 0.05		1	0.05	REP
Arsenic (As)	231758-1		< 0.05		1	0.05	REP
Arsenic (As)	231759-1		< 0.05		1	0.05	REP

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Barium (Ba)	231744-1	< MDL	< 0.001		1	0.001	BLE
Barium (Ba)	231754-1	0.34563333	0.331	95.8	1	0.001	REF
Barium (Ba)	231757-1	0.055	0.055	100.5	1	0.001	REP
Barium (Ba)	231758-1	0.010	0.010	97.3	1	0.001	REP
Barium (Ba)	231759-1	0.016	0.016	100.6	1	0.001	REP
Beryllium (Be)	231744-1	< MDL	< 0.001		1	0.001	BLE
Beryllium (Be)	231754-1	0.60306666	0.590	97.8	1	0.001	REF
Beryllium (Be)	231757-1		< 0.001		1	0.001	REP
Beryllium (Be)	231758-1		< 0.001		1	0.001	REP
Beryllium (Be)	231759-1		< 0.001		1	0.001	REP
Boron (B)	231744-1	< MDL	< 0.01		1	0.01	BLE
Boron (B)	231754-1	1.56577777	1.49	95.2	1	0.01	REF
Boron (B)	231757-1		< 0.01		1	0.01	REP
Boron (B)	231758-1	0.04	0.04	100.0	1	0.01	REP
Boron (B)	231759-1	0.02	0.02	99.4	1	0.01	REP
Cadmium (Cd)	231744-1	< MDL	< 0.005		1	0.005	BLE
Cadmium (Cd)	231754-1	0.23944444	0.227	94.6	1	0.005	REF
Cadmium (Cd)	231757-1	0.047	0.047	99.9	1	0.005	REP
Cadmium (Cd)	231758-1		< 0.005		1	0.005	REP
Cadmium (Cd)	231759-1		< 0.005		1	0.005	REP
Calcium (Ca)	231744-1	< MDL	< 0.1		1	0.1	BLE
Calcium (Ca)	231746-1	88.7555555	88.9	100.1	1	0.1	REF
Calcium (Ca)	231757-1	27.4	27.3	99.5	1	0.1	REP
Calcium (Ca)	231758-1	85.2	86.4	101.4	1	0.1	REP
Calcium (Ca)	231759-1	32.3	32.1	99.5	1	0.1	REP
Chromium (Cr)	231744-1	< MDL	< 0.005		1	0.005	BLE
Chromium (Cr)	231754-1	0.43412222	0.415	95.7	1	0.005	REF
Chromium (Cr)	231757-1	0.006	0.006	100.0	1	0.005	REP
Chromium (Cr)	231758-1		< 0.005		1	0.005	REP
Chromium (Cr)	231759-1		< 0.005		1	0.005	REP
Cobalt (Co)	231744-1	< MDL	< 0.005		1	0.005	BLE
Cobalt (Co)	231754-1	0.73388888	0.708	96.5	1	0.005	REF
Cobalt (Co)	231757-1		< 0.005		1	0.005	REP
Cobalt (Co)	231758-1		< 0.005		1	0.005	REP
Cobalt (Co)	231759-1		< 0.005		1	0.005	REP
Copper (Cu)	231744-1	< MDL	< 0.005		1	0.005	BLE
Copper (Cu)	231754-1	0.90426666	0.906	100.2	1	0.005	REF
Copper (Cu)	231757-1	0.086	0.085	99.3	1	0.005	REP
Copper (Cu)	231758-1	0.678	0.685	101.1	1	0.005	REP
Copper (Cu)	231759-1		< 0.005		1	0.005	REP
Iron (Fe)	231744-1	< MDL	< 0.005		1	0.005	BLE
Iron (Fe)	231754-1	0.79790444	0.801	100.3	1	0.005	REF
Iron (Fe)	231757-1	0.023	0.023	98.8	1	0.005	REP
Iron (Fe)	231758-1		< 0.005		1	0.005	REP
Iron (Fe)	231759-1	0.008	0.008	99.6	1	0.005	REP
Lead (Pb)	231744-1	< MDL	< 0.05		1	0.05	BLE
Lead (Pb)	231754-1	1.86400000	1.84	98.7	1	0.05	REF
Lead (Pb)	231757-1		< 0.05		1	0.05	REP
Lead (Pb)	231758-1		< 0.05		1	0.05	REP
Lead (Pb)	231759-1		< 0.05		1	0.05	REP
Magnesium (Mg)	231744-1	< MDL	< 0.1		1	0.1	BLE
Magnesium (Mg)	231746-1	25.9366666	25.5	98.5	1	0.1	REF

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Magnesium (Mg)	231757-1	7.8	7.7	98.9	1	0.1	REP
Magnesium (Mg)	231758-1	9.1	9.0	99.3	1	0.1	REP
Magnesium (Mg)	231759-1	9.3	9.4	100.9	1	0.1	REP
Manganese (Mn)	231744-1	< MDL	< 0.001		1	0.001	BLE
Manganese (Mn)	231754-1	0.64556666	0.633	98.1	1	0.001	REF
Manganese (Mn)	231757-1	0.775	0.764	98.6	1	0.001	REP
Manganese (Mn)	231758-1	0.027	0.027	101.3	1	0.001	REP
Manganese (Mn)	231759-1		< 0.001		1	0.001	REP
Molybdenum (Mo)	231744-1	< MDL	< 0.01		1	0.01	BLE
Molybdenum (Mo)	231754-1	0.52988888	0.51	97.0	1	0.01	REF
Molybdenum (Mo)	231757-1		< 0.01		1	0.01	REP
Molybdenum (Mo)	231758-1		< 0.01		1	0.01	REP
Molybdenum (Mo)	231759-1		< 0.01		1	0.01	REP
Nickel (Ni)	231744-1	< MDL	< 0.02		1	0.02	BLE
Nickel (Ni)	231754-1	0.74666666	0.73	98.3	1	0.02	REF
Nickel (Ni)	231757-1		< 0.02		1	0.02	REP
Nickel (Ni)	231758-1		< 0.02		1	0.02	REP
Nickel (Ni)	231759-1		< 0.02		1	0.02	REP
Phosphorus (P)	231744-1	< MDL	< 0.1		1	0.1	BLE
Phosphorus (P)	231757-1		< 0.1		1	0.1	REP
Phosphorus (P)	231758-1		< 0.1		1	0.1	REP
Phosphorus (P)	231759-1		< 0.1		1	0.1	REP
Potassium (K)	231744-1	< MDL	< 0.1		1	0.1	BLE
Potassium (K)	231746-1	4.17122222	4.0	96.2	1	0.1	REF
Potassium (K)	231757-1	1.5	1.5	99.9	1	0.1	REP
Potassium (K)	231758-1	6.7	6.5	97.2	1	0.1	REP
Potassium (K)	231759-1	1.4	1.4	99.8	1	0.1	REP
Selenium (Se)	231744-1	< MDL	< 0.05		1	0.05	BLE
Selenium (Se)	231754-1	0.71785555	0.70	97.7	1	0.05	REF
Selenium (Se)	231757-1		< 0.05		1	0.05	REP
Selenium (Se)	231758-1		< 0.05		1	0.05	REP
Selenium (Se)	231759-1		< 0.05		1	0.05	REP
Silicon (Si)	231744-1	< MDL	< 0.05		1	0.05	BLE
Silicon (Si)	231746-1	1.09294444	1.10	100.2	1	0.05	REF
Silicon (Si)	231757-1	5.57	5.55	99.6	1	0.05	REP
Silicon (Si)	231758-1	9.49	9.42	99.2	1	0.05	REP
Silicon (Si)	231759-1	10.2	10.3	100.5	1	0.05	REP
Silver (Ag)	231744-1	< MDL	< 0.01		1	0.01	BLE
Silver (Ag)	231757-1		< 0.01		1	0.01	REP
Silver (Ag)	231758-1		< 0.01		1	0.01	REP
Silver (Ag)	231759-1		< 0.01		1	0.01	REP
Sodium (Na)	231744-1	< MDL	< 0.1		1	0.1	BLE
Sodium (Na)	231746-1	49.8788888	49.1	98.5	1	0.1	REF
Sodium (Na)	231757-1	3.1	3.1	99.5	1	0.1	REP
Sodium (Na)	231758-1	11.2	11.2	100.3	1	0.1	REP
Sodium (Na)	231759-1	6.1	6.1	99.3	1	0.1	REP
Strontium (Sr)	231744-1	< MDL	< 0.001		1	0.001	BLE
Strontium (Sr)	231754-1	0.08649111	0.082	94.3	1	0.001	REF
Strontium (Sr)	231757-1	0.243	0.240	98.9	1	0.001	REP
Strontium (Sr)	231758-1	0.407	0.402	98.8	1	0.001	REP
Strontium (Sr)	231759-1	0.126	0.127	100.5	1	0.001	REP
Sulfur (S)	231744-1	< MDL	< 0.05		1	0.05	BLE

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Sulfur (S)	231746-1	38.3836666	37.8	98.4	1	0.05	REF
Sulfur (S)	231757-1	15.3	15.1	99.0	1	0.05	REP
Sulfur (S)	231758-1	80.0	79.8	99.7	1	0.05	REP
Sulfur (S)	231759-1	9.85	9.72	98.7	1	0.05	REP
Tin (Sn)	231744-1	< MDL	< 0.05		1	0.05	BLE
Tin (Sn)	231752-1	3.61542857	3.60	100.7	1	0.05	REF
Tin (Sn)	231757-1		< 0.05		1	0.05	REP
Tin (Sn)	231758-1		< 0.05		1	0.05	REP
Tin (Sn)	231759-1		< 0.05		1	0.05	REP
Titanium (Ti)	231744-1	< MDL	< 0.002		1	0.002	BLE
Titanium (Ti)	231752-1	0.21574285	0.212	103.8	1	0.002	REF
Titanium (Ti)	231757-1		< 0.002		1	0.002	REP
Titanium (Ti)	231758-1		< 0.002		1	0.002	REP
Titanium (Ti)	231759-1		< 0.002		1	0.002	REP
Vanadium (V)	231744-1	< MDL	< 0.01		1	0.01	BLE
Vanadium (V)	231754-1	1.36733333	1.33	97.0	1	0.01	REF
Vanadium (V)	231757-1		< 0.01		1	0.01	REP
Vanadium (V)	231758-1		< 0.01		1	0.01	REP
Vanadium (V)	231759-1		< 0.01		1	0.01	REP
Zinc (Zn)	231744-1	< MDL	< 0.05		1	0.05	BLE
Zinc (Zn)	231754-1	0.91475555	0.89	97.5	1	0.05	REF
Zinc (Zn)	231757-1	2.62	2.63	100.2	1	0.05	REP
Zinc (Zn)	231758-1	0.51	0.51	99.5	1	0.05	REP
Zinc (Zn)	231759-1		< 0.05		1	0.05	REP

***ICP Total UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Aluminum (Al)	232268-1	< MDL	< 0.06		1	0.06	BLL
Aluminum (Al)	232273-1	0.37997500	0.45	118.4	1	0.06	REF
Aluminum (Al)	232274-1	0.24	0.21	89.3	1	0.06	REP
Aluminum (Al)	232275-1	0.22	0.22	98.9	1	0.06	REP
Aluminum (Al)	232276-1		< 0.06		1	0.06	REP
Antimony (Sb)	232268-1	< MDL	< 0.06		1	0.06	BLL
Antimony (Sb)	232273-1	0.52062500	0.52	99.2	1	0.06	REF
Antimony (Sb)	232274-1		< 0.06		1	0.06	REP
Antimony (Sb)	232275-1		< 0.06		1	0.06	REP
Antimony (Sb)	232276-1		< 0.06		1	0.06	REP
Arsenic (As)	232268-1	< MDL	< 0.06		1	0.06	BLL
Arsenic (As)	232273-1	0.70917500	0.71	99.7	1	0.06	REF
Arsenic (As)	232274-1		< 0.06		1	0.06	REP
Arsenic (As)	232275-1		< 0.06		1	0.06	REP
Arsenic (As)	232276-1		< 0.06		1	0.06	REP
Barium (Ba)	232268-1	< MDL	< 0.001		1	0.001	BLL
Barium (Ba)	232273-1	0.35345000	0.350	99.1	1	0.001	REF
Barium (Ba)	232274-1	0.017	0.017	98.5	1	0.001	REP
Barium (Ba)	232275-1	0.007	0.007	101.2	1	0.001	REP
Barium (Ba)	232276-1	0.058	0.059	100.9	1	0.001	REP
Beryllium (Be)	232268-1	< MDL	< 0.001		1	0.001	BLL
Beryllium (Be)	232273-1	0.59197500	0.594	100.4	1	0.001	REF
Beryllium (Be)	232274-1		< 0.001		1	0.001	REP
Beryllium (Be)	232275-1		< 0.001		1	0.001	REP
Beryllium (Be)	232276-1		< 0.001		1	0.001	REP

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Boron (B)	232268-1	< MDL	< 0.01		1	0.01	BLL
Boron (B)	232273-1	1.55625000	1.58	101.5	1	0.01	REF
Boron (B)	232274-1		< 0.01		1	0.01	REP
Boron (B)	232275-1		< 0.01		1	0.01	REP
Boron (B)	232276-1		< 0.01		1	0.01	REP
Cadmium (Cd)	232268-1	< MDL	< 0.006		1	0.006	BLL
Cadmium (Cd)	232273-1	0.23385000	0.232	99.0	1	0.006	REF
Cadmium (Cd)	232274-1	0.031	0.028	90.7	1	0.006	REP
Cadmium (Cd)	232275-1		< 0.006		1	0.006	REP
Cadmium (Cd)	232276-1	0.046	0.046	100.3	1	0.006	REP
Calcium (Ca)	232268-1	< MDL	0.1		1	0.1	BLL
Calcium (Ca)	232269-1	92.3070519	95.7	103.7	1	0.1	REF
Calcium (Ca)	232274-1	0.5	0.5	94.2	1	0.1	REP
Calcium (Ca)	232275-1	0.5	0.5	102.0	1	0.1	REP
Calcium (Ca)	232276-1	26.8	26.8	100.0	1	0.1	REP
Chromium (Cr)	232268-1	< MDL	< 0.006		1	0.006	BLL
Chromium (Cr)	232273-1	0.43735000	0.440	100.7	1	0.006	REF
Chromium (Cr)	232274-1		< 0.006		1	0.006	REP
Chromium (Cr)	232275-1		< 0.006		1	0.006	REP
Chromium (Cr)	232276-1		< 0.006		1	0.006	REP
Cobalt (Co)	232268-1	< MDL	< 0.006		1	0.006	BLL
Cobalt (Co)	232273-1	0.73560000	0.746	101.4	1	0.006	REF
Cobalt (Co)	232274-1		< 0.006		1	0.006	REP
Cobalt (Co)	232275-1		< 0.006		1	0.006	REP
Cobalt (Co)	232276-1		< 0.006		1	0.006	REP
Copper (Cu)	232268-1	< MDL	< 0.02		1	0.02	BLL
Copper (Cu)	232273-1	0.93977500	0.93	98.9	1	0.02	REF
Copper (Cu)	232274-1	1.21	1.09	90.4	1	0.02	REP
Copper (Cu)	232275-1	0.58	0.55	94.8	1	0.02	REP
Copper (Cu)	232276-1	0.09	0.09	98.9	1	0.02	REP
Iron (Fe)	232268-1	< MDL	< 0.05		1	0.05	BLL
Iron (Fe)	232273-1	0.82587500	0.81	98.4	1	0.05	REF
Iron (Fe)	232274-1	2.07	1.83	88.3	1	0.006	REP
Iron (Fe)	232275-1	0.489	0.444	90.8	1	0.006	REP
Iron (Fe)	232276-1	0.10	0.10	100.6	1	0.05	REP
Lead (Pb)	232268-1	< MDL	< 0.06		1	0.06	BLL
Lead (Pb)	232273-1	1.87275000	1.88	100.4	1	0.06	REF
Lead (Pb)	232274-1	1.69	1.63	96.7	1	0.06	REP
Lead (Pb)	232275-1	0.16	0.15	96.1	1	0.06	REP
Lead (Pb)	232276-1		< 0.06		1	0.06	REP
Magnesium (Mg)	232268-1	< MDL	< 0.1		1	0.1	BLL
Magnesium (Mg)	232269-1	26.1042500	27.1	103.8	1	0.1	REF
Magnesium (Mg)	232274-1		< 0.1		1	0.1	REP
Magnesium (Mg)	232275-1		< 0.1		1	0.1	REP
Magnesium (Mg)	232276-1	7.8	7.8	100.4	1	0.1	REP
Manganese (Mn)	232268-1	< MDL	< 0.001		1	0.001	BLL
Manganese (Mn)	232273-1	0.65535000	0.661	100.9	1	0.001	REF
Manganese (Mn)	232274-1	0.067	0.063	93.4	1	0.001	REP
Manganese (Mn)	232275-1	0.012	0.012	98.0	1	0.001	REP
Manganese (Mn)	232276-1	0.783	0.787	100.5	1	0.001	REP
Molybdenum (Mo)	232268-1	< MDL	< 0.01		1	0.01	BLL
Molybdenum (Mo)	232273-1	0.56895000	0.56	98.4	1	0.01	REF

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Molybdenum (Mo)	232274-1		< 0.01		1	0.01	REP
Molybdenum (Mo)	232275-1		< 0.01		1	0.01	REP
Molybdenum (Mo)	232276-1		< 0.01		1	0.01	REP
Nickel (Ni)	232268-1	< MDL	< 0.02		1	0.02	BLL
Nickel (Ni)	232273-1	0.77057500	0.78	101.2	1	0.02	REF
Nickel (Ni)	232274-1		< 0.02		1	0.02	REP
Nickel (Ni)	232275-1		< 0.02		1	0.02	REP
Nickel (Ni)	232276-1		< 0.02		1	0.02	REP
Phosphorus (P)	232268-1	< MDL	< 0.1		1	0.1	BLL
Phosphorus (P)	232274-1		< 0.1		1	0.1	REP
Phosphorus (P)	232275-1		< 0.1		1	0.1	REP
Phosphorus (P)	232276-1		< 0.1		1	0.1	REP
Potassium (K)	232268-1	< MDL	< 0.1		1	0.1	BLL
Potassium (K)	232269-1	4.03501333	4.1	101.1	1	0.1	REF
Potassium (K)	232274-1	0.2	0.2	97.8	1	0.1	REP
Potassium (K)	232275-1	0.2	0.2	94.0	1	0.1	REP
Potassium (K)	232276-1	1.5	1.5	98.7	1	0.1	REP
Selenium (Se)	232268-1	< MDL	< 0.06		1	0.06	BLL
Selenium (Se)	232273-1	0.74505000	0.74	99.6	1	0.06	REF
Selenium (Se)	232274-1		< 0.06		1	0.06	REP
Selenium (Se)	232275-1		< 0.06		1	0.06	REP
Selenium (Se)	232276-1		< 0.06		1	0.06	REP
Silicon (Si)	232268-1	< MDL	< 0.06		1	0.06	BLL
Silicon (Si)	232269-1	1.17518266	1.09	92.8	1	0.06	REF
Silicon (Si)	232274-1	0.47	0.45	95.4	1	0.06	REP
Silicon (Si)	232275-1	0.52	0.50	95.5	1	0.06	REP
Silicon (Si)	232276-1	5.48	5.48	100.0	1	0.06	REP
Silver (Ag)	232268-1	< MDL	< 0.01		1	0.01	BLL
Silver (Ag)	232274-1	0.06	0.05	80.7	1	0.01	REP
Silver (Ag)	232275-1		< 0.01		1	0.01	REP
Silver (Ag)	232276-1		< 0.01		1	0.01	REP
Sodium (Na)	232268-1	< MDL	< 0.1		1	0.1	BLL
Sodium (Na)	232269-1	49.915333	52.0	104.3	1	0.1	REF
Sodium (Na)	232274-1	0.1	0.1	84.4	1	0.1	REP
Sodium (Na)	232275-1	<0.1	0.1	100.3	1	0.1	REP
Sodium (Na)	232276-1	3.0	3.0	99.6	1	0.1	REP
Strontium (Sr)	232268-1	< MDL	0.001		1	0.001	BLL
Strontium (Sr)	232273-1	0.08878250	0.091	102.7	1	0.001	REF
Strontium (Sr)	232274-1	0.003	0.003	87.6	1	0.001	REP
Strontium (Sr)	232275-1	0.003	0.003	103.3	1	0.001	REP
Strontium (Sr)	232276-1	0.253	0.249	98.5	1	0.001	REP
Sulfur (S)	232268-1	< MDL	< 0.06		1	0.06	BLL
Sulfur (S)	232269-1	38.1126025	39.4	103.4	1	0.06	REF
Sulfur (S)	232274-1	4.34	3.98	91.7	1	0.06	REP
Sulfur (S)	232275-1	1.57	1.54	97.9	1	0.06	REP
Sulfur (S)	232276-1	14.7	14.7	100.1	1	0.06	REP
Tin (Sn)	232268-1	< MDL	< 0.06		1	0.06	BLL
Tin (Sn)	232272-1	3.63940000	3.73	102.5	1	0.06	REF
Tin (Sn)	232274-1		< 0.06		1	0.06	REP
Tin (Sn)	232275-1		< 0.06		1	0.06	REP
Tin (Sn)	232276-1		< 0.06		1	0.06	REP
Titanium (Ti)	232268-1	< MDL	< 0.002		1	0.002	BLL

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Titanium (Ti)	232272-1	0.21102000	0.194	91.8	1	0.002	REF
Titanium (Ti)	232274-1	0.011	0.010	92.1	1	0.002	REP
Titanium (Ti)	232275-1	0.012	0.011	92.6	1	0.002	REP
Titanium (Ti)	232276-1		< 0.002		1	0.002	REP
Vanadium (V)	232268-1	< MDL	< 0.01		1	0.01	BLL
Vanadium (V)	232273-1	1.41475000	1.42	100.6	1	0.01	REF
Vanadium (V)	232274-1		< 0.01		1	0.01	REP
Vanadium (V)	232275-1		< 0.01		1	0.01	REP
Vanadium (V)	232276-1		< 0.01		1	0.01	REP
Zinc (Zn)	232268-1	< MDL	< 0.05		1	0.05	BLL
Zinc (Zn)	232273-1	0.90227500	0.89	98.4	1	0.05	REF
Zinc (Zn)	232274-1	4.93	4.50	91.2	1	0.05	REP
Zinc (Zn)	232275-1	0.48	0.47	98.3	1	0.05	REP
Zinc (Zn)	232276-1	2.50	2.52	100.8	1	0.05	REP

***ICPMS Dissolved UNITS:** ug/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Aluminum (Al)	232353-1	< MDL	< 0.2		1	0.2	BLL
Aluminum (Al)	232354-1	54.3643221	57.3	105.4	1	0.2	REF
Aluminum (Al)	232355-1	23.9	23.8	99.6	1	0.2	REP
Aluminum (Al)	232356-1	54.7	55.0	100.5	1	0.2	REP
Antimony (Sb)	232353-1	0.00688562	0.013		1	0.005	BLL
Antimony (Sb)	232354-1		31.6		1	0.005	REF
Antimony (Sb)	231700-1	0.013	0.012	95.6	1	0.005	REP
Antimony (Sb)	231770-1	0.175	0.175	99.8	1	0.005	REP
Antimony (Sb)	232355-1	0.013	0.013	99.5	1	0.005	REP
Antimony (Sb)	232356-1	0.175	0.176	100.5	1	0.005	REP
Arsenic (As)	232353-1	< MDL	< 0.1		1	0.1	BLL
Arsenic (As)	232354-1	35.0005842	33.6	95.9	1	0.1	REF
Arsenic (As)	232355-1	<0.1	0.1	108.5	1	0.1	REP
Arsenic (As)	232356-1	0.3	0.3	97.4	1	0.1	REP
Barium (Ba)	232353-1	< MDL	< 0.02		1	0.02	BLL
Barium (Ba)	232354-1	62.1316108	62.7	100.9	1	0.02	REF
Barium (Ba)	231700-1	2.14	2.12	99.2	1	0.02	REP
Barium (Ba)	231770-1	11.1	11.3	101.5	1	0.02	REP
Barium (Ba)	232355-1	2.14	2.12	99.1	1	0.02	REP
Barium (Ba)	232356-1	11.2	11.3	100.8	1	0.02	REP
Beryllium (Be)	232353-1	0.00224543	0.005		1	0.002	BLL
Beryllium (Be)	232354-1	36.3986985	38.6	106.2	1	0.002	REF
Beryllium (Be)	232355-1	0.004	0.003	68.1	1	0.002	REP
Beryllium (Be)	232356-1	0.009	0.011	119.5	1	0.002	REP
Bismuth (Bi)	232353-1	< MDL	< 0.02		1	0.02	BLL
Bismuth (Bi)	232354-1	15.5389535	7.73	49.8	1	0.02	REF
Bismuth (Bi)	232355-1		< 0.02		1	0.02	REP
Bismuth (Bi)	232356-1		< 0.02		1	0.02	REP
Cadmium (Cd)	232353-1	< MDL	< 0.01		1	0.01	BLL
Cadmium (Cd)	232354-1	60.2564490	58.9	97.8	1	0.01	REF
Cadmium (Cd)	231700-1	0.03	0.03	88.2	1	0.01	REP
Cadmium (Cd)	231770-1	0.10	0.10	99.4	1	0.01	REP
Cadmium (Cd)	232355-1	0.03	0.03	96.3	1	0.01	REP
Cadmium (Cd)	232356-1	0.10	0.10	101.3	1	0.01	REP
Chromium (Cr)	232353-1	< MDL	< 0.2		1	0.2	BLL

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Chromium (Cr)	232354-1	67.0757531	62.2	92.8	1	0.2	REF
Chromium (Cr)	231700-1	1.2	1.8	150.8	1	0.2	REP
Chromium (Cr)	231770-1	1.6	2.5	159.5	1	0.2	REP
Chromium (Cr)	232355-1	1.2	1.2	100.2	1	0.2	REP
Chromium (Cr)	232356-1	1.5	1.5	97.9	1	0.2	REP
Cobalt (Co)	232353-1	< MDL	0.015		1	0.005	BLL
Cobalt (Co)	232354-1	62.8803782	57.7	91.8	1	0.005	REF
Cobalt (Co)	232355-1	0.074	0.072	97.0	1	0.005	REP
Cobalt (Co)	232356-1	0.231	0.233	101.0	1	0.005	REP
Copper (Cu)	232353-1	< MDL	< 0.05		1	0.05	BLL
Copper (Cu)	232354-1	62.2043843	62.7	100.7	1	0.05	REF
Copper (Cu)	231700-1	0.57	0.38	67.0	1	0.05	REP
Copper (Cu)	231770-1	3.54	3.31	93.5	1	0.05	REP
Copper (Cu)	232355-1	0.57	0.45	78.9	1	0.05	REP
Copper (Cu)	232356-1	3.53	3.43	97.1	1	0.05	REP
Lead (Pb)	232353-1	< MDL	< 0.01		1	0.01	BLL
Lead (Pb)	232354-1	62.9929221	55.8	88.6	1	0.01	REF
Lead (Pb)	232355-1	0.03	0.03	90.5	1	0.01	REP
Lead (Pb)	232356-1	0.07	0.07	101.3	1	0.01	REP
Lithium (Li)	232353-1	< MDL	< 0.05		1	0.05	BLL
Lithium (Li)	232354-1	32.3199228	35.5	109.7	1	0.05	REF
Lithium (Li)	232355-1	2.63	2.56	97.3	1	0.05	REP
Lithium (Li)	232356-1	13.1	13.3	101.5	1	0.05	REP
Manganese (Mn)	232353-1	0.01069498	0.015		1	0.005	BLL
Manganese (Mn)	232354-1	75.7573885	75.9	100.2	1	0.005	REF
Manganese (Mn)	232355-1	6.01	5.95	99.0	1	0.005	REP
Manganese (Mn)	232356-1	8.61	8.88	103.1	1	0.005	REP
Molybdenum (Mo)	232353-1	< MDL	< 0.05		1	0.05	BLL
Molybdenum (Mo)	232354-1	74.8778395	72.4	96.7	1	0.05	REF
Molybdenum (Mo)	232355-1	0.07	0.07	97.4	1	0.05	REP
Molybdenum (Mo)	232356-1	0.76	0.76	100.4	1	0.05	REP
Nickel (Ni)	232353-1	< MDL	< 0.05		1	0.05	BLL
Nickel (Ni)	232354-1	57.1707753	59.1	103.3	1	0.05	REF
Nickel (Ni)	232355-1	0.87	0.87	99.5	1	0.05	REP
Nickel (Ni)	232356-1	3.23	3.27	101.2	1	0.05	REP
Selenium (Se)	232353-1	< MDL	< 0.2		1	0.2	BLL
Selenium (Se)	232354-1	41.7205339	40.5	97.2	1	0.2	REF
Selenium (Se)	232355-1	0.4	0.4	111.6	1	0.2	REP
Selenium (Se)	232356-1	0.7	0.7	98.4	1	0.2	REP
Silver (Ag)	232353-1	< MDL	< 0.02		1	0.02	BLL
Silver (Ag)	232355-1		< 0.02		1	0.02	REP
Silver (Ag)	232356-1		< 0.02		1	0.02	REP
Strontium (Sr)	232353-1	0.01977173	0.013		1	0.005	BLL
Strontium (Sr)	232354-1	109.610868	116	106.1	1	0.005	REF
Strontium (Sr)	232355-1	134	134	100.0	1	0.005	REP
Strontium (Sr)	232356-1	132	131	99.2	1	0.005	REP
Thallium (Tl)	232353-1	0.00341025	0.004		1	0.002	BLL
Thallium (Tl)	232354-1	38.2040492	33.2	86.9	1	0.002	REF
Thallium (Tl)	232355-1	0.004	0.005	113.6	1	0.002	REP
Thallium (Tl)	232356-1	0.014	0.013	94.8	1	0.002	REP
Tin (Sn)	232353-1	0.01406443	0.01		1	0.01	BLL
Tin (Sn)	232354-1	58.2414567	52.7	90.4	1	0.01	REF

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Tin (Sn)	232355-1	0.01	0.01	89.7	1	0.01	REP
Tin (Sn)	232356-1	0.03	0.02	76.2	1	0.01	REP
Uranium (U)	232353-1	< MDL	< 0.002		1	0.002	BLL
Uranium (U)	232354-1	38.1002192	33.5	88.0	1	0.002	REF
Uranium (U)	232355-1	0.064	0.063	98.4	1	0.002	REP
Uranium (U)	232356-1	0.160	0.165	103.1	1	0.002	REP
Vanadium (V)	232353-1	< MDL	< 0.05		1	0.05	BLL
Vanadium (V)	232354-1	72.3718975	69.3	95.8	1	0.05	REF
Vanadium (V)	232355-1	0.41	0.41	100.2	1	0.05	REP
Vanadium (V)	232356-1	0.65	0.65	99.8	1	0.05	REP
Zinc (Zn)	232353-1	< MDL	< 0.2		1	0.2	BLL
Zinc (Zn)	232354-1	73.2518067	73.6	100.5	1	0.2	REF
Zinc (Zn)	231700-1	3.2	3.2	98.9	1	0.2	REP
Zinc (Zn)	231770-1	55.0	55.2	100.4	1	0.2	REP
Zinc (Zn)	232355-1	3.2	3.0	95.0	1	0.2	REP
Zinc (Zn)	232356-1	54.9	55.9	101.7	1	0.2	REP

***Mercury dissolved UNITS:** ug/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Mercury (Hg)	231877-1	< MDL	< 0.02		1	0.02	BLL
Mercury (Hg)	231879-1	1.50770731	1.58	104.5	1	0.02	REF
Mercury (Hg)	231882-1		< 0.02		1	0.02	REP
Mercury (Hg)	231883-1		< 0.02		1	0.02	REP
Mercury (Hg)	231884-1		< 0.02		1	0.02	REP
Mercury (Hg)	231885-1		< 0.02		1	0.02	REP

***Mercury total UNITS:** ug/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Mercury (Hg)	231780-1	< MDL	< 0.02		1	0.02	BLL
Mercury (Hg)	231781-1	1.51738709	1.51	99.2	1	0.02	REF
Mercury (Hg)	231782-1	0.02	0.02	88.6	1	0.02	REP
Mercury (Hg)	231783-1		< 0.02		1	0.02	REP

***Nitrogen Ammonia UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Nitrogen, Ammonia as N	231686-1	< MDL	< 0.002		1	0.002	BLE
Nitrogen, Ammonia as N	231689-1	17.1248888	17.3	100.9	25	0.05	REF
Nitrogen, Ammonia as N	231692-1		< 0.002		1	0.002	REP

***Nitrogen NO 2 UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Nitrogen, Nitrite as N	231688-1	< MDL	< 0.002		1	0.002	BLE
Nitrogen, Nitrite as N	231691-1	1.01799322	0.999	98.1	1	0.002	REF
Nitrogen, Nitrite as N	231694-1		< 0.002		1	0.002	REP

***Nitrogen NO 23 UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Nitrogen, Nitrate + Nitrite as N	231687-1	< MDL	< 0.002		1	0.002	BLE

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Nitrogen, Nitrate + Nitrite as N	231690-1	6.65	6.59	99.6	5	0.01	REF
Nitrogen, Nitrate + Nitrite as N	231693-1	0.416	0.417	100.2	1	0.002	REP

***Nitrogen. Total UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Nitrogen, Total as N	231627-1	< MDL	< 0.02		1	0.02	BLL
Nitrogen, Total as N	231629-1	5.01270000	5.39	107.5	1	0.02	REF
Nitrogen, Total as N	231631-1	0.08	0.06	79.7	1	0.02	REP
Nitrogen, Total as N	231633-1	0.11	0.10	91.8	1	0.02	REP
Nitrogen, Total as N	231634-1	0.08	0.08	105.4	1	0.02	REP
Nitrogen, Total as N	231636-1	0.14	0.12	83.8	1	0.02	REP

***pH UNITS:** pH Units **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
pH	231637-1	6.00	6.02	100.3	1	0.01	REF
pH	231675-1	7.05	7.07	100.3	1	0.01	REP

***Phosphorus Total UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Phosphorus, Total as P	231619-1	< MDL	< 0.002		1	0.002	BLL
Phosphorus, Total as P	231620-1	4.25789090	4.2	97.9	50	0.1	REF
Phosphorus, Total as P	231621-1	0.005	0.005	97.9	1	0.002	REP

***Residue Filterable UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Solids, Total Dissolved (FR)	231799-1	< MDL	< 10		1	10	BLE
Solids, Total Dissolved (FR)	231800-1	1900	1820	95.5	1	10	REF
Solids, Total Dissolved (FR)	231801-1	294	305	103.7	1	10	REP
Solids, Total Dissolved (FR)	231802-1	16,200	16300	100.6	1	10	REP

***Residue Nonfilt. UNITS:** mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Solids, Total Suspended (NFR)	231731-1	< MDL	< 5		1	5	BLE
Solids, Total Suspended (NFR)	231732-1	451.284430	443	98.1	1	5	REF
Solids, Total Suspended (NFR)	231733-1		< 5		1	5	REP

***SpecificConductance UNITS:** uS/cm **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Conductivity (25C)	231659-1	< MDL	< 2		1	2	BLE
Conductivity (25C)	231661-1	15.4075000	15	97.2	1	2	REF
Conductivity (25C)	231662-1	712.024000	719	101.0	1	2	REF
Conductivity (25C)	231674-1	373.973571	370	98.9	1	2	REF
Conductivity (25C)	231676-1	226	226	100.0	1	2	REP

DOC UNITS: mg/L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE

QC Information:

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Carbon, Dissolved Organic	231563-1	< MDL	< 0.5		1	0.5	BLL
Carbon, Dissolved Organic	231564-1	9.97540000	9.4	94.4	1	0.5	REF
Carbon, Dissolved Organic	231565-1	10.0	9.8	98.1	1	0.5	REF
Carbon, Dissolved Organic	231588-1	1.0	1.0	103.8	1	0.5	REP
Carbon, Dissolved Organic	231589-1		< 0.5		1	0.5	REP
Carbon, Dissolved Organic	231596-1	1.7	1.8	106.4	1	0.5	REP
Carbon, Dissolved Organic	231590-1	5.0	6.0	100.4	1	0.5	SPK
Carbon, Dissolved Organic	231591-1	5.0	5.2	100.9	1	0.5	SPK
Carbon, Dissolved Organic	231599-1	5.0	5.4	106.7	1	0.5	SPK

Hardness Diss. CaMg **UNITS:** mg CaCO3 / L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Hardness, Dissolved Calcium+Magnes	231744-1		< 0.4		1	0.4	BLE
Hardness, Dissolved Calcium+Magnes	231757-1		200		1	0.4	REP
Hardness, Dissolved Calcium+Magnes	231758-1		506		1	0.4	REP
Hardness, Dissolved Calcium+Magnes	231759-1		238		1	0.4	REP

Hardness Diss.Total **UNITS:** mg CaCO3 / L **MATRIX:** WWOT

ANALYTE	ALIQ#	EXPECTED	RESULT	% REC	DIL'N	MDL	QC TYPE
Hardness, Dissolved Total - calc.	231744-1		< 0.4		1	0.4	BLE
Hardness, Dissolved Total - calc.	231757-1		212		1	0.4	REP
Hardness, Dissolved Total - calc.	231758-1		513		1	0.4	REP
Hardness, Dissolved Total - calc.	231759-1		238		1	0.4	REP

Note: **All QC information is batch associated. Duplicate analysis are not necessarily those of this report. Percent recovery for duplicate analysis represents the percent recovery of REP2 as compared to REP1 of a sample duplicate.**

BLE - Blank, Equipment
BLL - Blank, Method
BLX - Blank, Extraction
REA - Replicate Spike, Known Addition
REF - Reference Material
REG - Regular Sample
RRF - Replicate Reference Material
REK - Replicate, Spike
REP - Replicate, Regular
RTS - Replicate Test Sample
SPA - Spike, Known Addition
SPK - Spike
TST - Test Sample 1=Present 2=Absent
MDL - Method Detection Limit

Appendix B2. Surface Water Quality Data: Travel Blanks, Casino Project, 2008-2012

Parameter	RDL	Date															
		21-May-08	05-Jul-08	09-Sep-08	22-Sep-09	06-Oct-09	04-Nov-09	02-Dec-09	21-Apr-10	10-May-10	17-Jun-10	08-Jul-10	22-Aug-11	06-Oct-11	29-Mar-12	25-May-12	17-Sep-12
Physical Tests																	
Hardness CaCO3	10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5
Conductivity	1	1	<1	1	1	1	1	2	<1	1	2	1	1	1	1.2	<1	1.2
pH	N/A	4.5	5.8	6.2	6.1	6.0	5.4	6	6.4	6.2	6.1	5.92	6.22	6.06	5.66	5.32	5.77
Total Suspended Solids	4	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<4	<1	<1	<1	<1
Total Dissolved Solids	10	2	<1	<1	<10	2	<10	<10	-	<10	<10	<1	<10	<10	<10	<10	<10
Turbidity	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Anions & Nutrients																	
Ammonia as N	0.005	<0.005	0.014	0.01	<0.01	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	0.005	0.005	<0.005	<0.005	0.022
Alkalinity, Total (as $CaCO_3$)	0.5	<0.5	<0.5	<0.5	1.2	1.0	<0.5	0.5	1.0	1.1	-	1.1	1.1	0.6	<0.5	<0.5	<0.5
Acidity (pH 8.3) as $CaCO_3$	0.5	-	-	-	-	-	-	<0.5	<0.5	0.9	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromide (Br)	0.4	-	-	-	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.01	<0.01	<0.01
Chloride (Cl)	0.5	1.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (F)	0.01	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate (SO4)	0.5	0.9	1.3	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	1	<0.5	<0.5	1.39	0.90
Total Nitrogen (N)	0.02	-	-	-	-	-	-	-	-	-	-	-	<0.02	<0.02	<0.02	0.025	0.037
Nitrate (as N)	0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	*0.036*	0.003	<0.002	0.003	<0.002	<0.002	<0.002	0.0051	<0.002	<0.002
Nitrite (as N)	0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Nitrate plus Nitrite (N)	0.02	-	-	-	-	-	-	-	-	-	-	-	<0.002	<0.002	0.0051	<0.002	<0.002
Total Kjeldahl Nitrogen	0.02	<0.02	0.04	<0.02	0.03	<0.02	0.06	<0.02	<0.02	*0.23*	<0.02	0.03	<0.02	<0.02	<0.02	0.025	0.037
Ortho Phosphate as P	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cyanide, Weak Acid Diss	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0009	-	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Organic Carbon	0.5	-	-	-	-	-	-	-	0.5	1.2	<0.5	<0.5	0.9	<0.5	<0.5	0.94	-
Total Organic Carbon	0.5	-	-	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.91	<0.5
Total Metals																	
Aluminum	0.0002	<0.0002	***0.0012***	0.0008	<0.0002	*0.0011*	0.0003	<0.0002	0.0005	*0.0013*	0.0005	<0.0002	*0.0024*	0.0008	0.0005	0.00036	*0.00187*
Antimony	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Arsenic	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Barium	0.00002	0.00006	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00006	<0.00002	0.00003	<0.00002	<0.00002	0.00002	<0.00002	<0.00002
Beryllium	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005	<0.000005	<0.000005	0.000021	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Calcium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Copper	0.00005	0.00007	<0.00005	<0.00005	<0.00005	<0.00005	**<0.00005**	<0.00005	<0.00005	0.00012	<0.00005	0.00008	<0.00005	<0.00005	<0.00005	<0.00005	0.000122

Note:

Italic	Exceeds RDL value by 5x
Bold	Dissolved metal values greater than Total metals
RDL	Reportable Detection Limit
"-"	No data available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameter	RDL	Date															
		21-May-08	05-Jul-08	09-Sep-08	22-Sep-09	06-Oct-09	04-Nov-09	02-Dec-09	21-Apr-10	10-May-10	17-Jun-10	08-Jul-10	22-Aug-11	06-Oct-11	29-Mar-12	25-May-12	17-Sep-12
Iron	0.001	0.003	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0015
Lead	0.000005	*0.000074*	*0.000042*	0.000009	<0.000005	<0.000005	**<0.000005**	<0.000005	<0.000005	*0.000032*	0.000005	0.000009	<0.000005	0.000007	<0.000005	<0.000005	0.0000060
Lithium	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Magnesium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Manganese	0.00005	0.00008	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00012	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Mercury	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	<0.00001	<0.00001	-
Molybdenum	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00003	<0.00002	<0.00002	<0.00002	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Phosphorous	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	0.0022
Potassium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Silicon	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silver	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Strontium	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00006	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Thallium	0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00008	<0.0002	<0.0002	<0.0002
Titanium	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002	0.000007	<0.000002	<0.000002	0.000002	0.000008	<0.000002	<0.000002	<0.000002	0.000009	<0.000002	<0.000002	<0.000002	<0.000002	0.000008	<0.000002	<0.000002
Vanadium	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0001	*0.0011*	*0.0008*	<0.0001	0.0002	0.0001	0.0002	0.0002	<0.0001	*0.0008*	0.0003	0.0002	*0.0008*	0.0002	0.0001	<0.0001	0.00013
Zirconium	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Dissolved Metals																	
Aluminum	0.0002	<0.0002	*0.0024*	0.0007	<0.0002	<0.0002	0.0006	<0.0002	0.0002	<0.0002	<0.0002	0.0003	<0.0002	*0.0011*	0.0002	<0.0002	-
Antimony	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	-
Arsenic	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	-
Barium	0.00002	<0.00002	0.00006	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00003	0.00002	0.00002	0.00003	<0.00002	-
Beryllium	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-
Bismuth	0.000005	<0.000005	<0.000005	0.000007	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	-
Boron	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Cadmium	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	-
Calcium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Chromium	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-
Cobalt	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	-
Copper	0.00005	0.00007	<0.00005	<0.00005	<0.00005	<0.00005	*0.00166*	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00005	0.00006	<0.00005	-
Iron	0.001	0.001	0.002	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Lead	0.000005	*0.000058*	*0.000043*	0.000017	<0.000005	<0.000005	*0.000166*	<0.000005	<0.000005	<0.000005	<0.000005	0.000009	<0.000005	0.000007	0.000013	<0.000005	-
Lithium	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-

Note:

Italic	Exceeds RDL value by 5x
Bold	Dissolved metal values greater than Total metals
RDL	Reportable Detection Limit
"-"	No data available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B2. Surface Water Quality Data: Travel Blanks, Casino Project, 2008-2012

Parameter	RDL	Date															
		21-May-08	05-Jul-08	09-Sep-08	22-Sep-09	06-Oct-09	04-Nov-09	02-Dec-09	21-Apr-10	10-May-10	17-Jun-10	08-Jul-10	22-Aug-11	06-Oct-11	29-Mar-12	25-May-12	17-Sep-12
Magnesium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Manganese	0.00005	<0.00005	<0.00005	0.00006	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	-
Mercury	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	<0.00001	<0.00001	<0.00001
Molybdenum	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00009	<0.00005	-
Nickel	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00005	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	-
Phosphorous	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	<0.002	-
Potassium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Selenium	0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	-
Silicon	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Silver	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	-
Sodium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Strontium	0.00005	<0.00005	0.00008	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	-
Thallium	0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	-
Tin	0.0002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00009	<0.0002	<0.0002	-
Titanium	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Uranium	0.000002	0.000003	0.000004	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	0.000003	0.000009	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	-
Vanadium	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.00037	-
Zinc	0.0001	*0.0008*	*0.0007*	<0.0001	0.0002	<0.0001	*0.0021*	<0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001	0.0002	<0.0001	<0.0001	-
Zirconium	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-

Note:

Italic	Exceeds RDL value by 5x
Bold	Dissolved metal values greater than Total metals
RDL	Reportable Detection Limit
"-"	No data available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B3. Surface Water Quality Data: Field Blanks, Casino Project, 2008-2012

Parameter	RDL	Date																		
		21-May-08	09-Jul-08	30-Jun-09	09-Aug-09	22-Sep-09	06-Oct-09	02-Dec-09	23-Mar-10	10-May-10	15-Jun-10	09-Jul-10	10-Aug-10	14-Sep-10	29-Mar-11	29-Apr-11	22-Aug-11	07-Oct-11	29-Mar-12	25-May-12
Physical Tests																				
Hardness CaCO3	10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5
Conductivity	1	1	<1	1	2	1	1	1	1	1	1	2	2	1	1	1	1	2	1.1	<1
pH	N/A	4.5	5.2	6.0	6.3	6.2	6.1	6	5.9	6.1	5.8	5.90	5.61	5.55	5.58	6.15	6.13	6.06	5.59	5.42
Total Suspended Solids	4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Dissolved Solids	10	6	2	<1	1500	<10	2	<10	<10	<10	<10	<1	<10	<10	<10	<10	<10	<10	<10	<10
Turbidity	0.1	0.2	0.1	0.1	0.5	<0.1	<0.1	0.1	0.4	<0.1	0.1	<0.1	<0.1	<0.1	0.1	0.1	0.2	<0.1	<0.1	<0.1
Dissolved Anions & Nutrients																				
Ammonia as N	0.005	*0.071*	0.009	0.02	0.01	<0.01	<0.01	<0.01	<0.01	0.005	<0.01	0.008	*0.062*	<0.005	<0.005	<0.005	*0.027*	0.006	<0.005	<0.005
Alkalinity, Total (as $CaCO_3$)	0.5	<0.5	<0.5	0.7	1.3	1.3	1.0	0.6	0.7	1.4	0.7	1.1	0.9	0.8	<0.5	<0.5	1.8	0.6	<0.5	<0.5
Acidity (pH 8.3) as $CaCO_3$	0.5	-	-	1.7	<0.5	-	-	<0.5	-	1.0	<0.5	0.7	0.7	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromide (Br)	0.4	-	-	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.01	<0.01
Chloride (Cl)	0.5	0.9	0.7	1.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	<0.5	<0.5	<0.5
Fluoride (F)	0.01	-	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate (SO4)	0.5	*3.5*	1.8	0.6	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	0.6	1.4	<0.5	<0.5	<0.5	2.3	<0.5	<0.5	<0.5
Total Nitrogen (N)	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.06	*0.29*	<0.02	<0.02	<0.02
Nitrate (as N)	0.002	<0.002	0.012	<0.002	0.007	<0.002	<0.002	0.002	<0.002	<0.002	0.010	<0.002	<0.02	<0.002	<0.002	<0.002	<0.002	<0.002	0.0069	<0.002
Nitrite (as N)	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Nitrate plus Nitrite (N)	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.002	<0.002	<0.002	<0.002	0.0069	<0.002
Total Kjeldahl Nitrogen	0.02	<0.02	0.05	0.10	0.04	<0.02	0.02	0.04	<0.02	<0.02	0.05	<0.02	0.09	*0.45*	0.03	0.06	*0.29*	<0.02	<0.02	<0.02
Ortho Phosphate as P	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.005	0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Cyanide, Weak Acid Diss	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cyanide, Total	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0021	<0.0005	<0.0005	<0.0005	<0.0005	0.00055
Dissolved Organic Carbon	0.5	-	-	-	-	-	-	-	0.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Organic Carbon	0.5	-	-	1.3	<0.5	<0.5	<0.5	<0.5	0.6	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.02
Total Metals																				
Aluminum	0.0002	**<0.0002**	***0.0013***	0.0005	**0.0010**	*0.0034*	*0.0053*	0.0009	0.0008	0.0010	0.0009	<0.0002	0.001	<0.0002	0.001	0.0009	*0.0014*	*0.0041*	*0.0013*	***0.00141***
Antimony	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00009	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Arsenic	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00004	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Barium	0.00002	<0.00002	*0.00057*	0.00003	<0.00002	*0.00039*	0.00005	0.00003	<0.00002	<0.00002	0.00003	<0.00002	0.00004	<0.00002	0.00006	0.00004	0.00002	*0.00015*	<0.00002	0.000022
Beryllium	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005	<0.000005	<0.000005	0.000016	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	<0.000005	0.000006	<0.000005	<0.000005	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000006	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	<0.000005	<0.000005	*0.000026*	<0.000005
Calcium	0.05	<0.05	0.07	<0.05	<0.05	0.12	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	0.09	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000008	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Copper	0.00005	0.00009	0.00006	<0.00005	<0.00005	*0.00062*	<0.00005	0.00011	<0.00005	<0.00005	<0.00005	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00009	0.00012	0.000064

Note:

Italic	Exceeds RDL value by 5x
Bold	Dissolved metal values greater than Total metals
RDL	Reportable Detection Limit
"-"	No data available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B3. Surface Water Quality Data: Field Blanks, Casino Project, 2008-2012

Parameter	RDL	Date																		
		21-May-08	09-Jul-08	30-Jun-09	09-Aug-09	22-Sep-09	06-Oct-09	02-Dec-09	23-Mar-10	10-May-10	15-Jun-10	09-Jul-10	10-Aug-10	14-Sep-10	29-Mar-11	29-Apr-11	22-Aug-11	07-Oct-11	29-Mar-12	25-May-12
Iron	0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	0.003	<0.001	0.0011
Lead	0.000005	0.000014	0.000008	0.000021	0.000018	*0.000162*	0.000025	*0.000118*	0.000013	<0.000005	*0.000066*	0.000007	*0.00013*	0.000015	0.000008	0.000009	*0.000034*	*0.000131*	0.000008	<0.000005
Lithium	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Magnesium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Manganese	0.00005	<0.00005	0.00015	**<0.00005**	<0.00005	*0.00061*	0.00006	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00009	<0.00005	<0.00005	0.00019	<0.00005	<0.00005
Mercury	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	<0.00001	-	<0.00001	<0.00001
Molybdenum	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	*0.00019*	0.00003	<0.00002	0.00003	<0.00002	<0.00002	0.00002	0.0001	<0.00002	0.00003	0.00006	<0.00002	<0.00002	<0.00002	<0.00002
Phosphorous	0.002	<0.002	*0.043*	*0.035*	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	<0.002	-	<0.002	<0.002
Potassium	0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Silicon	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silver	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000006	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05	<0.05	<0.05	<0.05	<0.05	0.19	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Strontium	0.00005	<0.00005	*0.00094*	<0.00005	<0.00005	0.00038	<0.00005	0.00006	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00015	0.00007	<0.00005	0.00006	<0.00005	<0.00005
Thallium	0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	*0.0001*	*0.0007*	<0.0002
Titanium	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002	0.000005	0.000004	<0.000002	0.000004	0.000004	*0.000026*	*0.000013*	<0.000002	0.000007	<0.000002	<0.000002	0.000002	*0.000013*	*0.000033*	*0.000035*	*0.000055*	<0.000002	<0.000002	<0.000002
Vanadium	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.0001	**<0.0001**	***0.0022***	**<0.0001**	0.0002	*0.0035*	0.0004	0.0004	0.0003	0.0002	0.0002	<0.0001	0.0002	<0.0001	*0.001*	*0.0016*	<0.0001	*0.001*	*0.0007*	<0.0001
Zirconium	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Dissolved Metals																				
Aluminum	0.0002	***0.0017***	***0.0031***	0.0009	***0.0015***	0.0004	*0.0020*	0.0004	0.0005	0.0009	0.0008	0.0006	0.001	0.0006	*0.0026*	0.0008	0.0007	*0.0016*	<0.0002	*0.002*
Antimony	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Arsenic	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	0.00004	<0.00002	<0.00002	<0.00002
Barium	0.00002	<0.00002	<0.00002	*0.00012*	0.00008	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00002	0.00002	<0.00002	0.00005	0.00004	<0.00002	<0.00002	0.00003	<0.00002	0.000047
Beryllium	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Boron	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.000005	<0.000005	0.000008	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	0.000008	<0.000005	<0.000005	<0.000005	<0.000005
Calcium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	0.1	<0.05	0.22	<0.05	<0.05	<0.05
Chromium	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Copper	0.00005	<0.00005	0.00010	0.00013	0.00009	0.00006	<0.00005	0.00007	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Iron	0.001	<0.001	<0.001	0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.0019
Lead	0.000005	<0.000005	<0.000005	*0.000042*	*0.000036*	<0.000005	<0.000005	0.000025	<0.000005	<0.000005	0.000006	0.000006	0.000022	0.000021	<0.000005	<0.000005	<0.000005	0.000007	<0.000005	0.0000138
Lithium	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Note:

Italic	Exceeds RDL value by 5x
Bold	Dissolved metal values greater than Total metals
RDL	Reportable Detection Limit
"-"	No data available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B3. Surface Water Quality Data: Field Blanks, Casino Project, 2008-2012

Parameter	RDL	Date																		
		21-May-08	09-Jul-08	30-Jun-09	09-Aug-09	22-Sep-09	06-Oct-09	02-Dec-09	23-Mar-10	10-May-10	15-Jun-10	09-Jul-10	10-Aug-10	14-Sep-10	29-Mar-11	29-Apr-11	22-Aug-11	07-Oct-11	29-Mar-12	25-May-12
Magnesium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Manganese	0.00005	<0.00005	<0.00005	***0.00048***	0.00008	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00006	0.00008	0.00011	0.00008	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Mercury	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.00001	<0.00001
Molybdenum	0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel	0.00002	<0.00002	0.00002	0.00002	0.00003	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00004	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Phosphorous	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	-	-	-	<0.002	<0.002
Potassium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Silicon	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silver	0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Sodium	0.05	0.07	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Strontium	0.00005	<0.00005	<0.00005	0.00013	<0.00005	<0.00005	<0.00005	0.00008	0.00008	0.00006	<0.00005	<0.00005	<0.00005	<0.00005	0.00011	<0.00005	0.00006	<0.00005	<0.00005	<0.00005
Thallium	0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tin	0.0002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00005	<0.0002	<0.0002
Titanium	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.000002	<0.000002	0.000006	<0.000002	<0.000002	0.000002	<0.000002	<0.000002	<0.000002	0.000005	0.000004	<0.000002	***0.000014***	***0.000011***	***0.000029***	<0.000002	0.000007	<0.000002	<0.000002	<0.000002
Vanadium	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	<0.0002	<0.0002
Zinc	0.0001	***0.0056***	***0.0042***	***0.0035***	0.0003	0.0002	0.0002	<0.0001	0.0002	0.0002	<0.0001	0.0004	0.0005	<0.0001	<0.0001	0.0005	0.0005	0.0002	0.0002	0.00016
Zirconium	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Note:

Italic	Exceeds RDL value by 5x
Bold	Dissolved metal values greater than Total metals
RDL	Reportable Detection Limit
"-"	No data available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Water Basin/Site	Sample Collection Date	Metal	RDL	Total (T) Metals		Dissolved (D) Metals		% D > T
				Value	Value ÷ RDL	Value	Value ÷ RDL	
Casino Creek								
W12	2008-05-23	Zinc	0.0001	0.0575	575	0.0731	731	27.1
W12	2008-07-08	Chromium	0.0001	0.0006	6	0.0008	8	33.3
W12	2008-09-10	Lead	0.000005	0.000962	192.4	0.00124	248	28.9
W12	2008-10-11	Potassium	0.05	1.8	36	2.28	45.6	26.7
W12	2009-06-30	Sodium	0.05	3.32	66.4	4.64	92.8	39.8
W12	2010-05-10	Sodium	0.05	3.57	71.4	7.45	149	108.7
W12	2011-08-23	Sodium	0.05	4.73	94.6	7.78	155.6	64.5
W12	2011-10-07	Sodium	0.05	6.97	139.4	9.7	194	39.2
W43	2008-07-08	Aluminum	0.0002	0.0036	18	0.0056	28	55.6
W43	2011-10-07	Lead	0.000005	0.00854	1708	0.0118	2360	38.2
W13	2008-05-21	Zinc	0.0001	0.0063	63	0.0084	84	33.3
W13	2008-07-09	Zinc	0.0001	0.0014	14	0.0066	66	371.4
W13	2009-08-06	Nickel	0.00002	0.00016	8	0.00097	48.5	506.3
W13	2010-07-08	Cadmium	0.000005	0.00005	10	0.000105	21	110.0
W13	2011-08-23	Molybdenum	0.000050	0.00035	7	0.00051	10.2	45.7
W11	2008-05-22	Zinc	0.0001	0.0072	72	0.0098	98	36.1
W11	2008-07-09	Zinc	0.0001	0.0018	18	0.0051	51	183.3
W11	2009-05-19	Nickel	0.00002	0.00069	34.5	0.00093	46.5	34.8
W11	2009-05-19	Zinc	0.0001	0.0049	49	0.0067	67	36.7
W11	2010-04-21	Cadmium	0.000005	0.000069	13.8	0.00013	26	88.4
W11	2010-06-15	Silicon	0.1	4.3	43	5.4	54	25.6
W11	2011-03-29	Nickel	0.00002	0.00031	15.5	0.00065	32.5	109.7
W18	2009-06-29	Anitmony	0.00002	0.00012	6	0.00021	10.5	75.0
W18	2009-08-06	Lead	0.000005	0.000253	50.6	0.000388	77.6	53.4
W18	2011-04-30	Zinc	0.0001	0.004	40	0.0052	52	30.0
W4	2008-05-22	Zinc	0.0001	0.0048	48	0.0069	69	43.8
W4	2009-05-19	Aluminum	0.0002	0.118	590	0.194	970	64.4
W4	2009-06-29	Molybdenum	0.000050	0.00037	7.4	0.00049	9.8	32.4
W4	2009-10-05	Aluminum	0.0002	0.033	165	0.127	635	284.8
W4	2009-11-04	Aluminum	0.0002	0.0169	84.5	0.0617	308.5	265.1
W4	2009-12-01	Aluminum	0.0002	0.012	60	0.0205	102.5	70.8
W4	2010-06-15	Zinc	0.0001	0.0013	13	0.0027	27	107.7
W4	2010-09-15	Nickel	0.00002	0.0004	20	0.00075	37.5	87.5
W4	2010-09-15	Zinc	0.0001	0.0024	24	0.006	60	150.0
W4	2011-08-23	Molybdenum	0.000050	0.0008	16	0.00108	21.6	35.0
W4	2012-03-29	Aluminum	0.0002	0.0467	233.5	0.18	900	285.4
Dip Creek								
W22	2011-06-13	Zinc	0.0001	0.0009	9	0.0012	12	33.3
R2	2009-09-04	Iron	0.001	0.025	25	0.034	34	36.0
R2	2010-01-29	Sodium	0.05	3.27	65.4	4.9	98	49.8
R2	2010-07-08	Silicon	0.1	3.3	33	4.2	42	27.3
R2	2011-10-04	Nickel	0.00002	0.00037	18.5	0.00058	29	56.8
R2	2012-03-29	Arsenic	0.00002	0.00015	7.5	0.00019	9.5	26.7
W9	2008-07-09	Zinc	0.0001	0.0022	22	0.0054	54	145.5
W9	2008-09-09	Zinc	0.0001	0.0019	19	0.0038	38	100.0
W9	2009-06-29	Molybdenum	0.000050	0.00034	6.8	0.0005	10	47.1
W9	2010-04-22	Aluminum	0.0002	0.0349	174.5	0.046	230	31.8
W9	2010-04-22	Iron	0.001	0.11	110	0.146	146	32.7
W9	2010-04-22	Lead	0.000005	0.000062	12.4	0.00008	16	29.0
W9	2010-07-08	Silicon	0.1	3.6	36	4.8	48	33.3
W9	2011-03-30	Nickel	0.00002	0.00022	11	0.00043	21.5	95.5
W5	2008-05-22	Zinc	0.0001	0.0042	42	0.0053	53	26.2
W5	2008-07-09	Zinc	0.0001	0.002	20	0.0047	47	135.0
W5	2009-08-05	Cobalt	0.000005	0.000029	5.8	0.000038	7.6	31.0
W16	2008-05-21	Zinc	0.0001	0.0036	36	0.0064	64	77.8
W16	2008-07-09	Zinc	0.0001	0.0015	15	0.0039	39	160.0
W16	2010-04-21	Lead	0.000005	0.000029	5.8	0.000038	7.6	31.0
W16	2010-07-08	Silicon	0.1	3.6	36	4.8	48	33.3
W16	2011-06-13	Molybdenum	0.000050	0.00049	9.8	0.00065	13	32.7
W19	2011-06-13	Molybdenum	0.000050	0.00048	9.6	0.00062	12.4	29.2
W19	2011-08-23	Molybdenum	0.000050	0.00075	15	0.00099	19.8	32.0
W19	2012-05-25	Molybdenum	0.000050	0.000548	10.96	0.000952	19.04	73.7

Note: RDL Reportable Detection Limit

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Water Basin/Site	Sample Collection Date	Metal	RDL	Total (T) Metals		Dissolved (D) Metals		% D > T
				Value	Value ÷ RDL	Value	Value ÷ RDL	
Klotassin River								
W20	2010-01-29	Sodium	0.05	3.5	70	5.7	114	62.9
W20	2010-07-07	Silicon	0.1	3.5	35	4.4	44	25.7
W20	2011-08-23	Molybdenum	0.000050	0.00058	11.6	0.00078	15.6	34.5
W21	2009-10-05	Aluminum	0.0002	0.0129	64.5	0.0265	132.5	105.4
W21	2009-10-05	Potassium	0.05	0.77	15.4	1.08	21.6	40.3
W21	2009-10-05	Molybdenum	0.000050	0.00072	14.4	0.00144	28.8	100.0
W21	2009-10-05	Uranium	0.000002	0.00105	525	0.00425	2125	304.8
W21	2010-01-29	Sodium	0.05	3.72	74.4	5.4	108	45.2
W21	2010-06-15	Lead	0.000005	0.000027	5.4	0.000034	6.8	25.9
W21	2010-07-07	Calcium	0.05	13.4	268	17.4	348	29.9
W21	2010-07-07	Silicon	0.1	3.5	35	5	50	42.9
W21	2011-03-29	Copper	0.00005	0.00066	13.2	0.00086	17.2	30.3
W21	2011-10-04	Lead	0.000005	0.000034	6.8	0.000314	62.8	823.5
Britannia Creek								
W7	2008-07-08	Zinc	0.0001	0.0061	61	0.0107	107	75.4
W3	2008-05-23	Zinc	0.0001	0.0073	73	0.0098	98	34.2
W3	2008-10-11	Zinc	0.0001	0.0006	6	0.0009	9	50.0
W3	2009-10-06	Cobalt	0.000005	0.000032	6.4	0.000054	10.8	68.8
W3	2010-07-07	Nickel	0.00002	0.00066	33	0.00094	47	42.4
W3	2010-08-08	Cobalt	0.000005	0.000028	5.6	0.000038	7.6	35.7
W3	2010-08-08	Manganese	0.00005	0.00086	17.2	0.00263	52.6	205.8
W3	2010-09-14	Cadmium	0.000005	0.000027	5.4	0.000051	10.2	88.9
W3	2010-09-14	Copper	0.00005	0.00336	67.2	0.00634	126.8	88.7
W3	2010-09-14	Nickel	0.00002	0.0009	45	0.00166	83	84.4
W3	2010-09-14	Lead	0.000005	0.00004	8	0.000339	67.8	747.5
W3	2010-09-14	Zinc	0.0001	0.0016	16	0.0076	76	375.0
W14	2008-05-23	Zinc	0.0001	0.0026	26	0.0083	83	219.2
W14	2008-07-08	Zinc	0.0001	0.0006	6	0.0058	58	866.7
W14	2009-06-30	Zinc	0.0001	0.0029	29	0.0056	56	93.1
W14	2010-05-08	Zinc	0.0001	0.0025	25	0.0038	38	52.0
W14	2010-07-07	Silicon	0.1	3.3	33	4.2	42	27.3
W14	2010-08-08	Cobalt	0.000005	0.000053	10.6	0.000073	14.6	37.7
W14	2010-08-08	Iron	0.001	0.051	51	0.099	99	94.1
W14	2010-08-08	Manganese	0.00005	0.00038	7.6	0.00347	69.4	813.2
W14	2010-08-08	Molybdenum	0.000050	0.0004	8	0.00062	12.4	55.0
W14	2010-08-08	Nickel	0.00002	0.00056	28	0.00075	37.5	33.9
W14	2010-09-14	Nickel	0.00002	0.00064	32	0.00223	111.5	248.4
W14	2010-09-14	Lead	0.000005	0.000045	9	0.000061	12.2	35.6
W14	2010-10-15	Zinc	0.0001	0.0009	9	0.0014	14	55.6
W14	2011-10-06	Tin	0.00001	0.00006	6	0.0001	10	66.7
W2	2008-05-23	Zinc	0.0001	0.0049	49	0.0081	81	65.3
W2	2008-07-08	Zinc	0.0001	0.0016	16	0.0061	61	281.3
W2	2009-10-06	Molybdenum	0.000050	0.0006	12	0.00081	16.2	35.0
W2	2009-11-04	Zinc	0.0001	0.0006	6	0.0008	8	33.3
W2	2010-06-16	Nickel	0.00002	0.00047	23.5	0.00059	29.5	25.5
W2	2010-07-07	Nickel	0.00002	0.00065	32.5	0.00084	42	29.2
W2	2010-07-07	Lead	0.000005	0.000035	7	0.000053	10.6	51.4
W2	2011-04-28	Lead	0.000005	0.000032	6.4	0.000086	17.2	168.8
W2	2011-08-22	Molybdenum	0.000050	0.00049	9.8	0.00065	13	32.7
W1	2008-07-08	Zinc	0.0001	0.0008	8	0.0045	45	462.5
W1	2008-09-10	Lead	0.000005	0.000064	12.8	0.000262	52.4	309.4
W1	2008-09-10	Zinc	0.0001	0.0008	8	0.0012	12	50.0
W1	2009-08-08	Aluminum	0.0002	0.0143	71.5	0.107	535	648.3
W1	2009-08-08	Arsenic	0.00002	0.00047	23.5	0.00076	38	61.7
W1	2009-08-08	Cobalt	0.000005	0.000029	5.8	0.000167	33.4	475.9
W1	2009-08-08	Copper	0.00005	0.00185	37	0.00269	53.8	45.4
W1	2009-08-08	Iron	0.001	0.01	10	0.174	174	1640.0
W1	2009-08-08	Manganese	0.00005	0.00055	11	0.0106	212	1827.3
W1	2009-08-08	Nickel	0.00002	0.00054	27	0.00106	53	96.3
W1	2009-08-08	Anitmony	0.00002	0.00028	14	0.00039	19.5	39.3
W1	2009-08-08	Zinc	0.0001	0.0007	7	0.0041	41	485.7

Note: RDL Reportable Detection Limit

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Water Basin/Site	Sample Collection Date	Metal	RDL	Total (T) Metals		Dissolved (D) Metals		% D > T
				Value	Value ÷ RDL	Value	Value ÷ RDL	
Britannia Creek								
W1	2010-01-29	Silicon	0.1	4.5	45	5.73	57.3	27.3
W1	2010-09-14	Copper	0.00005	0.00282	56.4	0.00385	77	36.5
W1	2010-09-14	Nickel	0.00002	0.00079	39.5	0.00127	63.5	60.8
W1	2010-09-14	Lead	0.000005	0.000034	6.8	0.000247	49.4	626.5
W1	2010-09-14	Zinc	0.0001	0.0009	9	0.005	50	455.6
W1	2011-10-06	Zinc	0.0001	0.0008	8	0.0023	23	187.5
Yukon River								
W17	2008-05-22	Zinc	0.0001	0.0014	14	0.0086	86	514.3
W17	2008-07-08	Zinc	0.0001	0.0012	12	0.005	50	316.7
W17	2008-09-09	Copper	0.00005	0.00175	35	0.00245	49	40.0
W17	2008-09-09	Zinc	0.0001	0.0014	14	0.0023	23	64.3
W17	2009-08-06	Lead	0.000005	0.000225	45	0.00226	452	904.4
W17	2011-08-22	Molybdenum	0.000050	0.00039	7.8	0.00055	11	41.0
W6b	2008-05-21	Molybdenum	0.000050	0.00059	11.8	0.00088	17.6	49.2
W6b	2010-01-29	Sodium	0.05	1.99	39.8	3.5	70	75.9
W6b	2010-02-24	Iron	0.001	0.019	19	0.04	40	110.5
W6b	2010-02-24	Zinc	0.0001	0.0018	18	0.0058	58	222.2
W6b	2011-04-29	Arsenic	0.00002	0.00025	12.5	0.00035	17.5	40.0
W6b	2011-04-29	Molybdenum	0.000050	0.00076	15.2	0.00109	21.8	43.4
W6b	2011-04-29	Sodium	0.05	1.43	28.6	2.05	41	43.4
W6b	2011-04-29	Uranium	0.000002	0.00091	455	0.00123	615	35.2
W6a	2008-05-21	Molybdenum	0.000050	0.00068	13.6	0.00101	20.2	48.5
W6a	2008-07-08	Zinc	0.0001	0.0029	29	0.0046	46	58.6
W6a	2009-08-06	Lead	0.000005	0.000085	17	0.000199	39.8	134.1
W15	2008-05-21	Molybdenum	0.000050	0.00066	13.2	0.00086	17.2	30.3
W15	2008-07-08	Zinc	0.0001	0.0045	45	0.0065	65	44.4
W15	2009-09-22	Zinc	0.0001	0.002	20	0.0046	46	130.0
W15	2010-01-29	Sodium	0.05	1.82	36.4	3.1	62	70.3
W15	2010-07-07	Molybdenum	0.000050	0.00079	15.8	0.00104	20.8	31.6

Note: RDL Reportable Detection Limit

Appendix B5. Surface Water Quality Statistics: All sites all parameters, Casino Project, 2008-2012

Parameters	CCME[1] Guideline	unit	W12											W8											
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	16	3.06	4.25	3.51	3.43	0.36	0.09	9.70	0	16	100	13	6.90	7.80	7.48	7.60	0.31	0.08	24.42	0	0	0
Conductivity	-	µS/cm	16	209	1610	875	930	379	95	2.31	0	0	0	13	72	373	244	265	95	26	2.56	0	0	0
Total Hardness CaCO3	-	mg/L	16	56	521	294	286	143	36	2.06	0	0	0	13	30	156	106	107	41	11	2.61	0	0	0
Dissolved Hardness CaCO3	-	mg/L	5	57	589	353	397	212	95	1.67	0	0	0	6	31	164	115	131	50	20	2.31	0	0	0
Ion Balance	-	no unit	4	0.87	1.10	0.99	1.00	0.09	0.05	10.53	0	0	0	4	0.89	1.00	0.95	0.95	0.06	0.03	14.88	0	0	0
Total Dissolved Solids	-	mg/L	16	120	1120	590	610	273	68	2.16	0	0	0	13	54	238	166	160	53	15	3.13	0	0	0
Total Suspended Solids	-	mg/L	15	2.0	77.6	18.7	11.0	21.2	5.5	0.88	0	0	0	13	2.0	30.9	8.3	5.0	7.8	2.2	1.07	0	0	0
Turbidity	-	NTU	16	2.5	59.6	19.4	15.4	15.5	3.9	1.25	0	0	0	13	1.0	13.4	5.3	3.4	3.7	1.0	1.40	0	0	0
Ammonia as N	0.499[a]	mg/L	16	0.007	0.180	0.061	0.050	0.049	0.012	1.25	0	0	0	13	0.005	0.048	0.017	0.014	0.012	0.003	1.39	2	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	16	0.25	0.25	0.25	0.25	0	-	-	16	0	0	13	8.19	59.0	37.37	38.0	16.42	4.55	2.28	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	5	2.43	130.00	51.17	33.70	51.94	23.23	0.99	0	0	0	6	0.25	0.25	0.25	0.25	0	-	-	6	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	14	22.20	229.00	110.15	113.00	56.28	15.04	1.96	0	0	0	9	0.25	4.60	2.01	2.10	1.40	0.47	1.44	2	0	0
Bromide (Br)	-	mg/L	12	0.01	0.20	0.17	0.20	0.07	0.02	2.35	12	0	0	10	0.01	0.20	0.16	0.20	0.08	0.03	1.96	10	0	0
Chloride (Cl)	120	mg/L	16	0.25	1.10	0.53	0.55	0.29	0.07	1.82	7	0	0	13	0.25	2.00	0.56	0.25	0.53	0.15	1.07	8	0	0
Fluoride (F)	0.12	mg/L	12	0.066	0.410	0.241	0.220	0.104	0.030	2.33	0	11	92	10	0.049	0.140	0.098	0.100	0.026	0.008	3.84	0	1	10
Sulphate (SO4)	-	mg/L	16	79.20	820.00	370.76	380.00	203.61	50.90	1.82	0	0	0	13	18.90	126.00	75.45	73.00	31.52	8.74	2.39	0	0	0
Total Nitrogen (N)	-	mg/L	5	0.16	0.58	0.32	0.30	0.17	0.07	1.90	0	0	0	6	0.21	0.60	0.29	0.23	0.15	0.06	1.85	0	0	0
Nitrate (as N)	13	mg/L	16	0.014	0.105	0.048	0.031	0.031	0.008	1.56	0	0	0	13	0.011	0.165	0.088	0.090	0.049	0.013	1.81	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	5	0.014	0.105	0.057	0.042	0.041	0.018	1.40	0	0	0	6	0.032	0.165	0.109	0.114	0.051	0.021	2.14	0	0	0
Nitrite (as N)	0.06	mg/L	16	0.001	0.010	0.004	0.003	0.003	0.001	1.28	6	0	0	13	0.001	0.010	0.002	0.001	0.003	0.001	0.91	10	0	0
Total Kjeldahl Nitrogen	-	mg/L	16	0.05	0.56	0.24	0.19000	0.1552	0.0388	1.56	0	0	0	13	0.05	0.57	0.18	0.12000	0.1443	0.0400	1.25	0	0	0
Ortho Phosphate as P	-	mg/L	16	0.0005	0.0150	0.0027	0.0020	0.0035	0.0009	0.77	3	0	0	13	0.0005	0.0070	0.0017	0.0010	0.0017	0.0005	1.02	3	0	0
Cyanide, Total	0.005	mg/L	15	0.00025	0.00130	0.00034	0.00025	0.00027	0.00007	1.23	13	1	7	13	0.00025	0.00140	0.00048	0.00025	0.00036	0.00010	1.34	8	0	0
Cyanide, Weak Acid Diss	-	mg/L	15	0.00025	0.00070	0.00028	0.00025	0.00012	0.00003	2.41	14	0	0	13	0.00025	0.00110	0.00043	0.00025	0.00030	0.00008	1.43	9	0	0
Dissolved Organic Carbon	-	mg/L	9	1.70	7.00	3.08	2.20	1.98	0.66	1.56	0	0	0	8	1.40	12.20	4.67	3.75	3.63	1.28	1.29	0	0	0
Total Organic Carbon	-	mg/L	13	1.50	14.20	5.56	3.00	4.76	1.32	1.17	0	0	0	10	1.50	18.20	6.18	4.30	6.00	1.90	1.03	0	0	0
Total Aluminum	0.1[b]	mg/L	16	2.26	18.50	8.97	8.04	4.79	1.20	1.87	0	16	100	13	0.3580	0.9870	0.5746	0.5340	0.1820	0.0505	3.16	0	13	100
Total Antimony	-	mg/L	16	0.00	0.00	0.00	0.00016	0.0001	0.0000	2.62	0	0	0	13	0.00	0.00	0.00	0.00009	0.0000	0.0000	4.15	0	0	0
Total Arsenic	0.005	mg/L	16	0.00	0.00	0.00	0.00042	0.0006	0.0002	1.12	0	0	0	13	0.00	0.00	0.00	0.00030	0.0002	0.0001	2.02	0	0	0
Total Barium	-	mg/L	16	0.01	0.04	0.02	0.02510	0.0114	0.0029	1.90	0	0	0	13	0.04	0.07	0.05	0.05240	0.0103	0.0029	5.24	0	0	0
Total Beryllium	-	mg/L	16	0.00	0.00	0.00	0.00049	0.0002	0.0001	2.05	0	0	0	13	0.00	0.00	0.00	0.00004	0.0000	0.0000	3.64	0	0	0
Total Bismuth	-	mg/L	16	0.0000025	0.0000820	0.0000149	0.0000060	0.0000214	0.0000053	0.70	9	0	0	13	0.0000025	0.0000307	0.0000057	0.0000025	0.0000078	0.0000022	0.73	9	0	0
Total Boron	1.5	mg/L	16	0.03	0.15	0.04	0.02500	0.0427	0.0107	0.95	16	0	0	13	0.03	0.03	0.03	0.02500	0	-	-	13	0	0
Total Cadmium	0.000032 [c]	mg/L	16	0.000520	0.004600	0.002355	0.002355	0.001155	0.000289	2.04	0	16	100	13	0.000152	0.000382	0.000242	0.000252	0.000068	0.000019	3.58	0	13	100
Total Calcium	-	mg/L	16	16.50	151.00	87.16	84.80	41.93	10.48	2.08	0	0	0	13	9.08	46.40	31.51	31.30	12.00	3.33	2.63	0	0	0
Total Chromium	0.001	mg/L	16	0.00030	0.00080	0.00059	0.00060	0.00015	0.00004	3.99	0	0	0	13	0.00005	0.00051	0.00017	0.00010	0.00015	0.00004	1.16	5	0	0
Total Cobalt	-	mg/L	16	0.007200	0.079700	0.035865	0.036000	0.019245	0.004811	1.86	0	0	0	13	0.001130	0.005020	0.002349	0.002310	0.001015	0.000281	2.31	0	0	0
Total Copper	0.0023[d]	mg/L	16	0.1790	1.4300	0.7808	0.7905	0.3697	0.0924	2.11	0	16	100	13	0.0317	0.0922	0.0573	0.0581	0.0155	0.0043	3.70	0	13	100
Total Iron	0.3	mg/L	16	6.480	39.100	21.694	19.850	10.591	2.648	2.05	0	16	100	13	0.076	1.650	0.873	0.873	0.508	0.141	1.72	0	11	85
Total Lead	0.003[e]	mg/L	16	0.000661	0.002730	0.001487	0.001500	0.000518	0.000129	2.87	0	1	6	13	0.000176	0.001370	0.000501	0.000293	0.000437	0.000121	1.14	0	1	8
Total Lithium	-	mg/L	16	0.00093	0.00800	0.00472	0.00530	0.00208	0.00052	2.27	0	0	0	13	0.00025	0.00140	0.00092	0.00100	0.00035	0.00010	2.65	2	0	0
Total Magnesium	-	mg/L	16	3.67	37.20	18.60	17.90	9.31	2.33	2.00	0	0	0	13	1.87	10.30	6.65	7.03	2.61	0.73	2.55	0	0	0
Total Manganese	-	mg/L	16	0.2430	1.9700	0.9774	1.0105	0.4688	0.1172	2.08	0	0	0	13	0.0539	0.1570	0.0780	0.0679	0.0278	0.0077	2.80	0	0	0
Total Mercury	0.000026	mg/L	14	0.0000050	0.0000250	0.0000093	0.0000050	0.0000078	0.0000021	1.19	12	0	0	10	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	10	0	0
Total Molybdenum	0.073	mg/L	16	0.00003	0.00034	0.00019	0.00017	0.00009	0.00002	2.09	3	0	0	13	0.00014	0.00078	0.00027	0.00023	0.00016	0.00004	1.65	0	0	0
Total Nickel	0.0033[f]	mg/L	16	0.00176	0.01230	0.00596	0.00575	0.00269	0.00067	2.22	0	0	0	13	0.00071	0.00126	0.00093	0.00092	0.00018	0.00005	5.27	0	0	0
Total Phosphorus	-	mg/L	14	0.0040	0.1110	0.0213	0.0095	0.0314	0.0084	0.68	1	0	0	10	0.0010	0.0310	0.0107	0.0045	0.0117	0.0037	0.91	3	0	0
Total Potassium	-	mg/L	16	1.05	2.50	1.71	1.80	0.47	0.12	3.67	0	0	0	13	0.73	1.16	0.89	0.88	0.13	0.04	7.05	0	0	0
Total Selenium	0.001	mg/L	16	0.00008	0.00040	0.00022	0.00023	0.00008	0.00002	2.82	0	0	0	13	0.00002	0.00009	0.00005	0.00006	0.00002	0.00001	2.69	2	0	0
Total Silicon	-	mg/L	16	2.78	13.00	7.88	8.35	2.74	0.69	2.88	0	0	0	13	2.84	6.90	5.45	5.80	1.34	0.37	4.07	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W12											W8										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silver	0.0001	mg/L	16	0.000008	0.000096	0.000026	0.000020	0.000021	0.000005	1.24	2	0	0	13	0.000003	0.000063	0.000009	0.000003	0.000017	0.000005	0.52	10	0	0
Total Sodium	-	mg/L	16	1.24	10.40	5.61	5.43	2.64	0.66	2.12	0	0	0	13	1.01	4.88	3.33	3.53	1.18	0.33	2.82	0	0	0
Total Strontium	-	mg/L	16	0.051	0.457	0.252	0.266	0.118	0.030	2.14	0	0	0	13	0.059	0.361	0.220	0.217	0.091	0.025	2.41	0	0	0
Total Sulphur	-	mg/L	5	27.00	280.00	162.00	183.00	97.74	43.71	1.66	0	0	0	6	5.00	45.00	29.00	32.00	14.46	5.90	2.01	1	0	0
Total Thallium	0.0008	mg/L	16	0.0000226	0.0001200	0.0000652	0.0000665	0.0000267	0.0000067	2.44	0	0	0	13	0.0000040	0.0000100	0.0000071	0.0000070	0.0000020	0.0000006	3.54	0	0	0
Total Tin	-	mg/L	16	0.000005	0.000500	0.000047	0.000005	0.000124	0.000031	0.38	15	0	0	13	0.000005	0.000100	0.000027	0.000005	0.000039	0.000011	0.71	11	0	0
Total Titanium	-	mg/L	16	0.00025	0.01050	0.00269	0.00145	0.00343	0.00086	0.78	7	0	0	13	0.00025	0.01260	0.00223	0.00025	0.00365	0.00101	0.61	8	0	0
Total Uranium	0.015	mg/L	16	0.00276	0.02280	0.01110	0.01140	0.00534	0.00134	2.08	0	0	0	13	0.00098	0.00429	0.00224	0.00193	0.00100	0.00028	2.24	0	0	0
Total Vanadium	-	mg/L	16	0.00010	0.00160	0.00045	0.00035	0.00044	0.00011	1.03	8	0	0	13	0.00010	0.00094	0.00022	0.00010	0.00024	0.00007	0.91	9	0	0
Total Zinc	0.03	mg/L	16	0.04120	0.37700	0.17698	0.17500	0.09062	0.02266	1.95	0	16	100	13	0.01240	0.03160	0.01880	0.01830	0.00530	0.00147	3.55	0	1	8
Total Zirconium	-	mg/L	16	0.00005	0.00050	0.00020	0.00020	0.00014	0.00004	1.41	8	0	0	13	0.00005	0.00042	0.00013	0.00005	0.00012	0.00003	1.08	7	0	0
Dissolved Aluminum	0.1	mg/L	16	1.78	18.80	8.52	7.36	5.15	1.29	1.65	0	16	100	13	0.0275	0.4340	0.1125	0.0569	0.1208	0.0335	0.93	0	3	23
Dissolved Antimony	-	mg/L	16	0.00004	0.00020	0.00012	0.00011	0.00006	0.000014	2.00	3	0	0	13	0.00005	0.00011	0.00008	0.00008	0.00002	0.000005	4.96	0	0	0
Dissolved Arsenic	-	mg/L	16	0.00010	0.00060	0.00034	0.00031	0.00012	0.000030	2.80	0	0	0	13	0.00007	0.00035	0.00021	0.00018	0.00008	0.000023	2.52	0	0	0
Dissolved Barium	-	mg/L	16	0.007900	0.043600	0.020372	0.022600	0.011002	0.002750	1.85	0	0	0	13	0.030500	0.067800	0.051415	0.049800	0.011700	0.003245	4.39	0	0	0
Dissolved Beryllium	-	mg/L	16	0.000025	0.000880	0.000414	0.000440	0.000237	0.000059	1.75	1	0	0	13	0.000005	0.000030	0.000012	0.000010	0.000008	0.000002	1.38	6	0	0
Dissolved Bismuth	-	mg/L	16	0.0000025	0.0000150	0.0000064	0.0000025	0.0000056	0.0000014	1.16	14	0	0	13	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	13	0	0
Dissolved Boron	-	mg/L	16	0.025	0.150	0.056	0.025	0.056	0.014	1.01	16	0	0	13	0.025	0.025	0.025	0.025	0	-	-	13	0	0
Dissolved Cadmium	-	mg/L	16	0.000050	0.004620	0.002167	0.002090	0.001270	0.000317	1.71	0	0	0	13	0.000117	0.000316	0.000200	0.000190	0.000058	0.000016	3.42	0	0	0
Dissolved Calcium	-	mg/L	16	17.00	175.00	87.88	85.20	43.51	10.88	2.02	0	0	0	13	9.38	49.50	32.22	34.00	12.48	3.46	2.58	0	0	0
Dissolved Chromium	-	mg/L	16	0.00024	0.00080	0.00046	0.00045	0.00018	0.00004	2.56	3	0	0	13	0.00005	0.00030	0.00010	0.00005	0.00008	0.00002	1.30	7	0	0
Dissolved Cobalt	-	mg/L	16	0.000630	0.076100	0.033396	0.030000	0.020648	0.005162	1.62	0	0	0	13	0.000914	0.004760	0.002251	0.002270	0.001020	0.000283	2.21	0	0	0
Dissolved Copper	-	mg/L	16	0.0162	1.3400	0.7236	0.7295	0.4078	0.1019	1.77	0	0	0	13	0.0097	0.0493	0.0272	0.0278	0.0100	0.0028	2.73	0	0	0
Dissolved Iron	-	mg/L	16	0.355	35.100	16.522	15.300	12.214	3.053	1.35	0	0	0	13	0.001	0.423	0.219	0.203	0.150	0.042	1.46	0	0	0
Dissolved Lead	-	mg/L	16	0.000050	0.001900	0.001162	0.001185	0.000497	0.000124	2.34	0	0	0	13	0.000003	0.000712	0.000136	0.000092	0.000180	0.000050	0.76	1	0	0
Dissolved Lithium	-	mg/L	16	0.00089	0.00800	0.00459	0.00520	0.00202	0.00050	2.27	0	0	0	13	0.00025	0.00150	0.00091	0.00100	0.00032	0.00009	2.83	1	0	0
Dissolved Magnesium	-	mg/L	16	0.34	37.20	17.83	15.90	10.70	2.67	1.67	0	0	0	13	1.74	10.10	6.77	7.47	2.66	0.74	2.54	0	0	0
Dissolved Manganese	-	mg/L	16	0.0154	1.8800	0.9172	0.8595	0.5196	0.1299	1.77	0	0	0	13	0.0374	0.1510	0.0738	0.0683	0.0295	0.0082	2.50	0	0	0
Dissolved Mercury	-	mg/L	13	0.0000050	0.0000250	0.0000096	0.0000050	0.0000088	0.0000024	1.10	13	0	0	9	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	9	0	0
Dissolved Molybdenum	-	mg/L	16	0.00003	0.00031	0.00014	0.00013	0.00009	0.00002	1.46	7	0	0	13	0.00014	0.00028	0.00022	0.00021	0.00004	0.00001	5.36	0	0	0
Dissolved Nickel	-	mg/L	16	0.00020	0.01160	0.00566	0.00520	0.00300	0.00075	1.88	0	0	0	13	0.00072	0.00110	0.00088	0.00081	0.00013	0.00004	6.92	0	0	0
Dissolved Phosphorus	-	mg/L	13	0.0010	0.0160	0.0066	0.0050	0.0039	0.0011	1.67	4	0	0	9	0.0010	0.0115	0.0046	0.0020	0.0047	0.0016	0.98	4	0	0
Dissolved Potassium	-	mg/L	16	0.99	2.60	1.76	1.80	0.50	0.13	3.51	0	0	0	13	0.66	1.20	0.89	0.88	0.14	0.04	6.17	0	0	0
Dissolved Selenium	-	mg/L	16	0.00007	0.00050	0.00022	0.00019	0.00011	0.00003	2.01	1	0	0	13	0.00002	0.00009	0.00006	0.00006	0.00002	0.00001	2.67	2	0	0
Dissolved Silicon	-	mg/L	16	2.60	14.10	7.96	8.90	3.21	0.80	2.47	0	0	0	13	2.69	7.30	5.55	5.90	1.49	0.41	3.73	0	0	0
Dissolved Silver	-	mg/L	16	0.000003	0.000030	0.000016	0.000016	0.000007	0.000002	2.26	4	0	0	13	0.000003	0.000018	0.000004	0.000003	0.000005	0.000001	0.93	11	0	0
Dissolved Sodium	-	mg/L	15	1.19	10.30	5.76	6.10	2.79	0.72	2.06	0	0	0	13	0.99	4.89	3.40	3.72	1.21	0.34	2.82	0	0	0
Dissolved Strontium	-	mg/L	16	0.050	0.444	0.248	0.257	0.113	0.028	2.20	0	0	0	13	0.056	0.350	0.219	0.210	0.091	0.025	2.40	0	0	0
Dissolved Sulphur	-	mg/L	5	26.00	278.00	164.20	199.00	98.13	43.88	1.67	0	0	0	6	5.00	44.00	29.00	32.00	14.81	6.04	1.96	1	0	0
Dissolved Thallium	-	mg/L	16	0.0000164	0.0001000	0.0000643	0.0000700	0.0000266	0.0000067	2.42	0	0	0	13	0.0000030	0.0000090	0.0000061	0.0000060	0.0000018	0.0000005	3.48	0	0	0
Dissolved Tin	-	mg/L	16	0.000005	0.000500	0.000057	0.000005	0.000124	0.000031	0.46	13	0	0	13	0.000005	0.000100	0.000025	0.000005	0.000039	0.000011	0.65	12	0	0
Dissolved Titanium	-	mg/L	16	0.00025	0.00250	0.00107	0.00110	0.00072	0.00018	1.48	9	0	0	13	0.00025	0.00140	0.00057	0.00025	0.00044	0.00012	1.28	8	0	0
Dissolved Uranium	-	mg/L	16	0.00033	0.02090	0.01008	0.00996	0.00592	0.00148	1.70	0	0	0	13	0.00064	0.00220	0.00150	0.00135	0.00054	0.00015	2.75	0	0	0
Dissolved Vanadium	-	mg/L	16	0.00010	0.00060	0.00027	0.00015	0.00020	0.00005	1.37	12	0	0	13	0.00010	0.00035	0.00013	0.00010	0.00007	0.00002	1.75	11	0	0
Dissolved Zinc	-	mg/L	16	0.00340	0.32800	0.16683	0.15200	0.09664	0.02416	1.73	0	0	0	13	0.00630	0.02180	0.01349	0.01300	0.00448	0.00124	3.01	0	0	0
Dissolved Zirconium	-	mg/L	16	0.00005	0.00030	0.00018	0.00021	0.00010	0.00002	1.85	8	0	0	13	0.00005	0.00030	0.00010	0.00005	0.00008	0.00002	1.22	8	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W43											W13										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	10	6.90	7.64	7.40	7.48	0.22	0.07	34.21	0	0	0	12	7.46	8.20	7.89	8.00	0.25	0.07	31.22	0	0	0
Conductivity	-	µS/cm	10	208	300	236	222	30	9	7.93	0	0	0	12	76	444	253	259	104	30	2.44	0	0	0
Total Hardness CaCO3	-	mg/L	11	80	141	104	100	18	5	5.86	0	0	0	12	41	214	123	125	49	14	2.52	0	0	0
Dissolved Hardness CaCO3	-	mg/L	2	90	100	95	95	7	5	13.44	0	0	0	5	38	223	126	115	72	32	1.76	0	0	0
Ion Balance	-	no unit	2	1.00	1.10	1.05	1.05	0.07	0.05	14.85	0	0	0	4	0.87	1.00	0.94	0.94	0.06	0.03	15.51	0	0	0
Total Dissolved Solids	-	mg/L	10	110	210	151	150	29	9	5.20	0	0	0	12	70	260	154	145	57	17	2.68	0	0	0
Total Suspended Solids	-	mg/L	8	0.5	4.0	1.1	0.5	1.3	0.5	0.88	6	0	0	12	0.5	91.5	15.0	5.8	25.3	7.3	0.59	3	0	0
Turbidity	-	NTU	10	0.2	3.7	0.8	0.4	1.0	0.3	0.78	0	0	0	12	0.1	13.3	2.1	0.5	4.0	1.1	0.54	0	0	0
Ammonia as N	0.499[a]	mg/L	8	0.003	0.016	0.009	0.005	0.006	0.002	1.51	5	0	0	12	0.003	0.047	0.017	0.009	0.016	0.005	1.04	3	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	10	59.0	93.0	73.88	70.0	11.11	3.51	6.65	0	0	0	12	28.8	141.0	96.48	105.0	34.78	10.04	2.77	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	4	0.25	0.25	0.25	0.25	0	-	-	4	0	0	5	0.25	0.25	0.25	0.25	0	-	-	5	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	8	4.60	22.10	11.16	10.74	5.97	2.11	1.87	0	0	0	7	0.25	5.70	2.43	1.90	2.25	0.85	1.08	2	0	0
Bromide (Br)	-	mg/L	6	0.01	0.20	0.14	0.20	0.10	0.04	1.34	6	0	0	9	0.01	0.20	0.16	0.20	0.09	0.03	1.82	9	0	0
Chloride (Cl)	120	mg/L	10	0.25	5.00	0.85	0.25	1.47	0.47	0.58	6	0	0	12	0.25	1.10	0.56	0.43	0.35	0.10	1.60	6	0	0
Fluoride (F)	0.12	mg/L	6	0.080	0.092	0.087	0.090	0.005	0.002	16.13	0	0	0	9	0.034	0.110	0.065	0.060	0.022	0.007	2.99	0	0	0
Sulphate (SO4)	-	mg/L	10	34.00	54.00	40.95	38.50	6.62	2.09	6.19	0	0	0	12	0.25	110.00	33.50	28.00	30.04	8.67	1.12	1	0	0
Total Nitrogen (N)	-	mg/L	4	0.18	0.58	0.31	0.24	0.18	0.09	1.67	0	0	0	5	0.30	0.74	0.53	0.53	0.16	0.07	3.25	0	0	0
Nitrate (as N)	13	mg/L	10	0.128	0.479	0.236	0.173	0.128	0.041	1.84	0	0	0	12	0.082	0.419	0.272	0.291	0.103	0.030	2.65	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	4	0.138	0.479	0.238	0.168	0.162	0.081	1.47	0	0	0	5	0.084	0.419	0.277	0.297	0.130	0.058	2.13	0	0	0
Nitrite (as N)	0.06	mg/L	10	0.001	0.002	0.001	0.001	0.000	0.000	2.69	7	0	0	12	0.001	0.003	0.001	0.001	0.001	0.000	1.93	10	0	0
Total Kjeldahl Nitrogen	-	mg/L	10	0.01	0.10	0.06	0.06400	0.0258	0.0082	2.16	1	0	0	12	0.03	0.66	0.18	0.13500	0.1691	0.0488	1.09	0	0	0
Ortho Phosphate as P	-	mg/L	10	0.0005	0.0630	0.0086	0.0020	0.0192	0.0061	0.45	1	0	0	12	0.0005	0.0040	0.0015	0.0012	0.0010	0.0003	1.48	4	0	0
Cyanide, Total	0.005	mg/L	8	0.00025	0.00025	0.00025	0.00025	0	-	-	8	0	0	12	0.00025	0.00150	0.00057	0.00025	0.00047	0.00014	1.22	7	0	0
Cyanide, Weak Acid Diss	-	mg/L	8	0.00025	0.00025	0.00025	0.00025	0	-	-	8	0	0	12	0.00025	0.00130	0.00045	0.00025	0.00038	0.00011	1.17	9	0	0
Dissolved Organic Carbon	-	mg/L	2	1.00	2.00	1.50	1.50	0.71	0.50	2.12	0	0	0	6	1.31	11.50	4.30	3.15	3.68	1.50	1.17	0	0	0
Total Organic Carbon	-	mg/L	5	0.90	2.00	1.26	1.00	0.46	0.20	2.76	0	0	0	9	1.20	10.80	4.01	3.00	2.92	0.97	1.37	0	0	0
Total Aluminum	0.1[b]	mg/L	11	0.0023	0.0269	0.0126	0.0139	0.0097	0.0029	1.30	0	0	0	12	0.0132	0.7190	0.1577	0.0743	0.2058	0.0594	0.77	0	5	42
Total Antimony	-	mg/L	11	0.00	0.00	0.00	0.00294	0.0005	0.0001	5.88	0	0	0	12	0.00	0.00	0.00	0.00023	0.0001	0.0000	3.87	0	0	0
Total Arsenic	0.005	mg/L	11	0.00	0.00	0.00	0.00068	0.0003	0.0001	2.25	0	0	0	12	0.00	0.00	0.00	0.00136	0.0004	0.0001	3.09	0	0	0
Total Barium	-	mg/L	11	0.04	0.07	0.05	0.04750	0.0090	0.0027	5.75	0	0	0	12	0.05	0.11	0.09	0.08955	0.0153	0.0044	5.65	0	0	0
Total Beryllium	-	mg/L	11	0.00	0.00	0.00	0.00001	0	-	-	11	0	0	12	0.00	0.00	0.00	0.00001	0.0000	0.0000	0.96	8	0	0
Total Bismuth	-	mg/L	11	0.0000025	0.0000100	0.0000032	0.0000025	0.0000023	0.0000007	1.41	10	0	0	12	0.0000025	0.0000140	0.0000050	0.0000025	0.0000043	0.0000012	1.17	8	0	0
Total Boron	1.5	mg/L	11	0.03	0.03	0.03	0.02500	0	-	-	11	0	0	12	0.03	0.03	0.03	0.02500	0	-	-	12	0	0
Total Cadmium	0.000032 [c]	mg/L	11	0.039600	0.068000	0.047400	0.045800	0.008143	0.002455	5.82	0	11	100	12	0.000026	0.000519	0.000124	0.000087	0.000134	0.000039	0.93	0	10	83
Total Calcium	-	mg/L	11	21.40	38.90	28.50	27.40	5.08	1.53	5.61	0	0	0	12	11.40	56.60	33.05	33.60	12.47	3.60	2.65	0	0	0
Total Chromium	0.001	mg/L	11	0.00005	0.00005	0.00005	0.00005	0	-	-	11	0	0	12	0.00005	0.00190	0.00042	0.00015	0.00061	0.00018	0.69	4	2	17
Total Cobalt	-	mg/L	11	0.000162	0.000524	0.000254	0.000221	0.000110	0.000033	2.30	0	0	0	12	0.000018	0.000645	0.000161	0.000074	0.000195	0.000056	0.83	0	0	0
Total Copper	0.0023[d]	mg/L	11	0.0463	0.0909	0.0671	0.0686	0.0128	0.0039	5.25	0	11	100	12	0.0005	0.0092	0.0024	0.0011	0.0028	0.0008	0.88	0	4	33
Total Iron	0.3	mg/L	11	0.021	0.112	0.050	0.047	0.028	0.008	1.80	0	0	0	12	0.021	0.906	0.206	0.071	0.272	0.079	0.76	0	3	25
Total Lead	0.003[e]	mg/L	11	0.004290	0.018300	0.011422	0.009910	0.005099	0.001537	2.24	0	11	100	12	0.000025	0.073000	0.010740	0.003560	0.020573	0.005939	0.52	0	5	42
Total Lithium	-	mg/L	11	0.00160	0.00300	0.00222	0.00220	0.00041	0.00012	5.45	0	0	0	12	0.00070	0.00270	0.00153	0.00150	0.00064	0.00019	2.39	0	0	0
Total Magnesium	-	mg/L	11	6.38	10.70	7.89	7.57	1.24	0.37	6.37	0	0	0	12	3.07	17.60	9.80	9.67	4.35	1.26	2.25	0	0	0
Total Manganese	-	mg/L	11	0.2470	1.0700	0.4135	0.3510	0.2336	0.0704	1.77	0	0	0	12	0.0045	0.1730	0.0517	0.0401	0.0518	0.0149	1.00	0	0	0
Total Mercury	0.000026	mg/L	10	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	10	0	0	10	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	10	0	0
Total Molybdenum	0.073	mg/L	11	0.00003	0.00003	0.00003	0.00003	0	-	-	11	0	0	12	0.00034	0.00088	0.00058	0.00053	0.00019	0.00005	3.07	0	0	0
Total Nickel	0.0033[f]	mg/L	11	0.00039	0.00062	0.00050	0.00049	0.00007	0.00002	6.98	0	0	0	12	0.00016	0.00146	0.00056	0.00036	0.00042	0.00012	1.33	0	0	0
Total Phosphorus	-	mg/L	10	0.0010	0.0050	0.0028	0.0030	0.0013	0.0004	2.16	2	0	0	10	0.0020	0.0647	0.0132	0.0070	0.0189	0.0060	0.70	0	0	0
Total Potassium	-	mg/L	11	1.10	1.62	1.34	1.35	0.13	0.04	10.03	0	0	0	12	0.89	1.41	1.09	1.08	0.14	0.04	7.54	0	0	0
Total Selenium	0.001	mg/L	11	0.00002	0.00002	0.00002	0.00002	0	-	-	11	0	0	12	0.00002	0.00028	0.00006	0.00005	0.00007	0.00002	0.86	4	0	0
Total Silicon	-	mg/L	11	4.60	6.60	5.65	5.80	0.51	0.15	11.12	0	0	0	12	3.02	6.00	5.06	5.35	1.01	0.29	5.00	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

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Parameters	CCME[1] Guideline	unit	W43											W13										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silver	0.0001	mg/L	11	0.000045	0.000215	0.000118	0.000105	0.000053	0.000016	2.24	0	6	55	12	0.000003	0.000152	0.000027	0.000016	0.000042	0.000012	0.63	5	1	8
Total Sodium	-	mg/L	11	2.74	3.75	3.26	3.28	0.30	0.09	10.96	0	0	0	12	1.17	5.59	3.71	3.85	1.32	0.38	2.80	0	0	0
Total Strontium	-	mg/L	11	0.195	0.342	0.255	0.245	0.044	0.013	5.77	0	0	0	12	0.072	0.380	0.214	0.222	0.087	0.025	2.47	0	0	0
Total Sulphur	-	mg/L	5	11.00	16.00	13.40	14.00	2.30	1.03	5.82	0	0	0	5	5.00	39.00	15.40	5.00	15.32	6.85	1.01	3	0	0
Total Thallium	0.0008	mg/L	11	0.0000220	0.0000293	0.0000256	0.0000250	0.0000023	0.0000007	10.92	0	0	0	12	0.0000010	0.0000249	0.0000064	0.0000030	0.0000076	0.0000022	0.84	2	0	0
Total Tin	-	mg/L	11	0.000005	0.000120	0.000033	0.000005	0.000048	0.000014	0.69	10	0	0	12	0.000005	0.000300	0.000038	0.000005	0.000087	0.000025	0.43	11	0	0
Total Titanium	-	mg/L	11	0.00025	0.00060	0.00031	0.00025	0.00014	0.00004	2.22	9	0	0	12	0.00025	0.02890	0.00723	0.00195	0.01034	0.00299	0.70	3	0	0
Total Uranium	0.015	mg/L	11	0.00077	0.00238	0.00136	0.00126	0.00051	0.00015	2.68	0	0	0	12	0.00369	0.02440	0.01217	0.01195	0.00685	0.00198	1.78	0	0	0
Total Vanadium	-	mg/L	11	0.00010	0.00030	0.00012	0.00010	0.00006	0.00002	1.96	10	0	0	12	0.00010	0.00231	0.00058	0.00035	0.00068	0.00020	0.85	5	0	0
Total Zinc	0.03	mg/L	11	2.22000	3.62000	2.62909	2.55000	0.39513	0.11914	6.65	0	11	100	12	0.00140	0.03290	0.00770	0.00610	0.00864	0.00249	0.89	0	1	8
Total Zirconium	-	mg/L	11	0.00005	0.00005	0.00005	0.00005	0	-	-	11	0	0	12	0.00005	0.00030	0.00011	0.00005	0.00010	0.00003	1.10	8	0	0
Dissolved Aluminum	0.1	mg/L	8	0.0013	0.0062	0.0034	0.0031	0.0021	0.0007	1.64	0	0	0	12	0.0023	0.1390	0.0348	0.0153	0.0484	0.0140	0.72	0	2	17
Dissolved Antimony	-	mg/L	8	0.00180	0.00360	0.00278	0.00270	0.00060	0.000214	4.60	0	0	0	12	0.00009	0.00026	0.00020	0.00021	0.00005	0.000014	4.18	0	0	0
Dissolved Arsenic	-	mg/L	8	0.00028	0.00047	0.00033	0.00031	0.00006	0.000022	5.30	0	0	0	12	0.00045	0.00178	0.00112	0.00111	0.00044	0.000128	2.53	0	0	0
Dissolved Barium	-	mg/L	8	0.045100	0.063100	0.053550	0.052250	0.006799	0.002404	7.88	0	0	0	12	0.039800	0.107000	0.078408	0.084350	0.018685	0.005394	4.20	0	0	0
Dissolved Beryllium	-	mg/L	8	0.000005	0.000005	0.000005	0.000005	0	-	-	8	0	0	12	0.000005	0.000020	0.000007	0.000005	0.000004	0.000001	1.50	10	0	0
Dissolved Bismuth	-	mg/L	8	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	8	0	0	12	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	12	0	0
Dissolved Boron	-	mg/L	8	0.025	0.025	0.025	0.025	0	-	-	8	0	0	12	0.025	0.025	0.025	0.025	0	-	-	12	0	0
Dissolved Cadmium	-	mg/L	8	0.041100	0.070500	0.048175	0.045100	0.009808	0.003467	4.91	0	0	0	12	0.000023	0.000120	0.000062	0.000049	0.000037	0.000011	1.67	0	0	0
Dissolved Calcium	-	mg/L	8	24.70	40.40	30.20	28.70	5.39	1.91	5.60	0	0	0	12	10.60	58.60	32.81	33.30	12.94	3.74	2.53	0	0	0
Dissolved Chromium	-	mg/L	8	0.00005	0.00030	0.00008	0.00005	0.00009	0.00003	0.92	7	0	0	12	0.00005	0.00030	0.00010	0.00005	0.00009	0.00002	1.17	8	0	0
Dissolved Cobalt	-	mg/L	8	0.000157	0.000488	0.000264	0.000236	0.000111	0.000039	2.37	0	0	0	12	0.000010	0.000253	0.000041	0.000018	0.000068	0.000020	0.60	0	0	0
Dissolved Copper	-	mg/L	8	0.0447	0.0709	0.0589	0.0589	0.0097	0.0034	6.10	0	0	0	12	0.0003	0.0069	0.0015	0.0008	0.0018	0.0005	0.81	0	0	0
Dissolved Iron	-	mg/L	8	0.007	0.034	0.017	0.013	0.010	0.004	1.74	0	0	0	12	0.001	0.108	0.028	0.012	0.034	0.010	0.81	0	0	0
Dissolved Lead	-	mg/L	8	0.002050	0.012600	0.006218	0.005205	0.004047	0.001431	1.54	0	0	0	12	0.000007	0.002730	0.000580	0.000122	0.000878	0.000253	0.66	0	0	0
Dissolved Lithium	-	mg/L	8	0.00180	0.00320	0.00231	0.00215	0.00045	0.00016	5.15	0	0	0	12	0.00025	0.00270	0.00140	0.00135	0.00071	0.00021	1.96	1	0	0
Dissolved Magnesium	-	mg/L	8	6.81	11.00	8.18	7.97	1.41	0.50	5.79	0	0	0	12	2.80	18.60	9.86	9.89	4.47	1.29	2.20	0	0	0
Dissolved Manganese	-	mg/L	8	0.2490	1.0800	0.4458	0.3645	0.2738	0.0968	1.63	0	0	0	12	0.0015	0.0939	0.0214	0.0117	0.0279	0.0080	0.77	0	0	0
Dissolved Mercury	-	mg/L	6	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	6	0	0	9	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	9	0	0
Dissolved Molybdenum	-	mg/L	8	0.00003	0.00035	0.00008	0.00003	0.00011	0.00004	0.72	5	0	0	12	0.00018	0.00099	0.00060	0.00056	0.00022	0.00006	2.71	0	0	0
Dissolved Nickel	-	mg/L	8	0.00039	0.00061	0.00051	0.00050	0.00008	0.00003	6.49	0	0	0	12	0.00015	0.00097	0.00040	0.00031	0.00025	0.00007	1.57	0	0	0
Dissolved Phosphorus	-	mg/L	6	0.0010	0.0050	0.0018	0.0010	0.0016	0.0007	1.14	4	0	0	9	0.0010	0.0110	0.0038	0.0030	0.0039	0.0013	0.96	4	0	0
Dissolved Potassium	-	mg/L	8	1.18	1.68	1.40	1.38	0.14	0.05	9.81	0	0	0	12	0.80	1.38	1.09	1.15	0.15	0.04	7.21	0	0	0
Dissolved Selenium	-	mg/L	8	0.00002	0.00002	0.00002	0.00002	0	-	-	8	0	0	12	0.00002	0.00031	0.00007	0.00005	0.00008	0.00002	0.79	5	0	0
Dissolved Silicon	-	mg/L	8	5.20	6.60	5.70	5.65	0.47	0.17	12.15	0	0	0	12	2.49	6.50	4.96	5.20	1.15	0.33	4.31	0	0	0
Dissolved Silver	-	mg/L	8	0.000008	0.000090	0.000029	0.000023	0.000025	0.000009	1.16	0	0	0	12	0.000003	0.000020	0.000005	0.000003	0.000005	0.000002	0.92	9	0	0
Dissolved Sodium	-	mg/L	8	2.89	3.95	3.32	3.35	0.35	0.12	9.59	0	0	0	12	1.16	5.39	3.77	3.99	1.35	0.39	2.80	0	0	0
Dissolved Strontium	-	mg/L	8	0.226	0.362	0.266	0.251	0.048	0.017	5.48	0	0	0	12	0.065	0.366	0.210	0.217	0.085	0.024	2.48	0	0	0
Dissolved Sulphur	-	mg/L	2	16.00	17.00	16.50	16.50	0.71	0.50	23.33	0	0	0	5	5.00	42.00	17.00	10.00	15.80	7.06	1.08	2	0	0
Dissolved Thallium	-	mg/L	8	0.0000210	0.0000270	0.0000244	0.0000250	0.0000020	0.0000007	12.21	0	0	0	12	0.0000010	0.0000030	0.0000014	0.0000010	0.0000008	0.0000002	1.79	9	0	0
Dissolved Tin	-	mg/L	8	0.000005	0.000080	0.000014	0.000005	0.000027	0.000009	0.54	7	0	0	12	0.000005	0.000100	0.000022	0.000005	0.000037	0.000011	0.60	11	0	0
Dissolved Titanium	-	mg/L	8	0.00025	0.00100	0.00034	0.00025	0.00027	0.00009	1.30	7	0	0	12	0.00025	0.00144	0.00049	0.00025	0.00046	0.00013	1.06	9	0	0
Dissolved Uranium	-	mg/L	8	0.00081	0.00229	0.00145	0.00128	0.00051	0.00018	2.85	0	0	0	12	0.00243	0.02390	0.01188	0.01182	0.00690	0.00199	1.72	0	0	0
Dissolved Vanadium	-	mg/L	8	0.00010	0.00010	0.00010	0.00010	0	-	-	8	0	0	12	0.00010	0.00035	0.00015	0.00010	0.00009	0.00003	1.64	9	0	0
Dissolved Zinc	-	mg/L	8	2.26000	3.73000	2.65000	2.52000	0.47401	0.16759	5.59	0	0	0	12	0.00110	0.00840	0.00379	0.00280	0.00247	0.00071	1.53	0	0	0
Dissolved Zirconium	-	mg/L	8	0.00005	0.00005	0.00005	0.00005	0	-	-	8	0	0	12	0.00005	0.00020	0.00008	0.00005	0.00005	0.00001	1.59	8	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B5. Surface Water Quality Statistics: All sites all parameters, Casino Project, 2008-2012

Parameters	CCME[1] Guideline	unit	W11											W18										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	24	7.20	8.12	7.86	7.90	0.24	0.05	33.30	0	0	0	22	7.20	8.20	7.79	7.82	0.23	0.05	34.37	0	0	0
Conductivity	-	µS/cm	24	85	450	262	275	95	19	2.76	0	0	0	22	53	267	168	162	66	14	2.56	0	0	0
Total Hardness CaCO3	-	mg/L	24	45	204	129	137	46	9	2.80	0	0	0	22	25	124	78	74	29	6	2.66	0	0	0
Dissolved Hardness CaCO3	-	mg/L	6	47	207	140	147	58	24	2.41	0	0	0	6	26	124	90	100	37	15	2.41	0	0	0
Ion Balance	-	no unit	4	0.84	1.00	0.96	0.99	0.08	0.04	12.43	0	0	0	4	0.79	1.10	0.97	0.99	0.13	0.06	7.47	0	0	0
Total Dissolved Solids	-	mg/L	24	78	278	174	195	50	10	3.51	0	0	0	22	54	170	108	105	37	8	2.95	0	0	0
Total Suspended Solids	-	mg/L	24	0.5	53.0	9.4	2.5	15.0	3.1	0.62	6	0	0	22	0.5	46.0	6.4	1.0	11.8	2.5	0.55	10	0	0
Turbidity	-	NTU	24	0.4	22.5	3.1	1.6	4.8	1.0	0.65	0	0	0	22	0.1	4.6	0.8	0.3	1.2	0.2	0.65	0	0	0
Ammonia as N	0.499[a]	mg/L	24	0.003	0.260	0.029	0.006	0.053	0.011	0.54	12	0	0	22	0.003	0.190	0.029	0.010	0.042	0.009	0.68	8	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	24	25.0	127.0	76.86	82.0	28.89	5.90	2.66	0	0	0	22	15.5	98.0	61.75	62.5	23.50	5.01	2.63	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	6	0.25	0.25	0.25	0.25	0	-	-	6	0	0	6	0.25	0.25	0.25	0.25	0	-	-	6	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	13	0.25	3.90	1.56	1.60	1.11	0.31	1.40	3	0	0	13	0.25	4.30	1.58	1.40	1.19	0.33	1.33	3	0	0
Bromide (Br)	-	mg/L	20	0.01	0.20	0.17	0.20	0.07	0.01	2.60	20	0	0	20	0.01	0.20	0.17	0.20	0.07	0.01	2.60	20	0	0
Chloride (Cl)	120	mg/L	23	0.25	1.40	0.50	0.25	0.37	0.08	1.36	14	0	0	22	0.25	2.50	0.61	0.25	0.60	0.13	1.03	12	0	0
Fluoride (F)	0.12	mg/L	20	0.055	0.100	0.082	0.080	0.013	0.003	6.52	0	0	0	20	0.028	0.060	0.044	0.040	0.009	0.002	5.11	0	0	0
Sulphate (SO4)	-	mg/L	24	9.30	107.00	57.15	62.00	22.05	4.50	2.59	0	0	0	22	0.25	49.00	23.23	23.00	13.04	2.78	1.78	2	0	0
Total Nitrogen (N)	-	mg/L	6	0.21	0.57	0.38	0.38	0.12	0.05	3.22	0	0	0	6	0.18	0.62	0.40	0.39	0.14	0.06	2.75	0	0	0
Nitrate (as N)	13	mg/L	24	0.031	0.289	0.169	0.180	0.083	0.017	2.03	0	0	0	22	0.037	0.333	0.191	0.181	0.092	0.020	2.07	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	6	0.062	0.289	0.213	0.247	0.089	0.036	2.39	0	0	0	6	0.105	0.320	0.200	0.179	0.084	0.034	2.38	0	0	0
Nitrite (as N)	0.06	mg/L	24	0.001	0.010	0.002	0.001	0.002	0.000	0.99	17	0	0	22	0.001	0.010	0.002	0.001	0.002	0.000	0.90	18	0	0
Total Kjeldahl Nitrogen	-	mg/L	24	0.01	0.51	0.20	0.16000	0.1402	0.0286	1.44	1	0	0	22	0.01	0.52	0.20	0.17000	0.1408	0.0300	1.41	2	0	0
Ortho Phosphate as P	-	mg/L	24	0.0005	0.0420	0.0037	0.0010	0.0087	0.0018	0.42	8	0	0	22	0.0005	0.0420	0.0033	0.0010	0.0087	0.0019	0.38	6	0	0
Cyanide, Total	0.005	mg/L	24	0.00025	0.00160	0.00045	0.00025	0.00035	0.00007	1.27	17	0	0	22	0.00025	0.00150	0.00050	0.00025	0.00038	0.00008	1.34	13	0	0
Cyanide, Weak Acid Diss	-	mg/L	24	0.00025	0.00110	0.00039	0.00025	0.00025	0.00005	1.56	17	0	0	22	0.00025	0.00120	0.00044	0.00025	0.00029	0.00006	1.53	14	0	0
Dissolved Organic Carbon	-	mg/L	12	1.44	13.60	6.30	5.30	3.82	1.10	1.65	0	0	0	12	1.84	21.00	8.03	6.70	5.77	1.67	1.39	0	0	0
Total Organic Carbon	-	mg/L	20	1.72	19.90	6.58	5.20	5.01	1.12	1.31	0	0	0	20	1.80	21.80	7.84	5.40	5.87	1.31	1.34	0	0	0
Total Aluminum	0.1[b]	mg/L	24	0.0417	0.6300	0.2154	0.1680	0.1685	0.0344	1.28	0	16	67	22	0.0060	0.7090	0.1323	0.0694	0.1777	0.0379	0.74	0	9	41
Total Antimony	-	mg/L	24	0.00	0.00	0.00	0.00015	0.0001	0.0000	2.82	0	0	0	22	0.00	0.00	0.00	0.00014	0.0000	0.0000	5.33	0	0	0
Total Arsenic	0.005	mg/L	24	0.00	0.00	0.00	0.00069	0.0003	0.0001	3.07	0	0	0	22	0.00	0.00	0.00	0.00039	0.0002	0.0000	2.51	0	0	0
Total Barium	-	mg/L	24	0.04	0.09	0.06	0.06220	0.0126	0.0026	5.03	0	0	0	22	0.03	0.06	0.05	0.04355	0.0095	0.0020	4.80	0	0	0
Total Beryllium	-	mg/L	24	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.13	9	0	0	22	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.20	14	0	0
Total Bismuth	-	mg/L	24	0.0000025	0.0000310	0.0000053	0.0000025	0.0000077	0.0000016	0.68	20	0	0	22	0.0000025	0.0000140	0.0000030	0.0000025	0.0000025	0.0000005	1.23	21	0	0
Total Boron	1.5	mg/L	24	0.03	0.03	0.03	0.02500	0	-	-	24	0	0	22	0.03	0.03	0.03	0.02500	0	-	-	22	0	0
Total Cadmium	0.000032 [c]	mg/L	24	0.000041	0.000278	0.000094	0.000085	0.000050	0.000010	1.90	0	21	88	22	0.000003	0.000064	0.000021	0.000013	0.000018	0.000004	1.19	2	9	41
Total Calcium	-	mg/L	24	12.50	54.60	34.80	36.45	11.99	2.45	2.90	0	0	0	22	6.71	34.00	21.19	20.05	7.77	1.66	2.73	0	0	0
Total Chromium	0.001	mg/L	24	0.00005	0.00100	0.00024	0.00010	0.00027	0.00005	0.88	9	0	0	22	0.00005	0.00070	0.00021	0.00015	0.00019	0.00004	1.07	8	0	0
Total Cobalt	-	mg/L	24	0.000045	0.000973	0.000394	0.000330	0.000289	0.000059	1.37	0	0	0	22	0.000009	0.000421	0.000098	0.000054	0.000118	0.000025	0.83	0	0	0
Total Copper	0.0023[d]	mg/L	24	0.0044	0.0328	0.0161	0.0161	0.0085	0.0017	1.90	0	24	100	22	0.0004	0.0079	0.0019	0.0012	0.0020	0.0004	0.92	0	5	23
Total Iron	0.3	mg/L	24	0.032	1.040	0.339	0.307	0.256	0.052	1.32	0	13	54	22	0.004	0.617	0.139	0.053	0.192	0.041	0.73	0	4	18
Total Lead	0.003[e]	mg/L	23	0.000041	0.010000	0.001363	0.000671	0.002075	0.000433	0.66	0	2	9	22	0.000003	0.000711	0.000154	0.000061	0.000205	0.000044	0.75	4	0	0
Total Lithium	-	mg/L	24	0.00060	0.00260	0.00133	0.00130	0.00045	0.00009	2.95	0	0	0	22	0.00025	0.00200	0.00077	0.00070	0.00037	0.00008	2.06	2	0	0
Total Magnesium	-	mg/L	24	3.28	18.60	10.28	10.80	4.01	0.82	2.56	0	0	0	22	1.95	9.96	6.20	5.82	2.48	0.53	2.50	0	0	0
Total Manganese	-	mg/L	24	0.0145	0.1340	0.0468	0.0331	0.0307	0.0063	1.53	0	0	0	22	0.0015	0.0330	0.0091	0.0037	0.0099	0.0021	0.92	0	0	0
Total Mercury	0.000026	mg/L	21	0.0000050	0.0000100	0.0000057	0.0000050	0.0000018	0.0000004	3.19	18	0	0	19	0.0000050	0.0000100	0.0000053	0.0000050	0.0000011	0.0000003	4.59	18	0	0
Total Molybdenum	0.073	mg/L	24	0.00025	0.00101	0.00065	0.00066	0.00023	0.00005	2.86	0	0	0	22	0.00045	0.00239	0.00127	0.00119	0.00053	0.00011	2.41	0	0	0
Total Nickel	0.0033[f]	mg/L	24	0.00024	0.00167	0.00062	0.00052	0.00039	0.00008	1.61	0	0	0	22	0.00011	0.00109	0.00041	0.00030	0.00030	0.00006	1.38	0	0	0
Total Phosphorus	-	mg/L	21	0.0010	0.0310	0.0097	0.0050	0.0099	0.0022	0.98	5	0	0	19	0.0010	0.0320	0.0079	0.0030	0.0088	0.0020	0.90	5	0	0
Total Potassium	-	mg/L	24	0.50	1.41	0.98	0.96	0.21	0.04	4.65	0	0	0	22	0.64	1.50	1.06	1.02	0.25	0.05	4.24	0	0	0
Total Selenium	0.001	mg/L	24	0.00002	0.00028	0.00012	0.00012	0.00005	0.00001	2.26	1	0	0	22	0.00002	0.00009	0.00004	0.00004	0.00002	0.00000	1.83	10	0	0
Total Silicon	-	mg/L	24	2.83	6.50	5.06	5.25	0.98	0.20	5.17	0	0	0	22	2.30	5.90	4.97	5.30	0.90	0.19	5.51	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W11											W18										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silver	0.0001	mg/L	24	0.000003	0.000091	0.000010	0.000003	0.000019	0.000004	0.51	15	0	0	22	0.000003	0.000010	0.000003	0.000003	0.000002	0.000000	1.73	19	0	0
Total Sodium	-	mg/L	24	1.33	5.53	3.54	3.73	1.12	0.23	3.15	0	0	0	22	1.07	6.42	3.37	3.26	1.24	0.26	2.72	0	0	0
Total Strontium	-	mg/L	24	0.073	0.367	0.220	0.232	0.076	0.015	2.90	0	0	0	22	0.041	0.231	0.118	0.112	0.049	0.010	2.42	0	0	0
Total Sulphur	-	mg/L	6	5.00	39.00	23.17	24.00	11.81	4.82	1.96	1	0	0	6	5.00	17.00	11.00	12.00	5.06	2.07	2.17	2	0	0
Total Thallium	0.0008	mg/L	24	0.0000010	0.0000220	0.0000047	0.0000030	0.0000043	0.0000009	1.08	3	0	0	22	0.0000010	0.0000100	0.0000035	0.0000030	0.0000026	0.0000006	1.37	6	0	0
Total Tin	-	mg/L	24	0.000005	0.000100	0.000013	0.000005	0.000027	0.000005	0.48	24	0	0	22	0.000005	0.000500	0.000041	0.000005	0.000118	0.000025	0.35	19	0	0
Total Titanium	-	mg/L	24	0.00025	0.02050	0.00406	0.00110	0.00574	0.00117	0.71	7	0	0	22	0.00025	0.02040	0.00375	0.00065	0.00591	0.00126	0.64	10	0	0
Total Uranium	0.015	mg/L	24	0.00209	0.02400	0.00975	0.00970	0.00565	0.00115	1.73	0	0	0	22	0.00121	0.00826	0.00399	0.00336	0.00228	0.00049	1.75	0	0	0
Total Vanadium	-	mg/L	24	0.00010	0.00260	0.00050	0.00020	0.00064	0.00013	0.78	11	0	0	22	0.00010	0.00210	0.00059	0.00035	0.00059	0.00013	0.99	4	0	0
Total Zinc	0.03	mg/L	24	0.00180	0.02110	0.00648	0.00550	0.00406	0.00083	1.60	0	0	0	22	0.00020	0.00770	0.00204	0.00140	0.00212	0.00045	0.96	0	0	0
Total Zirconium	-	mg/L	24	0.00005	0.00070	0.00016	0.00015	0.00014	0.00003	1.14	9	0	0	22	0.00005	0.00060	0.00017	0.00015	0.00014	0.00003	1.21	8	0	0
Dissolved Aluminum	0.1	mg/L	24	0.0093	0.2680	0.0696	0.0339	0.0787	0.0161	0.88	0	5	21	22	0.0048	0.3460	0.0729	0.0356	0.0877	0.0187	0.83	0	6	27
Dissolved Antimony	-	mg/L	24	0.00009	0.00019	0.00014	0.00014	0.00002	0.000005	5.95	0	0	0	22	0.00006	0.00021	0.00014	0.00014	0.00003	0.000007	4.27	0	0	0
Dissolved Arsenic	-	mg/L	24	0.00035	0.00091	0.00058	0.00054	0.00014	0.000028	4.22	0	0	0	22	0.00027	0.00069	0.00039	0.00037	0.00010	0.000020	4.07	0	0	0
Dissolved Barium	-	mg/L	24	0.032900	0.091700	0.059238	0.060150	0.014441	0.002948	4.10	0	0	0	22	0.025200	0.061900	0.043814	0.041100	0.011115	0.002370	3.94	0	0	0
Dissolved Beryllium	-	mg/L	24	0.000005	0.000030	0.000010	0.000005	0.000009	0.000002	1.10	17	0	0	22	0.000005	0.000020	0.000007	0.000005	0.000004	0.000001	1.82	16	0	0
Dissolved Bismuth	-	mg/L	24	0.0000025	0.0000150	0.0000033	0.0000025	0.0000028	0.0000006	1.17	22	0	0	22	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	22	0	0
Dissolved Boron	-	mg/L	24	0.025	0.025	0.025	0.025	0	-	-	24	0	0	22	0.025	0.025	0.025	0.025	0	-	-	22	0	0
Dissolved Cadmium	-	mg/L	24	0.000023	0.000130	0.000069	0.000068	0.000027	0.000005	2.57	0	0	0	22	0.000003	0.000063	0.000015	0.000011	0.000016	0.000003	0.98	4	0	0
Dissolved Calcium	-	mg/L	24	12.50	55.20	34.33	37.20	11.52	2.35	2.98	0	0	0	22	7.21	32.90	21.11	19.45	7.89	1.68	2.68	0	0	0
Dissolved Chromium	-	mg/L	24	0.00005	0.00030	0.00011	0.00010	0.00008	0.00002	1.41	10	0	0	22	0.00005	0.00050	0.00016	0.00010	0.00012	0.00003	1.30	7	0	0
Dissolved Cobalt	-	mg/L	24	0.000033	0.000572	0.000260	0.000248	0.000160	0.000033	1.63	0	0	0	22	0.000010	0.000131	0.000041	0.000032	0.000031	0.000007	1.35	0	0	0
Dissolved Copper	-	mg/L	24	0.0034	0.0292	0.0116	0.0085	0.0076	0.0016	1.52	0	0	0	22	0.0004	0.0078	0.0016	0.0010	0.0018	0.0004	0.91	0	0	0
Dissolved Iron	-	mg/L	24	0.002	0.376	0.106	0.065	0.099	0.020	1.07	0	0	0	22	0.002	0.192	0.049	0.028	0.053	0.011	0.91	0	0	0
Dissolved Lead	-	mg/L	23	0.000009	0.000703	0.000175	0.000114	0.000185	0.000039	0.94	0	0	0	22	0.000003	0.000388	0.000063	0.000018	0.000106	0.000023	0.60	1	0	0
Dissolved Lithium	-	mg/L	24	0.00025	0.00240	0.00125	0.00130	0.00048	0.00010	2.62	1	0	0	22	0.00025	0.00220	0.00064	0.00060	0.00046	0.00010	1.40	8	0	0
Dissolved Magnesium	-	mg/L	24	3.23	17.60	10.01	10.55	3.75	0.77	2.67	0	0	0	22	1.89	10.20	6.09	5.68	2.44	0.52	2.49	0	0	0
Dissolved Manganese	-	mg/L	24	0.0136	0.1110	0.0346	0.0269	0.0230	0.0047	1.50	0	0	0	22	0.0011	0.0266	0.0050	0.0027	0.0067	0.0014	0.74	0	0	0
Dissolved Mercury	-	mg/L	20	0.0000050	0.0000200	0.0000063	0.0000050	0.0000036	0.0000008	1.74	17	0	0	18	0.0000050	0.0000100	0.0000053	0.0000050	0.0000012	0.0000003	4.48	17	0	0
Dissolved Molybdenum	-	mg/L	24	0.00025	0.00099	0.00064	0.00063	0.00021	0.00004	3.01	0	0	0	22	0.00045	0.00239	0.00126	0.00116	0.00054	0.00011	2.34	0	0	0
Dissolved Nickel	-	mg/L	24	0.00019	0.00112	0.00050	0.00045	0.00024	0.00005	2.12	0	0	0	22	0.00010	0.00076	0.00033	0.00025	0.00021	0.00004	1.61	0	0	0
Dissolved Phosphorus	-	mg/L	20	0.0010	0.0100	0.0033	0.0010	0.0033	0.0007	1.01	11	0	0	17	0.0010	0.0094	0.0030	0.0010	0.0028	0.0007	1.04	9	0	0
Dissolved Potassium	-	mg/L	24	0.45	1.47	0.96	0.94	0.22	0.05	4.35	0	0	0	22	0.63	1.53	1.05	1.05	0.24	0.05	4.28	0	0	0
Dissolved Selenium	-	mg/L	24	0.00007	0.00028	0.00012	0.00012	0.00005	0.00001	2.55	0	0	0	22	0.00002	0.00012	0.00004	0.00002	0.00003	0.00001	1.42	12	0	0
Dissolved Silicon	-	mg/L	24	2.74	6.40	4.97	5.20	0.92	0.19	5.38	0	0	0	22	2.34	6.10	4.87	5.00	0.94	0.20	5.21	0	0	0
Dissolved Silver	-	mg/L	24	0.000003	0.000013	0.000005	0.000003	0.000004	0.000001	1.29	17	0	0	22	0.000003	0.000007	0.000003	0.000003	0.000001	0.000000	2.58	20	0	0
Dissolved Sodium	-	mg/L	24	1.37	5.33	3.47	3.66	1.06	0.22	3.28	0	0	0	22	1.10	6.46	3.31	3.20	1.19	0.25	2.77	0	0	0
Dissolved Strontium	-	mg/L	24	0.072	0.365	0.217	0.228	0.074	0.015	2.92	0	0	0	22	0.041	0.250	0.117	0.113	0.051	0.011	2.29	0	0	0
Dissolved Sulphur	-	mg/L	6	5.00	40.00	23.67	24.00	12.40	5.06	1.91	1	0	0	6	5.00	16.00	10.50	12.00	4.55	1.86	2.31	2	0	0
Dissolved Thallium	-	mg/L	24	0.0000010	0.0000050	0.0000030	0.0000030	0.0000012	0.0000002	2.44	4	0	0	22	0.0000010	0.0000050	0.0000024	0.0000030	0.0000011	0.0000002	2.08	7	0	0
Dissolved Tin	-	mg/L	24	0.000005	0.000100	0.000013	0.000005	0.000027	0.000005	0.48	24	0	0	22	0.000005	0.000100	0.000014	0.000005	0.000028	0.000006	0.51	20	0	0
Dissolved Titanium	-	mg/L	24	0.00025	0.00210	0.00060	0.00025	0.00061	0.00013	0.97	16	0	0	22	0.00025	0.00260	0.00062	0.00025	0.00065	0.00014	0.95	15	0	0
Dissolved Uranium	-	mg/L	24	0.00144	0.02370	0.00946	0.00934	0.00556	0.00113	1.70	0	0	0	22	0.00102	0.00863	0.00393	0.00324	0.00238	0.00051	1.65	0	0	0
Dissolved Vanadium	-	mg/L	24	0.00010	0.00060	0.00018	0.00010	0.00014	0.00003	1.29	16	0	0	22	0.00010	0.00100	0.00034	0.00030	0.00021	0.00005	1.58	4	0	0
Dissolved Zinc	-	mg/L	24	0.00110	0.00980	0.00420	0.00430	0.00190	0.00039	2.21	0	0	0	22	0.00020	0.00520	0.00112	0.00060	0.00120	0.00026	0.93	0	0	0
Dissolved Zirconium	-	mg/L	24	0.00005	0.00050	0.00012	0.00010	0.00011	0.00002	1.14	11	0	0	22	0.00005	0.00050	0.00017	0.00020	0.00013	0.00003	1.35	8	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W4											W24											
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	24	7.30	8.20	7.84	7.90	0.24	0.05	32.03	0	0	0	1	7.69	7.69	7.69	7.69	0	-	-	0	0	0
Conductivity	-	µS/cm	24	71	387	234	236	82	17	2.85	0	0	0	1	132	132	132	132	0	-	-	0	0	0
Total Hardness CaCO3	-	mg/L	24	37	176	111	111	39	8	2.87	0	0	0	1	62	62	62	62	0	-	-	0	0	0
Dissolved Hardness CaCO3	-	mg/L	6	33	176	123	129	52	21	2.36	0	0	0	1	58	58	58	58	0	-	-	0	0	0
Moisture	-	%	-	-	-	-	-	-	-	-	-	-	-	1	75	75	75	75	0	-	-	0	0	0
Ion Balance	-	no unit	4	0.93	1.00	0.98	1.00	0.03	0.02	28.07	0	0	0	1	0.97	0.97	0.97	0.97	0	-	-	0	0	0
Total Dissolved Solids	-	mg/L	24	72	232	154	150	44	9	3.52	0	0	0	1	74	74	74	74	0	-	-	0	0	0
Total Suspended Solids	-	mg/L	24	0.5	130.0	13.9	2.0	32.8	6.7	0.43	7	0	0	1	0.5	0.5	0.5	0.5	0	-	-	1	0	0
Turbidity	-	NTU	24	0.2	51.0	3.5	0.8	10.4	2.1	0.33	0	0	0	1	0.4	0.4	0.4	0.4	0	-	-	0	0	0
Ammonia as N	0.499[a]	mg/L	24	0.003	0.250	0.033	0.010	0.053	0.011	0.62	10	0	0	1	0.043	0.043	0.043	0.043	0	-	-	0	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	24	22.0	125.0	78.04	79.0	27.81	5.68	2.81	0	0	0	1	40.0	40.0	40.0	40.0	0	-	-	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	6	0.25	0.25	0.25	0.25	0	-	-	6	0	0	1	0.25	0.25	0.25	0.25	0	-	-	1	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	13	0.25	4.50	1.64	1.40	1.29	0.36	1.27	3	0	0	1	1.80	1.80	1.80	1.80	0	-	-	0	0	0
Bromide (Br)	-	mg/L	20	0.01	0.20	0.17	0.20	0.07	0.01	2.60	20	0	0	1	0.20	0.20	0.20	0.20	0	-	-	1	0	0
Chloride (Cl)	120	mg/L	24	0.25	6.40	0.83	0.25	1.27	0.26	0.65	13	0	0	1	0.25	0.25	0.25	0.25	0	-	-	1	0	0
Fluoride (F)	0.12	mg/L	20	0.040	0.100	0.068	0.070	0.013	0.003	5.19	0	0	0	1	0.060	0.060	0.060	0.060	0	-	-	0	0	0
Sulphate (SO4)	-	mg/L	24	7.16	70.50	39.02	41.00	16.68	3.40	2.34	0	0	0	1	21.00	21.00	21.00	21.00	0	-	-	0	0	0
Total Nitrogen (N)	-	mg/L	6	0.16	0.74	0.39	0.36	0.19	0.08	2.08	0	0	0	1	0.24	0.24	0.24	0.24	0	-	-	0	0	0
Nitrate (as N)	13	mg/L	24	0.022	0.264	0.145	0.158	0.080	0.016	1.81	0	0	0	1	0.205	0.205	0.205	0.205	0	-	-	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	6	0.052	0.264	0.174	0.182	0.082	0.034	2.11	0	0	0	1	0.205	0.205	0.205	0.205	0	-	-	0	0	0
Nitrite (as N)	0.06	mg/L	24	0.001	0.004	0.001	0.001	0.001	0.000	1.72	18	0	0	1	0.001	0.001	0.001	0.001	0	-	-	1	0	0
Total Kjeldahl Nitrogen	-	mg/L	23	0.01	0.69	0.21	0.17000	0.1604	0.0334	1.30	1	0	0	1	0.03	0.03	0.03	0.03000	0	-	-	0	0	0
Ortho Phosphate as P	-	mg/L	24	0.0005	0.0480	0.0036	0.0010	0.0097	0.0020	0.37	7	0	0	1	0.0010	0.0010	0.0010	0.0010	0	-	-	0	0	0
Cyanide, Total	0.005	mg/L	23	0.00025	0.00210	0.00053	0.00025	0.00044	0.00009	1.20	13	1	4	1	0.00025	0.00025	0.00025	0.00025	0	-	-	1	0	0
Cyanide, Weak Acid Diss	-	mg/L	24	0.00025	0.00170	0.00049	0.00025	0.00036	0.00007	1.36	14	0	0	1	0.00025	0.00025	0.00025	0.00025	0	-	-	1	0	0
Dissolved Organic Carbon	-	mg/L	12	2.10	13.40	6.76	7.00	3.63	1.05	1.86	0	0	0	1	8.80	8.80	8.80	8.80	0	-	-	0	0	0
Total Organic Carbon	-	mg/L	20	1.80	19.80	7.18	5.65	4.80	1.07	1.50	0	0	0	1	9.20	9.20	9.20	9.20	0	-	-	0	0	0
Total Aluminum	0.1[b]	mg/L	24	0.0120	0.9450	0.1589	0.0811	0.2397	0.0489	0.66	0	9	38	1	0.0436	0.0436	0.0436	0.0436	0	-	-	0	0	0
Total Antimony	-	mg/L	24	0.00	0.00	0.00	0.00013	0.0001	0.0000	2.12	0	0	0	1	0.00	0.00	0.00	0.00030	0	-	-	0	0	0
Total Arsenic	0.005	mg/L	24	0.00	0.00	0.00	0.00043	0.0005	0.0001	1.26	0	0	0	1	0.00	0.00	0.00	0.00063	0	-	-	0	0	0
Total Barium	-	mg/L	24	0.04	0.10	0.06	0.05850	0.0151	0.0031	4.07	0	0	0	1	0.04	0.04	0.04	0.03960	0	-	-	0	0	0
Total Beryllium	-	mg/L	24	0.00	0.00	0.00	0.00001	0.0000	0.0000	0.71	16	0	0	1	0.00	0.00	0.00	0.00001	0	-	-	0	0	0
Total Bismuth	-	mg/L	24	0.0000025	0.0000177	0.0000044	0.0000025	0.0000048	0.0000010	0.92	20	0	0	1	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	1	0	0
Total Boron	1.5	mg/L	24	0.03	0.03	0.03	0.02500	0	-	-	24	0	0	1	0.03	0.03	0.03	0.02500	0	-	-	1	0	0
Total Cadmium	0.000032 [c]	mg/L	24	0.000012	0.000271	0.000048	0.000027	0.000067	0.000014	0.73	0	8	33	1	0.000013	0.000013	0.000013	0.000013	0	-	-	0	0	0
Total Calcium	-	mg/L	24	10.10	47.20	29.55	29.40	10.02	2.05	2.95	0	0	0	1	16.30	16.30	16.30	16.30	0	-	-	0	0	0
Total Chromium	0.001	mg/L	24	0.00005	0.00126	0.00023	0.00010	0.00027	0.00006	0.83	9	1	4	1	0.00030	0.00030	0.00030	0.00030	0	-	-	0	0	0
Total Cobalt	-	mg/L	24	0.000017	0.001700	0.000227	0.000079	0.000403	0.000082	0.56	0	0	0	1	0.000043	0.000043	0.000043	0.000043	0	-	-	0	0	0
Total Copper	0.0023[d]	mg/L	24	0.0015	0.0278	0.0079	0.0059	0.0070	0.0014	1.13	0	18	75	1	0.0014	0.0014	0.0014	0.0014	0	-	-	0	0	0
Total Iron	0.3	mg/L	24	0.011	1.930	0.258	0.126	0.422	0.086	0.61	0	4	17	1	0.039	0.039	0.039	0.039	0	-	-	0	0	0
Total Lead	0.003[e]	mg/L	23	0.000028	0.010700	0.000751	0.000182	0.002194	0.000457	0.34	0	2	9	1	0.000081	0.000081	0.000081	0.000081	0	-	-	0	0	0
Total Lithium	-	mg/L	24	0.00060	0.00160	0.00109	0.00100	0.00026	0.00005	4.19	0	0	0	1	0.00025	0.00025	0.00025	0.00025	0	-	-	1	0	0
Total Magnesium	-	mg/L	24	2.85	15.10	9.13	9.03	3.37	0.69	2.71	0	0	0	1	5.19	5.19	5.19	5.19	0	-	-	0	0	0
Total Manganese	-	mg/L	24	0.0038	0.2150	0.0275	0.0115	0.0474	0.0097	0.58	0	0	0	1	0.0006	0.0006	0.0006	0.0006	0	-	-	0	0	0
Total Mercury	0.000026	mg/L	21	0.0000050	0.0000100	0.0000055	0.0000050	0.0000015	0.0000003	3.64	19	0	0	1	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	1	0	0
Total Molybdenum	0.073	mg/L	24	0.00037	0.00138	0.00103	0.00113	0.00030	0.00006	3.50	0	0	0	1	0.00028	0.00028	0.00028	0.00028	0	-	-	0	0	0
Total Nickel	0.0033[f]	mg/L	24	0.00016	0.00171	0.00047	0.00037	0.00039	0.00008	1.21	0	0	0	1	0.00064	0.00064	0.00064	0.00064	0	-	-	0	0	0
Total Phosphorus	-	mg/L	21	0.0010	0.0910	0.0136	0.0060	0.0234	0.0051	0.58	2	0	0	1	0.0040	0.0040	0.0040	0.0040	0	-	-	0	0	0
Total Potassium	-	mg/L	24	0.59	1.54	1.04	1.01	0.23	0.05	4.52	0	0	0	1	0.43	0.43	0.43	0.43	0	-	-	0	0	0
Total Selenium	0.001	mg/L	24	0.00002	0.00015	0.00007	0.00007	0.00002	0.00000	2.98	1	0	0	1	0.00043	0.00043	0.00043	0.00043	0	-	-	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W4											W24											
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silicon	-	mg/L	24	3.07	6.10	4.97	5.10	0.82	0.17	6.04	0	0	0	1	2.80	2.80	2.80	2.80	0	-	-	0	0	0
Total Silver	0.0001	mg/L	24	0.000003	0.000090	0.000009	0.000003	0.000021	0.000004	0.43	21	0	0	1	0.000003	0.000003	0.000003	0.000003	0	-	-	1	0	0
Total Sodium	-	mg/L	24	1.22	6.02	4.00	4.08	1.33	0.27	2.99	0	0	0	1	0.90	0.90	0.90	0.90	0	-	-	0	0	0
Total Strontium	-	mg/L	24	0.065	0.309	0.184	0.179	0.065	0.013	2.83	0	0	0	1	0.044	0.044	0.044	0.044	0	-	-	0	0	0
Total Sulphur	-	mg/L	6	5.00	26.00	16.83	17.00	7.47	3.05	2.25	1	0	0	1	5.00	5.00	5.00	5.00	0	-	-	1	0	0
Total Thallium	0.0008	mg/L	24	0.0000010	0.0000300	0.0000040	0.0000020	0.0000066	0.0000013	0.61	11	0	0	1	0.0000040	0.0000040	0.0000040	0.0000040	0	-	-	0	0	0
Total Tin	-	mg/L	24	0.000005	0.000100	0.000013	0.000005	0.000027	0.000005	0.48	24	0	0	1	0.000005	0.000005	0.000005	0.000005	0	-	-	1	0	0
Total Titanium	-	mg/L	24	0.00025	0.03130	0.00394	0.00145	0.00702	0.00143	0.56	7	0	0	1	0.00110	0.00110	0.00110	0.00110	0	-	-	0	0	0
Total Uranium	0.015	mg/L	24	0.00222	0.01850	0.00746	0.00663	0.00428	0.00087	1.74	0	0	0	1	0.00031	0.00031	0.00031	0.00031	0	-	-	0	0	0
Total Vanadium	-	mg/L	24	0.00010	0.00389	0.00067	0.00040	0.00097	0.00020	0.69	8	0	0	1	0.00010	0.00010	0.00010	0.00010	0	-	-	1	0	0
Total Zinc	0.03	mg/L	24	0.00050	0.02380	0.00379	0.00180	0.00553	0.00113	0.69	0	0	0	1	0.00310	0.00310	0.00310	0.00310	0	-	-	0	0	0
Total Zirconium	-	mg/L	24	0.00005	0.00070	0.00018	0.00015	0.00016	0.00003	1.11	9	0	0	1	0.00020	0.00020	0.00020	0.00020	0	-	-	0	0	0
Dissolved Aluminum	0.1	mg/L	24	0.0060	0.2470	0.0569	0.0270	0.0655	0.0134	0.87	0	4	17	1	0.0395	0.0395	0.0395	0.0395	0	-	-	0	0	0
Dissolved Antimony	-	mg/L	24	0.00007	0.00022	0.00013	0.00013	0.00003	0.000006	4.79	0	0	0	1	0.00030	0.00030	0.00030	0.00030	0	-	-	0	0	0
Dissolved Arsenic	-	mg/L	24	0.00030	0.00075	0.00041	0.00039	0.00010	0.000020	4.24	0	0	0	1	0.00060	0.00060	0.00060	0.00060	0	-	-	0	0	0
Dissolved Barium	-	mg/L	24	0.027000	0.098700	0.057133	0.054150	0.017435	0.003559	3.28	0	0	0	1	0.038600	0.038600	0.038600	0.038600	0	-	-	0	0	0
Dissolved Beryllium	-	mg/L	24	0.000005	0.000020	0.000007	0.000005	0.000004	0.000001	1.64	17	0	0	1	0.000005	0.000005	0.000005	0.000005	0	-	-	1	0	0
Dissolved Bismuth	-	mg/L	24	0.0000025	0.0000050	0.0000026	0.0000025	0.0000005	0.0000001	5.10	23	0	0	1	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	1	0	0
Dissolved Boron	-	mg/L	24	0.025	0.025	0.025	0.025	0	-	-	24	0	0	1	0.025	0.025	0.025	0.025	0	-	-	1	0	0
Dissolved Cadmium	-	mg/L	24	0.000006	0.000047	0.000023	0.000021	0.000010	0.000002	2.23	0	0	0	1	0.000003	0.000003	0.000003	0.000003	0	-	-	1	0	0
Dissolved Calcium	-	mg/L	24	8.91	46.60	29.06	28.45	9.94	2.03	2.92	0	0	0	1	14.40	14.40	14.40	14.40	0	-	-	0	0	0
Dissolved Chromium	-	mg/L	24	0.00005	0.00030	0.00012	0.00008	0.00009	0.00002	1.33	12	0	0	1	0.00030	0.00030	0.00030	0.00030	0	-	-	0	0	0
Dissolved Cobalt	-	mg/L	24	0.000014	0.000174	0.000071	0.000062	0.000048	0.000010	1.50	0	0	0	1	0.000029	0.000029	0.000029	0.000029	0	-	-	0	0	0
Dissolved Copper	-	mg/L	24	0.0014	0.0147	0.0056	0.0041	0.0040	0.0008	1.41	0	0	0	1	0.0013	0.0013	0.0013	0.0013	0	-	-	0	0	0
Dissolved Iron	-	mg/L	24	0.003	0.201	0.066	0.043	0.060	0.012	1.09	0	0	0	1	0.026	0.026	0.026	0.026	0	-	-	0	0	0
Dissolved Lead	-	mg/L	23	0.000006	0.000495	0.000077	0.000029	0.000106	0.000022	0.73	0	0	0	1	0.000012	0.000012	0.000012	0.000012	0	-	-	0	0	0
Dissolved Lithium	-	mg/L	24	0.00025	0.00150	0.00102	0.00100	0.00032	0.00007	3.14	1	0	0	1	0.00025	0.00025	0.00025	0.00025	0	-	-	1	0	0
Dissolved Magnesium	-	mg/L	24	2.54	15.30	9.08	8.52	3.33	0.68	2.73	0	0	0	1	5.41	5.41	5.41	5.41	0	-	-	0	0	0
Dissolved Manganese	-	mg/L	24	0.0034	0.0233	0.0093	0.0076	0.0054	0.0011	1.73	0	0	0	1	0.0002	0.0002	0.0002	0.0002	0	-	-	0	0	0
Dissolved Mercury	-	mg/L	20	0.0000050	0.0000100	0.0000053	0.0000050	0.0000011	0.0000003	4.70	19	0	0	-	-	-	-	-	-	-	-	-	-	-
Dissolved Molybdenum	-	mg/L	24	0.00033	0.00141	0.00106	0.00110	0.00029	0.00006	3.68	0	0	0	1	0.00030	0.00030	0.00030	0.00030	0	-	-	0	0	0
Dissolved Nickel	-	mg/L	24	0.00015	0.00089	0.00037	0.00032	0.00021	0.00004	1.75	0	0	0	1	0.00054	0.00054	0.00054	0.00054	0	-	-	0	0	0
Dissolved Phosphorus	-	mg/L	20	0.0010	0.0120	0.0040	0.0030	0.0034	0.0008	1.17	6	0	0	-	-	-	-	-	-	-	-	-	-	-
Dissolved Potassium	-	mg/L	24	0.59	1.57	1.03	1.02	0.23	0.05	4.50	0	0	0	1	0.45	0.45	0.45	0.45	0	-	-	0	0	0
Dissolved Selenium	-	mg/L	24	0.00002	0.00015	0.00007	0.00007	0.00003	0.00001	2.52	1	0	0	1	0.00036	0.00036	0.00036	0.00036	0	-	-	0	0	0
Dissolved Silicon	-	mg/L	24	2.24	6.40	4.90	5.10	0.97	0.20	5.03	0	0	0	1	2.60	2.60	2.60	2.60	0	-	-	0	0	0
Dissolved Silver	-	mg/L	24	0.000003	0.000028	0.000004	0.000003	0.000005	0.000001	0.73	21	0	0	1	0.000003	0.000003	0.000003	0.000003	0	-	-	1	0	0
Dissolved Sodium	-	mg/L	24	1.19	6.16	3.99	3.82	1.29	0.26	3.08	0	0	0	1	0.90	0.90	0.90	0.90	0	-	-	0	0	0
Dissolved Strontium	-	mg/L	24	0.057	0.299	0.183	0.179	0.064	0.013	2.83	0	0	0	1	0.044	0.044	0.044	0.044	0	-	-	0	0	0
Dissolved Sulphur	-	mg/L	6	5.00	27.00	17.17	17.00	8.26	3.37	2.08	1	0	0	1	5.00	5.00	5.00	5.00	0	-	-	1	0	0
Dissolved Thallium	-	mg/L	24	0.0000010	0.0000050	0.0000019	0.0000010	0.0000011	0.0000002	1.66	13	0	0	1	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	0	0	0
Dissolved Tin	-	mg/L	24	0.000005	0.000100	0.000014	0.000005	0.000027	0.000006	0.52	23	0	0	1	0.000005	0.000005	0.000005	0.000005	0	-	-	1	0	0
Dissolved Titanium	-	mg/L	24	0.00025	0.00230	0.00060	0.00025	0.00062	0.00013	0.96	16	0	0	1	0.00110	0.00110	0.00110	0.00110	0	-	-	0	0	0
Dissolved Uranium	-	mg/L	24	0.00150	0.01820	0.00734	0.00639	0.00440	0.00090	1.67	0	0	0	1	0.00028	0.00028	0.00028	0.00028	0	-	-	0	0	0
Dissolved Vanadium	-	mg/L	24	0.00010	0.00080	0.00027	0.00025	0.00018	0.00004	1.48	9	0	0	1	0.00040	0.00040	0.00040	0.00040	0	-	-	0	0	0
Dissolved Zinc	-	mg/L	24	0.00050	0.00690	0.00212	0.00155	0.00173	0.00035	1.23	0	0	0	1	0.00040	0.00040	0.00040	0.00040	0	-	-	0	0	0
Dissolved Zirconium	-	mg/L	24	0.00005	0.00050	0.00014	0.00010	0.00011	0.00002	1.28	9	0	0	1	0.00020	0.00020	0.00020	0.00020	0	-	-	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B5. Surface Water Quality Statistics: All sites all parameters, Casino Project, 2008-2012

Parameters	CCME[1] Guideline	unit	W22											R2											
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	5	7.26	8.00	7.71	7.92	0.34	0.15	22.83	0	0	0	19	7.37	7.90	7.70	7.70	0.15	0.03	50.81	0	0	0
Conductivity	-	µS/cm	5	69	289	179	220	100	45	1.80	0	0	0	19	51	263	159	163	50	11	3.18	0	0	0
Total Hardness CaCO3	-	mg/L	5	28	132	75	71	43	19	1.73	0	0	0	5	26	125	83	93	37	16	2.26	0	0	0
Dissolved Hardness CaCO3	-	mg/L	5	30	128	74	70	41	19	1.79	0	0	0	19	27	118	75	76	22	5	3.45	0	0	0
Ion Balance	-	no unit	3	0.92	1.00	0.97	0.99	0.04	0.03	22.25	0	0	0	3	0.91	1.00	0.96	0.98	0.05	0.03	20.38	0	0	0
Total Dissolved Solids	-	mg/L	5	54	164	100	82	46	20	2.19	0	0	0	19	70	150	102	100	24	6	4.20	0	0	0
Total Suspended Solids	-	mg/L	5	0.5	10.0	4.1	0.5	4.9	2.2	0.83	3	0	0	19	0.5	31.1	3.2	0.5	7.1	1.6	0.45	11	0	0
Turbidity	-	NTU	5	0.2	2.2	1.1	1.1	0.9	0.4	1.21	0	0	0	19	0.1	3.1	0.5	0.2	0.7	0.2	0.68	1	0	0
Ammonia as N	0.499[a]	mg/L	5	0.010	0.046	0.022	0.020	0.014	0.006	1.58	0	0	0	19	0.003	0.070	0.013	0.005	0.016	0.004	0.80	11	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	5	16.0	137.0	70.68	65.0	48.80	21.82	1.45	0	0	0	19	21.3	88.0	63.70	67.0	17.08	3.92	3.73	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	5	0.25	0.25	0.25	0.25	0	-	-	5	0	0	5	0.25	0.25	0.25	0.25	0	-	-	5	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	5	0.25	7.50	2.47	2.10	2.97	1.33	0.83	2	0	0	13	0.70	7.30	2.48	1.60	1.88	0.52	1.32	0	0	0
Bromide (Br)	-	mg/L	5	0.01	0.20	0.12	0.20	0.11	0.05	1.14	5	0	0	19	0.01	0.20	0.18	0.20	0.06	0.01	2.92	19	0	0
Chloride (Cl)	120	mg/L	5	0.25	0.80	0.47	0.25	0.30	0.13	1.56	3	0	0	19	0.25	1.10	0.36	0.25	0.22	0.05	1.63	14	0	0
Fluoride (F)	0.12	mg/L	5	0.038	0.062	0.046	0.040	0.010	0.005	4.55	0	0	0	19	0.037	0.080	0.053	0.050	0.009	0.002	5.86	0	0	0
Sulphate (SO4)	-	mg/L	5	8.10	15.00	11.11	9.86	2.94	1.32	3.78	0	0	0	19	0.25	43.00	17.31	17.00	9.14	2.10	1.89	1	0	0
Total Nitrogen (N)	-	mg/L	5	0.22	0.54	0.38	0.38	0.12	0.05	3.30	0	0	0	5	0.37	0.61	0.44	0.41	0.10	0.04	4.62	0	0	0
Nitrate (as N)	13	mg/L	5	0.092	0.296	0.188	0.196	0.090	0.040	2.08	0	0	0	19	0.009	0.403	0.207	0.199	0.133	0.030	1.56	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	5	0.092	0.296	0.189	0.199	0.090	0.040	2.10	0	0	0	5	0.011	0.359	0.229	0.268	0.142	0.063	1.61	0	0	0
Nitrite (as N)	0.06	mg/L	5	0.001	0.002	0.001	0.001	0.001	0.000	2.20	3	0	0	19	0.001	0.005	0.002	0.001	0.001	0.000	1.32	14	0	0
Total Kjeldahl Nitrogen	-	mg/L	5	0.02	0.44	0.19	0.16000	0.1628	0.0728	1.18	0	0	0	18	0.0200	0.5940	0.1869	0.1700	0.1311	0.0309	1.43	0	0	0
Ortho Phosphate as P	-	mg/L	5	0.0005	0.0030	0.0015	0.0010	0.0010	0.0004	1.50	1	0	0	19	0.0005	0.0310	0.0029	0.0010	0.0068	0.0016	0.42	4	0	0
Cyanide, Total	0.005	mg/L	5	0.00025	0.00135	0.00047	0.00025	0.00049	0.00022	0.96	4	0	0	19	0.00025	0.00150	0.00040	0.00025	0.00034	0.00008	1.18	15	0	0
Cyanide, Weak Acid Diss	-	mg/L	5	0.00025	0.00070	0.00043	0.00025	0.00025	0.00011	1.74	3	0	0	19	0.00025	0.00110	0.00040	0.00025	0.00028	0.00006	1.45	14	0	0
Dissolved Organic Carbon	-	mg/L	5	2.04	7.40	5.21	6.30	2.51	1.12	2.07	0	0	0	12	2.24	15.70	8.04	6.55	4.91	1.42	1.64	0	0	0
Total Organic Carbon	-	mg/L	5	2.00	7.40	4.38	4.10	2.28	1.02	1.93	1	0	0	19	2.40	19.50	7.34	6.10	4.71	1.08	1.56	0	0	0
Total Aluminum	0.1[b]	mg/L	5	0.0098	0.1980	0.0841	0.0874	0.0771	0.0345	1.09	0	2	40	19	0.0093	0.3700	0.0658	0.0238	0.1007	0.0231	0.65	0	3	16
Total Antimony	-	mg/L	5	0.00	0.00	0.00	0.00006	0.0000	0.0000	5.75	0	0	0	19	0.00	0.00	0.00	0.00003	0.0000	0.0000	3.69	0	0	0
Total Arsenic	0.005	mg/L	5	0.00	0.00	0.00	0.00029	0.0001	0.0001	2.79	0	0	0	19	0.00	0.00	0.00	0.00020	0.0001	0.0000	2.47	0	0	0
Total Barium	-	mg/L	5	0.01	0.10	0.06	0.06380	0.0350	0.0156	1.69	0	0	0	19	0.04	0.07	0.05	0.04980	0.0105	0.0024	4.82	0	0	0
Total Beryllium	-	mg/L	5	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.59	3	0	0	19	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.15	14	0	0
Total Bismuth	-	mg/L	5	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	5	0	0	19	0.0000025	0.0000077	0.0000028	0.0000025	0.0000012	0.0000003	2.33	18	0	0
Total Boron	1.5	mg/L	5	0.03	0.03	0.03	0.02500	0	-	-	5	0	0	19	0.03	0.03	0.03	0.02500	0	-	-	19	0	0
Total Cadmium	0.000032 [c]	mg/L	5	0.000003	0.000022	0.000013	0.000014	0.000007	0.000003	1.82	1	2	40	19	0.000003	0.000038	0.000007	0.000005	0.000008	0.000002	0.87	8	1	5
Total Calcium	-	mg/L	5	8.29	34.50	20.00	19.00	10.90	4.87	1.84	0	0	0	19	6.74	26.20	18.08	18.20	4.90	1.12	3.69	0	0	0
Total Chromium	0.001	mg/L	5	0.00005	0.00029	0.00016	0.00020	0.00011	0.00005	1.50	2	0	0	19	0.00005	0.00060	0.00018	0.00010	0.00017	0.00004	1.07	7	0	0
Total Cobalt	-	mg/L	5	0.000041	0.000149	0.000091	0.000071	0.000045	0.000020	2.00	0	0	0	19	0.000013	0.000319	0.000057	0.000030	0.000073	0.000017	0.77	0	0	0
Total Copper	0.0023[d]	mg/L	5	0.0003	0.0017	0.0010	0.0009	0.0006	0.0003	1.71	0	0	0	19	0.0005	0.0026	0.0011	0.0009	0.0006	0.0001	1.86	0	2	11
Total Iron	0.3	mg/L	5	0.056	0.371	0.161	0.094	0.131	0.059	1.23	0	1	20	19	0.006	0.625	0.088	0.029	0.153	0.035	0.58	0	2	11
Total Lead	0.003[e]	mg/L	5	0.000012	0.000438	0.000146	0.000121	0.000172	0.000077	0.85	0	0	0	19	0.000003	0.000232	0.000047	0.000018	0.000063	0.000015	0.75	1	0	0
Total Lithium	-	mg/L	5	0.00107	0.00470	0.00263	0.00240	0.00145	0.00065	1.81	0	0	0	19	0.00060	0.00130	0.00099	0.00100	0.00021	0.00005	4.81	0	0	0
Total Magnesium	-	mg/L	5	1.71	11.30	6.03	5.74	3.91	1.75	1.54	0	0	0	19	2.43	12.70	7.35	7.35	2.37	0.54	3.09	0	0	0
Total Manganese	-	mg/L	5	0.0011	0.0771	0.0419	0.0419	0.0277	0.0124	1.52	0	0	0	19	0.0032	0.0371	0.0068	0.0049	0.0075	0.0017	0.90	0	0	0
Total Mercury	0.000026	mg/L	4	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	4	0	0	16	0.0000050	0.0000100	0.0000053	0.0000050	0.0000013	0.0000003	4.25	15	0	0
Total Molybdenum	0.073	mg/L	5	0.00023	0.00052	0.00038	0.00037	0.00011	0.00005	3.41	0	0	0	19	0.00029	0.00098	0.00075	0.00076	0.00017	0.00004	4.48	0	0	0
Total Nickel	0.0033[f]	mg/L	5	0.00021	0.00057	0.00032	0.00027	0.00014	0.00006	2.25	0	0	0	19	0.00020	0.00108	0.00041	0.00031	0.00023	0.00005	1.78	0	0	0
Total Phosphorus	-	mg/L	4	0.0030	0.0208	0.0087	0.0055	0.0084	0.0042	1.04	0	0	0	16	0.0010	0.0400	0.0062	0.0040	0.0093	0.0023	0.66	2	0	0
Total Potassium	-	mg/L	5	0.36	1.16	0.75	0.69	0.29	0.13	2.57	0	0	0	19	0.41	0.85	0.64	0.66	0.11	0.03	5.56	0	0	0
Total Selenium	0.001	mg/L	5	0.00002	0.00004	0.00002	0.00002	0.00001	0.00000	2.68	4	0	0	19	0.00002	0.00010	0.00006	0.00006	0.00002	0.00000	3.03	2	0	0
Total Silicon	-	mg/L	5	3.09	5.80	4.88	5.10	1.10	0.49	4.45	0	0	0	19	2.20	5.00	4.42	4.60	0.71	0.16	6.26	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

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Parameters	CCME[1] Guideline	unit	W22											R2										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silver	0.0001	mg/L	5	0.000003	0.000007	0.000003	0.000003	0.000002	0.000001	1.84	4	0	0	19	0.000003	0.000007	0.000003	0.000003	0.000001	0.000000	2.65	18	0	0
Total Sodium	-	mg/L	5	1.56	5.07	3.04	2.82	1.45	0.65	2.10	0	0	0	19	0.89	4.04	2.88	3.00	0.80	0.18	3.59	0	0	0
Total Strontium	-	mg/L	5	0.052	0.339	0.175	0.153	0.116	0.052	1.50	0	0	0	19	0.052	0.229	0.151	0.155	0.043	0.010	3.49	0	0	0
Total Sulphur	-	mg/L	5	5.00	5.00	5.00	5.00	0	-	-	5	0	0	5	5.00	16.00	7.20	5.00	4.92	2.20	1.46	4	0	0
Total Thallium	0.0008	mg/L	5	0.0000010	0.0000038	0.0000024	0.0000020	0.0000011	0.0000005	2.20	1	0	0	19	0.0000010	0.0000058	0.0000015	0.0000010	0.0000013	0.0000003	1.19	15	0	0
Total Tin	-	mg/L	5	0.000005	0.000300	0.000092	0.000050	0.000123	0.000055	0.75	3	0	0	19	0.000005	0.000100	0.000015	0.000005	0.000030	0.000007	0.50	19	0	0
Total Titanium	-	mg/L	5	0.00025	0.00692	0.00228	0.00090	0.00284	0.00127	0.80	2	0	0	19	0.00025	0.01120	0.00165	0.00025	0.00324	0.00074	0.51	10	0	0
Total Uranium	0.015	mg/L	5	0.00163	0.01440	0.00608	0.00371	0.00536	0.00240	1.13	0	0	0	19	0.00111	0.00569	0.00236	0.00227	0.00123	0.00028	1.92	0	0	0
Total Vanadium	-	mg/L	5	0.00010	0.00078	0.00036	0.00020	0.00028	0.00013	1.27	1	0	0	19	0.00010	0.00131	0.00030	0.00010	0.00034	0.00008	0.86	11	0	0
Total Zinc	0.03	mg/L	5	0.00030	0.00360	0.00139	0.00096	0.00128	0.00057	1.09	0	0	0	19	0.00020	0.00244	0.00065	0.00050	0.00055	0.00013	1.18	0	0	0
Total Zirconium	-	mg/L	5	0.00005	0.00021	0.00010	0.00010	0.00007	0.00003	1.56	2	0	0	19	0.00005	0.00040	0.00016	0.00010	0.00012	0.00003	1.40	5	0	0
Dissolved Aluminum	0.1	mg/L	5	0.0035	0.1140	0.0532	0.0256	0.0552	0.0247	0.96	0	2	40	19	0.0079	0.1660	0.0373	0.0225	0.0394	0.0090	0.95	0	1	5
Dissolved Antimony	-	mg/L	5	0.00005	0.00007	0.00006	0.00006	0.00001	0.000003	8.42	0	0	0	19	0.00001	0.00005	0.00003	0.00003	0.00001	0.000002	3.13	1	0	0
Dissolved Arsenic	-	mg/L	5	0.00020	0.00034	0.00027	0.00025	0.00006	0.000028	4.37	0	0	0	19	0.00014	0.00029	0.00020	0.00020	0.00004	0.000009	4.89	0	0	0
Dissolved Barium	-	mg/L	5	0.010100	0.104000	0.058860	0.058600	0.036533	0.016338	1.61	0	0	0	19	0.026400	0.068700	0.049595	0.049500	0.012181	0.002794	4.07	0	0	0
Dissolved Beryllium	-	mg/L	5	0.000005	0.000013	0.000008	0.000005	0.000004	0.000002	2.05	3	0	0	19	0.000005	0.000020	0.000007	0.000005	0.000004	0.000001	1.58	15	0	0
Dissolved Bismuth	-	mg/L	5	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	5	0	0	19	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	19	0	0
Dissolved Boron	-	mg/L	5	0.025	0.025	0.025	0.025	0	-	-	5	0	0	19	0.025	0.025	0.025	0.025	0	-	-	19	0	0
Dissolved Cadmium	-	mg/L	5	0.000003	0.000019	0.000010	0.000010	0.000007	0.000003	1.51	1	0	0	19	0.000003	0.000024	0.000006	0.000003	0.000006	0.000001	1.04	11	0	0
Dissolved Calcium	-	mg/L	5	9.05	32.80	19.51	18.60	10.15	4.54	1.92	0	0	0	19	6.24	29.00	17.92	18.20	5.48	1.26	3.27	0	0	0
Dissolved Chromium	-	mg/L	5	0.00005	0.00020	0.00012	0.00010	0.00007	0.00003	1.64	2	0	0	19	0.00005	0.00050	0.00016	0.00010	0.00012	0.00003	1.33	5	0	0
Dissolved Cobalt	-	mg/L	5	0.000035	0.000061	0.000048	0.000047	0.000012	0.000005	4.15	0	0	0	19	0.000015	0.000129	0.000037	0.000030	0.000026	0.000006	1.42	0	0	0
Dissolved Copper	-	mg/L	5	0.0002	0.0017	0.0008	0.0007	0.0006	0.0003	1.36	0	0	0	19	0.0004	0.0019	0.0010	0.0009	0.0004	0.0001	2.35	0	0	0
Dissolved Iron	-	mg/L	5	0.013	0.122	0.060	0.058	0.039	0.018	1.53	0	0	0	19	0.004	0.213	0.041	0.024	0.049	0.011	0.84	0	0	0
Dissolved Lead	-	mg/L	5	0.000003	0.000124	0.000034	0.000015	0.000051	0.000023	0.67	1	0	0	19	0.000003	0.000133	0.000025	0.000010	0.000036	0.000008	0.70	6	0	0
Dissolved Lithium	-	mg/L	5	0.00108	0.00470	0.00266	0.00270	0.00152	0.00068	1.75	0	0	0	19	0.00058	0.00120	0.00094	0.00100	0.00019	0.00004	4.89	0	0	0
Dissolved Magnesium	-	mg/L	5	1.84	11.20	6.17	5.68	3.93	1.76	1.57	0	0	0	19	2.46	12.70	7.32	7.49	2.30	0.53	3.19	0	0	0
Dissolved Manganese	-	mg/L	5	0.0010	0.0704	0.0293	0.0120	0.0309	0.0138	0.95	0	0	0	19	0.0025	0.0107	0.0047	0.0046	0.0018	0.0004	2.61	0	0	0
Dissolved Mercury	-	mg/L	2	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	2	0	0	16	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	16	0	0
Dissolved Molybdenum	-	mg/L	5	0.00033	0.00049	0.00042	0.00042	0.00007	0.00003	5.68	0	0	0	19	0.00028	0.00101	0.00075	0.00077	0.00018	0.00004	4.23	0	0	0
Dissolved Nickel	-	mg/L	5	0.00019	0.00047	0.00028	0.00024	0.00011	0.00005	2.51	0	0	0	19	0.00020	0.00090	0.00041	0.00033	0.00017	0.00004	2.35	0	0	0
Dissolved Phosphorus	-	mg/L	2	0.0020	0.0090	0.0055	0.0055	0.0049	0.0035	1.11	0	0	0	16	0.0010	0.0099	0.0031	0.0030	0.0024	0.0006	1.29	6	0	0
Dissolved Potassium	-	mg/L	5	0.38	1.11	0.77	0.70	0.28	0.13	2.70	0	0	0	19	0.44	0.84	0.64	0.64	0.11	0.03	5.75	0	0	0
Dissolved Selenium	-	mg/L	5	0.00002	0.00004	0.00002	0.00002	0.00001	0.00000	2.68	4	0	0	19	0.00002	0.00012	0.00006	0.00006	0.00002	0.00001	2.65	1	0	0
Dissolved Silicon	-	mg/L	5	2.98	5.70	4.86	5.10	1.09	0.49	4.47	0	0	0	19	1.98	5.70	4.31	4.40	0.86	0.20	5.01	0	0	0
Dissolved Silver	-	mg/L	5	0.000003	0.000003	0.000003	0.000003	0	-	-	5	0	0	19	0.000003	0.000003	0.000003	0.000003	0	-	-	19	0	0
Dissolved Sodium	-	mg/L	5	1.57	5.01	3.08	2.82	1.42	0.64	2.17	0	0	0	19	0.96	4.90	3.00	3.01	0.88	0.20	3.42	0	0	0
Dissolved Strontium	-	mg/L	5	0.055	0.330	0.175	0.155	0.113	0.051	1.54	0	0	0	19	0.051	0.233	0.151	0.159	0.045	0.010	3.33	0	0	0
Dissolved Sulphur	-	mg/L	5	5.00	5.00	5.00	5.00	0	-	-	5	0	0	5	5.00	14.00	6.80	5.00	4.02	1.80	1.69	4	0	0
Dissolved Thallium	-	mg/L	5	0.0000010	0.0000030	0.0000014	0.0000010	0.0000009	0.0000004	1.57	4	0	0	19	0.0000010	0.0000010	0.0000010	0.0000010	0	-	-	19	0	0
Dissolved Tin	-	mg/L	5	0.000005	0.000100	0.000043	0.000005	0.000052	0.000023	0.83	5	0	0	19	0.000005	0.000100	0.000016	0.000005	0.000030	0.000007	0.53	18	0	0
Dissolved Titanium	-	mg/L	5	0.00025	0.00122	0.00051	0.00025	0.00042	0.00019	1.22	3	0	0	19	0.00025	0.00164	0.00044	0.00025	0.00038	0.00009	1.15	14	0	0
Dissolved Uranium	-	mg/L	5	0.00170	0.01460	0.00619	0.00398	0.00547	0.00244	1.13	0	0	0	19	0.00104	0.00601	0.00235	0.00219	0.00132	0.00030	1.79	0	0	0
Dissolved Vanadium	-	mg/L	5	0.00010	0.00060	0.00033	0.00030	0.00020	0.00009	1.66	1	0	0	19	0.00010	0.00063	0.00024	0.00020	0.00017	0.00004	1.42	9	0	0
Dissolved Zinc	-	mg/L	5	0.00040	0.00120	0.00084	0.00090	0.00037	0.00017	2.26	0	0	0	19	0.00010	0.00296	0.00056	0.00050	0.00062	0.00014	0.91	0	0	0
Dissolved Zirconium	-	mg/L	5	0.00005	0.00020	0.00011	0.00010	0.00007	0.00003	1.68	2	0	0	19	0.00005	0.00030	0.00015	0.00010	0.00008	0.00002	1.83	3	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B5. Surface Water Quality Statistics: All sites all parameters, Casino Project, 2008-2012

Parameters	CCME[1] Guideline	unit	W9											W5											
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	27	7.20	8.30	7.78	7.80	0.22	0.04	35.72	0	0	0	22	7.30	8.20	7.81	7.87	0.22	0.05	35.74	0	0	0
Conductivity	-	µS/cm	27	65	265	176	172	62	12	2.81	0	0	0	22	68	305	189	194	70	15	2.72	0	0	0
Total Hardness CaCO3	-	mg/L	27	33	128	84	81	29	6	2.93	0	0	0	22	33	140	91	90	32	7	2.81	0	0	0
Dissolved Hardness CaCO3	-	mg/L	6	31	118	88	99	34	14	2.57	0	0	0	6	33	134	100	112	38	16	2.61	0	0	0
Ion Balance	-	no unit	4	0.88	1.00	0.96	0.98	0.05	0.03	17.73	0	0	0	4	0.91	1.10	1.00	0.99	0.08	0.04	12.54	0	0	0
Total Dissolved Solids	-	mg/L	27	56	180	110	110	30	6	3.66	0	0	0	22	68	180	120	115	30	6	4.04	0	0	0
Total Suspended Solids	-	mg/L	27	0.5	160.0	17.7	3.0	35.3	6.8	0.50	9	0	0	22	0.5	96.0	15.3	3.5	25.7	5.5	0.59	9	0	0
Turbidity	-	NTU	27	0.2	29.0	2.7	0.6	5.8	1.1	0.46	0	0	0	22	0.2	7.8	1.7	1.1	2.1	0.5	0.79	0	0	0
Ammonia as N	0.499[a]	mg/L	27	0.003	0.083	0.016	0.005	0.022	0.004	0.74	15	0	0	22	0.003	0.260	0.030	0.005	0.058	0.012	0.51	12	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	27	22.0	113.0	74.73	74.0	26.95	5.19	2.77	0	0	0	22	24.0	115.0	73.28	74.5	26.66	5.68	2.75	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	6	0.25	0.25	0.25	0.25	0	-	-	6	0	0	6	0.25	0.25	0.25	0.25	0	-	-	6	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	15	0.25	11.10	2.84	1.60	2.89	0.75	0.98	3	0	0	11	0.25	4.90	2.28	2.50	1.64	0.49	1.40	3	0	0
Bromide (Br)	-	mg/L	23	0.01	0.20	0.18	0.20	0.06	0.01	2.83	23	0	0	18	0.01	0.20	0.17	0.20	0.07	0.02	2.44	18	0	0
Chloride (Cl)	120	mg/L	27	0.25	1.60	0.59	0.50	0.42	0.08	1.42	13	0	0	22	0.25	2.50	0.68	0.65	0.52	0.11	1.31	9	0	0
Fluoride (F)	0.12	mg/L	23	0.041	0.060	0.053	0.050	0.005	0.001	9.78	0	0	0	18	0.040	0.070	0.059	0.060	0.008	0.002	7.76	0	0	0
Sulphate (SO4)	-	mg/L	27	0.25	33.00	14.62	15.00	7.88	1.52	1.86	2	0	0	22	0.25	45.00	22.05	23.50	11.26	2.40	1.96	2	0	0
Total Nitrogen (N)	-	mg/L	6	0.16	0.61	0.40	0.41	0.15	0.06	2.72	0	0	0	6	0.16	0.56	0.36	0.37	0.13	0.05	2.89	0	0	0
Nitrate (as N)	13	mg/L	27	0.016	0.317	0.137	0.130	0.092	0.018	1.49	0	0	0	22	0.006	0.300	0.142	0.143	0.085	0.018	1.67	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	6	0.037	0.317	0.197	0.198	0.105	0.043	1.88	0	0	0	6	0.046	0.300	0.191	0.186	0.096	0.039	2.00	0	0	0
Nitrite (as N)	0.06	mg/L	27	0.001	0.005	0.002	0.001	0.001	0.000	1.52	20	0	0	22	0.001	0.004	0.001	0.001	0.001	0.000	1.81	17	0	0
Total Kjeldahl Nitrogen	-	mg/L	26	0.01	0.58	0.20	0.16500	0.1266	0.0248	1.54	1	0	0	21	0.02	0.51	0.21	0.18000	0.1369	0.0299	1.53	0	0	0
Ortho Phosphate as P	-	mg/L	27	0.0005	0.0070	0.0019	0.0020	0.0014	0.0003	1.35	4	0	0	22	0.0005	0.0030	0.0017	0.0020	0.0008	0.0002	2.17	5	0	0
Cyanide, Total	0.005	mg/L	27	0.00025	0.00130	0.00053	0.00025	0.00037	0.00007	1.44	15	0	0	22	0.00025	0.00150	0.00054	0.00025	0.00037	0.00008	1.45	12	0	0
Cyanide, Weak Acid Diss	-	mg/L	27	0.00025	0.00110	0.00045	0.00025	0.00028	0.00005	1.60	17	0	0	22	0.00025	0.00130	0.00045	0.00025	0.00029	0.00006	1.57	13	0	0
Dissolved Organic Carbon	-	mg/L	14	2.62	14.10	6.64	5.15	3.58	0.96	1.85	0	0	0	10	2.50	14.10	6.71	5.65	3.95	1.25	1.70	0	0	0
Total Organic Carbon	-	mg/L	23	2.92	17.30	6.94	5.20	3.84	0.80	1.81	0	0	0	18	2.70	16.40	6.83	5.45	4.18	0.99	1.63	0	0	0
Total Aluminum	0.1[b]	mg/L	27	0.0073	0.7770	0.1439	0.0349	0.2047	0.0394	0.70	0	11	41	22	0.0105	0.5690	0.1452	0.0368	0.1751	0.0373	0.83	0	9	41
Total Antimony	-	mg/L	27	0.00	0.00	0.00	0.00008	0.0000	0.0000	5.56	0	0	0	22	0.00	0.00	0.00	0.00010	0.0000	0.0000	5.97	0	0	0
Total Arsenic	0.005	mg/L	27	0.00	0.00	0.00	0.00031	0.0003	0.0001	1.50	0	0	0	22	0.00	0.00	0.00	0.00036	0.0002	0.0000	2.12	0	0	0
Total Barium	-	mg/L	27	0.04	0.09	0.06	0.05260	0.0142	0.0027	4.14	0	0	0	22	0.04	0.09	0.06	0.05315	0.0134	0.0029	4.27	0	0	0
Total Beryllium	-	mg/L	27	0.00	0.00	0.00	0.00001	0.0000	0.0000	0.90	15	0	0	22	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.03	12	0	0
Total Bismuth	-	mg/L	27	0.0000025	0.0000120	0.0000041	0.0000025	0.0000029	0.0000006	1.42	19	0	0	22	0.0000025	0.0000123	0.0000039	0.0000025	0.0000026	0.0000006	1.47	16	0	0
Total Boron	1.5	mg/L	27	0.03	0.03	0.03	0.02500	0	-	-	27	0	0	22	0.03	0.03	0.03	0.02500	0	-	-	22	0	0
Total Cadmium	0.000032 [c]	mg/L	27	0.000003	0.000057	0.000016	0.000012	0.000016	0.000003	0.96	7	4	15	22	0.000003	0.000101	0.000024	0.000017	0.000023	0.000005	1.05	2	7	32
Total Calcium	-	mg/L	27	8.38	32.00	21.62	21.20	7.28	1.40	2.97	0	0	0	22	8.44	36.10	23.67	23.65	8.32	1.77	2.85	0	0	0
Total Chromium	0.001	mg/L	27	0.00005	0.00100	0.00025	0.00010	0.00026	0.00005	0.96	9	0	0	22	0.00005	0.00079	0.00025	0.00015	0.00024	0.00005	1.04	9	0	0
Total Cobalt	-	mg/L	27	0.000016	0.000825	0.000157	0.000071	0.000198	0.000038	0.79	0	0	0	22	0.000029	0.000645	0.000166	0.000093	0.000171	0.000036	0.97	0	0	0
Total Copper	0.0023[d]	mg/L	27	0.0005	0.0053	0.0014	0.0009	0.0010	0.0002	1.33	0	4	15	22	0.0008	0.0093	0.0032	0.0023	0.0025	0.0005	1.31	0	12	55
Total Iron	0.3	mg/L	27	0.008	1.440	0.267	0.084	0.364	0.070	0.73	0	7	26	22	0.039	0.973	0.252	0.089	0.278	0.059	0.91	0	7	32
Total Lead	0.003[e]	mg/L	27	0.000012	0.002130	0.000281	0.000084	0.000479	0.000092	0.59	0	1	4	22	0.000018	0.004120	0.000573	0.000124	0.001033	0.000220	0.55	0	3	14
Total Lithium	-	mg/L	27	0.00145	0.00310	0.00231	0.00230	0.00045	0.00009	5.18	0	0	0	22	0.00130	0.00250	0.00186	0.00190	0.00031	0.00007	6.03	0	0	0
Total Magnesium	-	mg/L	27	2.83	12.60	7.41	6.96	2.64	0.51	2.81	0	0	0	22	2.77	12.90	7.72	7.52	2.88	0.61	2.69	0	0	0
Total Manganese	-	mg/L	27	0.0025	0.1070	0.0307	0.0220	0.0243	0.0047	1.26	0	0	0	22	0.0104	0.0785	0.0287	0.0247	0.0186	0.0040	1.55	0	0	0
Total Mercury	0.000026	mg/L	23	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	23	0	0	19	0.0000050	0.0000100	0.0000053	0.0000050	0.0000011	0.0000003	4.59	18	0	0
Total Molybdenum	0.073	mg/L	27	0.00028	0.00081	0.00059	0.00059	0.00014	0.00003	4.28	0	0	0	22	0.00040	0.00099	0.00075	0.00081	0.00017	0.00004	4.53	0	0	0
Total Nickel	0.0033[f]	mg/L	27	0.00022	0.00210	0.00055	0.00034	0.00044	0.00009	1.25	0	0	0	22	0.00020	0.00122	0.00050	0.00032	0.00033	0.00007	1.52	0	0	0
Total Phosphorus	-	mg/L	24	0.0020	0.1260	0.0190	0.0055	0.0293	0.0060	0.65	0	0	0	19	0.0010	0.0530	0.0147	0.0090	0.0176	0.0040	0.84	2	0	0
Total Potassium	-	mg/L	27	0.51	1.30	0.76	0.71	0.20	0.04	3.87	0	0	0	22	0.57	1.37	0.84	0.77	0.22	0.05	3.75	0	0	0
Total Selenium	0.001	mg/L	27	0.00002	0.00007	0.00004	0.00004	0.00002	0.00000	2.14	12	0	0	22	0.00002	0.00009	0.00005	0.00005	0.00002	0.00000	3.02	3	0	0
Total Silicon	-	mg/L	27	2.58	5.60	4.73	5.00	0.81	0.16	5.83	0	0	0	22	2.63	5.90	4.81	5.15	0.86	0.18	5.61	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W9											W5										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silver	0.0001	mg/L	27	0.000003	0.000010	0.000003	0.000003	0.000002	0.000000	1.65	23	0	0	22	0.000003	0.000023	0.000005	0.000003	0.000005	0.000001	0.97	16	0	0
Total Sodium	-	mg/L	27	1.31	5.86	3.71	3.64	1.23	0.24	3.02	0	0	0	22	1.25	5.85	3.71	3.74	1.25	0.27	2.96	0	0	0
Total Strontium	-	mg/L	27	0.069	0.263	0.175	0.170	0.059	0.011	2.95	0	0	0	22	0.068	0.281	0.171	0.174	0.061	0.013	2.83	0	0	0
Total Sulphur	-	mg/L	6	5.00	5.00	5.00	5.00	0	-	-	6	0	0	6	5.00	14.00	10.00	11.50	4.10	1.67	2.44	2	0	0
Total Thallium	0.0008	mg/L	27	0.0000010	0.0000080	0.0000026	0.0000010	0.0000024	0.0000005	1.09	15	0	0	22	0.0000010	0.0000104	0.0000031	0.0000020	0.0000028	0.0000006	1.11	10	0	0
Total Tin	-	mg/L	27	0.000005	0.000100	0.000012	0.000005	0.000025	0.000005	0.47	27	0	0	22	0.000005	0.000200	0.000021	0.000005	0.000046	0.000010	0.45	20	0	0
Total Titanium	-	mg/L	27	0.00025	0.02710	0.00547	0.00150	0.00782	0.00151	0.70	10	0	0	22	0.00025	0.02190	0.00506	0.00170	0.00672	0.00143	0.75	8	0	0
Total Uranium	0.015	mg/L	27	0.00232	0.01140	0.00576	0.00529	0.00261	0.00050	2.21	0	0	0	22	0.00234	0.01320	0.00607	0.00556	0.00320	0.00068	1.89	0	0	0
Total Vanadium	-	mg/L	27	0.00010	0.00500	0.00078	0.00030	0.00108	0.00021	0.73	8	0	0	22	0.00010	0.00216	0.00068	0.00035	0.00067	0.00014	1.02	5	0	0
Total Zinc	0.03	mg/L	27	0.00030	0.00600	0.00141	0.00070	0.00150	0.00029	0.94	0	0	0	22	0.00030	0.00734	0.00201	0.00120	0.00188	0.00040	1.07	0	0	0
Total Zirconium	-	mg/L	27	0.00005	0.00080	0.00022	0.00020	0.00017	0.00003	1.26	5	0	0	22	0.00005	0.00050	0.00020	0.00020	0.00014	0.00003	1.44	6	0	0
Dissolved Aluminum	0.1	mg/L	27	0.0065	0.1820	0.0431	0.0239	0.0448	0.0086	0.96	0	4	15	22	0.0068	0.3550	0.0600	0.0206	0.0826	0.0176	0.73	0	5	23
Dissolved Antimony	-	mg/L	27	0.00005	0.00012	0.00007	0.00007	0.00002	0.000003	4.77	1	0	0	22	0.00006	0.00012	0.00009	0.00009	0.00002	0.000003	5.82	0	0	0
Dissolved Arsenic	-	mg/L	27	0.00019	0.00055	0.00030	0.00031	0.00008	0.000015	3.81	0	0	0	22	0.00022	0.00052	0.00033	0.00033	0.00007	0.000014	5.02	0	0	0
Dissolved Barium	-	mg/L	27	0.027900	0.087200	0.054548	0.050000	0.017791	0.003424	3.07	0	0	0	22	0.028500	0.089100	0.053950	0.050050	0.016310	0.003477	3.31	0	0	0
Dissolved Beryllium	-	mg/L	27	0.000005	0.000030	0.000010	0.000005	0.000008	0.000001	1.30	18	0	0	22	0.000005	0.000030	0.000009	0.000005	0.000006	0.000001	1.39	13	0	0
Dissolved Bismuth	-	mg/L	27	0.0000025	0.0000150	0.0000030	0.0000025	0.0000024	0.0000005	1.23	27	0	0	22	0.0000025	0.0000080	0.0000028	0.0000025	0.0000012	0.0000003	2.35	21	0	0
Dissolved Boron	-	mg/L	27	0.025	0.150	0.030	0.025	0.024	0.005	1.23	27	0	0	22	0.025	0.025	0.025	0.025	0	-	-	22	0	0
Dissolved Cadmium	-	mg/L	27	0.000003	0.000016	0.000007	0.000006	0.000005	0.000001	1.47	11	0	0	22	0.000003	0.000042	0.000013	0.000011	0.000009	0.000002	1.44	2	0	0
Dissolved Calcium	-	mg/L	27	7.81	34.10	21.37	20.20	7.36	1.42	2.90	0	0	0	22	8.82	35.00	23.09	23.00	7.78	1.66	2.97	0	0	0
Dissolved Chromium	-	mg/L	27	0.00005	0.00030	0.00014	0.00010	0.00009	0.00002	1.59	10	0	0	22	0.00005	0.00030	0.00015	0.00010	0.00011	0.00002	1.39	10	0	0
Dissolved Cobalt	-	mg/L	27	0.000017	0.000110	0.000054	0.000048	0.000024	0.000005	2.25	0	0	0	22	0.000037	0.000362	0.000071	0.000052	0.000068	0.000015	1.04	0	0	0
Dissolved Copper	-	mg/L	27	0.0005	0.0019	0.0010	0.0009	0.0004	0.0001	2.44	0	0	0	22	0.0007	0.0080	0.0025	0.0019	0.0017	0.0004	1.45	0	0	0
Dissolved Iron	-	mg/L	27	0.006	0.220	0.079	0.044	0.063	0.012	1.26	0	0	0	22	0.013	0.581	0.094	0.042	0.120	0.026	0.78	0	0	0
Dissolved Lead	-	mg/L	27	0.000003	0.000172	0.000042	0.000021	0.000046	0.000009	0.91	4	0	0	22	0.000003	0.000760	0.000079	0.000032	0.000161	0.000034	0.49	3	0	0
Dissolved Lithium	-	mg/L	27	0.00120	0.00310	0.00221	0.00210	0.00049	0.00009	4.52	0	0	0	22	0.00092	0.00250	0.00178	0.00185	0.00037	0.00008	4.77	0	0	0
Dissolved Magnesium	-	mg/L	27	2.75	12.80	7.32	6.81	2.63	0.51	2.78	0	0	0	22	2.77	12.80	7.64	7.27	2.79	0.60	2.74	0	0	0
Dissolved Manganese	-	mg/L	27	0.0015	0.0486	0.0175	0.0122	0.0128	0.0025	1.36	0	0	0	22	0.0014	0.0410	0.0161	0.0117	0.0100	0.0021	1.61	0	0	0
Dissolved Mercury	-	mg/L	23	0.0000050	0.0000250	0.0000059	0.0000050	0.0000042	0.0000009	1.41	23	0	0	18	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	18	0	0
Dissolved Molybdenum	-	mg/L	27	0.00029	0.00084	0.00062	0.00061	0.00014	0.00003	4.49	0	0	0	22	0.00033	0.00099	0.00076	0.00082	0.00017	0.00004	4.36	0	0	0
Dissolved Nickel	-	mg/L	27	0.00022	0.00073	0.00041	0.00037	0.00017	0.00003	2.39	0	0	0	22	0.00020	0.00087	0.00040	0.00033	0.00019	0.00004	2.06	0	0	0
Dissolved Phosphorus	-	mg/L	23	0.0010	0.0120	0.0042	0.0040	0.0027	0.0006	1.54	4	0	0	18	0.0010	0.0170	0.0048	0.0035	0.0045	0.0011	1.06	4	0	0
Dissolved Potassium	-	mg/L	27	0.50	1.27	0.75	0.71	0.20	0.04	3.78	0	0	0	22	0.55	1.34	0.83	0.77	0.21	0.05	3.93	0	0	0
Dissolved Selenium	-	mg/L	27	0.00002	0.00010	0.00004	0.00004	0.00002	0.00000	1.85	14	0	0	22	0.00002	0.00007	0.00005	0.00005	0.00001	0.00000	3.89	2	0	0
Dissolved Silicon	-	mg/L	27	2.22	6.20	4.54	4.70	0.83	0.16	5.44	0	0	0	22	2.34	5.70	4.67	4.90	0.87	0.19	5.35	0	0	0
Dissolved Silver	-	mg/L	27	0.000003	0.000015	0.000003	0.000003	0.000002	0.000000	1.23	27	0	0	22	0.000003	0.000009	0.000003	0.000003	0.000002	0.000000	1.73	19	0	0
Dissolved Sodium	-	mg/L	27	1.34	5.90	3.71	3.49	1.23	0.24	3.01	0	0	0	22	1.34	5.90	3.67	3.59	1.21	0.26	3.04	0	0	0
Dissolved Strontium	-	mg/L	27	0.066	0.270	0.175	0.172	0.062	0.012	2.83	0	0	0	22	0.065	0.270	0.171	0.176	0.060	0.013	2.87	0	0	0
Dissolved Sulphur	-	mg/L	6	5.00	5.00	5.00	5.00	0	-	-	6	0	0	6	5.00	13.00	9.50	11.00	3.56	1.45	2.67	2	0	0
Dissolved Thallium	-	mg/L	27	0.0000010	0.0000050	0.0000013	0.0000010	0.0000009	0.0000002	1.47	24	0	0	22	0.0000010	0.0000070	0.0000017	0.0000010	0.0000014	0.0000003	1.22	14	0	0
Dissolved Tin	-	mg/L	27	0.000005	0.000100	0.000013	0.000005	0.000025	0.000005	0.50	27	0	0	22	0.000005	0.000100	0.000021	0.000005	0.000034	0.000007	0.60	19	0	0
Dissolved Titanium	-	mg/L	27	0.00025	0.00230	0.00063	0.00025	0.00059	0.00011	1.07	18	0	0	21	0.00025	0.00220	0.00063	0.00025	0.00065	0.00014	0.98	14	0	0
Dissolved Uranium	-	mg/L	27	0.00161	0.01190	0.00561	0.00543	0.00280	0.00054	2.01	0	0	0	22	0.00163	0.01300	0.00595	0.00567	0.00327	0.00070	1.82	0	0	0
Dissolved Vanadium	-	mg/L	27	0.00010	0.00080	0.00032	0.00030	0.00020	0.00004	1.60	8	0	0	22	0.00010	0.00140	0.00036	0.00030	0.00030	0.00006	1.17	6	0	0
Dissolved Zinc	-	mg/L	27	0.00010	0.00590	0.00105	0.00050	0.00153	0.00029	0.69	0	0	0	22	0.00040	0.00530	0.00148	0.00070	0.00157	0.00034	0.94	0	0	0
Dissolved Zirconium	-	mg/L	27	0.00005	0.00040	0.00017	0.00020	0.00009	0.00002	1.89	4	0	0	22	0.00005	0.00040	0.00017	0.00020	0.00010	0.00002	1.73	4	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W16											W19										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	22	7.40	8.30	7.83	7.90	0.20	0.04	39.62	0	0	0	5	7.48	7.91	7.72	7.79	0.18	0.08	42.47	0	0	0
Conductivity	-	µS/cm	22	108	327	200	190	60	13	3.35	0	0	0	5	101	248	171	174	66	30	2.58	0	0	0
Total Hardness CaCO3	-	mg/L	22	57	154	96	93	28	6	3.39	0	0	0	5	53	105	80	80	25	11	3.12	0	0	0
Dissolved Hardness CaCO3	-	mg/L	5	54	136	102	112	35	16	2.93	0	0	0	5	50	105	78	78	27	12	2.92	0	0	0
Moisture	-	%	1	20	20	20	20	0	-	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-
Ion Balance	-	no unit	3	0.94	1.10	1.01	1.00	0.08	0.05	12.54	0	0	0	3	0.95	1.00	0.98	1.00	0.03	0.02	34.06	0	0	0
Total Dissolved Solids	-	mg/L	22	92	180	135	140	25	5	5.37	0	0	0	5	84	158	122	130	30	13	4.07	0	0	0
Total Suspended Solids	-	mg/L	22	0.5	74.0	11.4	3.5	17.4	3.7	0.65	4	0	0	5	1.1	123.0	41.2	12.0	53.4	23.9	0.77	0	0	0
Turbidity	-	NTU	22	0.3	12.6	2.7	0.9	3.6	0.8	0.75	0	0	0	5	1.1	16.5	8.7	5.4	6.8	3.0	1.28	0	0	0
Ammonia as N	0.499[a]	mg/L	22	0.003	0.260	0.029	0.016	0.054	0.011	0.54	9	0	0	5	0.014	0.059	0.031	0.027	0.018	0.008	1.72	0	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	22	38.0	120.0	74.41	71.5	23.13	4.93	3.22	0	0	0	5	34.0	92.7	65.04	67.0	25.27	11.30	2.57	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	5	0.25	0.25	0.25	0.25	0	-	-	5	0	0	5	0.25	0.25	0.25	0.25	0	-	-	5	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	12	0.25	6.00	1.55	0.90	1.75	0.51	0.88	5	0	0	5	0.25	12.10	3.19	1.60	5.03	2.25	0.63	2	0	0
Bromide (Br)	-	mg/L	19	0.05	0.20	0.19	0.20	0.03	0.01	5.58	19	0	0	5	0.01	0.20	0.12	0.20	0.11	0.05	1.14	5	0	0
Chloride (Cl)	120	mg/L	22	0.25	5.00	0.77	0.43	1.03	0.22	0.74	11	0	0	5	0.25	0.90	0.51	0.25	0.36	0.16	1.43	3	0	0
Fluoride (F)	0.12	mg/L	19	0.050	0.080	0.061	0.060	0.008	0.002	7.14	0	0	0	5	0.059	0.070	0.063	0.060	0.005	0.002	13.73	0	0	0
Sulphate (SO4)	-	mg/L	22	15.00	62.00	28.16	28.00	10.92	2.33	2.58	0	0	0	5	12.00	31.00	20.10	20.00	8.16	3.65	2.46	0	0	0
Total Nitrogen (N)	-	mg/L	5	0.15	0.51	0.35	0.38	0.14	0.06	2.48	0	0	0	5	0.19	0.74	0.41	0.31	0.22	0.10	1.89	0	0	0
Nitrate (as N)	13	mg/L	22	0.001	0.274	0.104	0.089	0.077	0.016	1.35	1	0	0	5	0.036	0.104	0.071	0.081	0.029	0.013	2.41	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	5	0.054	0.274	0.153	0.145	0.080	0.036	1.91	0	0	0	5	0.039	0.106	0.072	0.081	0.029	0.013	2.53	0	0	0
Nitrite (as N)	0.06	mg/L	22	0.001	0.008	0.002	0.001	0.002	0.000	1.19	12	0	0	5	0.001	0.003	0.002	0.002	0.001	0.000	2.16	2	0	0
Total Kjeldahl Nitrogen	-	mg/L	21	0.01	4.00	0.41	0.20000	0.8328	0.1817	0.49	1	0	0	5	0.08	0.69	0.34	0.22800	0.2412	0.1079	1.39	0	0	0
Ortho Phosphate as P	-	mg/L	22	0.0005	0.0110	0.0021	0.0020	0.0021	0.0005	0.99	3	0	0	5	0.0019	0.0110	0.0050	0.0050	0.0037	0.0017	1.35	0	0	0
Cyanide, Total	0.005	mg/L	22	0.00025	0.00170	0.00056	0.00025	0.00043	0.00009	1.30	12	0	0	5	0.00025	0.00055	0.00031	0.00025	0.00013	0.00006	2.31	4	0	0
Cyanide, Weak Acid Diss	-	mg/L	22	0.00025	0.00120	0.00055	0.00050	0.00033	0.00007	1.67	10	0	0	5	0.00025	0.00110	0.00049	0.00025	0.00037	0.00017	1.32	3	0	0
Dissolved Organic Carbon	-	mg/L	11	3.50	15.50	8.36	7.70	3.78	1.14	2.21	0	0	0	5	5.44	17.80	10.89	10.20	5.21	2.33	2.09	0	0	0
Total Organic Carbon	-	mg/L	18	3.60	15.50	8.20	7.20	3.58	0.84	2.29	0	0	0	5	5.58	17.80	11.42	11.10	5.41	2.42	2.11	0	0	0
Total Aluminum	0.1[b]	mg/L	22	0.0102	0.4670	0.1418	0.0828	0.1422	0.0303	1.00	0	10	45	5	0.0111	0.7810	0.3424	0.2260	0.3500	0.1565	0.98	0	3	60
Total Antimony	-	mg/L	22	0.00	0.00	0.00	0.00009	0.0000	0.0000	4.81	0	0	0	5	0.00	0.00	0.00	0.00008	0.0000	0.0000	4.89	0	0	0
Total Arsenic	0.005	mg/L	22	0.00	0.00	0.00	0.00054	0.0002	0.0000	2.69	0	0	0	5	0.00	0.00	0.00	0.00112	0.0006	0.0003	2.30	0	0	0
Total Barium	-	mg/L	22	0.04	0.08	0.06	0.05390	0.0124	0.0026	4.59	0	0	0	5	0.05	0.09	0.06	0.06420	0.0160	0.0072	4.02	0	0	0
Total Beryllium	-	mg/L	22	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.23	10	0	0	5	0.00	0.00	0.00	0.00002	0.0000	0.0000	1.23	1	0	0
Total Bismuth	-	mg/L	22	0.0000025	0.0000100	0.0000035	0.0000025	0.0000021	0.0000005	1.66	17	0	0	5	0.0000025	0.0000103	0.0000056	0.0000025	0.0000042	0.0000019	1.33	3	0	0
Total Boron	1.5	mg/L	22	0.03	0.03	0.03	0.02500	0	-	-	22	0	0	5	0.03	0.03	0.03	0.02500	0	-	-	5	0	0
Total Cadmium	0.000032 [c]	mg/L	22	0.000003	0.000073	0.000021	0.000017	0.000017	0.000004	1.21	2	4	18	5	0.000013	0.000091	0.000036	0.000018	0.000033	0.000015	1.09	0	2	40
Total Calcium	-	mg/L	22	14.20	36.40	23.86	23.95	6.88	1.47	3.47	0	0	0	5	13.10	25.90	19.90	20.70	5.99	2.68	3.32	0	0	0
Total Chromium	0.001	mg/L	22	0.00005	0.00070	0.00031	0.00025	0.00023	0.00005	1.35	3	0	0	5	0.00010	0.00120	0.00065	0.00060	0.00052	0.00023	1.26	0	2	40
Total Cobalt	-	mg/L	22	0.000063	0.000575	0.000191	0.000131	0.000142	0.000030	1.35	0	0	0	5	0.000207	0.001000	0.000514	0.000411	0.000327	0.000146	1.57	0	0	0
Total Copper	0.0023[d]	mg/L	22	0.0008	0.0089	0.0028	0.0022	0.0019	0.0004	1.48	0	10	45	5	0.0008	0.0083	0.0038	0.0031	0.0030	0.0013	1.26	0	3	60
Total Iron	0.3	mg/L	22	0.078	1.090	0.353	0.265	0.266	0.057	1.33	0	10	45	5	0.748	2.680	1.377	1.210	0.794	0.355	1.73	0	5	100
Total Lead	0.003[e]	mg/L	22	0.000015	0.003010	0.000363	0.000128	0.000652	0.000139	0.56	0	1	5	5	0.000015	0.002220	0.000741	0.000375	0.000918	0.000411	0.81	0	1	20
Total Lithium	-	mg/L	22	0.00110	0.00190	0.00140	0.00140	0.00017	0.00004	8.47	0	0	0	5	0.00060	0.00130	0.00107	0.00110	0.00028	0.00012	3.84	0	0	0
Total Magnesium	-	mg/L	22	5.15	15.40	8.72	8.17	2.75	0.59	3.17	0	0	0	5	4.71	10.10	7.29	7.01	2.57	1.15	2.84	0	0	0
Total Manganese	-	mg/L	22	0.0204	0.1330	0.0410	0.0329	0.0240	0.0051	1.70	0	0	0	5	0.0474	0.2750	0.1428	0.0965	0.0976	0.0437	1.46	0	0	0
Total Mercury	0.000026	mg/L	19	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	19	0	0	4	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	4	0	0
Total Molybdenum	0.073	mg/L	22	0.00049	0.00104	0.00079	0.00083	0.00017	0.00004	4.53	0	0	0	5	0.00048	0.00101	0.00069	0.00065	0.00021	0.00009	3.32	0	0	0
Total Nickel	0.0033[f]	mg/L	22	0.00032	0.00151	0.00075	0.00065	0.00038	0.00008	1.97	0	0	0	5	0.00060	0.00207	0.00124	0.00105	0.00068	0.00030	1.83	0	0	0
Total Phosphorus	-	mg/L	19	0.0030	0.0520	0.0133	0.0090	0.0119	0.0027	1.11	0	0	0	4	0.0120	0.0817	0.0409	0.0350	0.0324	0.0162	1.26	0	0	0
Total Potassium	-	mg/L	22	0.60	1.52	0.90	0.86	0.23	0.05	3.89	0	0	0	5	0.65	1.22	0.91	0.82	0.23	0.10	4.01	0	0	0
Total Selenium	0.001	mg/L	22	0.00002	0.00009	0.00006	0.00006	0.00002	0.00000	3.11	2	0	0	5	0.00002	0.00010	0.00006	0.00006	0.00003	0.00001	2.03	1	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

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Parameters	CCME[1] Guideline	unit	W16											W19										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silicon	-	mg/L	22	3.50	5.70	4.64	4.65	0.67	0.14	6.94	0	0	0	5	3.80	5.40	4.68	4.80	0.64	0.29	7.34	0	0	0
Total Silver	0.0001	mg/L	22	0.000003	0.000010	0.000003	0.000003	0.000002	0.000000	1.57	19	0	0	5	0.000003	0.000023	0.000009	0.000007	0.000008	0.000004	1.04	2	0	0
Total Sodium	-	mg/L	22	2.30	6.72	3.95	3.79	1.18	0.25	3.34	0	0	0	5	2.19	5.19	3.71	3.76	1.44	0.64	2.58	0	0	0
Total Strontium	-	mg/L	22	0.091	0.245	0.161	0.151	0.047	0.010	3.41	0	0	0	5	0.082	0.190	0.136	0.135	0.049	0.022	2.75	0	0	0
Total Sulphur	-	mg/L	5	5.00	18.00	10.40	11.00	5.55	2.48	1.87	2	0	0	5	5.00	12.00	7.60	5.00	3.58	1.60	2.12	3	0	0
Total Thallium	0.0008	mg/L	22	0.0000010	0.0000090	0.0000025	0.0000010	0.0000022	0.0000005	1.14	12	0	0	5	0.0000010	0.0000090	0.0000045	0.0000030	0.0000039	0.0000018	1.14	2	0	0
Total Tin	-	mg/L	22	0.000005	0.000005	0.000005	0.000005	0	-	-	22	0	0	5	0.000005	0.000100	0.000043	0.000005	0.000052	0.000023	0.83	5	0	0
Total Titanium	-	mg/L	22	0.00025	0.01830	0.00499	0.00260	0.00557	0.00119	0.90	4	0	0	5	0.00025	0.02800	0.01325	0.01080	0.01277	0.00571	1.04	1	0	0
Total Uranium	0.015	mg/L	22	0.00178	0.00971	0.00456	0.00438	0.00224	0.00048	2.03	0	0	0	5	0.00161	0.00580	0.00315	0.00265	0.00162	0.00072	1.95	0	0	0
Total Vanadium	-	mg/L	22	0.00010	0.00250	0.00090	0.00070	0.00074	0.00016	1.23	3	0	0	5	0.00060	0.00437	0.00221	0.00160	0.00160	0.00072	1.38	0	0	0
Total Zinc	0.03	mg/L	22	0.00040	0.00580	0.00171	0.00125	0.00140	0.00030	1.22	0	0	0	5	0.00050	0.00640	0.00300	0.00290	0.00260	0.00116	1.16	0	0	0
Total Zirconium	-	mg/L	22	0.00005	0.00050	0.00028	0.00020	0.00015	0.00003	1.78	1	0	0	5	0.00020	0.00060	0.00042	0.00040	0.00018	0.00008	2.37	0	0	0
Dissolved Aluminum	0.1	mg/L	22	0.0062	0.1170	0.0444	0.0384	0.0358	0.0076	1.24	0	16	73	5	0.0078	0.1210	0.0538	0.0389	0.0471	0.0211	1.14	0	1	20
Dissolved Antimony	-	mg/L	22	0.00005	0.00013	0.00009	0.00009	0.00002	0.000003	5.50	0	0	0	5	0.00005	0.00008	0.00007	0.00008	0.00001	0.000006	5.49	0	0	0
Dissolved Arsenic	-	mg/L	22	0.00030	0.00053	0.00044	0.00045	0.00007	0.000014	6.74	0	0	0	5	0.00052	0.00082	0.00066	0.00063	0.00013	0.000056	5.21	0	0	0
Dissolved Barium	-	mg/L	22	0.031300	0.082200	0.052959	0.050500	0.013933	0.002971	3.80	0	0	0	5	0.031400	0.087700	0.052260	0.041700	0.023163	0.010359	2.26	0	0	0
Dissolved Beryllium	-	mg/L	22	0.000005	0.000030	0.000008	0.000005	0.000006	0.000001	1.30	15	0	0	5	0.000005	0.000020	0.000010	0.000010	0.000006	0.000003	1.66	2	0	0
Dissolved Bismuth	-	mg/L	22	0.0000025	0.0000050	0.0000026	0.0000025	0.0000005	0.0000001	4.90	21	0	0	5	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	5	0	0
Dissolved Boron	-	mg/L	22	0.025	0.025	0.025	0.025	0	-	-	22	0	0	5	0.025	0.025	0.025	0.025	0	-	-	5	0	0
Dissolved Cadmium	-	mg/L	22	0.000003	0.000022	0.000010	0.000010	0.000006	0.000001	1.72	5	0	0	5	0.000007	0.000015	0.000012	0.000013	0.000003	0.000001	3.54	0	0	0
Dissolved Calcium	-	mg/L	22	13.40	36.00	23.39	21.90	6.59	1.41	3.55	0	0	0	5	12.90	25.80	19.42	20.00	6.33	2.83	3.07	0	0	0
Dissolved Chromium	-	mg/L	22	0.00005	0.00040	0.00018	0.00015	0.00013	0.00003	1.43	6	0	0	5	0.00020	0.00040	0.00027	0.00025	0.00008	0.00004	3.23	0	0	0
Dissolved Cobalt	-	mg/L	22	0.000043	0.000133	0.000085	0.000084	0.000024	0.000005	3.56	0	0	0	5	0.000044	0.000414	0.000171	0.000123	0.000142	0.000064	1.20	0	0	0
Dissolved Copper	-	mg/L	22	0.0008	0.0062	0.0022	0.0020	0.0012	0.0003	1.81	0	0	0	5	0.0006	0.0039	0.0023	0.0022	0.0013	0.0006	1.72	0	0	0
Dissolved Iron	-	mg/L	22	0.063	0.240	0.144	0.143	0.053	0.011	2.71	0	0	0	5	0.241	0.585	0.416	0.345	0.158	0.071	2.64	0	0	0
Dissolved Lead	-	mg/L	22	0.000003	0.000399	0.000051	0.000030	0.000081	0.000017	0.63	1	0	0	5	0.000012	0.000126	0.000059	0.000057	0.000046	0.000021	1.28	0	0	0
Dissolved Lithium	-	mg/L	22	0.00090	0.00200	0.00135	0.00130	0.00020	0.00004	6.61	0	0	0	5	0.00060	0.00120	0.00087	0.00080	0.00023	0.00010	3.78	0	0	0
Dissolved Magnesium	-	mg/L	22	5.03	14.90	8.68	8.18	2.59	0.55	3.36	0	0	0	5	4.34	9.75	7.06	6.86	2.60	1.16	2.71	0	0	0
Dissolved Manganese	-	mg/L	22	0.0008	0.0529	0.0268	0.0207	0.0148	0.0032	1.81	0	0	0	5	0.0024	0.2650	0.0798	0.0295	0.1078	0.0482	0.74	0	0	0
Dissolved Mercury	-	mg/L	17	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	17	0	0	2	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	2	0	0
Dissolved Molybdenum	-	mg/L	22	0.00056	0.00104	0.00081	0.00077	0.00014	0.00003	5.59	0	0	0	5	0.00062	0.00104	0.00085	0.00095	0.00020	0.00009	4.20	0	0	0
Dissolved Nickel	-	mg/L	22	0.00030	0.00116	0.00057	0.00051	0.00023	0.00005	2.47	0	0	0	5	0.00056	0.00120	0.00081	0.00074	0.00024	0.00011	3.35	0	0	0
Dissolved Phosphorus	-	mg/L	17	0.0020	0.0070	0.0046	0.0050	0.0017	0.0004	2.65	0	0	0	2	0.0060	0.0121	0.0091	0.0091	0.0043	0.0031	2.10	0	0	0
Dissolved Potassium	-	mg/L	22	0.57	1.49	0.89	0.86	0.23	0.05	3.92	0	0	0	5	0.60	1.16	0.87	0.77	0.23	0.10	3.76	0	0	0
Dissolved Selenium	-	mg/L	22	0.00002	0.00009	0.00006	0.00006	0.00002	0.00000	2.86	3	0	0	5	0.00002	0.00009	0.00005	0.00005	0.00003	0.00001	1.58	2	0	0
Dissolved Silicon	-	mg/L	22	3.30	5.50	4.59	4.75	0.62	0.13	7.36	0	0	0	5	2.93	4.90	4.27	4.90	0.91	0.41	4.69	0	0	0
Dissolved Silver	-	mg/L	22	0.000003	0.000003	0.000003	0.000003	0	-	-	22	0	0	5	0.000003	0.000003	0.000003	0.000003	0	-	-	5	0	0
Dissolved Sodium	-	mg/L	22	2.32	6.44	3.93	3.80	1.08	0.23	3.63	0	0	0	5	2.14	5.14	3.67	3.67	1.40	0.62	2.63	0	0	0
Dissolved Strontium	-	mg/L	22	0.089	0.248	0.162	0.153	0.047	0.010	3.46	0	0	0	5	0.081	0.185	0.133	0.132	0.051	0.023	2.61	0	0	0
Dissolved Sulphur	-	mg/L	5	5.00	19.00	10.80	12.00	5.93	2.65	1.82	2	0	0	5	5.00	11.00	6.20	5.00	2.68	1.20	2.31	4	0	0
Dissolved Thallium	-	mg/L	22	0.0000010	0.0000020	0.0000012	0.0000010	0.0000004	0.0000001	2.99	18	0	0	5	0.0000010	0.0000010	0.0000010	0.0000010	0	-	-	5	0	0
Dissolved Tin	-	mg/L	22	0.000005	0.000005	0.000005	0.000005	0	-	-	22	0	0	5	0.000005	0.000100	0.000043	0.000005	0.000052	0.000023	0.83	5	0	0
Dissolved Titanium	-	mg/L	22	0.00025	0.00170	0.00070	0.00060	0.00050	0.00011	1.39	10	0	0	5	0.00025	0.00200	0.00111	0.00137	0.00082	0.00037	1.36	2	0	0
Dissolved Uranium	-	mg/L	22	0.00162	0.00998	0.00447	0.00459	0.00229	0.00049	1.95	0	0	0	5	0.00114	0.00580	0.00281	0.00226	0.00189	0.00085	1.48	0	0	0
Dissolved Vanadium	-	mg/L	22	0.00010	0.00120	0.00044	0.00040	0.00027	0.00006	1.63	4	0	0	5	0.00050	0.00110	0.00080	0.00080	0.00022	0.00010	3.60	0	0	0
Dissolved Zinc	-	mg/L	22	0.00020	0.00640	0.00105	0.00050	0.00142	0.00030	0.74	0	0	0	5	0.00030	0.00080	0.00064	0.00070	0.00021	0.00009	3.10	0	0	0
Dissolved Zirconium	-	mg/L	22	0.00005	0.00040	0.00023	0.00020	0.00012	0.00003	1.90	3	0	0	5	0.00020	0.00040	0.00029	0.00025	0.00010	0.00005	2.83	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B5. Surface Water Quality Statistics: All sites all parameters, Casino Project, 2008-2012

Parameters	CCME[1] Guideline	unit	W20											W21										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	19	7.25	8.10	7.76	7.74	0.19	0.04	41.44	0	0	0	17	7.31	8.10	7.76	7.79	0.20	0.05	38.68	0	0	0
Conductivity	-	µS/cm	19	106	201	159	165	24	5	6.68	0	0	0	17	131	242	173	171	27	7	6.34	0	0	0
Total Hardness CaCO3	-	mg/L	19	54	86	74	75	10	2	7.12	0	0	0	17	57	108	80	82	13	3	6.26	0	0	0
Dissolved Hardness CaCO3	-	mg/L	6	51	88	71	74	15	6	4.79	0	0	0	4	63	95	80	82	13	7	5.95	0	0	0
Moisture	-	%	-	-	-	-	-	-	-	-	-	-	-	1	18	18	18	18	0	-	-	0	0	0
Ion Balance	-	no unit	4	0.94	1.00	0.98	0.99	0.03	0.01	34.65	0	0	0	3	0.99	1.10	1.03	1.00	0.06	0.04	16.93	0	0	0
Total Dissolved Solids	-	mg/L	19	76	130	100	100	16	4	6.32	0	0	0	17	84	160	111	110	19	4	5.96	0	0	0
Total Suspended Solids	-	mg/L	19	0.5	59.5	5.3	1.0	13.4	3.1	0.39	6	0	0	17	0.5	9.0	3.1	1.0	3.0	0.7	1.02	4	0	0
Turbidity	-	NTU	19	0.3	6.6	2.1	1.2	2.0	0.5	1.03	0	0	0	17	0.4	6.2	2.5	1.8	2.0	0.5	1.28	0	0	0
Ammonia as N	0.499[a]	mg/L	19	0.003	0.170	0.030	0.021	0.038	0.009	0.79	5	0	0	17	0.003	0.200	0.034	0.025	0.046	0.011	0.73	6	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	19	42.7	74.0	64.13	66.0	7.63	1.75	8.40	0	0	0	17	53.0	91.0	69.0	69.0	8.98	2.18	7.68	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	6	0.25	0.25	0.25	0.25	0	-	-	6	0	0	4	0.25	0.25	0.25	0.25	0	-	-	4	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	14	0.25	4.90	1.73	1.45	1.30	0.35	1.33	2	0	0	11	0.25	4.40	1.50	1.60	1.21	0.37	1.24	3	0	0
Bromide (Br)	-	mg/L	19	0.01	0.20	0.18	0.20	0.06	0.01	2.92	19	0	0	17	0.20	0.20	0.20	0.20	0	-	-	17	0	0
Chloride (Cl)	120	mg/L	19	0.25	1.00	0.34	0.25	0.21	0.05	1.66	15	0	0	16	0.25	1.40	0.44	0.25	0.37	0.09	1.19	12	0	0
Fluoride (F)	0.12	mg/L	19	0.120	0.160	0.132	0.130	0.013	0.003	10.04	0	11	58	17	0.100	0.140	0.118	0.120	0.011	0.003	10.25	0	5	29
Sulphate (SO4)	-	mg/L	19	8.01	28.00	17.28	17.00	5.40	1.24	3.20	0	0	0	17	11.00	39.00	20.29	18.00	6.80	1.65	2.99	0	0	0
Total Nitrogen (N)	-	mg/L	6	0.09	0.56	0.31	0.29	0.15	0.06	2.00	0	0	0	4	0.11	0.27	0.21	0.24	0.07	0.04	3.02	0	0	0
Nitrate (as N)	13	mg/L	19	0.008	0.154	0.083	0.083	0.039	0.009	2.11	0	0	0	17	0.001	0.135	0.073	0.081	0.034	0.008	2.14	1	0	0
Nitrate plus Nitrite (N)	-	mg/L	6	0.008	0.154	0.094	0.104	0.059	0.024	1.60	0	0	0	4	0.001	0.121	0.067	0.073	0.050	0.025	1.33	1	0	0
Nitrite (as N)	0.06	mg/L	19	0.001	0.006	0.002	0.001	0.001	0.000	1.23	15	0	0	17	0.001	0.003	0.001	0.001	0.001	0.000	2.06	15	0	0
Total Kjeldahl Nitrogen	-	mg/L	19	0.04	0.49	0.17	0.15000	0.1089	0.0250	1.56	0	0	0	17	0.05	0.47	0.18	0.15000	0.1091	0.0265	1.63	0	0	0
Ortho Phosphate as P	-	mg/L	19	0.0005	0.0080	0.0022	0.0012	0.0020	0.0005	1.06	2	0	0	17	0.0005	0.0070	0.0019	0.0020	0.0015	0.0004	1.27	2	0	0
Cyanide, Total	0.005	mg/L	19	0.00025	0.00150	0.00041	0.00025	0.00031	0.00007	1.32	13	0	0	17	0.00025	0.00150	0.00042	0.00025	0.00033	0.00008	1.27	12	0	0
Cyanide, Weak Acid Diss	-	mg/L	19	0.00025	0.00110	0.00036	0.00025	0.00026	0.00006	1.37	16	0	0	17	0.00025	0.00120	0.00041	0.00025	0.00032	0.00008	1.30	13	0	0
Dissolved Organic Carbon	-	mg/L	14	3.00	8.90	5.53	5.10	2.19	0.58	2.53	0	0	0	11	3.40	9.80	5.85	4.90	2.19	0.66	2.67	0	0	0
Total Organic Carbon	-	mg/L	19	2.50	9.70	5.06	4.40	1.99	0.46	2.54	1	0	0	17	3.20	10.10	6.12	5.70	2.08	0.50	2.94	0	0	0
Total Aluminum	0.1[b]	mg/L	19	0.0049	0.4870	0.0636	0.0214	0.1116	0.0256	0.57	0	3	16	17	0.0048	0.2220	0.0470	0.0204	0.0596	0.0144	0.79	0	3	18
Total Antimony	-	mg/L	19	0.00	0.00	0.00	0.00004	0.0000	0.0000	4.28	0	0	0	17	0.00	0.00	0.00	0.00004	0.0000	0.0000	3.98	0	0	0
Total Arsenic	0.005	mg/L	19	0.00	0.00	0.00	0.00044	0.0004	0.0001	1.46	0	0	0	17	0.00	0.00	0.00	0.00053	0.0002	0.0001	2.64	0	0	0
Total Barium	-	mg/L	19	0.03	0.06	0.04	0.04010	0.0072	0.0017	5.96	0	0	0	17	0.04	0.06	0.05	0.04590	0.0078	0.0019	6.01	0	0	0
Total Beryllium	-	mg/L	19	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.02	12	0	0	17	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.42	11	0	0
Total Bismuth	-	mg/L	19	0.0000025	0.0000050	0.0000026	0.0000025	0.0000006	0.0000001	4.59	18	0	0	17	0.0000025	0.0000070	0.0000028	0.0000025	0.0000011	0.0000003	2.53	16	0	0
Total Boron	1.5	mg/L	19	0.03	0.03	0.03	0.02500	0	-	-	19	0	0	17	0.03	0.03	0.03	0.02500	0	-	-	17	0	0
Total Cadmium	0.000032 [c]	mg/L	19	0.000003	0.000054	0.000012	0.000011	0.000011	0.000003	1.09	4	1	5	17	0.000003	0.000026	0.000011	0.000009	0.000006	0.000002	1.68	1	0	0
Total Calcium	-	mg/L	19	13.10	20.60	17.74	18.40	2.48	0.57	7.15	0	0	0	17	13.40	26.00	19.52	20.20	3.13	0.76	6.24	0	0	0
Total Chromium	0.001	mg/L	19	0.00005	0.00150	0.00029	0.00020	0.00033	0.00007	0.91	2	1	5	17	0.00010	0.00070	0.00025	0.00020	0.00015	0.00004	1.64	0	0	0
Total Cobalt	-	mg/L	19	0.000058	0.000604	0.000152	0.000126	0.000117	0.000027	1.30	0	0	0	17	0.000073	0.000256	0.000162	0.000158	0.000056	0.000013	2.91	0	0	0
Total Copper	0.0023[d]	mg/L	19	0.0006	0.0028	0.0012	0.0010	0.0006	0.0001	1.94	0	1	5	17	0.0006	0.0024	0.0012	0.0010	0.0006	0.0001	2.08	0	3	18
Total Iron	0.3	mg/L	19	0.150	1.900	0.550	0.348	0.478	0.110	1.15	0	10	53	17	0.226	1.180	0.491	0.393	0.272	0.066	1.81	0	13	76
Total Lead	0.003[e]	mg/L	19	0.000006	0.000430	0.000077	0.000061	0.000095	0.000022	0.82	0	0	0	17	0.000011	0.000178	0.000064	0.000040	0.000054	0.000013	1.18	0	0	0
Total Lithium	-	mg/L	19	0.00025	0.00060	0.00030	0.00025	0.00012	0.00003	2.54	16	0	0	17	0.00025	0.00090	0.00045	0.00050	0.00022	0.00005	2.10	8	0	0
Total Magnesium	-	mg/L	19	4.78	8.87	7.09	7.34	1.08	0.25	6.55	0	0	0	17	5.37	10.50	7.57	7.68	1.26	0.31	6.00	0	0	0
Total Manganese	-	mg/L	19	0.0198	0.1530	0.0627	0.0563	0.0438	0.0101	1.43	0	0	0	17	0.0254	0.1540	0.0787	0.0530	0.0515	0.0125	1.53	0	0	0
Total Mercury	0.000026	mg/L	16	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	16	0	0	14	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	14	0	0
Total Molybdenum	0.073	mg/L	19	0.00043	0.00064	0.00056	0.00058	0.00007	0.00002	8.60	0	0	0	17	0.00048	0.00108	0.00067	0.00067	0.00013	0.00003	5.27	0	0	0
Total Nickel	0.0033[f]	mg/L	19	0.00043	0.00183	0.00068	0.00053	0.00034	0.00008	1.99	0	0	0	17	0.00047	0.00120	0.00067	0.00057	0.00024	0.00006	2.75	0	0	0
Total Phosphorus	-	mg/L	16	0.0030	0.0573	0.0136	0.0100	0.0127	0.0032	1.07	0	0	0	14	0.0030	0.0180	0.0096	0.0090	0.0047	0.0012	2.07	0	0	0
Total Potassium	-	mg/L	19	0.58	0.85	0.74	0.73	0.07	0.02	10.09	0	0	0	17	0.58	1.33	0.83	0.79	0.18	0.04	4.67	0	0	0
Total Selenium	0.001	mg/L	19	0.00008	0.00029	0.00014	0.00012	0.00005	0.00001	2.62	0	0	0	17	0.00007	0.00022	0.00012	0.00012	0.00004	0.00001	3.22	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W20											W21										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silicon	-	mg/L	19	3.50	5.60	4.66	4.80	0.50	0.12	9.23	0	0	0	17	3.50	5.40	4.76	4.80	0.54	0.13	8.78	0	0	0
Total Silver	0.0001	mg/L	19	0.000003	0.000011	0.000003	0.000003	0.000002	0.000000	1.51	18	0	0	17	0.000003	0.000003	0.000003	0.000003	0	-	-	17	0	0
Total Sodium	-	mg/L	19	2.43	4.01	3.44	3.56	0.40	0.09	8.54	0	0	0	17	2.86	6.22	3.87	3.77	0.77	0.19	5.04	0	0	0
Total Strontium	-	mg/L	19	0.104	0.173	0.146	0.148	0.017	0.004	8.41	0	0	0	17	0.123	0.187	0.150	0.153	0.018	0.004	8.55	0	0	0
Total Sulphur	-	mg/L	6	5.00	5.00	5.00	5.00	0	-	-	6	0	0	4	5.00	11.00	6.50	5.00	3.00	1.50	2.17	3	0	0
Total Thallium	0.0008	mg/L	19	0.0000010	0.0000033	0.0000011	0.0000010	0.0000005	0.0000001	2.12	18	0	0	17	0.0000010	0.0000020	0.0000011	0.0000010	0.0000002	0.0000001	4.37	16	0	0
Total Tin	-	mg/L	19	0.000005	0.000100	0.000015	0.000005	0.000030	0.000007	0.50	19	0	0	17	0.000005	0.000010	0.000005	0.000005	0.000001	0.000000	4.37	16	0	0
Total Titanium	-	mg/L	19	0.00025	0.01770	0.00212	0.00070	0.00407	0.00093	0.52	8	0	0	17	0.00025	0.00970	0.00161	0.00060	0.00238	0.00058	0.68	7	0	0
Total Uranium	0.015	mg/L	19	0.00012	0.00050	0.00025	0.00024	0.00010	0.00002	2.62	0	0	0	17	0.00015	0.00340	0.00090	0.00081	0.00077	0.00019	1.16	0	0	0
Total Vanadium	-	mg/L	19	0.00010	0.00262	0.00056	0.00040	0.00056	0.00013	1.00	2	0	0	17	0.00010	0.00130	0.00044	0.00030	0.00035	0.00009	1.25	4	0	0
Total Zinc	0.03	mg/L	19	0.00020	0.00370	0.00094	0.00060	0.00098	0.00022	0.96	0	0	0	17	0.00030	0.00220	0.00084	0.00050	0.00058	0.00014	1.45	0	0	0
Total Zirconium	-	mg/L	19	0.00010	0.00049	0.00017	0.00010	0.00010	0.00002	1.68	0	0	0	17	0.00010	0.00040	0.00021	0.00020	0.00008	0.00002	2.71	0	0	0
Dissolved Aluminum	0.1	mg/L	19	0.0036	0.0475	0.0152	0.0099	0.0129	0.0030	1.18	0	0	0	17	0.0043	0.0419	0.0164	0.0124	0.0128	0.0031	1.28	0	0	0
Dissolved Antimony	-	mg/L	19	0.00001	0.00005	0.00003	0.00003	0.00001	0.000002	3.44	1	0	0	17	0.00002	0.00017	0.00005	0.00005	0.00003	0.000008	1.50	0	0	0
Dissolved Arsenic	-	mg/L	19	0.00027	0.00145	0.00052	0.00037	0.00036	0.000082	1.45	0	0	0	17	0.00035	0.00074	0.00049	0.00042	0.00013	0.000032	3.69	0	0	0
Dissolved Barium	-	mg/L	19	0.026300	0.056400	0.041274	0.039100	0.008816	0.002023	4.68	0	0	0	17	0.031900	0.061200	0.045982	0.047400	0.008188	0.001986	5.62	0	0	0
Dissolved Beryllium	-	mg/L	19	0.000005	0.000015	0.000007	0.000005	0.000003	0.000001	2.34	12	0	0	17	0.000005	0.000010	0.000006	0.000005	0.000002	0.000001	2.83	13	0	0
Dissolved Bismuth	-	mg/L	19	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	19	0	0	17	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	17	0	0
Dissolved Boron	-	mg/L	19	0.025	0.025	0.025	0.025	0	-	-	19	0	0	17	0.025	0.025	0.025	0.025	0	-	-	17	0	0
Dissolved Cadmium	-	mg/L	19	0.000003	0.000021	0.000007	0.000008	0.000005	0.000001	1.45	7	0	0	17	0.000003	0.000011	0.000007	0.000007	0.000003	0.000001	2.15	5	0	0
Dissolved Calcium	-	mg/L	19	12.80	20.50	17.53	17.80	2.31	0.53	7.57	0	0	0	17	14.70	27.40	19.81	19.80	3.16	0.77	6.27	0	0	0
Dissolved Chromium	-	mg/L	19	0.00005	0.00030	0.00017	0.00020	0.00008	0.00002	2.17	3	0	0	17	0.00005	0.00030	0.00019	0.00020	0.00009	0.00002	2.11	3	0	0
Dissolved Cobalt	-	mg/L	19	0.000025	0.000193	0.000095	0.000079	0.000049	0.000011	1.95	0	0	0	17	0.000027	0.000209	0.000121	0.000093	0.000058	0.000014	2.09	0	0	0
Dissolved Copper	-	mg/L	19	0.0005	0.0016	0.0010	0.0009	0.0004	0.0001	2.61	0	0	0	17	0.0005	0.0018	0.0011	0.0009	0.0005	0.0001	2.38	0	0	0
Dissolved Iron	-	mg/L	19	0.085	1.150	0.312	0.136	0.328	0.075	0.95	0	0	0	17	0.017	0.424	0.248	0.197	0.119	0.029	2.09	0	0	0
Dissolved Lead	-	mg/L	19	0.000003	0.000117	0.000026	0.000008	0.000034	0.000008	0.76	4	0	0	17	0.000003	0.000314	0.000042	0.000017	0.000075	0.000018	0.56	4	0	0
Dissolved Lithium	-	mg/L	19	0.00025	0.00050	0.00026	0.00025	0.00006	0.00001	4.59	18	0	0	17	0.00025	0.00090	0.00043	0.00050	0.00020	0.00005	2.15	8	0	0
Dissolved Magnesium	-	mg/L	19	4.53	9.09	7.06	7.18	1.16	0.27	6.09	0	0	0	17	5.63	10.90	7.58	7.57	1.29	0.31	5.88	0	0	0
Dissolved Manganese	-	mg/L	19	0.0008	0.1550	0.0564	0.0340	0.0475	0.0109	1.19	0	0	0	17	0.0025	0.1570	0.0735	0.0438	0.0573	0.0139	1.28	0	0	0
Dissolved Mercury	-	mg/L	15	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	15	0	0	13	0.0000050	0.0000100	0.0000054	0.0000050	0.0000014	0.0000004	3.88	12	0	0
Dissolved Molybdenum	-	mg/L	19	0.00046	0.00078	0.00057	0.00054	0.00008	0.00002	7.34	0	0	0	17	0.00052	0.00144	0.00072	0.00069	0.00023	0.00006	3.17	0	0	0
Dissolved Nickel	-	mg/L	19	0.00042	0.00083	0.00057	0.00052	0.00013	0.00003	4.54	0	0	0	17	0.00021	0.00084	0.00058	0.00055	0.00015	0.00004	3.89	0	0	0
Dissolved Phosphorus	-	mg/L	15	0.0010	0.0140	0.0059	0.0050	0.0039	0.0010	1.51	2	0	0	13	0.0020	0.0080	0.0048	0.0050	0.0018	0.0005	2.66	0	0	0
Dissolved Potassium	-	mg/L	19	0.55	0.86	0.74	0.75	0.08	0.02	8.75	0	0	0	17	0.60	1.39	0.86	0.82	0.20	0.05	4.33	0	0	0
Dissolved Selenium	-	mg/L	19	0.00008	0.00028	0.00014	0.00012	0.00005	0.00001	2.63	0	0	0	17	0.00002	0.00020	0.00011	0.00012	0.00004	0.00001	2.66	1	0	0
Dissolved Silicon	-	mg/L	19	3.41	5.40	4.46	4.40	0.53	0.12	8.45	0	0	0	17	3.30	5.70	4.71	4.90	0.60	0.15	7.79	0	0	0
Dissolved Silver	-	mg/L	19	0.000003	0.000003	0.000003	0.000003	0	-	-	19	0	0	17	0.000003	0.000003	0.000003	0.000003	0	-	-	17	0	0
Dissolved Sodium	-	mg/L	19	2.39	5.70	3.56	3.56	0.64	0.15	5.58	0	0	0	17	2.98	6.42	3.99	3.87	0.84	0.20	4.73	0	0	0
Dissolved Strontium	-	mg/L	19	0.101	0.170	0.145	0.149	0.018	0.004	7.92	0	0	0	17	0.119	0.190	0.149	0.151	0.020	0.005	7.37	0	0	0
Dissolved Sulphur	-	mg/L	6	5.00	5.00	5.00	5.00	0	-	-	6	0	0	4	5.00	10.00	6.25	5.00	2.50	1.25	2.50	3	0	0
Dissolved Thallium	-	mg/L	19	0.0000010	0.0000010	0.0000010	0.0000010	0	-	-	19	0	0	17	0.0000010	0.0000030	0.0000011	0.0000010	0.0000005	0.0000001	2.30	16	0	0
Dissolved Tin	-	mg/L	19	0.000005	0.000100	0.000015	0.000005	0.000030	0.000007	0.51	18	0	0	17	0.000005	0.000005	0.000005	0.000005	0	-	-	17	0	0
Dissolved Titanium	-	mg/L	19	0.00025	0.00110	0.00034	0.00025	0.00023	0.00005	1.49	16	0	0	17	0.00025	0.00090	0.00032	0.00025	0.00017	0.00004	1.85	14	0	0
Dissolved Uranium	-	mg/L	19	0.00012	0.00037	0.00023	0.00023	0.00007	0.00002	3.12	0	0	0	17	0.00016	0.00425	0.00108	0.00083	0.00114	0.00028	0.94	0	0	0
Dissolved Vanadium	-	mg/L	19	0.00010	0.00080	0.00036	0.00030	0.00022	0.00005	1.68	4	0	0	17	0.00010	0.00080	0.00034	0.00030	0.00021	0.00005	1.63	3	0	0
Dissolved Zinc	-	mg/L	19	0.00020	0.00110	0.00047	0.00040	0.00023	0.00005	2.01	0	0	0	17	0.00020	0.00070	0.00041	0.00040	0.00015	0.00004	2.67	0	0	0
Dissolved Zirconium	-	mg/L	19	0.00005	0.00020	0.00015	0.00015	0.00005	0.00001	2.73	1	0	0	17	0.00010	0.00030	0.00018	0.00020	0.00006	0.00002	2.87	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B5. Surface Water Quality Statistics: All sites all parameters, Casino Project, 2008-2012

Parameters	CCME[1] Guideline	unit	W7											W3										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	18	5.50	8.00	6.87	6.89	0.51	0.12	13.58	0	3	17	27	7.40	8.21	7.83	7.89	0.20	0.04	38.61	0	0	0
Conductivity	-	µS/cm	18	34	217	121	125	44	10	2.75	0	0	0	27	89	435	276	263	92	18	3.01	0	0	0
Total Hardness CaCO3	-	mg/L	18	15	61	42	42	13	3	3.28	0	0	0	27	46	189	129	126	44	8	2.97	0	0	0
Dissolved Hardness CaCO3	-	mg/L	4	32	63	49	51	13	7	3.78	0	0	0	6	48	197	146	170	58	24	2.51	0	0	0
Ion Balance	-	no unit	3	0.93	1.10	1.01	1.00	0.09	0.05	11.82	0	0	0	4	0.62	1.10	0.90	0.95	0.21	0.10	4.36	0	0	0
Total Dissolved Solids	-	mg/L	17	32	130	90	98	30	7	3.04	0	0	0	27	74	306	184	180	59	11	3.10	0	0	0
Total Suspended Solids	-	mg/L	18	0.5	40.0	8.9	1.0	14.0	3.3	0.64	5	0	0	27	0.5	34.0	4.2	0.5	7.8	1.5	0.54	14	0	0
Turbidity	-	NTU	18	0.1	15.5	2.5	0.4	4.2	1.0	0.59	0	0	0	27	0.1	7.5	0.9	0.3	1.6	0.3	0.59	0	0	0
Ammonia as N	0.499[a]	mg/L	18	0.003	0.250	0.037	0.015	0.062	0.015	0.59	6	0	0	27	0.003	0.052	0.016	0.010	0.015	0.003	1.09	10	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	18	0.6	15.0	7.23	7.05	3.40	0.80	2.13	0	0	0	27	22.0	130.0	75.18	72.0	26.26	5.05	2.86	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	4	0.25	0.25	0.25	0.25	0	-	-	4	0	0	6	0.25	0.25	0.25	0.25	0	-	-	6	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	11	0.25	7.60	2.78	1.30	2.86	0.86	0.97	2	0	0	15	0.25	5.00	1.79	1.39	1.51	0.39	1.19	3	0	0
Bromide (Br)	-	mg/L	14	0.20	0.20	0.20	0.20	0	-	-	14	0	0	23	0.01	0.20	0.18	0.20	0.06	0.01	2.83	23	0	0
Chloride (Cl)	120	mg/L	18	0.25	1.90	0.47	0.25	0.43	0.10	1.10	12	0	0	27	0.25	1.50	0.56	0.50	0.38	0.07	1.47	13	0	0
Fluoride (F)	0.12	mg/L	14	0.030	0.130	0.066	0.065	0.024	0.007	2.73	0	1	7	23	0.059	0.120	0.096	0.100	0.018	0.004	5.20	0	0	0
Sulphate (SO4)	-	mg/L	18	0.25	54.00	39.85	44.50	15.26	3.60	2.61	1	0	0	27	15.00	121.00	61.67	58.00	25.96	5.00	2.38	0	0	0
Total Nitrogen (N)	-	mg/L	4	0.07	0.64	0.24	0.13	0.27	0.13	0.91	0	0	0	6	0.37	0.68	0.53	0.54	0.12	0.05	4.25	0	0	0
Nitrate (as N)	13	mg/L	18	0.001	0.011	0.003	0.001	0.004	0.001	0.92	13	0	0	27	0.050	0.487	0.228	0.236	0.115	0.022	1.99	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	4	0.001	0.012	0.006	0.006	0.006	0.003	1.03	2	0	0	6	0.111	0.487	0.300	0.290	0.132	0.054	2.27	0	0	0
Nitrite (as N)	0.06	mg/L	18	0.001	0.010	0.002	0.001	0.002	0.001	0.90	15	0	0	27	0.001	0.004	0.002	0.001	0.001	0.000	1.69	19	0	0
Total Kjeldahl Nitrogen	-	mg/L	18	0.07	0.63	0.22	0.17000	0.1575	0.0371	1.40	0	0	0	27	0.08	0.56	0.22	0.21000	0.1117	0.0215	2.00	0	0	0
Ortho Phosphate as P	-	mg/L	18	0.0005	0.0040	0.0015	0.0010	0.0009	0.0002	1.68	4	0	0	27	0.0005	0.0460	0.0031	0.0010	0.0086	0.0017	0.36	6	0	0
Cyanide, Total	0.005	mg/L	18	0.00025	0.00150	0.00053	0.00025	0.00042	0.00010	1.25	11	0	0	27	0.00025	0.00150	0.00057	0.00025	0.00038	0.00007	1.48	14	0	0
Cyanide, Weak Acid Diss	-	mg/L	18	0.00025	0.00130	0.00049	0.00025	0.00038	0.00009	1.28	12	0	0	27	0.00025	0.00180	0.00054	0.00025	0.00042	0.00008	1.28	16	0	0
Dissolved Organic Carbon	-	mg/L	10	1.70	17.40	6.26	4.20	4.91	1.55	1.28	0	0	0	14	2.00	15.30	6.95	6.70	3.33	0.89	2.09	0	0	0
Total Organic Carbon	-	mg/L	15	1.90	18.50	5.96	4.00	4.67	1.21	1.28	0	0	0	23	1.50	17.40	7.22	6.40	3.48	0.73	2.08	0	0	0
Total Aluminum	0.1[b]	mg/L	18	0.0195	0.5890	0.1494	0.0619	0.1794	0.0423	0.83	0	7	39	27	0.0063	0.4150	0.0702	0.0237	0.1022	0.0197	0.69	0	5	19
Total Antimony	-	mg/L	18	0.00	0.00	0.00	0.00007	0.0000	0.0000	4.32	0	0	0	27	0.00	0.00	0.00	0.00032	0.0001	0.0000	3.86	0	0	0
Total Arsenic	0.005	mg/L	18	0.00	0.00	0.00	0.00025	0.0003	0.0001	1.36	0	0	0	27	0.00	0.00	0.00	0.00066	0.0003	0.0001	2.57	0	0	0
Total Barium	-	mg/L	18	0.03	0.07	0.05	0.04785	0.0097	0.0023	4.99	0	0	0	27	0.04	0.09	0.06	0.05440	0.0135	0.0026	4.23	0	0	0
Total Beryllium	-	mg/L	18	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.17	5	0	0	27	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.01	19	0	0
Total Bismuth	-	mg/L	18	0.0000025	0.0000400	0.0000105	0.0000025	0.0000123	0.0000029	0.85	11	0	0	27	0.0000025	0.0000130	0.0000038	0.0000025	0.0000030	0.0000006	1.29	22	0	0
Total Boron	1.5	mg/L	18	0.03	0.03	0.03	0.02500	0	-	-	18	0	0	27	0.03	0.03	0.03	0.02500	0	-	-	27	0	0
Total Cadmium	0.000032 [c]	mg/L	18	0.000087	0.000505	0.000213	0.000172	0.000114	0.000027	1.86	0	18	100	27	0.000008	0.000084	0.000029	0.000021	0.000020	0.000004	1.40	0	5	19
Total Calcium	-	mg/L	18	4.49	18.30	12.66	12.50	3.92	0.93	3.23	0	0	0	27	11.40	48.20	33.44	32.60	11.32	2.18	2.95	0	0	0
Total Chromium	0.001	mg/L	18	0.00005	0.00050	0.00019	0.00015	0.00015	0.00003	1.31	6	0	0	27	0.00005	0.00080	0.00021	0.00020	0.00019	0.00004	1.12	5	0	0
Total Cobalt	-	mg/L	18	0.000024	0.000793	0.000184	0.000079	0.000234	0.000055	0.79	0	0	0	27	0.000020	0.000545	0.000103	0.000045	0.000131	0.000025	0.78	0	0	0
Total Copper	0.0023[d]	mg/L	18	0.0009	0.0107	0.0037	0.0025	0.0029	0.0007	1.26	0	14	78	27	0.0013	0.0081	0.0030	0.0024	0.0017	0.0003	1.69	0	11	41
Total Iron	0.3	mg/L	18	0.010	0.646	0.159	0.047	0.206	0.049	0.77	0	4	22	27	0.004	0.540	0.091	0.028	0.145	0.028	0.63	0	3	11
Total Lead	0.003[e]	mg/L	18	0.000017	0.000856	0.000248	0.000076	0.000292	0.000069	0.85	0	0	0	27	0.000009	0.001470	0.000141	0.000040	0.000295	0.000057	0.48	0	0	0
Total Lithium	-	mg/L	18	0.00025	0.00130	0.00069	0.00070	0.00028	0.00007	2.46	3	0	0	27	0.00025	0.00080	0.00045	0.00050	0.00019	0.00004	2.39	11	0	0
Total Magnesium	-	mg/L	18	0.93	3.81	2.60	2.58	0.77	0.18	3.38	0	0	0	27	4.18	17.30	11.15	10.80	3.77	0.72	2.96	0	0	0
Total Manganese	-	mg/L	18	0.0008	0.0845	0.0157	0.0047	0.0247	0.0058	0.64	0	0	0	27	0.0002	0.0369	0.0091	0.0046	0.0115	0.0022	0.79	0	0	0
Total Mercury	0.000026	mg/L	15	0.0000050	0.0000100	0.0000053	0.0000050	0.0000013	0.0000003	4.13	14	0	0	24	0.0000050	0.0000100	0.0000052	0.0000050	0.0000010	0.0000002	5.10	23	0	0
Total Molybdenum	0.073	mg/L	18	0.00007	0.00049	0.00026	0.00026	0.00010	0.00002	2.71	0	0	0	27	0.00037	0.00143	0.00089	0.00088	0.00028	0.00005	3.13	0	0	0
Total Nickel	0.0033[f]	mg/L	18	0.00063	0.00217	0.00107	0.00097	0.00044	0.00010	2.41	0	0	0	27	0.00045	0.00211	0.00085	0.00069	0.00038	0.00007	2.21	0	0	0
Total Phosphorus	-	mg/L	15	0.0010	0.0480	0.0121	0.0050	0.0158	0.0041	0.76	2	0	0	24	0.0010	0.0300	0.0071	0.0035	0.0089	0.0018	0.80	7	0	0
Total Potassium	-	mg/L	18	0.34	2.53	0.76	0.55	0.54	0.13	1.42	0	0	0	27	1.03	2.44	1.81	1.77	0.44	0.08	4.15	0	0	0
Total Selenium	0.001	mg/L	18	0.00002	0.00015	0.00007	0.00006	0.00003	0.00001	1.93	2	0	0	27	0.00002	0.00019	0.00008	0.00008	0.00003	0.00001	2.48	2	0	0
Total Silicon	-	mg/L	18	2.40	11.20	7.85	8.05	2.73	0.64	2.87	0	0	0	27	2.62	6.00	4.70	4.90	0.75	0.15	6.22	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
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"max"	Maximum Value
"sd"	Standard Deviation
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"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W7											W3										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silver	0.0001	mg/L	18	0.000003	0.000026	0.000006	0.000003	0.000006	0.000001	0.92	12	0	0	27	0.000003	0.000014	0.000003	0.000003	0.000003	0.000001	1.17	24	0	0
Total Sodium	-	mg/L	18	0.92	5.27	3.52	3.71	1.32	0.31	2.67	0	0	0	27	1.40	5.90	3.93	3.98	1.23	0.24	3.20	0	0	0
Total Strontium	-	mg/L	18	0.031	0.141	0.085	0.089	0.027	0.006	3.11	0	0	0	27	0.071	0.345	0.209	0.204	0.072	0.014	2.91	0	0	0
Total Sulphur	-	mg/L	4	5.00	21.00	15.25	17.50	7.04	3.52	2.17	1	0	0	6	5.00	40.00	26.50	30.50	13.40	5.47	1.98	1	0	0
Total Thallium	0.0008	mg/L	18	0.0000010	0.0000110	0.0000035	0.0000030	0.0000027	0.0000006	1.27	3	0	0	27	0.0000010	0.0000080	0.0000026	0.0000020	0.0000019	0.0000004	1.34	11	0	0
Total Tin	-	mg/L	18	0.000005	0.000040	0.000008	0.000005	0.000008	0.000002	0.91	15	0	0	27	0.000005	0.000100	0.000014	0.000005	0.000026	0.000005	0.53	24	0	0
Total Titanium	-	mg/L	18	0.00025	0.01620	0.00348	0.00115	0.00498	0.00117	0.70	5	0	0	27	0.00025	0.01280	0.00190	0.00050	0.00315	0.00061	0.60	13	0	0
Total Uranium	0.015	mg/L	18	0.00004	0.00038	0.00013	0.00008	0.00010	0.00002	1.28	0	0	0	27	0.00339	0.03510	0.01226	0.00992	0.00801	0.00154	1.53	0	0	0
Total Vanadium	-	mg/L	18	0.00010	0.00120	0.00041	0.00025	0.00035	0.00008	1.16	4	0	0	27	0.00010	0.00085	0.00023	0.00010	0.00024	0.00005	0.96	18	0	0
Total Zinc	0.03	mg/L	18	0.00610	0.02800	0.01561	0.01410	0.00621	0.00146	2.51	0	0	0	27	0.00050	0.01330	0.00202	0.00110	0.00272	0.00052	0.74	0	0	0
Total Zirconium	-	mg/L	18	0.00005	0.00050	0.00015	0.00005	0.00014	0.00003	1.06	10	0	0	27	0.00005	0.00040	0.00017	0.00010	0.00011	0.00002	1.57	5	0	0
Dissolved Aluminum	0.1	mg/L	18	0.0092	0.3910	0.0899	0.0329	0.1163	0.0274	0.77	0	4	22	26	0.0056	0.2330	0.0377	0.0140	0.0540	0.0106	0.70	0	3	12
Dissolved Antimony	-	mg/L	18	0.00004	0.00009	0.00006	0.00006	0.00001	0.000003	4.60	0	0	0	26	0.00018	0.00049	0.00032	0.00031	0.00009	0.000017	3.62	0	0	0
Dissolved Arsenic	-	mg/L	18	0.00012	0.00064	0.00024	0.00021	0.00012	0.000028	2.03	0	0	0	26	0.00033	0.00083	0.00059	0.00058	0.00015	0.000029	3.97	0	0	0
Dissolved Barium	-	mg/L	18	0.028100	0.061100	0.046078	0.046800	0.009355	0.002205	4.93	0	0	0	26	0.031300	0.089600	0.056115	0.053750	0.014855	0.002913	3.78	0	0	0
Dissolved Beryllium	-	mg/L	18	0.000005	0.000050	0.000015	0.000008	0.000014	0.000003	1.09	9	0	0	26	0.000005	0.000020	0.000007	0.000005	0.000005	0.000001	1.38	22	0	0
Dissolved Bismuth	-	mg/L	18	0.0000025	0.0000150	0.0000032	0.0000025	0.0000029	0.0000007	1.08	17	0	0	26	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	26	0	0
Dissolved Boron	-	mg/L	18	0.025	0.025	0.025	0.025	0	-	-	18	0	0	26	0.025	0.025	0.025	0.025	0	-	-	26	0	0
Dissolved Cadmium	-	mg/L	18	0.000084	0.000431	0.000195	0.000160	0.000093	0.000022	2.09	0	0	0	26	0.000008	0.000066	0.000022	0.000018	0.000014	0.000003	1.61	0	0	0
Dissolved Calcium	-	mg/L	18	4.49	19.10	12.63	12.50	3.82	0.90	3.31	0	0	0	26	11.50	50.90	34.05	32.95	12.02	2.36	2.83	0	0	0
Dissolved Chromium	-	mg/L	18	0.00005	0.00030	0.00016	0.00020	0.00009	0.00002	1.78	6	0	0	26	0.00005	0.00030	0.00014	0.00015	0.00008	0.00001	1.87	7	0	0
Dissolved Cobalt	-	mg/L	18	0.000018	0.000554	0.000121	0.000061	0.000149	0.000035	0.81	0	0	0	26	0.000017	0.000255	0.000054	0.000043	0.000047	0.000009	1.16	0	0	0
Dissolved Copper	-	mg/L	18	0.0009	0.0079	0.0032	0.0022	0.0022	0.0005	1.43	0	0	0	26	0.0012	0.0072	0.0028	0.0022	0.0017	0.0003	1.65	0	0	0
Dissolved Iron	-	mg/L	18	0.005	0.312	0.068	0.017	0.098	0.023	0.69	0	0	0	26	0.003	0.227	0.037	0.016	0.052	0.010	0.71	0	0	0
Dissolved Lead	-	mg/L	18	0.000007	0.000330	0.000049	0.000017	0.000079	0.000019	0.62	0	0	0	26	0.000003	0.000339	0.000043	0.000016	0.000071	0.000014	0.61	2	0	0
Dissolved Lithium	-	mg/L	18	0.00025	0.00120	0.00069	0.00070	0.00027	0.00006	2.55	3	0	0	26	0.00025	0.00070	0.00044	0.00050	0.00018	0.00004	2.46	11	0	0
Dissolved Magnesium	-	mg/L	18	0.87	3.74	2.62	2.69	0.77	0.18	3.41	0	0	0	26	4.14	17.50	11.19	10.75	3.71	0.73	3.01	0	0	0
Dissolved Manganese	-	mg/L	18	0.0005	0.0672	0.0121	0.0035	0.0193	0.0045	0.63	0	0	0	26	0.0002	0.0189	0.0046	0.0030	0.0052	0.0010	0.90	0	0	0
Dissolved Mercury	-	mg/L	14	0.0000050	0.0000100	0.0000054	0.0000050	0.0000013	0.0000004	4.01	13	0	0	22	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	22	0	0
Dissolved Molybdenum	-	mg/L	18	0.00003	0.00078	0.00029	0.00026	0.00016	0.00004	1.78	1	0	0	26	0.00037	0.00143	0.00088	0.00087	0.00026	0.00005	3.34	0	0	0
Dissolved Nickel	-	mg/L	18	0.00059	0.00193	0.00101	0.00094	0.00040	0.00009	2.54	0	0	0	26	0.00044	0.00166	0.00079	0.00067	0.00035	0.00007	2.28	0	0	0
Dissolved Phosphorus	-	mg/L	14	0.0010	0.0180	0.0053	0.0025	0.0060	0.0016	0.88	4	0	0	22	0.0010	0.0130	0.0040	0.0030	0.0034	0.0007	1.18	7	0	0
Dissolved Potassium	-	mg/L	18	0.40	2.57	0.77	0.56	0.54	0.13	1.43	0	0	0	26	0.93	2.51	1.83	1.77	0.45	0.09	4.02	0	0	0
Dissolved Selenium	-	mg/L	18	0.00002	0.00015	0.00007	0.00006	0.00003	0.00001	2.16	1	0	0	26	0.00004	0.00019	0.00009	0.00008	0.00003	0.00001	2.98	0	0	0
Dissolved Silicon	-	mg/L	18	2.30	11.90	7.66	8.05	2.63	0.62	2.91	0	0	0	26	2.40	5.40	4.63	4.90	0.79	0.15	5.89	0	0	0
Dissolved Silver	-	mg/L	18	0.000003	0.000022	0.000004	0.000003	0.000005	0.000001	0.86	15	0	0	26	0.000003	0.000009	0.000003	0.000003	0.000002	0.000000	1.90	24	0	0
Dissolved Sodium	-	mg/L	18	0.99	5.03	3.59	3.94	1.29	0.30	2.78	0	0	0	26	1.50	5.81	3.90	4.10	1.16	0.23	3.35	0	0	0
Dissolved Strontium	-	mg/L	18	0.030	0.138	0.085	0.087	0.027	0.006	3.11	0	0	0	26	0.071	0.345	0.210	0.201	0.073	0.014	2.90	0	0	0
Dissolved Sulphur	-	mg/L	4	5.00	20.00	15.75	19.00	7.23	3.61	2.18	1	0	0	6	5.00	40.00	26.33	31.00	13.23	5.40	1.99	1	0	0
Dissolved Thallium	-	mg/L	18	0.0000010	0.0000070	0.0000023	0.0000020	0.0000017	0.0000004	1.33	7	0	0	26	0.0000010	0.0000040	0.0000020	0.0000015	0.0000011	0.0000002	1.73	13	0	0
Dissolved Tin	-	mg/L	18	0.000005	0.000090	0.000010	0.000005	0.000020	0.000005	0.50	16	0	0	26	0.000005	0.000100	0.000016	0.000005	0.000028	0.000005	0.59	22	0	0
Dissolved Titanium	-	mg/L	18	0.00025	0.00300	0.00061	0.00025	0.00077	0.00018	0.80	13	0	0	26	0.00025	0.00220	0.00050	0.00025	0.00051	0.00010	0.98	19	0	0
Dissolved Uranium	-	mg/L	18	0.00004	0.00029	0.00010	0.00007	0.00007	0.00002	1.41	0	0	0	26	0.00317	0.03560	0.01251	0.00977	0.00811	0.00159	1.54	0	0	0
Dissolved Vanadium	-	mg/L	18	0.00010	0.00050	0.00022	0.00020	0.00012	0.00003	1.74	8	0	0	26	0.00010	0.00040	0.00017	0.00010	0.00011	0.00002	1.52	18	0	0
Dissolved Zinc	-	mg/L	18	0.00810	0.02530	0.01461	0.01330	0.00522	0.00123	2.80	0	0	0	26	0.00040	0.00980	0.00173	0.00090	0.00233	0.00046	0.74	0	0	0
Dissolved Zirconium	-	mg/L	18	0.00005	0.00030	0.00011	0.00005	0.00008	0.00002	1.35	10	0	0	26	0.00005	0.00030	0.00015	0.00010	0.00009	0.00002	1.70	7	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W14											W2										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	22	7.00	8.20	7.85	7.91	0.29	0.06	27.23	0	0	0	21	7.10	8.10	7.82	7.90	0.23	0.05	33.40	0	0	0
Conductivity	-	µS/cm	22	49	585	290	283	141	30	2.06	0	0	0	21	78	445	285	287	105	23	2.72	0	0	0
Total Hardness CaCO3	-	mg/L	22	28	291	144	141	72	15	2.00	0	0	0	21	41	211	139	142	51	11	2.70	0	0	0
Dissolved Hardness CaCO3	-	mg/L	4	94	292	199	206	82	41	2.44	0	0	0	4	104	201	169	185	44	22	3.80	0	0	0
Ion Balance	-	no unit	3	0.98	1.10	1.03	1.00	0.06	0.04	15.97	0	0	0	3	1.00	1.10	1.03	1.00	0.06	0.03	17.90	0	0	0
Total Dissolved Solids	-	mg/L	22	46	370	198	200	81	17	2.44	0	0	0	21	78	320	196	200	64	14	3.06	0	0	0
Total Suspended Solids	-	mg/L	22	0.5	34.0	6.0	2.0	8.6	1.8	0.70	6	0	0	21	0.5	25.0	5.3	2.0	7.7	1.7	0.69	9	0	0
Turbidity	-	NTU	22	0.1	2.8	0.6	0.4	0.7	0.1	0.93	0	0	0	21	0.1	2.5	0.6	0.3	0.7	0.1	0.85	1	0	0
Ammonia as N	0.499[a]	mg/L	22	0.003	0.050	0.022	0.015	0.019	0.004	1.15	6	0	0	21	0.003	0.081	0.019	0.010	0.021	0.005	0.92	7	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	22	10.0	160.0	88.09	91.5	39.74	8.47	2.22	0	0	0	21	15.0	120.0	79.81	82.0	29.05	6.34	2.75	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	4	0.25	0.25	0.25	0.25	0	-	-	4	0	0	4	0.25	0.25	0.25	0.25	0	-	-	4	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	11	0.25	12.00	2.61	1.60	3.35	1.01	0.78	3	0	0	12	0.25	4.00	1.63	1.35	1.21	0.35	1.34	3	0	0
Bromide (Br)	-	mg/L	18	0.05	0.20	0.19	0.20	0.04	0.01	5.42	18	0	0	18	0.05	0.20	0.19	0.20	0.04	0.01	5.42	18	0	0
Chloride (Cl)	120	mg/L	22	0.25	1.70	0.79	0.70	0.45	0.10	1.76	6	0	0	21	0.25	1.40	0.59	0.60	0.35	0.08	1.69	8	0	0
Fluoride (F)	0.12	mg/L	18	0.040	0.150	0.094	0.100	0.029	0.007	3.22	0	2	11	18	0.050	0.130	0.096	0.100	0.023	0.005	4.17	0	1	6
Sulphate (SO4)	-	mg/L	22	0.25	130.00	60.59	53.50	36.94	7.88	1.64	1	0	0	21	8.80	110.00	62.61	60.00	28.09	6.13	2.23	0	0	0
Total Nitrogen (N)	-	mg/L	4	0.41	1510.00	377.89	0.58	754.74	377.37	0.50	0	0	0	4	0.34	0.60	0.45	0.44	0.11	0.06	3.96	0	0	0
Nitrate (as N)	13	mg/L	22	0.001	0.437	0.233	0.237	0.145	0.031	1.61	1	0	0	21	0.043	0.407	0.215	0.197	0.115	0.025	1.87	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	4	0.001	0.390	0.250	0.305	0.171	0.085	1.46	1	0	0	4	0.125	0.402	0.300	0.336	0.121	0.060	2.48	0	0	0
Nitrite (as N)	0.06	mg/L	22	0.001	0.010	0.002	0.001	0.003	0.001	0.87	16	0	0	21	0.001	0.012	0.003	0.001	0.003	0.001	0.89	14	0	0
Total Kjeldahl Nitrogen	-	mg/L	21	0.05	0.59	0.30	0.28	0.1513	0.0330	2.01	0	0	0	21	0.06	0.99	0.28	0.21000	0.2234	0.0487	1.23	0	0	0
Ortho Phosphate as P	-	mg/L	22	0.0005	0.0260	0.0025	0.0010	0.0053	0.0011	0.46	6	0	0	21	0.0005	0.0370	0.0032	0.0020	0.0078	0.0017	0.41	4	0	0
Cyanide, Total	0.005	mg/L	22	0.00025	0.00180	0.00091	0.00080	0.00048	0.00010	1.91	4	0	0	21	0.00025	0.00150	0.00070	0.00070	0.00043	0.00009	1.61	8	0	0
Cyanide, Weak Acid Diss	-	mg/L	22	0.00025	0.00170	0.00080	0.00085	0.00042	0.00009	1.91	6	0	0	21	0.00025	0.00140	0.00065	0.00070	0.00040	0.00009	1.62	9	0	0
Dissolved Organic Carbon	-	mg/L	10	5.20	29.20	12.39	10.70	6.40	2.02	1.94	0	0	0	9	3.70	21.20	8.86	8.00	5.16	1.72	1.71	0	0	0
Total Organic Carbon	-	mg/L	18	5.20	28.80	12.74	11.45	5.50	1.30	2.32	0	0	0	17	3.40	21.50	8.58	7.30	4.50	1.09	1.90	0	0	0
Total Aluminum	0.1[b]	mg/L	22	0.0131	0.5420	0.1448	0.0601	0.1688	0.0360	0.86	0	8	36	21	0.0059	0.4600	0.1018	0.0373	0.1259	0.0275	0.81	0	7	33
Total Antimony	-	mg/L	22	0.00	0.00	0.00	0.00023	0.0001	0.0000	3.46	0	0	0	21	0.00	0.00	0.00	0.00027	0.0001	0.0000	3.95	1	0	0
Total Arsenic	0.005	mg/L	22	0.00	0.00	0.00	0.00057	0.0002	0.0000	3.56	0	0	0	21	0.00	0.00	0.00	0.00067	0.0002	0.0000	3.11	0	0	0
Total Barium	-	mg/L	22	0.06	0.12	0.08	0.07410	0.0188	0.0040	4.16	0	0	0	21	0.05	0.08	0.06	0.06280	0.0127	0.0028	5.08	0	0	0
Total Beryllium	-	mg/L	22	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.27	7	0	0	21	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.03	14	0	0
Total Bismuth	-	mg/L	22	0.0000025	0.0000200	0.0000041	0.0000025	0.0000049	0.0000010	0.85	19	0	0	21	0.0000025	0.0005000	0.0000275	0.0000025	0.0001083	0.0000236	0.25	18	0	0
Total Boron	1.5	mg/L	22	0.03	0.03	0.03	0.02500	0	-	-	22	0	0	21	0.03	0.15	0.03	0.02500	0.0273	0.0060	1.13	21	0	0
Total Cadmium	0.000032 [c]	mg/L	22	0.000003	0.000031	0.000013	0.000012	0.000010	0.000002	1.30	6	4	18	21	0.000008	0.000069	0.000022	0.000021	0.000014	0.000003	1.59	1	2	10
Total Calcium	-	mg/L	22	7.03	68.10	34.58	33.65	16.96	3.62	2.04	0	0	0	21	10.30	53.60	34.83	35.70	12.96	2.83	2.69	0	0	0
Total Chromium	0.001	mg/L	22	0.00005	0.00070	0.00030	0.00030	0.00017	0.00004	1.80	1	0	0	21	0.00005	0.00070	0.00025	0.00020	0.00016	0.00004	1.55	3	0	0
Total Cobalt	-	mg/L	22	0.000024	0.000418	0.000111	0.000059	0.000105	0.000022	1.06	0	0	0	21	0.000020	0.000492	0.000120	0.000081	0.000117	0.000025	1.03	1	0	0
Total Copper	0.0023[d]	mg/L	22	0.0008	0.0042	0.0018	0.0016	0.0008	0.0002	2.38	0	5	23	21	0.0013	0.0060	0.0025	0.0024	0.0012	0.0003	2.06	0	8	38
Total Iron	0.3	mg/L	22	0.008	0.567	0.143	0.045	0.167	0.036	0.85	0	5	23	21	0.004	0.549	0.116	0.042	0.143	0.031	0.81	0	2	10
Total Lead	0.003[e]	mg/L	22	0.000007	0.001500	0.000145	0.000024	0.000318	0.000068	0.45	0	0	0	21	0.000007	0.000443	0.000124	0.000066	0.000131	0.000029	0.94	0	0	0
Total Lithium	-	mg/L	22	0.00025	0.00250	0.00094	0.00090	0.00044	0.00009	2.14	1	0	0	21	0.00025	0.00250	0.00082	0.00070	0.00051	0.00011	1.60	6	0	0
Total Magnesium	-	mg/L	22	2.61	29.50	14.12	13.80	7.32	1.56	1.93	0	0	0	21	3.76	19.60	12.65	12.80	4.66	1.02	2.72	0	0	0
Total Manganese	-	mg/L	22	0.0004	0.0431	0.0108	0.0054	0.0127	0.0027	0.85	0	0	0	21	0.0008	0.0369	0.0102	0.0050	0.0103	0.0022	1.00	0	0	0
Total Mercury	0.000026	mg/L	19	0.0000050	0.0000100	0.0000055	0.0000050	0.0000016	0.0000004	3.51	17	0	0	17	0.0000050	0.0000250	0.0000065	0.0000050	0.0000049	0.0000012	1.31	16	1	6
Total Molybdenum	0.073	mg/L	22	0.00009	0.00127	0.00051	0.00054	0.00026	0.00005	1.97	0	0	0	21	0.00026	0.00152	0.00077	0.00071	0.00034	0.00007	2.27	1	0	0
Total Nickel	0.0033[f]	mg/L	22	0.00045	0.00107	0.00066	0.00056	0.00021	0.00004	3.20	0	0	0	21	0.00046	0.00270	0.00087	0.00067	0.00052	0.00011	1.69	0	0	0
Total Phosphorus	-	mg/L	19	0.0010	0.0360	0.0111	0.0080	0.0098	0.0022	1.13	1	0	0	18	0.0010	0.0390	0.0098	0.0050	0.0097	0.0023	1.02	3	0	0
Total Potassium	-	mg/L	22	0.80	2.82	1.80	1.73	0.63	0.14	2.83	0	0	0	21	0.94	2.56	1.88	1.90	0.48	0.11	3.89	0	0	0
Total Selenium	0.001	mg/L	22	0.00002	0.00045	0.00010	0.00008	0.00008	0.00002	1.18	1	0	0	21	0.00002	0.00030	0.00010	0.00010	0.00006	0.00001	1.77	1	0	0
Total Silicon	-	mg/L	22	1.60	5.40	4.04	4.20	0.97	0.21	4.16	0	0	0	21	2.40	5.70	4.49	4.60	0.77	0.17	5.83	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W14											W2										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silver	0.0001	mg/L	22	0.000003	0.000011	0.000003	0.000003	0.000002	0.000000	1.58	20	0	0	21	0.000003	0.000015	0.000004	0.000003	0.000004	0.000001	1.08	20	0	0
Total Sodium	-	mg/L	22	0.87	9.44	4.39	4.49	2.17	0.46	2.02	0	0	0	21	1.30	6.67	4.24	4.45	1.48	0.32	2.86	0	0	0
Total Strontium	-	mg/L	22	0.055	0.531	0.277	0.281	0.134	0.029	2.06	0	0	0	21	0.067	0.340	0.235	0.244	0.086	0.019	2.73	0	0	0
Total Sulphur	-	mg/L	4	12.00	57.00	33.75	33.00	18.68	9.34	1.81	0	0	0	4	16.00	38.00	29.50	32.00	9.98	4.99	2.95	0	0	0
Total Thallium	0.0008	mg/L	22	0.0000010	0.0000070	0.0000032	0.0000030	0.0000019	0.0000004	1.64	5	0	0	21	0.0000010	0.0000250	0.0000040	0.0000030	0.0000052	0.0000011	0.76	9	0	0
Total Tin	-	mg/L	22	0.000005	0.000060	0.000010	0.000005	0.000016	0.000003	0.62	20	0	0	21	0.000005	0.002500	0.000130	0.000005	0.000543	0.000119	0.24	19	0	0
Total Titanium	-	mg/L	22	0.00025	0.01610	0.00366	0.00140	0.00443	0.00095	0.83	3	0	0	21	0.00025	0.01510	0.00318	0.00120	0.00421	0.00092	0.76	7	0	0
Total Uranium	0.015	mg/L	22	0.00125	0.09710	0.01278	0.00842	0.01992	0.00425	0.64	0	0	0	21	0.00290	0.04160	0.01495	0.01060	0.01180	0.00257	1.27	0	0	0
Total Vanadium	-	mg/L	22	0.00010	0.00140	0.00051	0.00045	0.00040	0.00009	1.28	5	0	0	21	0.00010	0.00250	0.00049	0.00030	0.00056	0.00012	0.88	9	0	0
Total Zinc	0.03	mg/L	22	0.00020	0.00410	0.00132	0.00095	0.00111	0.00024	1.19	0	0	0	21	0.00050	0.00600	0.00159	0.00130	0.00140	0.00031	1.13	0	0	0
Total Zirconium	-	mg/L	22	0.00010	0.00070	0.00036	0.00040	0.00014	0.00003	2.50	0	0	0	21	0.00005	0.00050	0.00022	0.00020	0.00013	0.00003	1.74	5	0	0
Dissolved Aluminum	0.1	mg/L	22	0.0085	0.3680	0.1020	0.0449	0.1170	0.0250	0.87	0	7	32	21	0.0056	0.2720	0.0613	0.0334	0.0792	0.0173	0.77	0	4	19
Dissolved Antimony	-	mg/L	22	0.00010	0.00032	0.00022	0.00023	0.00007	0.000014	3.33	0	0	0	21	0.00016	0.00042	0.00029	0.00028	0.00007	0.000016	3.91	0	0	0
Dissolved Arsenic	-	mg/L	22	0.00037	0.00078	0.00054	0.00053	0.00008	0.000018	6.42	0	0	0	21	0.00036	0.00076	0.00057	0.00061	0.00011	0.000024	5.20	0	0	0
Dissolved Barium	-	mg/L	22	0.042900	0.118000	0.075173	0.071000	0.020889	0.004453	3.60	0	0	0	21	0.036000	0.081100	0.061990	0.060100	0.014003	0.003056	4.43	0	0	0
Dissolved Beryllium	-	mg/L	22	0.000005	0.000030	0.000011	0.000010	0.000008	0.000002	1.37	10	0	0	21	0.000005	0.000020	0.000008	0.000005	0.000005	0.000001	1.64	14	0	0
Dissolved Bismuth	-	mg/L	22	0.0000025	0.0000060	0.0000027	0.0000025	0.0000007	0.0000002	3.56	21	0	0	21	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	21	0	0
Dissolved Boron	-	mg/L	22	0.025	0.025	0.025	0.025	0	-	-	22	0	0	21	0.025	0.025	0.025	0.025	0	-	-	21	0	0
Dissolved Cadmium	-	mg/L	22	0.000003	0.000028	0.000012	0.000010	0.000007	0.000002	1.55	4	0	0	21	0.000005	0.000049	0.000019	0.000015	0.000010	0.000002	1.83	0	0	0
Dissolved Calcium	-	mg/L	22	6.83	68.90	33.86	33.30	16.66	3.55	2.03	0	0	0	21	10.30	52.00	34.35	33.70	12.86	2.81	2.67	0	0	0
Dissolved Chromium	-	mg/L	22	0.00005	0.00050	0.00025	0.00020	0.00012	0.00003	2.03	1	0	0	21	0.00005	0.00030	0.00017	0.00020	0.00009	0.00002	1.97	3	0	0
Dissolved Cobalt	-	mg/L	22	0.000022	0.000225	0.000079	0.000053	0.000058	0.000012	1.35	0	0	0	21	0.000017	0.000241	0.000064	0.000051	0.000052	0.000011	1.23	0	0	0
Dissolved Copper	-	mg/L	22	0.0008	0.0032	0.0017	0.0016	0.0006	0.0001	2.91	0	0	0	21	0.0012	0.0053	0.0024	0.0022	0.0011	0.0002	2.09	0	0	0
Dissolved Iron	-	mg/L	22	0.004	0.284	0.083	0.035	0.092	0.020	0.89	0	0	0	21	0.003	0.236	0.054	0.025	0.067	0.015	0.81	0	0	0
Dissolved Lead	-	mg/L	22	0.000003	0.000786	0.000072	0.000019	0.000166	0.000035	0.43	2	0	0	21	0.000003	0.000577	0.000078	0.000024	0.000146	0.000032	0.53	2	0	0
Dissolved Lithium	-	mg/L	22	0.00025	0.00240	0.00086	0.00080	0.00046	0.00010	1.89	3	0	0	21	0.00025	0.00120	0.00068	0.00070	0.00026	0.00006	2.68	3	0	0
Dissolved Magnesium	-	mg/L	22	2.43	29.20	13.97	13.55	6.95	1.48	2.01	0	0	0	21	3.74	18.60	12.35	12.60	4.49	0.98	2.75	0	0	0
Dissolved Manganese	-	mg/L	22	0.0001	0.0320	0.0075	0.0032	0.0093	0.0020	0.81	0	0	0	21	0.0008	0.0186	0.0060	0.0030	0.0063	0.0014	0.96	0	0	0
Dissolved Mercury	-	mg/L	18	0.0000050	0.0000100	0.0000056	0.0000050	0.0000016	0.0000004	3.44	16	0	0	17	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	17	0	0
Dissolved Molybdenum	-	mg/L	22	0.00015	0.00138	0.00053	0.00053	0.00026	0.00006	1.99	0	0	0	21	0.00028	0.00145	0.00081	0.00079	0.00031	0.00007	2.58	0	0	0
Dissolved Nickel	-	mg/L	22	0.00040	0.00223	0.00068	0.00055	0.00039	0.00008	1.73	0	0	0	21	0.00047	0.00129	0.00070	0.00063	0.00022	0.00005	3.12	0	0	0
Dissolved Phosphorus	-	mg/L	18	0.0010	0.0150	0.0058	0.0035	0.0042	0.0010	1.39	1	0	0	17	0.0010	0.0130	0.0041	0.0030	0.0036	0.0009	1.15	4	0	0
Dissolved Potassium	-	mg/L	22	0.72	2.97	1.80	1.74	0.64	0.14	2.83	0	0	0	21	0.85	2.56	1.85	1.91	0.49	0.11	3.76	0	0	0
Dissolved Selenium	-	mg/L	22	0.00002	0.00043	0.00010	0.00009	0.00008	0.00002	1.33	1	0	0	21	0.00002	0.00020	0.00010	0.00009	0.00004	0.00001	2.64	1	0	0
Dissolved Silicon	-	mg/L	22	1.30	5.30	4.00	4.25	1.01	0.22	3.96	0	0	0	21	2.10	5.78	4.44	4.60	0.86	0.19	5.14	0	0	0
Dissolved Silver	-	mg/L	22	0.000003	0.000008	0.000003	0.000003	0.000001	0.000000	2.35	21	0	0	21	0.000003	0.000008	0.000003	0.000003	0.000001	0.000000	2.11	19	0	0
Dissolved Sodium	-	mg/L	22	0.96	9.41	4.37	4.41	2.09	0.44	2.10	0	0	0	21	1.40	6.08	4.13	4.65	1.34	0.29	3.09	0	0	0
Dissolved Strontium	-	mg/L	22	0.053	0.522	0.272	0.265	0.131	0.028	2.07	0	0	0	21	0.069	0.341	0.233	0.236	0.085	0.018	2.76	0	0	0
Dissolved Sulphur	-	mg/L	4	13.00	55.00	34.25	34.50	17.19	8.60	1.99	0	0	0	4	15.00	37.00	30.00	34.00	10.13	5.07	2.96	0	0	0
Dissolved Thallium	-	mg/L	22	0.0000010	0.0000060	0.0000026	0.0000030	0.0000015	0.0000003	1.73	8	0	0	21	0.0000010	0.0000040	0.0000020	0.0000020	0.0000011	0.0000002	1.83	10	0	0
Dissolved Tin	-	mg/L	22	0.000005	0.000100	0.000011	0.000005	0.000020	0.000004	0.52	19	0	0	21	0.000005	0.000060	0.000008	0.000005	0.000012	0.000003	0.65	19	0	0
Dissolved Titanium	-	mg/L	22	0.00025	0.00410	0.00117	0.00060	0.00131	0.00028	0.89	10	0	0	21	0.00025	0.00260	0.00074	0.00025	0.00079	0.00017	0.94	13	0	0
Dissolved Uranium	-	mg/L	22	0.00109	0.09540	0.01257	0.00806	0.01948	0.00415	0.65	0	0	0	21	0.00275	0.04200	0.01492	0.01040	0.01175	0.00256	1.27	0	0	0
Dissolved Vanadium	-	mg/L	22	0.00010	0.00080	0.00040	0.00040	0.00022	0.00005	1.77	4	0	0	21	0.00010	0.00060	0.00023	0.00020	0.00015	0.00003	1.53	9	0	0
Dissolved Zinc	-	mg/L	22	0.00020	0.00830	0.00178	0.00070	0.00218	0.00047	0.82	0	0	0	21	0.00040	0.00810	0.00156	0.00080	0.00192	0.00042	0.81	0	0	0
Dissolved Zirconium	-	mg/L	22	0.00010	0.00070	0.00034	0.00030	0.00014	0.00003	2.43	0	0	0	21	0.00005	0.00040	0.00021	0.00020	0.00011	0.00002	1.87	3	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B5. Surface Water Quality Statistics: All sites all parameters, Casino Project, 2008-2012

Parameters	CCME[1] Guideline	unit	W1											W17										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	21	7.20	8.20	7.84	7.90	0.25	0.05	31.14	0	0	0	9	7.40	8.06	7.81	7.90	0.21	0.07	36.57	0	0	0
Conductivity	-	µS/cm	21	92	492	314	312	113	25	2.77	0	0	0	9	96	350	220	193	92	31	2.38	0	0	0
Total Hardness CaCO3	-	mg/L	21	50	248	152	149	57	12	2.66	0	0	0	9	47	159	103	97	40	13	2.59	0	0	0
Dissolved Hardness CaCO3	-	mg/L	4	113	242	188	199	55	28	3.41	0	0	0	5	46	167	115	129	47	21	2.44	0	0	0
Ion Balance	-	no unit	3	0.96	1.00	0.99	1.00	0.02	0.01	42.72	0	0	0	3	0.88	1.00	0.96	0.99	0.07	0.04	14.37	0	0	0
Total Dissolved Solids	-	mg/L	21	92	350	213	220	70	15	3.06	0	0	0	9	94	210	145	150	44	15	3.27	0	0	0
Total Suspended Solids	-	mg/L	21	0.5	190.0	11.1	2.0	41.1	9.0	0.27	8	0	0	9	0.5	37.7	7.2	4.0	11.8	3.9	0.61	3	0	0
Turbidity	-	NTU	21	0.1	3.6	0.6	0.3	0.8	0.2	0.72	0	0	0	9	0.2	5.2	1.0	0.5	1.6	0.5	0.61	0	0	0
Ammonia as N	0.499[a]	mg/L	20	0.003	0.070	0.016	0.008	0.018	0.004	0.88	8	0	0	9	0.003	0.059	0.018	0.010	0.019	0.006	0.98	3	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	21	21.0	120.0	83.38	84.0	27.03	5.90	3.08	0	0	0	9	30.0	110.0	73.22	68.0	28.91	9.64	2.53	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	4	0.25	0.25	0.25	0.25	0	-	-	4	0	0	5	0.25	0.25	0.25	0.25	0	-	-	5	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	12	0.25	5.30	2.02	1.40	1.81	0.52	1.12	3	0	0	6	0.25	5.50	1.73	1.19	1.96	0.80	0.88	2	0	0
Bromide (Br)	-	mg/L	17	0.20	0.20	0.20	0.20	0	-	-	17	0	0	6	0.01	0.20	0.14	0.20	0.10	0.04	1.34	6	0	0
Chloride (Cl)	120	mg/L	21	0.25	7.40	1.30	0.80	1.81	0.39	0.72	7	0	0	9	0.25	1.30	0.94	1.10	0.37	0.12	2.57	1	0	0
Fluoride (F)	0.12	mg/L	17	0.070	0.120	0.101	0.100	0.014	0.003	7.42	0	0	0	6	0.047	0.080	0.067	0.069	0.013	0.005	5.34	0	0	0
Sulphate (SO4)	-	mg/L	21	17.00	140.00	72.29	68.00	33.79	7.37	2.14	0	0	0	9	1.60	66.00	33.56	30.00	21.70	7.23	1.55	0	0	0
Total Nitrogen (N)	-	mg/L	4	0.38	0.61	0.51	0.52	0.10	0.05	4.98	0	0	0	5	0.36	0.74	0.54	0.54	0.17	0.08	3.17	0	0	0
Nitrate (as N)	13	mg/L	21	0.050	0.470	0.229	0.202	0.128	0.028	1.79	0	0	0	8	0.052	0.282	0.153	0.152	0.075	0.026	2.05	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	4	0.201	0.470	0.340	0.344	0.110	0.055	3.08	0	0	0	4	0.099	0.282	0.183	0.176	0.077	0.039	2.38	0	0	0
Nitrite (as N)	0.06	mg/L	21	0.001	0.010	0.002	0.001	0.003	0.001	0.89	15	0	0	9	0.001	0.010	0.002	0.001	0.003	0.001	0.81	6	0	0
Total Kjeldahl Nitrogen	-	mg/L	20	0.05	0.50	0.24	0.23500	0.1124	0.0251	2.09	0	0	0	9	0.13	0.60	0.27	0.23000	0.1547	0.0516	1.73	0	0	0
Ortho Phosphate as P	-	mg/L	21	0.0005	0.0140	0.0020	0.0010	0.0028	0.0006	0.69	5	0	0	9	0.0005	0.0030	0.0012	0.0010	0.0009	0.0003	1.35	4	0	0
Cyanide, Total	0.005	mg/L	21	0.00025	0.00160	0.00060	0.00060	0.00041	0.00009	1.47	10	0	0	9	0.00025	0.00130	0.00074	0.00070	0.00043	0.00014	1.72	3	0	0
Cyanide, Weak Acid Diss	-	mg/L	21	0.00025	0.00140	0.00058	0.00050	0.00038	0.00008	1.53	10	0	0	9	0.00025	0.00140	0.00067	0.00060	0.00035	0.00012	1.89	2	0	0
Dissolved Organic Carbon	-	mg/L	10	0.25	11.30	7.41	7.45	3.09	0.98	2.40	1	0	0	5	4.22	16.80	9.66	9.20	4.79	2.14	2.02	0	0	0
Total Organic Carbon	-	mg/L	17	5.20	20.00	9.09	7.70	4.00	0.97	2.27	0	0	0	6	4.42	19.70	9.85	8.35	5.36	2.19	1.84	0	0	0
Total Aluminum	0.1[b]	mg/L	21	0.0089	0.7230	0.0875	0.0222	0.1600	0.0349	0.55	0	3	14	9	0.0166	0.4580	0.1187	0.0600	0.1447	0.0482	0.82	0	4	44
Total Antimony	-	mg/L	21	0.00	0.00	0.00	0.00028	0.0001	0.0000	5.03	0	0	0	9	0.00	0.00	0.00	0.00023	0.0001	0.0000	4.09	0	0	0
Total Arsenic	0.005	mg/L	21	0.00	0.00	0.00	0.00050	0.0003	0.0001	2.24	0	0	0	9	0.00	0.00	0.00	0.00062	0.0002	0.0001	3.10	0	0	0
Total Barium	-	mg/L	21	0.04	0.11	0.07	0.06060	0.0178	0.0039	3.71	0	0	0	9	0.05	0.12	0.08	0.06950	0.0217	0.0072	3.48	0	0	0
Total Beryllium	-	mg/L	21	0.00	0.00	0.00	0.00001	0.0000	0.0000	0.78	14	0	0	9	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.17	5	0	0
Total Bismuth	-	mg/L	21	0.0000025	0.0000090	0.0000028	0.0000025	0.0000014	0.0000003	1.98	20	0	0	9	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	9	0	0
Total Boron	1.5	mg/L	21	0.03	0.03	0.03	0.02500	0	-	-	21	0	0	9	0.03	0.03	0.03	0.02500	0	-	-	9	0	0
Total Cadmium	0.000032 [c]	mg/L	21	0.000009	0.000080	0.000019	0.000015	0.000015	0.000003	1.29	0	1	5	9	0.000013	0.000087	0.000027	0.000021	0.000023	0.000008	1.19	0	2	22
Total Calcium	-	mg/L	21	12.40	62.50	38.08	37.30	14.44	3.15	2.64	0	0	0	9	11.80	37.70	25.18	24.50	9.21	3.07	2.73	0	0	0
Total Chromium	0.001	mg/L	21	0.00005	0.00110	0.00022	0.00020	0.00022	0.00005	1.00	3	1	5	9	0.00005	0.00051	0.00022	0.00030	0.00016	0.00005	1.43	2	0	0
Total Cobalt	-	mg/L	21	0.000026	0.000848	0.000105	0.000051	0.000176	0.000038	0.60	0	0	0	9	0.000023	0.000342	0.000100	0.000062	0.000099	0.000033	1.01	0	0	0
Total Copper	0.0023[d]	mg/L	21	0.0013	0.0066	0.0023	0.0019	0.0012	0.0003	1.96	0	6	29	9	0.0009	0.0027	0.0016	0.0018	0.0006	0.0002	2.87	0	1	11
Total Iron	0.3	mg/L	21	0.006	1.000	0.102	0.031	0.216	0.047	0.47	0	1	5	9	0.014	0.589	0.144	0.058	0.183	0.061	0.79	0	1	11
Total Lead	0.003[e]	mg/L	21	0.000005	0.000866	0.000085	0.000033	0.000184	0.000040	0.46	0	0	0	9	0.000017	0.000401	0.000130	0.000094	0.000121	0.000040	1.07	0	0	0
Total Lithium	-	mg/L	21	0.00025	0.00090	0.00069	0.00070	0.00015	0.00003	4.44	1	0	0	9	0.00050	0.00110	0.00078	0.00080	0.00017	0.00006	4.57	0	0	0
Total Magnesium	-	mg/L	21	4.54	22.30	13.83	13.30	5.16	1.13	2.68	0	0	0	9	4.18	15.70	9.78	8.77	4.12	1.37	2.37	0	0	0
Total Manganese	-	mg/L	21	0.0001	0.0689	0.0071	0.0021	0.0152	0.0033	0.47	0	0	0	9	0.0016	0.0410	0.0106	0.0069	0.0121	0.0040	0.88	0	0	0
Total Mercury	0.000026	mg/L	18	0.0000050	0.0000100	0.0000056	0.0000050	0.0000016	0.0000004	3.44	16	0	0	7	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	7	0	0
Total Molybdenum	0.073	mg/L	21	0.00030	0.00110	0.00077	0.00078	0.00023	0.00005	3.40	0	0	0	9	0.00020	0.00049	0.00036	0.00039	0.00010	0.00003	3.71	0	0	0
Total Nickel	0.0033[f]	mg/L	21	0.00044	0.00227	0.00074	0.00063	0.00039	0.00008	1.91	0	0	0	9	0.00039	0.00154	0.00074	0.00067	0.00036	0.00012	2.04	0	0	0
Total Phosphorus	-	mg/L	18	0.0010	0.0840	0.0093	0.0040	0.0191	0.0045	0.49	2	0	0	7	0.0030	0.0326	0.0102	0.0050	0.0106	0.0040	0.96	0	0	0
Total Potassium	-	mg/L	21	1.12	2.90	1.96	1.97	0.47	0.10	4.16	0	0	0	9	0.95	1.73	1.23	1.16	0.26	0.09	4.76	0	0	0
Total Selenium	0.001	mg/L	21	0.00002	0.00017	0.00011	0.00011	0.00003	0.00001	3.20	1	0	0	9	0.00002	0.00011	0.00007	0.00007	0.00003	0.00001	2.41	1	0	0
Total Silicon	-	mg/L	21	2.60	5.60	4.49	4.50	0.67	0.15	6.71	0	0	0	9	2.30	4.60	3.83	4.00	0.85	0.28	4.49	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

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Parameters	CCME[1] Guideline	unit	W1											W17										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silver	0.0001	mg/L	21	0.000003	0.000010	0.000003	0.000003	0.000002	0.000000	1.75	20	0	0	9	0.000003	0.000012	0.000005	0.000003	0.000003	0.000001	1.31	6	0	0
Total Sodium	-	mg/L	21	1.39	6.09	4.17	4.39	1.30	0.28	3.20	0	0	0	9	1.54	5.05	3.48	3.87	1.24	0.41	2.80	0	0	0
Total Strontium	-	mg/L	21	0.081	0.381	0.239	0.236	0.085	0.019	2.82	0	0	0	9	0.083	0.265	0.171	0.163	0.063	0.021	2.72	0	0	0
Total Sulphur	-	mg/L	4	19.00	50.00	35.75	37.00	13.15	6.57	2.72	0	0	0	5	5.00	23.00	15.00	16.00	7.52	3.36	2.00	1	0	0
Total Thallium	0.0008	mg/L	21	0.0000010	0.0000110	0.0000027	0.0000030	0.0000023	0.0000005	1.20	8	0	0	9	0.0000010	0.0000052	0.0000028	0.0000030	0.0000014	0.0000005	1.95	2	0	0
Total Tin	-	mg/L	21	0.000005	0.000090	0.000009	0.000005	0.000019	0.000004	0.50	19	0	0	9	0.000005	0.000100	0.000034	0.000005	0.000043	0.000014	0.79	7	0	0
Total Titanium	-	mg/L	21	0.00025	0.02540	0.00247	0.00080	0.00550	0.00120	0.45	7	0	0	9	0.00025	0.01630	0.00386	0.00110	0.00529	0.00176	0.73	3	0	0
Total Uranium	0.015	mg/L	21	0.00350	0.03280	0.01385	0.01090	0.00943	0.00206	1.47	0	0	0	9	0.00126	0.00554	0.00248	0.00198	0.00141	0.00047	1.76	0	0	0
Total Vanadium	-	mg/L	21	0.00010	0.00200	0.00032	0.00020	0.00041	0.00009	0.77	9	0	0	9	0.00020	0.00169	0.00053	0.00030	0.00047	0.00016	1.12	0	0	0
Total Zinc	0.03	mg/L	21	0.00030	0.00620	0.00109	0.00080	0.00124	0.00027	0.87	0	0	0	9	0.00040	0.00523	0.00174	0.00140	0.00147	0.00049	1.18	0	0	0
Total Zirconium	-	mg/L	21	0.00010	0.00050	0.00022	0.00020	0.00011	0.00002	2.03	0	0	0	9	0.00010	0.00039	0.00022	0.00020	0.00011	0.00004	2.06	0	0	0
Dissolved Aluminum	0.1	mg/L	21	0.0078	0.2890	0.0574	0.0202	0.0739	0.0161	0.78	0	4	19	9	0.0113	0.1850	0.0638	0.0488	0.0651	0.0217	0.98	0	2	22
Dissolved Antimony	-	mg/L	21	0.00018	0.00039	0.00027	0.00027	0.00006	0.000013	4.50	0	0	0	9	0.00012	0.00027	0.00021	0.00024	0.00006	0.000019	3.77	0	0	0
Dissolved Arsenic	-	mg/L	21	0.00032	0.00076	0.00053	0.00052	0.00012	0.000026	4.49	0	0	0	9	0.00045	0.00069	0.00057	0.00056	0.00008	0.000025	7.45	0	0	0
Dissolved Barium	-	mg/L	21	0.036800	0.106000	0.064295	0.058900	0.019167	0.004183	3.35	0	0	0	9	0.043400	0.121000	0.073278	0.062700	0.025446	0.008482	2.88	0	0	0
Dissolved Beryllium	-	mg/L	21	0.000005	0.000020	0.000007	0.000005	0.000005	0.000001	1.59	15	0	0	9	0.000005	0.000020	0.000008	0.000005	0.000006	0.000002	1.38	7	0	0
Dissolved Bismuth	-	mg/L	21	0.0000025	0.0000050	0.0000026	0.0000025	0.0000005	0.0000001	4.80	20	0	0	9	0.0000025	0.0000084	0.0000032	0.0000025	0.0000020	0.0000007	1.60	8	0	0
Dissolved Boron	-	mg/L	21	0.025	0.025	0.025	0.025	0	-	-	21	0	0	9	0.025	0.025	0.025	0.025	0	-	-	9	0	0
Dissolved Cadmium	-	mg/L	21	0.000003	0.000049	0.000016	0.000014	0.000013	0.000003	1.29	4	0	0	9	0.000003	0.000029	0.000016	0.000018	0.000008	0.000003	1.91	1	0	0
Dissolved Calcium	-	mg/L	21	12.30	63.50	37.64	35.00	14.35	3.13	2.62	0	0	0	9	11.70	38.90	25.18	22.90	9.31	3.10	2.70	0	0	0
Dissolved Chromium	-	mg/L	21	0.00005	0.00040	0.00018	0.00020	0.00010	0.00002	1.73	5	0	0	9	0.00005	0.00030	0.00016	0.00020	0.00010	0.00003	1.58	3	0	0
Dissolved Cobalt	-	mg/L	21	0.000023	0.000204	0.000062	0.000045	0.000048	0.000011	1.29	0	0	0	9	0.000026	0.000086	0.000048	0.000041	0.000023	0.000008	2.13	0	0	0
Dissolved Copper	-	mg/L	21	0.0012	0.0051	0.0023	0.0019	0.0010	0.0002	2.35	0	0	0	9	0.0009	0.0025	0.0015	0.0015	0.0005	0.0002	2.86	0	0	0
Dissolved Iron	-	mg/L	21	0.004	0.236	0.052	0.021	0.066	0.014	0.79	0	0	0	9	0.011	0.157	0.059	0.050	0.054	0.018	1.09	0	0	0
Dissolved Lead	-	mg/L	21	0.000003	0.000564	0.000072	0.000014	0.000136	0.000030	0.53	7	0	0	9	0.000005	0.002260	0.000284	0.000031	0.000742	0.000247	0.38	0	0	0
Dissolved Lithium	-	mg/L	21	0.00025	0.00090	0.00066	0.00070	0.00019	0.00004	3.50	2	0	0	9	0.00025	0.00110	0.00070	0.00070	0.00025	0.00008	2.79	1	0	0
Dissolved Magnesium	-	mg/L	21	4.44	22.50	13.79	13.20	5.05	1.10	2.73	0	0	0	9	4.12	16.90	9.82	8.31	4.28	1.43	2.29	0	0	0
Dissolved Manganese	-	mg/L	21	0.0001	0.0184	0.0037	0.0013	0.0053	0.0012	0.71	0	0	0	9	0.0003	0.0073	0.0037	0.0033	0.0023	0.0008	1.59	0	0	0
Dissolved Mercury	-	mg/L	17	0.0000050	0.0000100	0.0000053	0.0000050	0.0000012	0.0000003	4.37	16	0	0	6	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	6	0	0
Dissolved Molybdenum	-	mg/L	21	0.00033	0.00106	0.00077	0.00082	0.00021	0.00005	3.62	0	0	0	9	0.00021	0.00055	0.00038	0.00040	0.00010	0.00003	3.65	0	0	0
Dissolved Nickel	-	mg/L	21	0.00047	0.00135	0.00073	0.00063	0.00026	0.00006	2.84	0	0	0	9	0.00030	0.00084	0.00056	0.00053	0.00017	0.00006	3.35	0	0	0
Dissolved Phosphorus	-	mg/L	17	0.0010	0.0130	0.0042	0.0030	0.0036	0.0009	1.16	6	0	0	6	0.0020	0.0110	0.0058	0.0040	0.0040	0.0016	1.45	0	0	0
Dissolved Potassium	-	mg/L	21	1.24	2.89	1.97	1.93	0.45	0.10	4.33	0	0	0	9	0.91	1.84	1.24	1.07	0.30	0.10	4.19	0	0	0
Dissolved Selenium	-	mg/L	21	0.00006	0.00016	0.00011	0.00011	0.00003	0.00001	3.61	0	0	0	9	0.00002	0.00011	0.00007	0.00008	0.00003	0.00001	2.49	1	0	0
Dissolved Silicon	-	mg/L	21	2.20	5.73	4.54	4.60	0.82	0.18	5.56	0	0	0	9	2.16	4.50	3.72	4.10	0.91	0.30	4.11	0	0	0
Dissolved Silver	-	mg/L	21	0.000003	0.000003	0.000003	0.000003	0	-	-	21	0	0	9	0.000003	0.000006	0.000003	0.000003	0.000001	0.000000	2.48	8	0	0
Dissolved Sodium	-	mg/L	21	1.50	5.95	4.10	4.20	1.18	0.26	3.47	0	0	0	9	1.55	5.31	3.50	3.71	1.22	0.41	2.87	0	0	0
Dissolved Strontium	-	mg/L	21	0.079	0.377	0.237	0.227	0.086	0.019	2.76	0	0	0	9	0.081	0.264	0.170	0.157	0.064	0.021	2.68	0	0	0
Dissolved Sulphur	-	mg/L	4	18.00	47.00	34.75	37.00	12.23	6.12	2.84	0	0	0	5	5.00	23.00	14.40	17.00	8.88	3.97	1.62	2	0	0
Dissolved Thallium	-	mg/L	21	0.0000010	0.0000050	0.0000024	0.0000020	0.0000014	0.0000003	1.74	8	0	0	9	0.0000010	0.0000040	0.0000018	0.0000010	0.0000011	0.0000004	1.63	5	0	0
Dissolved Tin	-	mg/L	21	0.000005	0.000080	0.000011	0.000005	0.000017	0.000004	0.63	17	0	0	9	0.000005	0.000100	0.000034	0.000005	0.000045	0.000015	0.77	8	0	0
Dissolved Titanium	-	mg/L	21	0.00025	0.00410	0.00085	0.00025	0.00110	0.00024	0.77	14	0	0	9	0.00025	0.00191	0.00076	0.00025	0.00067	0.00022	1.13	5	0	0
Dissolved Uranium	-	mg/L	21	0.00304	0.03340	0.01386	0.01100	0.00950	0.00207	1.46	0	0	0	9	0.00110	0.00561	0.00246	0.00201	0.00147	0.00049	1.68	0	0	0
Dissolved Vanadium	-	mg/L	21	0.00010	0.00060	0.00023	0.00020	0.00016	0.00004	1.39	10	0	0	9	0.00010	0.00080	0.00035	0.00030	0.00020	0.00007	1.71	1	0	0
Dissolved Zinc	-	mg/L	21	0.00020	0.00690	0.00160	0.00080	0.00187	0.00041	0.86	0	0	0	9	0.00040	0.00860	0.00236	0.00140	0.00277	0.00092	0.85	0	0	0
Dissolved Zirconium	-	mg/L	21	0.00010	0.00040	0.00021	0.00020	0.00009	0.00002	2.36	0	0	0	9	0.00010	0.00030	0.00019	0.00020	0.00008	0.00003	2.42	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

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Appendix B5. Surface Water Quality Statistics: All sites all parameters, Casino Project, 2008-2012

Parameters	CCME[1] Guideline	unit	W6B											W6A										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	25	7.70	8.20	7.97	8.00	0.14	0.03	56.05	0	0	0	23	7.60	8.20	7.95	8.00	0.15	0.03	53.24	0	0	0
Conductivity	-	µS/cm	25	170	243	205	204	17	3	12.16	0	0	0	23	150	257	187	180	29	6	6.39	0	0	0
Total Hardness CaCO3	-	mg/L	24	82	117	102	104	7	2	13.58	0	0	0	22	74	115	90	88	13	3	7.17	0	0	0
Dissolved Hardness CaCO3	-	mg/L	5	99	105	102	103	2	1	44.82	0	0	0	3	77	105	89	86	14	8	6.27	0	0	0
Ion Balance	-	no unit	3	0.88	1.00	0.94	0.93	0.06	0.03	15.54	0	0	0	2	0.91	1.00	0.96	0.96	0.06	0.05	15.01	0	0	0
Total Dissolved Solids	-	mg/L	25	80	180	129	130	25	5	5.15	0	0	0	23	68	150	114	110	22	5	5.18	0	0	0
Total Suspended Solids	-	mg/L	24	0.5	190.0	25.1	11.0	39.5	8.1	0.63	5	0	0	22	0.5	140.0	22.5	10.0	30.7	6.6	0.73	3	0	0
Turbidity	-	NTU	25	0.2	47.4	9.6	5.1	11.2	2.2	0.85	0	0	0	23	0.1	35.1	7.5	2.7	10.2	2.1	0.74	0	0	0
Ammonia as N	0.499[a]	mg/L	24	0.003	0.060	0.017	0.007	0.018	0.004	0.95	12	0	0	22	0.003	0.051	0.012	0.005	0.012	0.003	1.04	12	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	25	61.0	93.9	79.35	79.9	7.74	1.55	10.25	0	0	0	23	61.0	96.0	74.78	73.0	9.92	2.07	7.54	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	6	0.25	0.25	0.25	0.25	0	-	-	6	0	0	4	0.25	0.25	0.25	0.25	0	-	-	4	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	14	0.25	3.70	1.05	0.80	0.95	0.25	1.11	4	0	0	12	0.25	5.00	1.05	0.85	1.32	0.38	0.80	5	0	0
Bromide (Br)	-	mg/L	21	0.01	0.20	0.17	0.20	0.07	0.01	2.68	21	0	0	18	0.05	0.20	0.19	0.20	0.04	0.01	5.42	18	0	0
Chloride (Cl)	120	mg/L	25	0.25	1.30	0.43	0.25	0.31	0.06	1.37	17	0	0	23	0.25	2.20	0.51	0.25	0.46	0.09	1.12	14	0	0
Fluoride (F)	0.12	mg/L	21	0.080	0.140	0.111	0.110	0.014	0.003	7.82	0	3	14	19	0.090	0.130	0.107	0.110	0.011	0.002	10.11	0	1	5
Sulphate (SO4)	-	mg/L	25	19.00	33.00	25.98	25.00	4.31	0.86	6.03	0	0	0	23	12.00	34.00	21.13	21.00	6.23	1.30	3.39	0	0	0
Total Nitrogen (N)	-	mg/L	6	0.12	0.27	0.18	0.16	0.07	0.03	2.76	0	0	0	4	0.10	0.24	0.16	0.15	0.07	0.03	2.39	0	0	0
Nitrate (as N)	13	mg/L	25	0.001	0.117	0.033	0.019	0.033	0.007	1.00	2	0	0	23	0.001	0.168	0.034	0.015	0.044	0.009	0.77	2	0	0
Nitrate plus Nitrite (N)	-	mg/L	6	0.005	0.117	0.049	0.036	0.045	0.018	1.08	0	0	0	4	0.001	0.168	0.053	0.022	0.078	0.039	0.68	1	0	0
Nitrite (as N)	0.06	mg/L	25	0.001	0.008	0.002	0.001	0.002	0.000	1.11	18	0	0	23	0.001	0.019	0.002	0.001	0.004	0.001	0.57	18	0	0
Total Kjeldahl Nitrogen	-	mg/L	25	0.01	0.25	0.11	0.09000	0.0620	0.0124	1.77	1	0	0	23	0.01	0.24	0.12	0.11000	0.0669	0.0139	1.76	1	0	0
Ortho Phosphate as P	-	mg/L	25	0.0005	0.0450	0.0031	0.0010	0.0088	0.0018	0.36	7	0	0	23	0.0005	0.0460	0.0035	0.0010	0.0093	0.0019	0.37	5	0	0
Cyanide, Total	0.005	mg/L	24	0.00025	0.00070	0.00028	0.00025	0.00011	0.00002	2.49	22	0	0	22	0.00025	0.00110	0.00031	0.00025	0.00021	0.00005	1.49	20	0	0
Cyanide, Weak Acid Diss	-	mg/L	24	0.00025	0.00025	0.00025	0.00025	0	-	-	24	0	0	22	0.00025	0.00110	0.00029	0.00025	0.00018	0.00004	1.59	21	0	0
Dissolved Organic Carbon	-	mg/L	12	0.90	9.26	3.41	2.65	2.36	0.68	1.44	0	0	0	10	0.50	7.20	2.80	2.45	1.92	0.61	1.46	0	0	0
Total Organic Carbon	-	mg/L	20	1.60	10.00	3.50	2.85	2.16	0.48	1.62	0	0	0	18	0.80	7.70	2.69	2.45	1.53	0.36	1.76	0	0	0
Total Aluminum	0.1[b]	mg/L	24	0.0024	0.6780	0.1814	0.1220	0.1809	0.0369	1.00	0	14	58	22	0.0022	0.6360	0.1477	0.0911	0.1621	0.0346	0.91	0	10	45
Total Antimony	-	mg/L	24	0.00	0.00	0.00	0.00013	0.0000	0.0000	2.94	1	0	0	22	0.00	0.00	0.00	0.00010	0.0000	0.0000	4.79	0	0	0
Total Arsenic	0.005	mg/L	24	0.00	0.00	0.00	0.00054	0.0004	0.0001	1.60	0	0	0	22	0.00	0.00	0.00	0.00051	0.0003	0.0001	1.70	0	0	0
Total Barium	-	mg/L	24	0.05	0.15	0.06	0.05700	0.0223	0.0045	2.80	0	0	0	22	0.03	0.11	0.05	0.04600	0.0173	0.0037	2.98	0	0	0
Total Beryllium	-	mg/L	24	0.00	0.00	0.00	0.00001	0.0000	0.0000	0.91	11	0	0	22	0.00	0.00	0.00	0.00001	0.0000	0.0000	0.78	13	0	0
Total Bismuth	-	mg/L	24	0.0000025	0.0005000	0.0000256	0.0000025	0.0001011	0.0000206	0.25	16	0	0	22	0.0000025	0.0000160	0.0000044	0.0000025	0.0000037	0.0000008	1.18	16	0	0
Total Boron	1.5	mg/L	24	0.03	0.03	0.03	0.02500	0	-	-	24	0	0	22	0.03	0.03	0.03	0.02500	0	-	-	22	0	0
Total Cadmium	0.000032 [c]	mg/L	24	0.000014	0.000621	0.000111	0.000067	0.000133	0.000027	0.83	0	17	71	22	0.000008	0.000369	0.000064	0.000039	0.000081	0.000017	0.78	0	14	64
Total Calcium	-	mg/L	24	22.20	33.40	27.76	28.05	2.17	0.44	12.79	0	0	0	22	20.20	32.10	24.95	24.30	3.56	0.76	7.02	0	0	0
Total Chromium	0.001	mg/L	24	0.00005	0.00110	0.00033	0.00025	0.00028	0.00006	1.15	7	1	4	22	0.00005	0.00110	0.00029	0.00020	0.00026	0.00006	1.11	1	1	5
Total Cobalt	-	mg/L	24	0.000014	0.001930	0.000298	0.000172	0.000405	0.000083	0.74	1	0	0	22	0.000003	0.001160	0.000202	0.000110	0.000266	0.000057	0.76	1	0	0
Total Copper	0.0023[d]	mg/L	24	0.0004	0.0081	0.0018	0.0011	0.0017	0.0004	1.02	0	5	21	22	0.0003	0.0060	0.0014	0.0012	0.0013	0.0003	1.13	0	4	18
Total Iron	0.3	mg/L	24	0.019	2.170	0.399	0.190	0.497	0.102	0.80	0	10	42	22	0.002	1.560	0.300	0.161	0.366	0.078	0.82	0	8	36
Total Lead	0.003[e]	mg/L	24	0.000009	0.002900	0.000409	0.000162	0.000611	0.000125	0.67	1	0	0	22	0.000003	0.001830	0.000301	0.000135	0.000411	0.000088	0.73	1	0	0
Total Lithium	-	mg/L	24	0.00110	0.00262	0.00198	0.00195	0.00043	0.00009	4.57	1	0	0	22	0.00100	0.00210	0.00149	0.00140	0.00033	0.00007	4.57	0	0	0
Total Magnesium	-	mg/L	24	6.37	9.01	7.88	7.93	0.68	0.14	11.66	0	0	0	22	5.24	8.73	6.77	6.53	0.98	0.21	6.88	0	0	0
Total Manganese	-	mg/L	24	0.0048	0.1970	0.0395	0.0263	0.0423	0.0086	0.93	0	0	0	22	0.0003	0.1320	0.0223	0.0147	0.0286	0.0061	0.78	0	0	0
Total Mercury	0.000026	mg/L	22	0.0000050	0.0000200	0.0000057	0.0000050	0.0000032	0.0000007	1.78	21	0	0	20	0.0000050	0.0000100	0.0000053	0.0000050	0.0000011	0.0000003	4.70	19	0	0
Total Molybdenum	0.073	mg/L	24	0.00059	0.00126	0.00103	0.00102	0.00018	0.00004	5.70	0	0	0	22	0.00068	0.00128	0.00102	0.00101	0.00015	0.00003	6.61	0	0	0
Total Nickel	0.0033[f]	mg/L	24	0.00042	0.01010	0.00253	0.00214	0.00229	0.00047	1.10	0	0	0	22	0.00028	0.00662	0.00164	0.00124	0.00145	0.00031	1.13	0	0	0
Total Phosphorus	-	mg/L	22	0.0010	0.2680	0.0360	0.0170	0.0574	0.0122	0.63	3	0	0	20	0.0010	0.1970	0.0279	0.0130	0.0441	0.0099	0.63	4	0	0
Total Potassium	-	mg/L	24	0.70	1.17	0.84	0.80	0.13	0.03	6.19	0	0	0	22	0.69	1.07	0.80	0.76	0.11	0.02	7.17	0	0	0
Total Selenium	0.001	mg/L	24	0.00030	0.00069	0.00047	0.00047	0.00010	0.00002	4.68	0	0	0	22	0.00023	0.00068	0.00034	0.00031	0.00011	0.00002	2.93	0	0	0
Total Silicon	-	mg/L	24	2.30	4.00	3.15	3.15	0.41	0.08	7.76	0	0	0	22	2.50	3.60	3.07	3.10	0.34	0.07	9.02	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W6B											W6A										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silver	0.0001	mg/L	24	0.000003	0.000022	0.000005	0.000003	0.000005	0.000001	1.10	16	0	0	22	0.000003	0.000011	0.000004	0.000003	0.000002	0.000001	1.46	18	0	0
Total Sodium	-	mg/L	24	1.43	2.21	1.82	1.84	0.21	0.04	8.63	0	0	0	22	1.54	2.23	1.84	1.81	0.21	0.04	8.71	0	0	0
Total Strontium	-	mg/L	24	0.104	0.147	0.126	0.128	0.010	0.002	12.79	0	0	0	22	0.089	0.135	0.113	0.111	0.014	0.003	7.94	0	0	0
Total Sulphur	-	mg/L	5	5.00	11.00	9.60	11.00	2.61	1.17	3.68	1	0	0	3	5.00	10.00	6.67	5.00	2.89	1.67	2.31	2	0	0
Total Thallium	0.0008	mg/L	24	0.0000010	0.0000250	0.0000066	0.0000045	0.0000061	0.0000012	1.07	6	0	0	22	0.0000010	0.0000160	0.0000042	0.0000035	0.0000034	0.0000007	1.25	4	0	0
Total Tin	-	mg/L	24	0.000005	0.002500	0.000125	0.000005	0.000507	0.000104	0.25	20	0	0	22	0.000005	0.000050	0.000007	0.000005	0.000010	0.000002	0.76	20	0	0
Total Titanium	-	mg/L	24	0.00025	0.01710	0.00450	0.00265	0.00451	0.00092	1.00	6	0	0	22	0.00025	0.01720	0.00403	0.00215	0.00455	0.00097	0.88	4	0	0
Total Uranium	0.015	mg/L	24	0.00086	0.00144	0.00104	0.00098	0.00016	0.00003	6.55	0	0	0	22	0.00085	0.00161	0.00105	0.00098	0.00023	0.00005	4.68	0	0	0
Total Vanadium	-	mg/L	24	0.00010	0.00320	0.00086	0.00045	0.00087	0.00018	0.99	6	0	0	22	0.00010	0.00280	0.00063	0.00035	0.00068	0.00014	0.94	6	0	0
Total Zinc	0.03	mg/L	24	0.00110	0.04360	0.00820	0.00560	0.00930	0.00190	0.88	1	1	4	22	0.00080	0.02480	0.00484	0.00285	0.00559	0.00119	0.87	0	0	0
Total Zirconium	-	mg/L	24	0.00005	0.00050	0.00014	0.00010	0.00014	0.00003	0.99	12	0	0	22	0.00005	0.00060	0.00012	0.00005	0.00014	0.00003	0.88	13	0	0
Dissolved Aluminum	0.1	mg/L	24	0.0014	0.0809	0.0228	0.0217	0.0193	0.0039	1.18	0	0	0	22	0.0015	0.0642	0.0182	0.0170	0.0150	0.0032	1.21	0	0	0
Dissolved Antimony	-	mg/L	24	0.00008	0.00017	0.00012	0.00012	0.00002	0.000005	5.14	0	0	0	22	0.00007	0.00013	0.00010	0.00010	0.00001	0.000003	6.85	0	0	0
Dissolved Arsenic	-	mg/L	24	0.00018	0.00059	0.00042	0.00042	0.00010	0.000020	4.30	0	0	0	22	0.00012	0.00053	0.00039	0.00042	0.00011	0.000023	3.71	0	0	0
Dissolved Barium	-	mg/L	24	0.038900	0.061300	0.046729	0.045900	0.005439	0.001110	8.59	0	0	0	22	0.034500	0.073000	0.042491	0.039300	0.010060	0.002145	4.22	0	0	0
Dissolved Beryllium	-	mg/L	24	0.000005	0.000010	0.000005	0.000005	0.000001	0.000000	5.10	23	0	0	22	0.000005	0.000010	0.000005	0.000005	0.000001	0.000000	4.90	21	0	0
Dissolved Bismuth	-	mg/L	24	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	24	0	0	22	0.0000025	0.0000060	0.0000027	0.0000025	0.0000007	0.0000002	3.56	21	0	0
Dissolved Boron	-	mg/L	24	0.025	0.025	0.025	0.025	0	-	-	24	0	0	22	0.025	0.025	0.025	0.025	0	-	-	22	0	0
Dissolved Cadmium	-	mg/L	24	0.000011	0.000094	0.000033	0.000025	0.000022	0.000005	1.51	0	0	0	22	0.000005	0.000064	0.000023	0.000019	0.000016	0.000003	1.44	0	0	0
Dissolved Calcium	-	mg/L	24	24.70	32.30	27.17	27.00	1.82	0.37	14.97	0	0	0	22	20.10	32.80	24.40	23.80	3.46	0.74	7.06	0	0	0
Dissolved Chromium	-	mg/L	24	0.00005	0.00020	0.00008	0.00005	0.00005	0.00001	1.51	17	0	0	22	0.00005	0.00020	0.00009	0.00005	0.00005	0.00001	1.67	12	0	0
Dissolved Cobalt	-	mg/L	24	0.000007	0.000098	0.000028	0.000022	0.000023	0.000005	1.22	0	0	0	22	0.000003	0.000073	0.000021	0.000015	0.000020	0.000004	1.07	1	0	0
Dissolved Copper	-	mg/L	24	0.0003	0.0026	0.0010	0.0008	0.0006	0.0001	1.69	0	0	0	22	0.0003	0.0021	0.0008	0.0007	0.0005	0.0001	1.70	0	0	0
Dissolved Iron	-	mg/L	24	0.004	0.170	0.036	0.024	0.040	0.008	0.90	0	0	0	22	0.001	0.128	0.026	0.018	0.032	0.007	0.81	1	0	0
Dissolved Lead	-	mg/L	24	0.000003	0.000137	0.000038	0.000040	0.000031	0.000006	1.24	3	0	0	22	0.000003	0.000199	0.000047	0.000024	0.000055	0.000012	0.86	4	0	0
Dissolved Lithium	-	mg/L	24	0.00130	0.00232	0.00177	0.00180	0.00026	0.00005	6.82	0	0	0	22	0.00100	0.00180	0.00135	0.00125	0.00025	0.00005	5.46	0	0	0
Dissolved Magnesium	-	mg/L	24	6.69	8.55	7.78	7.92	0.54	0.11	14.51	0	0	0	22	5.16	8.53	6.64	6.43	0.95	0.20	6.98	0	0	0
Dissolved Manganese	-	mg/L	24	0.0010	0.0853	0.0103	0.0034	0.0183	0.0037	0.56	0	0	0	22	0.0003	0.0117	0.0034	0.0023	0.0034	0.0007	1.00	0	0	0
Dissolved Mercury	-	mg/L	21	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	21	0	0	19	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	19	0	0
Dissolved Molybdenum	-	mg/L	24	0.00088	0.00129	0.00111	0.00109	0.00013	0.00003	8.66	0	0	0	22	0.00090	0.00129	0.00108	0.00106	0.00011	0.00002	9.94	0	0	0
Dissolved Nickel	-	mg/L	24	0.00039	0.00386	0.00143	0.00121	0.00090	0.00018	1.58	0	0	0	22	0.00027	0.00252	0.00095	0.00079	0.00062	0.00013	1.53	0	0	0
Dissolved Phosphorus	-	mg/L	21	0.0010	0.0100	0.0027	0.0010	0.0028	0.0006	0.98	12	0	0	19	0.0010	0.0080	0.0023	0.0010	0.0023	0.0005	0.99	13	0	0
Dissolved Potassium	-	mg/L	24	0.64	1.11	0.81	0.78	0.12	0.02	6.63	0	0	0	22	0.67	1.06	0.79	0.76	0.11	0.02	7.42	0	0	0
Dissolved Selenium	-	mg/L	24	0.00035	0.00062	0.00047	0.00048	0.00008	0.00002	5.63	0	0	0	22	0.00023	0.00066	0.00034	0.00032	0.00011	0.00002	3.12	0	0	0
Dissolved Silicon	-	mg/L	24	1.95	3.60	2.89	2.98	0.32	0.07	9.04	0	0	0	22	2.30	3.50	2.89	2.80	0.29	0.06	9.79	0	0	0
Dissolved Silver	-	mg/L	24	0.000003	0.000003	0.000003	0.000003	0	-	-	24	0	0	22	0.000003	0.000003	0.000003	0.000003	0	-	-	22	0	0
Dissolved Sodium	-	mg/L	24	1.51	3.50	1.90	1.82	0.38	0.08	5.06	0	0	0	22	1.55	2.11	1.83	1.84	0.17	0.04	10.44	0	0	0
Dissolved Strontium	-	mg/L	24	0.109	0.145	0.125	0.126	0.010	0.002	12.96	0	0	0	22	0.087	0.136	0.112	0.112	0.014	0.003	7.80	0	0	0
Dissolved Sulphur	-	mg/L	5	5.00	13.00	8.60	10.00	3.51	1.57	2.45	2	0	0	3	5.00	12.00	7.33	5.00	4.04	2.33	1.81	2	0	0
Dissolved Thallium	-	mg/L	23	0.0000010	0.0000054	0.0000025	0.0000030	0.0000014	0.0000003	1.73	9	0	0	22	0.0000010	0.0000050	0.0000020	0.0000020	0.0000011	0.0000002	1.87	9	0	0
Dissolved Tin	-	mg/L	24	0.000005	0.000100	0.000015	0.000005	0.000028	0.000006	0.54	23	0	0	22	0.000005	0.000080	0.000009	0.000005	0.000016	0.000003	0.54	20	0	0
Dissolved Titanium	-	mg/L	24	0.00025	0.00350	0.00055	0.00025	0.00079	0.00016	0.69	20	0	0	22	0.00025	0.00210	0.00043	0.00025	0.00043	0.00009	1.00	17	0	0
Dissolved Uranium	-	mg/L	24	0.00075	0.00152	0.00103	0.00096	0.00019	0.00004	5.42	0	0	0	22	0.00080	0.00162	0.00104	0.00096	0.00023	0.00005	4.54	0	0	0
Dissolved Vanadium	-	mg/L	24	0.00010	0.00050	0.00019	0.00010	0.00012	0.00002	1.63	13	0	0	22	0.00010	0.00060	0.00020	0.00020	0.00013	0.00003	1.59	10	0	0
Dissolved Zinc	-	mg/L	24	0.00030	0.00900	0.00231	0.00175	0.00200	0.00041	1.15	0	0	0	22	0.00030	0.00690	0.00168	0.00110	0.00171	0.00036	0.98	0	0	0
Dissolved Zirconium	-	mg/L	24	0.00005	0.00020	0.00006	0.00005	0.00003	0.00001	1.83	22	0	0	22	0.00005	0.00020	0.00006	0.00005	0.00003	0.00001	1.79	19	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

Appendix B5. Surface Water Quality Statistics: All sites all parameters, Casino Project, 2008-2012

Parameters	CCME[1] Guideline	unit	W15											W23											
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
pH	6.5 - 9.0	pH unit	21	7.70	8.10	7.94	7.99	0.11	0.02	70.18	0	0	0	2	7.83	7.96	7.90	7.90	0.09	0.07	85.89	0	0	0
Conductivity	-	µS/cm	21	150	224	196	203	23	5	8.47	0	0	0	2	214	390	302	302	124	88	2.43	0	0	0
Total Hardness CaCO3	-	mg/L	21	79	113	97	100	10	2	10.22	0	0	0	2	104	187	146	146	59	42	2.48	0	0	0
Dissolved Hardness CaCO3	-	mg/L	3	99	102	101	101	2	1	65.90	0	0	0	2	102	196	149	149	66	47	2.24	0	0	0
Moisture	-	%	1	41	41	41	41	0	-	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-
Ion Balance	-	no unit	2	0.93	0.96	0.95	0.95	0.02	0.01	44.55	0	0	0	2	0.99	1.00	1.00	1.00	0.01	0.01	140.71	0	0	0
Total Dissolved Solids	-	mg/L	21	92	150	118	120	17	4	7.14	0	0	0	2	150	240	195	195	64	45	3.06	0	0	0
Total Suspended Solids	-	mg/L	21	0.5	200.0	23.9	8.0	43.7	9.5	0.55	5	0	0	2	0.5	2.0	1.3	1.3	1.1	0.8	1.18	1	0	0
Turbidity	-	NTU	21	0.1	39.7	7.2	3.9	9.5	2.1	0.76	0	0	0	2	0.1	0.3	0.2	0.2	0.1	0.1	1.41	0	0	0
Ammonia as N	0.499[a]	mg/L	21	0.003	0.047	0.015	0.011	0.013	0.003	1.18	9	0	0	2	0.025	0.085	0.055	0.055	0.042	0.030	1.30	0	0	0
Alkalinity, Total (as CaCO3)	-	mg/L	21	63.0	92.0	77.24	77.0	9.23	2.01	8.37	0	0	0	2	64.0	100.0	82.0	82.0	25.46	18.00	3.22	0	0	0
Acidity (pH 4.5) as CaCO3	-	mg/L	3	0.25	0.25	0.25	0.25	0	-	-	3	0	0	2	0.25	0.25	0.25	0.25	0	-	-	2	0	0
Acidity (pH8.3) as CaCO3	-	mg/L	12	0.25	2.60	0.84	0.55	0.77	0.22	1.08	5	0	0	2	0.25	1.90	1.08	1.08	1.17	0.83	0.92	1	0	0
Bromide (Br)	-	mg/L	18	0.20	0.20	0.20	0.20	0	-	-	18	0	0	2	0.20	0.20	0.20	0.20	0	-	-	2	0	0
Chloride (Cl)	120	mg/L	21	0.25	1.60	0.48	0.25	0.37	0.08	1.32	13	0	0	2	0.80	1.40	1.10	1.10	0.42	0.30	2.59	0	0	0
Fluoride (F)	0.12	mg/L	18	0.090	0.130	0.111	0.110	0.011	0.003	10.30	0	2	11	2	0.070	0.070	0.070	0.070	0	-	-	0	0	0
Sulphate (SO4)	-	mg/L	21	13.00	32.00	23.14	23.00	5.11	1.12	4.53	0	0	0	2	43.00	94.00	68.50	68.50	36.06	25.50	1.90	0	0	0
Total Nitrogen (N)	-	mg/L	3	0.11	0.35	0.24	0.25	0.12	0.07	1.96	0	0	0	2	0.54	0.76	0.65	0.65	0.16	0.11	4.18	0	0	0
Nitrate (as N)	13	mg/L	21	0.001	0.099	0.034	0.016	0.036	0.008	0.95	3	0	0	2	0.313	0.443	0.378	0.378	0.092	0.065	4.11	0	0	0
Nitrate plus Nitrite (N)	-	mg/L	3	0.001	0.071	0.027	0.009	0.038	0.022	0.70	1	0	0	2	0.313	0.443	0.378	0.378	0.092	0.065	4.11	0	0	0
Nitrite (as N)	0.06	mg/L	21	0.001	0.009	0.002	0.001	0.002	0.000	1.06	14	0	0	2	0.001	0.001	0.001	0.001	0	-	-	2	0	0
Total Kjeldahl Nitrogen	-	mg/L	21	0.01	0.42	0.13	0.10000	0.1017	0.0222	1.26	1	0	0	2	0.23	0.31	0.27	0.27000	0.0566	0.0400	4.77	0	0	0
Ortho Phosphate as P	-	mg/L	21	0.0005	0.0090	0.0019	0.0010	0.0020	0.0004	0.93	5	0	0	2	0.0020	0.0060	0.0040	0.0040	0.0028	0.0020	1.41	0	0	0
Cyanide, Total	0.005	mg/L	21	0.00025	0.00150	0.00033	0.00025	0.00029	0.00006	1.16	19	0	0	2	0.00025	0.00140	0.00083	0.00083	0.00081	0.00058	1.01	1	0	0
Cyanide, Weak Acid Diss	-	mg/L	21	0.00025	0.00025	0.00025	0.00025	0	-	-	21	0	0	2	0.00025	0.00160	0.00093	0.00093	0.00095	0.00068	0.97	1	0	0
Dissolved Organic Carbon	-	mg/L	10	0.90	6.20	2.58	2.25	1.74	0.55	1.48	0	0	0	2	11.20	13.70	12.45	12.45	1.77	1.25	7.04	0	0	0
Total Organic Carbon	-	mg/L	18	0.70	6.90	2.74	2.40	1.63	0.38	1.68	0	0	0	2	10.20	14.00	12.10	12.10	2.69	1.90	4.50	0	0	0
Total Aluminum	0.1[b]	mg/L	21	0.0015	0.7080	0.1536	0.0847	0.1944	0.0424	0.79	0	9	43	2	0.0380	0.1590	0.0985	0.0985	0.0856	0.0605	1.15	0	1	50
Total Antimony	-	mg/L	21	0.00	0.00	0.00	0.00011	0.0000	0.0000	3.50	0	0	0	2	0.00	0.00	0.00	0.00040	0.0001	0.0001	4.71	0	0	0
Total Arsenic	0.005	mg/L	21	0.00	0.00	0.00	0.00049	0.0004	0.0001	1.33	0	0	0	2	0.00	0.00	0.00	0.00082	0.0002	0.0001	4.83	0	0	0
Total Barium	-	mg/L	21	0.04	0.14	0.06	0.05600	0.0222	0.0048	2.74	0	0	0	2	0.05	0.07	0.06	0.05605	0.0136	0.0097	4.11	0	0	0
Total Beryllium	-	mg/L	21	0.00	0.00	0.00	0.00001	0.0000	0.0000	0.71	13	0	0	2	0.00	0.00	0.00	0.00001	0.0000	0.0000	1.18	1	0	0
Total Bismuth	-	mg/L	21	0.0000025	0.0000150	0.0000040	0.0000025	0.0000035	0.0000008	1.14	17	0	0	2	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	2	0	0
Total Boron	1.5	mg/L	21	0.03	0.03	0.03	0.02500	0	-	-	21	0	0	2	0.03	0.03	0.03	0.02500	0	-	-	2	0	0
Total Cadmium	0.000032 [c]	mg/L	21	0.000003	0.000591	0.000082	0.000036	0.000136	0.000030	0.60	1	11	52	2	0.000009	0.000018	0.000014	0.000014	0.000006	0.000005	2.12	0	0	0
Total Calcium	-	mg/L	21	22.00	31.50	26.82	27.60	2.51	0.55	10.69	0	0	0	2	26.80	47.60	37.20	37.20	14.71	10.40	2.53	0	0	0
Total Chromium	0.001	mg/L	21	0.00005	0.00120	0.00030	0.00020	0.00031	0.00007	0.95	7	1	5	2	0.00010	0.00040	0.00025	0.00025	0.00021	0.00015	1.18	0	0	0
Total Cobalt	-	mg/L	21	0.000003	0.001400	0.000221	0.000091	0.000336	0.000073	0.66	1	0	0	2	0.000042	0.000103	0.000073	0.000073	0.000043	0.000031	1.68	0	0	0
Total Copper	0.0023[d]	mg/L	21	0.0002	0.0072	0.0015	0.0009	0.0016	0.0004	0.89	0	2	10	2	0.0015	0.0020	0.0017	0.0017	0.0004	0.0003	4.24	0	0	0
Total Iron	0.3	mg/L	21	0.001	1.950	0.313	0.132	0.477	0.104	0.66	0	6	29	2	0.024	0.145	0.085	0.085	0.086	0.061	0.99	0	0	0
Total Lead	0.003[e]	mg/L	21	0.000005	0.002490	0.000326	0.000118	0.000563	0.000123	0.58	0	0	0	2	0.000008	0.000041	0.000025	0.000025	0.000023	0.000017	1.05	0	0	0
Total Lithium	-	mg/L	21	0.00120	0.00260	0.00170	0.00160	0.00046	0.00010	3.67	0	0	0	2	0.00060	0.00070	0.00065	0.00065	0.00007	0.00005	9.19	0	0	0
Total Magnesium	-	mg/L	21	5.80	9.04	7.41	7.65	0.90	0.20	8.25	0	0	0	2	8.99	16.60	12.80	12.80	5.38	3.81	2.38	0	0	0
Total Manganese	-	mg/L	21	0.0001	0.1730	0.0244	0.0109	0.0400	0.0087	0.61	0	0	0	2	0.0035	0.0074	0.0054	0.0054	0.0027	0.0019	1.97	0	0	0
Total Mercury	0.000026	mg/L	19	0.0000050	0.0000100	0.0000053	0.0000050	0.0000011	0.0000003	4.59	18	0	0	1	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	1	0	0
Total Molybdenum	0.073	mg/L	21	0.00066	0.00130	0.00099	0.00099	0.00019	0.00004	5.20	0	0	0	2	0.00036	0.00041	0.00039	0.00039	0.00004	0.00003	10.89	0	0	0
Total Nickel	0.0033[f]	mg/L	21	0.00019	0.00925	0.00187	0.00113	0.00218	0.00047	0.86	0	0	0	2	0.00059	0.00078	0.00069	0.00069	0.00013	0.00010	5.10	0	0	0
Total Phosphorus	-	mg/L	19	0.0010	0.2340	0.0305	0.0110	0.0542	0.0124	0.56	5	0	0	1	0.0050	0.0050	0.0050	0.0050	0	-	-	0	0	0
Total Potassium	-	mg/L	21	0.71	1.11	0.80	0.76	0.11	0.02	7.45	0	0	0	2	1.43	1.91	1.67	1.67	0.34	0.24	4.92	0	0	0
Total Selenium	0.001	mg/L	21	0.00026	0.00057	0.00042	0.00038	0.00010	0.00002	4.16	0	0	0	2	0.00012	0.00016	0.00014	0.00014	0.00003	0.00002	4.95	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Parameters	CCME[1] Guideline	unit	W15											W23										
			n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL	n	min	max	mean	median	sd	se	cov	<DL	>GL	%>GL
Total Silicon	-	mg/L	21	2.60	3.60	3.12	3.00	0.30	0.06	10.54	0	0	0	2	4.10	4.20	4.15	4.15	0.07	0.05	58.69	0	0	0
Total Silver	0.0001	mg/L	21	0.000003	0.000012	0.000004	0.000003	0.000003	0.000001	1.30	16	0	0	2	0.000003	0.000003	0.000003	0.000003	0	-	-	2	0	0
Total Sodium	-	mg/L	21	1.50	2.23	1.80	1.82	0.19	0.04	9.48	0	0	0	2	2.53	3.86	3.20	3.20	0.94	0.67	3.40	0	0	0
Total Strontium	-	mg/L	21	0.091	0.136	0.119	0.123	0.013	0.003	9.41	0	0	0	2	0.182	0.342	0.262	0.262	0.113	0.080	2.32	0	0	0
Total Sulphur	-	mg/L	3	5.00	12.00	9.00	10.00	3.61	2.08	2.50	1	0	0	2	14.00	32.00	23.00	23.00	12.73	9.00	1.81	0	0	0
Total Thallium	0.0008	mg/L	21	0.0000010	0.0000200	0.0000045	0.0000040	0.0000043	0.0000009	1.05	6	0	0	2	0.0000030	0.0000050	0.0000040	0.0000040	0.0000014	0.0000010	2.83	0	0	0
Total Tin	-	mg/L	21	0.000005	0.000070	0.000008	0.000005	0.000014	0.000003	0.59	19	0	0	2	0.000005	0.000070	0.000038	0.000038	0.000046	0.000033	0.82	1	0	0
Total Titanium	-	mg/L	21	0.00025	0.01610	0.00406	0.00300	0.00446	0.00097	0.91	6	0	0	2	0.00060	0.00320	0.00190	0.00190	0.00184	0.00130	1.03	0	0	0
Total Uranium	0.015	mg/L	21	0.00086	0.00153	0.00106	0.00101	0.00018	0.00004	5.84	0	0	0	2	0.00693	0.01410	0.01052	0.01052	0.00507	0.00359	2.07	0	0	0
Total Vanadium	-	mg/L	21	0.00010	0.00320	0.00064	0.00040	0.00078	0.00017	0.82	7	0	0	2	0.00030	0.00080	0.00055	0.00055	0.00035	0.00025	1.56	0	0	0
Total Zinc	0.03	mg/L	21	0.00080	0.03810	0.00618	0.00280	0.00921	0.00201	0.67	0	1	5	2	0.00040	0.00070	0.00055	0.00055	0.00021	0.00015	2.59	0	0	0
Total Zirconium	-	mg/L	21	0.00005	0.00070	0.00011	0.00005	0.00015	0.00003	0.72	13	0	0	2	0.00020	0.00040	0.00030	0.00030	0.00014	0.00010	2.12	0	0	0
Dissolved Aluminum	0.1	mg/L	21	0.0010	0.0693	0.0199	0.0150	0.0187	0.0041	1.06	0	0	0	2	0.0356	0.1070	0.0713	0.0713	0.0505	0.0357	1.41	0	1	50
Dissolved Antimony	-	mg/L	21	0.00009	0.00016	0.00011	0.00010	0.00002	0.000004	5.68	0	0	0	2	0.00035	0.00044	0.00040	0.00040	0.00006	0.000045	6.21	0	0	0
Dissolved Arsenic	-	mg/L	21	0.00013	0.00055	0.00036	0.00042	0.00013	0.000029	2.77	0	0	0	2	0.00071	0.00076	0.00074	0.00074	0.00004	0.000025	20.79	0	0	0
Dissolved Barium	-	mg/L	21	0.036600	0.072300	0.048914	0.044500	0.012875	0.002810	3.80	0	0	0	2	0.042000	0.070100	0.056050	0.056050	0.019870	0.014050	2.82	0	0	0
Dissolved Beryllium	-	mg/L	21	0.000005	0.000010	0.000005	0.000005	0.000002	0.000000	3.64	19	0	0	2	0.000005	0.000020	0.000013	0.000013	0.000011	0.000008	1.18	1	0	0
Dissolved Bismuth	-	mg/L	21	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	21	0	0	2	0.0000025	0.0000025	0.0000025	0.0000025	0	-	-	2	0	0
Dissolved Boron	-	mg/L	21	0.025	0.025	0.025	0.025	0	-	-	21	0	0	2	0.025	0.025	0.025	0.025	0	-	-	2	0	0
Dissolved Cadmium	-	mg/L	21	0.000003	0.000095	0.000025	0.000021	0.000022	0.000005	1.15	1	0	0	2	0.000003	0.000011	0.000007	0.000007	0.000006	0.000004	1.12	1	0	0
Dissolved Calcium	-	mg/L	21	18.50	30.00	25.82	26.00	3.07	0.67	8.41	0	0	0	2	26.60	49.30	37.95	37.95	16.05	11.35	2.36	0	0	0
Dissolved Chromium	-	mg/L	21	0.00005	0.00020	0.00009	0.00005	0.00005	0.00001	1.62	12	0	0	2	0.00020	0.00040	0.00030	0.00030	0.00014	0.00010	2.12	0	0	0
Dissolved Cobalt	-	mg/L	21	0.000003	0.000083	0.000020	0.000013	0.000021	0.000005	0.94	3	0	0	2	0.000050	0.000071	0.000061	0.000061	0.000015	0.000011	4.07	0	0	0
Dissolved Copper	-	mg/L	21	0.0003	0.0026	0.0008	0.0007	0.0006	0.0001	1.38	0	0	0	2	0.0016	0.0018	0.0017	0.0017	0.0002	0.0001	8.27	0	0	0
Dissolved Iron	-	mg/L	21	0.001	0.159	0.027	0.013	0.040	0.009	0.68	1	0	0	2	0.021	0.076	0.049	0.049	0.039	0.028	1.25	0	0	0
Dissolved Lead	-	mg/L	21	0.000003	0.000125	0.000042	0.000030	0.000035	0.000008	1.19	2	0	0	2	0.000005	0.000027	0.000016	0.000016	0.000016	0.000011	1.03	0	0	0
Dissolved Lithium	-	mg/L	21	0.00110	0.00210	0.00152	0.00150	0.00031	0.00007	4.86	0	0	0	2	0.00050	0.00060	0.00055	0.00055	0.00007	0.00005	7.78	0	0	0
Dissolved Magnesium	-	mg/L	21	5.54	8.52	7.22	7.52	0.87	0.19	8.26	0	0	0	2	8.74	17.60	13.17	13.17	6.26	4.43	2.10	0	0	0
Dissolved Manganese	-	mg/L	21	0.0001	0.0131	0.0025	0.0016	0.0035	0.0008	0.72	0	0	0	2	0.0010	0.0034	0.0022	0.0022	0.0017	0.0012	1.32	0	0	0
Dissolved Mercury	-	mg/L	18	0.0000050	0.0000050	0.0000050	0.0000050	0	-	-	18	0	0	-	-	-	-	-	-	-	-	-	-	-
Dissolved Molybdenum	-	mg/L	21	0.00078	0.00132	0.00105	0.00104	0.00017	0.00004	6.18	0	0	0	2	0.00042	0.00045	0.00044	0.00044	0.00002	0.00002	20.51	0	0	0
Dissolved Nickel	-	mg/L	21	0.00016	0.00378	0.00105	0.00086	0.00091	0.00020	1.16	0	0	0	2	0.00064	0.00065	0.00065	0.00065	0.00001	0.00000	91.22	0	0	0
Dissolved Phosphorus	-	mg/L	18	0.0010	0.0090	0.0022	0.0010	0.0026	0.0006	0.86	13	0	0	-	-	-	-	-	-	-	-	-	-	-
Dissolved Potassium	-	mg/L	21	0.69	1.07	0.78	0.76	0.09	0.02	8.95	0	0	0	2	1.35	2.10	1.73	1.73	0.53	0.38	3.25	0	0	0
Dissolved Selenium	-	mg/L	21	0.00025	0.00057	0.00041	0.00039	0.00010	0.00002	4.07	0	0	0	2	0.00011	0.00018	0.00015	0.00015	0.00005	0.00004	2.93	0	0	0
Dissolved Silicon	-	mg/L	21	1.84	3.80	2.79	2.80	0.41	0.09	6.77	0	0	0	2	4.10	4.40	4.25	4.25	0.21	0.15	20.03	0	0	0
Dissolved Silver	-	mg/L	21	0.000003	0.000003	0.000003	0.000003	0	-	-	21	0	0	2	0.000003	0.000003	0.000003	0.000003	0	-	-	2	0	0
Dissolved Sodium	-	mg/L	21	1.55	3.10	1.83	1.79	0.32	0.07	5.82	0	0	0	2	2.55	4.10	3.33	3.33	1.10	0.78	3.03	0	0	0
Dissolved Strontium	-	mg/L	21	0.091	0.132	0.117	0.121	0.013	0.003	9.26	0	0	0	2	0.174	0.349	0.262	0.262	0.124	0.088	2.11	0	0	0
Dissolved Sulphur	-	mg/L	3	5.00	12.00	9.00	10.00	3.61	2.08	2.50	1	0	0	2	14.00	36.00	25.00	25.00	15.56	11.00	1.61	0	0	0
Dissolved Thallium	-	mg/L	21	0.0000010	0.0000050	0.0000023	0.0000020	0.0000013	0.0000003	1.77	8	0	0	2	0.0000020	0.0000040	0.0000030	0.0000030	0.0000014	0.0000010	2.12	0	0	0
Dissolved Tin	-	mg/L	21	0.000005	0.000080	0.000009	0.000005	0.000016	0.000004	0.54	19	0	0	2	0.000005	0.000060	0.000033	0.000033	0.000039	0.000028	0.84	1	0	0
Dissolved Titanium	-	mg/L	21	0.00025	0.00220	0.00050	0.00025	0.00051	0.00011	1.00	14	0	0	2	0.00025	0.00110	0.00068	0.00068	0.00060	0.00043	1.12	1	0	0
Dissolved Uranium	-	mg/L	21	0.00080	0.00154	0.00102	0.00099	0.00018	0.00004	5.82	0	0	0	2	0.00682	0.01410	0.01046	0.01046	0.00515	0.00364	2.03	0	0	0
Dissolved Vanadium	-	mg/L	21	0.00010	0.00060	0.00020	0.00010	0.00013	0.00003	1.52	11	0	0	2	0.00030	0.00080	0.00055	0.00055	0.00035	0.00025	1.56	0	0	0
Dissolved Zinc	-	mg/L	21	0.00030	0.00840	0.00193	0.00110	0.00213	0.00046	0.91	0	0	0	2	0.00030	0.00030	0.00030	0.00030	0	-	-	0	0	0
Dissolved Zirconium	-	mg/L	21	0.00005	0.00020	0.00006	0.00005	0.00003	0.00001	1.75	20	0	0	2	0.00030	0.00040	0.00035	0.00035	0.00007	0.00005	4.95	0	0	0

Note:

1) Canadian water quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 2007
a) Ammonia (NH3) guideline based on ph=8 and temp=20
b) Aluminum (AL-T)= 0.005 mg/L at pH < 6.5: 0.1 mg/L at pH ≥ 6.5
c) Cadmium (Cd) mg/L: 10^(0.86*(log(hardness))-3.2)/1000
d) Copper (Cu) mg/L: (e^0.8545[ln(hardness)]-1.465)*0.2/1000; minimum is 0.002mg/L regardless of water hardness
e) Lead (Pb) mg/L: (e^1.273[ln(hardness)]-4.705)/1000; minimum is 0.001mg/L regardless of water hardness
f) Nickel (Ni) mg/L: (e^0.76[(ln(hardness)]+1.06)/1000; minimum is 0.025mg/L regardless of water hardness

"n"	Count
"min"	Minimum Value
"max"	Maximum Value
"sd"	Standard Deviation
"se"	Standard Error
"cov"	Covariance
"<DL"	# of Non-detectable Values
">GL"	# of Exceedances of CCME Guic
"%>GL"	% of Parameters that Exceed CCME Guidelin
"-"	No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B6. Surface Water Quality *In situ* Data, Casino Project, 2008-2012

Watershed/ Site		Sample Date / Parameter	May-08	Jul-08	Sep-08	Oct-08	May-09	Jun-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Mar-11	01-Apr-11	29-Apr-11	Aug-11	Oct-11	Mar-12	May-12	Jul-12
Casino Creek	W12	Temperature (°C)	4.2	7	0.7	0.4	-	6	4.7	2.4	-	-	-	-	-	-	-	0	8.8	4.5	3.1	-	-	0.4	-	-	-	-	-0.09	1.53	-
		Conductivity (µS/cm)	203	1034	690	1026	-	613	592.7	1069	-	-	-	-	-	-	-	611.8	1250	922	894	-	-	1021	-	-	-	-	1446	293	-
		pH	3.95	3.32	3.48	3.47	-	3.67	3.7	3.33	-	-	-	-	-	-	-	3.34	3.35	3.17	3.14	-	-	4.17	-	-	-	-	3.4	3.86	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.25	10.93	-
	W8	Temperature (°C)	2.5	3.1	3.5	-	-	-	4.8	-	-	-	-	-	-	-	-	-0.1	-	5.7	6.2	-	-	1.4	-	1.4	2.39	-0.13	-0.09	2.98	-
		Conductivity (µS/cm)	84	281	211	-	-	-	338.2	-	-	-	-	-	-	-	-	160	-	267.1	238.8	-	-	354	-	336	-	217	354	99	-
		pH	7.32	7.41	7.67	-	-	-	7.89	-	-	-	-	-	-	-	-	7.61	-	7.82	7.06	-	-	7.5	-	7.6	7.28	8.05	7.25	6.54	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.83	-	11.11	12.65	-
	W43	Temperature (°C)	4.1	3.6	4.2	1.5	-	3.4	3.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.69
		Conductivity (µS/cm)	274	242	347	228	-	223	276.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	184
		pH	6.8	6.7	7.35	6.79	-	7.08	6.81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.84
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	W13	Temperature (°C)	0	3	1.9	-	-	-	2	1.6	-	-	-	-	-	-	-	-	-	3	3.8	-	-	0.5	-	-	1.78	0.54	-0.1	-	-
		Conductivity (µS/cm)	102	324	195	-	-	-	274.6	271	-	-	-	-	-	-	-	-	-	279.6	210.1	-	-	433	-	-	-	202	368	118	-
		pH	7.76	7.82	7.52	-	-	-	8.04	7.76	-	-	-	-	-	-	-	-	-	7.89	7.05	-	-	7.62	-	-	7.75	8.03	7.31	6.82	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.05	-	9.74	10.13	-
	W11	Temperature (°C)	2.6	7.5	2.5	0	5.1	3.6	4.6	2.9	1.5	0	0	0	-	-	0.1	-0.1	7.4	7	7	1.2	-0.1	1.1	-	4.4	2.4	-0.12	-0.11	3.3	-
		Conductivity (µS/cm)	101.2	298	207	278	160	84.7	341.9	296	312	349.6	364.5	-	-	-	289.8	206.8	286	255.2	234.1	216	261	398	-	291	-	258	429	111.7	-
		pH	7.53	7.84	7.74	6.93	7.56	7.36	8.05	7.84	7.84	7.55	7.73	7.7	-	-	8.15	7.62	7.81	7.65	7.09	7.77	7.69	7.61	-	7.51	7.9	7.66	7.8	7.71	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.37	-	11.52	12.51	-
	W18	Temperature (°C)	-	-	3.1	0	4.9	3.7	4.6	3.3	1.7	0.1	0	-	-	-	0.1	-0.1	3.1	7.5	6.5	5.1	-0.1	0.7	-	0.1	2.99	1.01	-0.1	3.8	-
		Conductivity (µS/cm)	-	-	113	165	101	63.1	215.4	180	190	216.9	238.2	-	-	-	262.3	118.9	86	139.4	113.5	122	164	267	-	239	-	151	250	58.8	-
		pH	-	-	7.59	7.58	7.52	7.38	7.89	7.72	7.77	7.86	-	-	-	-	7.86	7.47	7.24	7.56	6.7	7.67	7.32	7.15	-	7.37	7.77	7.45	7.9	7.46	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.22	-	9.87	12.21	-
	W4	Temperature (°C)	1.6	6.4	2.3	0	2.2	4.2	9	1.9	1.9	0	0	-	-	-	-0.1	0	1.9	4.1	4.3	3.4	-0.1	0	-	0.1	3.46	-0.06	-0.08	1.3	-
		Conductivity (µS/cm)	85	232	162	240	164	98.7	295.1	264	272	-	326.7	-	-	-	266	193.8	199	215.3	185	145	248	346	-	252	-	208	368	70.5	-
		pH	7.46	7.73	7.83	7.66	7.57	7.48	7.93	7.77	7.8	7.54	7.55	-	-	-	7.44	7.94	7.51	7.54	7	7.61	7.49	7.52	-	7.72	7.82	7.71	7.8	7.28	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.96	-	9.56	13.22	-
Dip Creek	W22	Temperature (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.12	3.88	-
		Conductivity (µS/cm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	273	121	-
		pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.4	7.4	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.83	9.66	-
	R2	Temperature (°C)	-	-	-	-	-	-	6.2	3.3	1.9	0	0.1	0	0.1	0.1	-	-0.1	7	4.8	5.6	1.7	-0.1	2.3	-	0	-	-0.02	-0.1	1.4	-
		Conductivity (µS/cm)	-	-	-	-	-	-	143.3	140	146	-	177.3	39.3	72.3	199.7	-	155.4	112	104.1	113.7	98	145	205	-	243	-	128	206	50.4	-
		pH	-	-	-	-	-	-	7.53	7.56	7.6	7.66	-	7.31	7.34	7.61	-	7.55	7.51	7.64	6.75	7.55	6.92	7.68	-	7.46	-	7.65	7.5	7.23	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.78	12.77	-
	W9	Temperature (°C)	0.2	5.7	2.5	0.1	0.6	4.8	8.6	2.6	2.1	0	0	0	0	0	-0.1	0.1	3.4	5.7	4.9	2.5	-0.1	0	-	0.7	-	-	-0.1	1.4	-
		Conductivity (µS/cm)	60	103	129	172	53	106.8	203.6	176	183.1	-	222	74.3	15.8	137.7	252	150.7	140	131.6	138.8	124	174	284	-	231	-	-	245	64.8	-
		pH	7.2	7.5	7.62	7.51	7.35	7.49	7.81	7.64	7.72	7.58	7.64	7.5	7.23	7.47	7.52	7.52	7.55	7.38	7.02	7.29	7.35	7.8	-	7.6	-	-	7.35	7.26	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.05	12.88	-
	W5	Temperature (°C)	1.1	6.1	-	0.4	1.8	4.2	7.3	2.4	1.9	0	0.1	-	-	-	0	-	4	-	4.6	3.8	-0.1	-0.1	-	0.3	4.39	-0.12	-0.11	2.3	-
		Conductivity (µS/cm)	58.2	119	-	198	121	106.1	230.8	202	209	-	252.2	-	-	-	275.8	-	155.4	-	153.5	144	194	278	-	244	-	179	286	71	-
		pH	7.4	7.56	-	7.62	7.62	7.52	7.85	7.7	7.73	7.58	7.5	-	-	-	7.94	-	8.7	-	7.03	7.42	7.31	7.7	-	7.54	7.8	8.02	7.7	7.55	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.26	-	8.47	12.35	-
	W16	Temperature (°C)	0	6.9	3.9	-	3	5.7	9.6	3.3	1.4	0	0	-	-	-	0	-0.1	6.9	9	6.2	2.8	-0.1	0.6	-	0.2	5.31	0.04	-	-	-
		Conductivity (µS/cm)	127	141	119	-	92	40.1	233.1	217	222	-	260.2	-	-	-	311.2	201.5	177	165.8	154.4	145	199	295	-	271	-	191	-	-	-
		pH	7.58	7.46	7.6	-	7.39	7.14	7.81	7.7	7.75	7.44	8.89	-	-	-	7.98	7.7	7.67	7.43	6.86	7.47	6.93	8.06	-	7.83	7.75	7.9	-	-	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.82	-	-	-	-
	W19	Temperature (°C)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.08	5	-
		Conductivity (µS/cm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	230	122.2	-
		pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.88	7.31	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	10.44	-

Note:

"-" No Data Available

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix B6. Surface Water Quality *In situ* Data, Casino Project, 2008-2012

Watershed/ Site		Sample Date / Parameter	May-08	Jul-08	Sep-08	Oct-08	May-09	Jun-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Mar-11	01-Apr-11	29-Apr-11	Aug-11	Oct-11	Mar-12	May-12	Jul-12
Klotassin River	W20	Temperature (°C)	-	-	-	-	-	-	-	4.7	3.6	0.1	0.2	0.1	0.2	0.4	1.2	5.5	7.8	7.8	10.8	4.7	-	0.01	-	3.8	-	-	0	5.2	-
		Conductivity (µS/cm)	-	-	-	-	-	-	-	151	159.5	159.8	152.2	67.7	165.2	167	177.7	175	163.9	137.3	151.2	126	-	40	-	184	-	-	168	121.2	-
		pH	-	-	-	-	-	-	-	7.46	7.46	7.49	7.55	7.68	7.4	7.42	8.15	7.63	7.67	8.41	7.24	6.52	-	8.34	-	7.4	-	-	7.95	7.38	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.23	10.48	-
	W21	Temperature (°C)	-	-	-	-	-	-	-	4.5	3.1	0	0.1	0	0	0	0.5	4.7	8.1	8	10.3	4.5	-	0.1	-	0.5	-	-	-	-	-
		Conductivity (µS/cm)	-	-	-	-	-	-	-	165	174.3	178.5	168.9	9	165.8	168.8	234.1	182.8	179.1	139.9	146.1	115	-	69.4	-	203	-	-	-	-	-
		pH	-	-	-	-	-	-	-	7.64	7.89	7.63	7.73	7.42	7.83	7.16	7.83	7.64	7.69	7.92	7.18	6.24	-	9.53	-	7.6	-	-	-	-	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Britannia Creek	W7	Temperature (°C)	0.1	7.9	2.7	0	-	2.6	6.2	4.6	0	-	-	-	-	-	0.1	0.1	6	7.7	5.9	3.9	-	1.1	-	1.3	6.01	-0.1	-	-	-
		Conductivity (µS/cm)	30.7	107	117	136	-	74.3	112.2	148	159	-	-	-	-	-	141.2	58.7	78	119.3	137.9	140	-	166	-	80	113	119	-	-	-
		pH	6.22	7.13	6.81	6.93	-	6.6	7.62	7.37	7.99	-	-	-	-	-	7.99	6.3	6.82	7.89	6.04	6.42	-	6.69	-	7.12	6.75	7.1	-	-	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	-	-
	W3	Temperature (°C)	2	8.2	4.5	1.8	7.2	5.7	7.8	5.5	2.3	0	0	0	0	0	0.4	2.2	6.7	10.3	10.7	6	1.4	2.2	-	0.1	7.83	0.79	-0.06	3.7	-
		Conductivity (µS/cm)	82	263	175	265	197	135.5	234.1	259	285	312.9	280.1	7.1	366.8	375.4	378.3	255.1	258	212.7	230.9	121	272	373	-	352	-	274	413	117.9	-
		pH	7.42	7.7	7.66	7.98	7.66	7.59	7.71	7.72	7.71	7.7	7.81	7.64	7.75	8.07	7.96	7.73	7.72	7.73	7.18	7.05	7.64	7.43	-	7.88	6.96	7.78	7.91	7.57	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.72	-	11.73	11.92	-
	W14	Temperature (°C)	0.1	5	3	0.3	0.9	1.9	5.4	3.2	0.5	0	0	-	-	-	0	0	3.7	7.7	9.48	3.8	0	0	-	0.2	-	-	-	-	-
		Conductivity (µS/cm)	35	318	188	294	119	102	445.7	251	301	405.5	470.2	-	-	-	398.1	111.7	349	250.9	232.4	164	31	566	-	420	-	-	-	-	-
		pH	7.11	7.65	8.04	7.56	7.49	7.43	7.9	7.82	7.79	7.77	7.6	-	-	-	8.07	7.5	7.77	7.95	7.26	7.05	7.57	7.21	-	8.04	-	-	-	-	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	W2	Temperature (°C)	1.8	6.5	4.1	-	3.8	4.8	-	4.6	1.4	0.1	0	0	-	0	0.5	1.2	5.2	9.6	6.6	-	-	1	-	0.1	7.27	0.63	-	-	-
		Conductivity (µS/cm)	72	287	179	-	156	46.5	-	257	296	343.3	375	-	-	343.5	389.1	170.8	286	224.6	219.6	-	-	400	-	381	-	299	-	-	-
		pH	7.44	7.54	7.64	-	7.56	7.06	-	7.7	7.88	7.7	7.76	7.87	-	7.85	7.84	7.62	7.7	7.63	7.33	-	-	7.53	-	7.93	7.01	7.85	-	-	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.95	-	-	-	-
	W1	Temperature (°C)	3.4	7.4	4.6	1.9	-	6.6	8.1	-	1.9	0	1.3	0.2	-	-	0	0.2	5.4	8.5	7.8	4	1	-	0	0.1	6.92	-0.12	-	-	-
		Conductivity (µS/cm)	65.8	280	201	298	-	138.6	372.2	-	324	375.6	389.2	489.9	-	-	453	197	311	247	257.8	201.3	315	-	529	552	-	288	-	-	-
		pH	7.5	7.88	7.77	7.77	-	7.66	7.96	-	7.88	7.86	8.26	7.77	-	-	7.95	7.7	7.79	7.85	7.17	7.03	7.73	-	7.65	7.87	7.12	7.7	-	-	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.61	-	-	-	-
Yukon River	W17	Temperature (°C)	0.7	5.3	4.1	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	0.42	2.7	-
		Conductivity (µS/cm)	87.9	185	179	-	-	-	258.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	323	-	-	311	101.4	-
		pH	7.9	7.7	7.5	-	-	-	7.81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.1	-	-	7.8	7.82	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	12.61	-
	W6b	Temperature (°C)	7.9	14.5	9.6	4.3	-	13.6	19.5	12.4	5	0	-	0.2	0.4	0.9	0.5	8.4	13.9	16.3	19.8	12.2	-	-	0.1	0.4	-	-	-0.04	11.4	-
		Conductivity (µS/cm)	163	187	220	183	-	94.3	186.3	198	199.9	126.2	-	199.6	215.7	219.2	193.9	201.8	196.1	202.7	205.9	190	-	-	259	197	-	-	223	288.7	-
		pH	7.92	8.22	8.23	8.02	-	8.1	8.44	8.25	8.07	8.18	-	7.94	8	7.77	8.43	8.02	8.1	7.94	8.1	7.37	-	-	7.89	8.04	-	-	8.4	8.11	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	9.27	-
	W6a	Temperature (°C)	7.1	13.9	10	3.6	8.6	12.5	17.3	12	5.6	0	0	-	0.6	1.2	0.6	2.3	13.7	14.9	18.08	11.8	-	-	1.2	0.6	-	-	-	-	-
		Conductivity (µS/cm)	147	149	174	225	198	151	123.8	101	161.6	159.5	203.7	-	232	244	182.5	137.5	166	160	202.4	192	-	-	274	182	-	-	-	-	-
		pH	8.05	8	8.08	8.01	8.15	8.1	8.45	8.19	8.07	8.21	8.89	-	8.24	7.96	8.61	8.01	8.16	7.95	8.02	7.34	-	-	7.67	7.99	-	-	-	-	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	W15	Temperature (°C)	9.4	14.2	9.9	-	-	13.6	16.9	9.2	5.6	0.2	0	0.4	1.3	1.1	3.4	6.8	13.7	16.5	17.9	12.9	-	-	-	5.9	-	-	-	-	-
		Conductivity (µS/cm)	164	162	216	-	-	152.7	180.3	160	163	124.15	186	222.5	211.7	211.1	194.4	191.8	167.5	201.9	201.7	193	-	-	-	212	-	-	-	-	-
		pH	8.06	8.1	8.14	-	-	8.11	8.4	8.07	8.06	8.05	8.69	7.73	7.7	8.32	8.67	8.09	8.12	7.97	7.98	7.31	-	-	-	7.81	-	-	-	-	-
		Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note:

"-" No Data Available

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Appendix C

Sediment Quality Data and Analysis

- **C1. Sediment Quality Data, Casino Project, 1993-1995 and 2008-2012**
- **C2. Appendix C2. Sediment Quality Summary Statistics, Casino Project, 1993-1994 and 2008-2012**

Appendix C1: Sediment Quality Raw Data, Casino Project, 2008-2012

Parameter	RDL	CCME SQ Guidelines[a]														Dip Creek							
				S4	S5/W12	S5/W12-1	S5/W12-2	S3/W8	W13	W11	S6/W4	W24-1	W24-2	W24-3	W24-1	R2-1	R2-2	S8/W9	S7/W5	W16-1	W16-2	W16-3	W16
		ISQG[b]	PEL[c]	9-Aug-10	10-Sep-08	08-Aug-09		10-Sep-08	9-Sep-08	9-Sep-08	9-Sep-08	22-Aug-11			23-Aug-11	5-Aug-09		9-Sep-08	9-Sep-08	22-Aug-11			23-Aug-11
Aluminum	100	-	-	13100	11100	12400	3470	8010	10800	11200	11800	8450	6910	5880	12600	4570	4580	12000	13200	8990	7900	9440	7270
Antimony	0.1	-	-	1.0	2.4	3.0	2.9	1.2	2.3	2.6	0.8	2.2	2.1	3.1	1.4	0.2	0.2	0.6	0.7	0.5	0.4	0.4	0.6
Arsenic	0.2	5.9	17	**17.3**	**46.0**	**45.5**	**22.9**	**24.5**	**25.8**	**27.5**	*13.0*	**45.8**	**42.3**	**44.3**	**37.2**	5.8	*8.4*	*6.4*	*10.0*	*6.9*	*6.1*	*6.6*	*8.5*
Barium	0.1	-	-	336	188	187	73.1	140	272	217	156	134	115	88.3	231	96.8	128	169	206	115	110	121	115
Beryllium	0.1	-	-	0.4	0.3	<0.1	0.4	0.4	0.4	0.4	0.2	0.6	0.5	<0.4	0.8	0.1	0.2	0.4	0.4	<0.4	<0.4	<0.4	<0.4
Bismuth	0.1	-	-	0.3	0.9	1.0	0.8	0.3	0.2	0.3	0.1	0.6	0.2	0.2	0.2	<0.1	<0.1	0.2	0.2	<0.1	0.1	<0.1	<0.1
Cadmium	0.05	0.6	3.5	*1.28*	0.35	*0.64*	0.09	*1.80*	*1.55*	*1.78*	0.35	0.41	0.34	0.29	*0.77*	0.09	0.11	0.19	0.26	0.13	0.14	0.14	0.16
Calcium	100	-	-	10400	1170	1170	415	2030	3780	3920	3590	3840	2720	2320	13600	1370	1440	5440	5090	3230	2850	3400	3050
Chromium	1	37.3	90	15	13	14	6	5	12	9	14	17	16	12	24	4	4	18	15	11	10	12	15
Cobalt	0.3	-	-	8.8	10.1	10.3	1.8	29.1	10.4	23.2	11.1	8.1	6.8	6.7	8.9	4.8	5.0	8.5	10.5	7.2	6.8	7.5	6.8
Copper	0.5	35.7	197	23.6	**223**	**265**	*145*	**292**	15.0	*191*	33.4	17.1	15.7	18.4	23.6	7.1	5.5	12.6	19.8	10.6	11.4	11.4	10.3
Iron	100	-	-	22600	83500	287000	220000	36600	27300	34900	29100	19600	17200	19000	19800	14000	13900	25700	27500	18700	17800	19500	25100
Lead	0.1	35	91.3	17.8	*73.9*	*74.8*	26.4	*42.9*	**192**	**111**	24.9	13.0	11.1	11.3	16.2	3.0	3.5	11.8	14.3	7.7	6.7	7.1	8.1
Lithium	5	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	100	-	-	4690	3460	2740	1040	2880	4970	4440	6040	2830	2340	2040	4920	2160	2170	5370	5590	4050	3550	4110	3230
Manganese	0.2	-	-	609	407	526	94.9	1200	1400	1390	500	432	274	245	594	433	488	514	709	356	383	361	431
Mercury	0.05	0.17	0.486	0.09	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	0.06	0.05	<0.05	0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Moisture %	0.3	-	-	63	35	58	45	23	25	29	37	36	53	34	75	19	22	30	31	19	17	15	20
Molybdenum	0.1	-	-	1.2	5.0	5.7	5.1	2.9	1.2	2.4	1.5	0.9	0.9	1.1	1.0	0.9	0.8	1.1	1.1	0.6	0.6	0.6	0.7
Nickel	0.8	-	-	11.2	7.5	8.0	2.1	6.4	9.4	9.9	8.2	14.9	13.6	12.7	17.8	4.9	5.5	12.2	12.5	9.1	8.6	9.9	8.2
pH	0.01	-	-	7.23	3.28	3.20	2.78	7.16	7.41	7.29	6.66	5.91	6.61	6.35	6.48	7.40	7.30	6.92	6.59	7.45	7.41	7.35	7.30
Phosphorus	10	-	-	677	577	524	435	434	498	444	584	537	452	473	786	320	327	965	703	492	467	509	556
Potassium	100	-	-	787	880	818	392	665	2120	1300	2170	784	685	616	1120	548	724	1080	1480	1030	879	1020	826
Selenium	0.5	-	-	0.5	<0.5	1.2	1.1	<0.5	<0.5	<0.5	<0.5	1.0	<0.5	0.8	2.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5
Silver	0.05	-	-	0.21	0.62	0.74	0.56	0.12	0.38	0.29	0.08	0.13	0.09	0.08	0.27	<0.05	<0.05	0.10	0.11	<0.05	<0.05	<0.05	<0.05
Sodium	100	-	-	154	<100	<100	<100	<100	<100	<100	176	120	<100	<100	175	<100	<100	197	156	182	169	193	153
Strontium	0.1	-	-	135	9.2	10.9	4.7	14.8	25.4	28.1	17.6	17.6	13.1	10.2	51.6	10.6	11.9	33.2	36.3	21.7	19.7	22.6	20.3
Thallium	0.05	-	-	0.18	0.17	0.18	0.09	0.13	0.32	0.22	0.25	0.29	0.23	0.19	0.30	0.07	0.08	0.15	0.22	0.12	0.11	0.12	0.10
Tin	0.1	-	-	0.4	0.5	0.4	0.2	0.2	0.7	0.5	0.5	0.6	0.5	0.6	1.3	0.3	0.3	0.5	0.5	0.4	0.5	0.5	0.4
Titanium	1	-	-	615	471	427	184	342	859	722	974	395	309	260	550	234	304	748	888	630	546	650	520
Uranium	0.05	-	-	19.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	2	-	-	42	46	39	23	31	50	45	70	37	32	32	44	20	21	54	53	36	35	39	64
Zinc	1	123	315	101	*169*	*143*	37	*180*	*226*	*192*	94	70	60	64	73	33	32	64	76	55	51	57	45
Zirconium	0.5	-	-	2.5	0.8	1.9	1.5	0.9	1.0	0.9	0.9	1.0	0.8	<0.5	3.4	0.7	0.7	1.3	1.5	1.2	1.2	1.3	1.1

Note:

[a]Canadian sediment quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 1999

[b]ISQG: Interim Freshwater Sediment Quality Guideli

[c]PEL:Probable Effects Levels

Italics	Results exceed ISQG
Bold	Results exceed PEL
RDL	Reportable Detection Li
"-"	No data available

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Appendix C1: Sediment Quality Raw Data, Casino Project, 2008-2012

Parameter	RDL	CCME SQ Guidelines		Klotassin River						Britannia Creek					Yukon River					
				W20	W21	W21-1	W21-2	W21-3	W21	W7	W3	W14	S2/W2	S1/W1	W6B-1	W6B-2	W6A	W15	W15-1	W15-2
		ISQG[d]	PEL[c]	8-Aug-10	8-Aug-10	22-Aug-11			23-Aug-11	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	10-Sep-08	8-Aug-10		8-Aug-10	22-Aug-11		
Aluminum	100	-	-	15000	7850	4830	5140	4720	6150	6810	6160	6690	5940	6900	7130	8990	6540	11500	4680	8070
Antimony	0.1	-	-	0.4	0.3	0.2	0.2	0.2	0.2	0.8	1.0	0.8	0.9	0.9	1.0	0.9	0.8	1.6	0.5	1.1
Arsenic	0.2	5.9	17	*6.4*	*7.2*	4.8	4.6	4.5	5.1	*13.1*	**18.5**	*12.2*	**18.4**	*15.5*	*9.6*	*9.0*	*7.2*	*14.3*	4.4	*8.4*
Barium	0.1	-	-	172	109	65.5	64.3	59.4	69.6	144	98.9	159	96.8	96.7	350	340	248	558	262	400
Beryllium	0.1	-	-	0.6	0.4	<0.4	<0.4	<0.4	<0.4	0.2	0.2	0.1	0.2	0.2	0.3	0.4	0.3	<0.4	0.6	0.4
Bismuth	0.1	-	-	0.2	0.1	<0.1	0.1	<0.1	<0.1	0.5	0.1	<0.1	0.2	0.1	0.1	0.2	0.1	<0.1	0.2	<0.1
Cadmium	0.05	0.6	3.5	0.29	0.18	<0.05	0.05	<0.05	0.08	*0.68*	0.21	0.08	0.19	0.15	*1.28*	*1.14*	*0.70*	*2.05*	*0.69*	*1.20*
Calcium	100	-	-	6310	3670	2030	2130	1910	2690	1200	1860	2250	1850	2300	8810	10700	9350	15600	4980	11600
Chromium	1	37.3	90	38	19	12	13	11	17	6	15	9	12	17	24	28	22	31	13	21
Cobalt	0.3	-	-	11.7	7.3	4.7	5.0	4.6	5.8	8.3	7.3	6.6	6.9	8.0	8.7	9.8	7.0	13.1	5.3	8.8
Copper	0.5	35.7	197	29.9	14.9	5.9	6.3	6.0	7.1	*57.0*	18.0	6.4	15.8	20.3	27.5	28.5	18.0	*42.0*	13.4	24.5
Iron	100	-	-	26100	18400	12500	13600	12800	16300	16500	13900	16700	13800	16000	20500	22900	17200	27600	13200	20300
Lead	0.1	35	91.3	7.4	5.0	3.0	3.1	2.9	3.5	11.4	10.5	4.4	7.8	9.6	8.3	8.1	6.3	15.9	4.4	8.2
Lithium	5	-	-	13	8									-	10	10	9	-	-	-
Magnesium	100	-	-	8670	4360	3050	3390	2950	4120	3560	4840	3890	4800	4890	6720	7910	6640	9850	3860	7320
Manganese	0.2	-	-	439	355	196	205	206	219	450	343	355	354	336	348	554	359	701	320	444
Mercury	0.05	0.17	0.486	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	0.10	0.06	<0.05	0.12	0.06
Moisture %	0.3	-	-	39	25	24	23	22	18	20	20	23	21	23	28	42	27	41	-	31
Molybdenum	0.1	-	-	0.9	0.7	0.5	0.5	0.5	0.7	5.5	2.5	0.4	2.7	2.4	1.2	1.2	1.0	1.9	0.7	1.3
Nickel	0.8	-	-	30.8	17.0	10.4	11.8	10.5	13.4	5.1	13.8	6.0	13.3	13.0	37.2	40.5	28.8	55.9	21.7	36.7
pH	0.01	-	-	6.65	7.27	7.07	7.24	7.36	7.39	6.45	7.27	7.37	7.38	7.45	7.73	7.96	8.00	7.96	7.39	7.92
Phosphorus	10	-	-	902	607	464	497	445	569	337	374	431	428	405	960	891	868	1040	664	835
Potassium	100	-	-	843	552	385	415	400	491	1310	1360	1280	1190	1480	669	817	562	1230	448	793
Selenium	0.5	-	-	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	0.6	0.5	<0.5	1.7	0.8
Silver	0.05	-	-	0.10	0.06	<0.05	<0.05	<0.05	<0.05	0.12	0.05	<0.05	0.06	0.18	0.13	0.14	0.10	0.30	0.08	0.17
Sodium	100	-	-	265	196	144	148	141	163	<100	<100	107	<100	<100	114	165	113	<100	193	131
Strontium	0.1	-	-	52.9	29.0	14.2	15.0	13.1	17.7	9.7	11.6	14.6	12.4	13.5	44.2	51.5	42.1	73.4	29.1	52.9
Thallium	0.05	-	-	0.09	0.06	<0.05	<0.05	<0.05	<0.05	0.17	0.12	0.12	0.12	0.12	0.11	0.10	0.08	0.18	0.05	0.12
Tin	0.1	-	-	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.2	0.4	0.4	0.3	1.8	0.7	0.5
Titanium	1	-	-	698	447	282	310	284	404	443	292	568	254	365	310	415	275	387	218	274
Uranium	0.05	-	-	3.20	1.74	-	-	-	-	-	-	-		-	1.12	1.55	1.31	-	-	-
Vanadium	2	-	-	57	35	25	27	23	36	30	23	36	23	27	39	42	30	52	24	36
Zinc	1	123	315	84	53	32	34	32	36	65	40	34	41	43	*147*	*129*	98	*212*	70	*154*
Zirconium	0.5	-	-	2.7	1.3	2.0	2.0	1.8	1.8	1.1	0.7	0.6	0.7	0.8	1.7	2.0	1.6	2.1	1.3	1.7

Note:

[a]Canadian sediment quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 1999

[b]ISQG: Interim Freshwater Sediment Qual

[c]PEL:Probable Effects Levels

Italics	Results exceed ISQG
Bold	Results exceed PEL
RDL	Reportable Detection Lim
"-"	No data available

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Appendix C2. Sediment Quality Summary Statistics, Casino Project, 2008-2011

Parameter	RDL	CCME SQ Guidelines[a]		Casino Creek watershed																		Dip Creek watershed							
				S4		S5/W12					S3/W8		W13		W11		S6/W4		W24		R2		S8/W9		S7/W5		W16	
		ISQG[b]	PEL[c]	n	Mean	n	Min	Mean	Max	sd	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Aluminum	100	-	-	1	13100	2	7935	9518	11100	2238	1	8010	1	10800	1	11200	1	11800	1	8460	1	4575	1	12000	1	13200	1	8400
Antimony	0.1	-	-	1	1.00	2	2.40	2.68	2.95	0.39	1	1.20	1	2.30	1	2.60	1	0.80	1	2.20	1	0.20	1	0.60	1	0.70	1	0.48
Arsenic	0.2-0.5	5.9	17	1	**17.30**	2	**34.20**	**40.10**	**46.00**	8.34	1	**24.50**	1	**25.80**	1	**27.50**	1	*13.00*	1	**42.40**	1	*7.10*	1	*6.40*	1	*10.00*	1	*7.03*
Barium	0	-	-	1	336	2	130	159	188	41	1	140	1	272	1	217	1	156	1	142	1	112	1	169	1	206	1	115
Beryllium	0.1-0.4	-	-	1	0.40	2	0.23	0.26	0.30	0.05	1	0.40	1	0.40	1	0.40	1	0.20	1	0.53	1	0.15	1	0.40	1	0.40	1	0.20
Bismuth	0.1	-	-	1	0.30	2	0.90	0.90	0.90	0	1	0.30	1	0.20	1	0.30	1	0.10	1	0.30	1	0.05	1	0.20	1	0.20	1	0.06
Cadmium	0.05	0.6	3.5	1	*1.28*	2	0.35	0.36	0.37	0.01	1	*1.80*	1	*1.55*	1	*1.78*	1	0.35	1	0.45	1	0.10	1	0.19	1	*0.26*	1	0.14
Calcium	100	-	-	1	10400	2	793	981	1170	267	1	2030	1	3780	1	3920	1	3590	1	5620	1	1405	1	5440	1	5090	1	3133
Chromium	1	37.3	90	1	15.00	2	10.00	11.50	13.00	2.12	1	5.00	1	12.00	1	9.00	1	14.00	1	17.25	1	4.00	1	18.00	1	15.00	1	12.00
Cobalt	0.3	-	-	1	8.80	2	6.05	8.08	10.10	2.86	1	29.10	1	10.40	1	23.20	1	11.10	1	7.63	1	4.90	1	8.50	1	10.50	1	7.08
Copper	0.5	35.7	197	1	**23.60**	2	**205.00**	**214.00**	**223.00**	12.73	1	**292.00**	1	15.00	1	*191.00*	1	33.40	1	18.70	1	6.30	1	12.60	1	19.80	1	10.93
Iron	100	-	-	1	22600	2	83500	168500	253500	120208	1	36600	1	27300	1	34900	1	29100	1	18900	1	13950	1	25700	1	27500	1	20275
Lead	0.1	35	91.3	1	17.80	2	*50.60*	*62.25*	*73.90*	16.48	1	*42.90*	1	**192.00**	1	**111.00**	1	24.90	1	12.90	1	3.25	1	11.80	1	14.30	1	7.40
Lithium	5	-	-	1	11.00	0					0		0		0				0		0		0		0		0	-
Magnesium	100	-	-	1	4690	2	1890	2675	3460	1110	1	2880	1	4970	1	4440	1	6040	1	3033	1	2165	1	5370	1	5590	1	3735
Manganese	0	-	-	1	609	2	310	359	407	68	1	1200	1	1400	1	1390	1	500	1	386	1	461	1	514	1	709	1	383
Mercury	0.05	0.17	0.49	1	0.09	2	0.03	0.03	0.04	0.01	1	0.03	1	0.03	1	0.03	1	0.03	1	0.06	1	0.03	1	0.03	1	0.03	1	0.03
Moisture (%)	0.3	-	-	1	63.00	2	35.00	43.25	51.50	11.67	1	23.00	1	25.00	1	29.00	1	37.00	1	49.50	1	20.50	1	30.00	1	31.00	1	17.75
Molybdenum	0.1	-	-	1	1.20	2	5.00	5.20	5.40	0.28	1	2.90	1	1.20	1	2.40	1	1.50	1	0.98	1	0.85	1	1.10	1	1.10	1	0.63
Nickel	0.8	-	-	1	11.20	2	5.05	6.28	7.50	1.73	1	6.40	1	9.40	1	9.90	1	8.20	1	14.75	1	5.20	1	12.20	1	12.50	1	8.95
pH (pH units)	0.01	-	-	1	7.23	2	2.99	3.14	3.28	0.21	1	7.16	1	7.41	1	7.29	1	6.66	1	6.34	1	7.35	1	6.92	1	6.59	1	7.38
Phosphorus	10	-	-	1	677	2	480	528	577	69	1	434	1	498	1	444	1	584	1	562	1	324	1	965	1	703	1	506
Potassium	100	-	-	1	787	2	605	743	880	194	1	665	1	2120	1	1300	1	2170	1	801	1	636	1	1080	1	1480	1	939
Selenium	0.5	-	-	1	0.50	2	0.25	0.70	1.15	0.64	1	0.25	1	0.25	1	0.25	1	0.25	1	1.11	1	0.25	1	0.25	1	0.25	1	0.36
Silver	0.05	-	-	1	0.21	2	0.62	0.64	0.65	0.02	1	0.12	1	0.38	1	0.29	1	0.08	1	0.14	1	0.03	1	0.10	1	0.11	1	0.03
Sodium	100	-	-	1	154.00	2	50.00	50.00	50.00	0	1	50.00	1	50.00	1	50.00	1	176.00	1	98.75	1	50.00	1	197.00	1	156.00	1	174.25
Strontium	0.1	-	-	1	135.00	2	7.80	8.50	9.20	0.99	1	14.80	1	25.40	1	28.10	1	17.60	1	23.13	1	11.25	1	33.20	1	36.30	1	21.08
Thallium	0.05	-	-	1	0.18	2	0.14	0.15	0.17	0.02	1	0.13	1	0.32	1	0.22	1	0.25	1	0.25	1	0.08	1	0.15	1	0.22	1	0.11
Tin	0.1	-	-	1	0.40	2	0.30	0.40	0.50	0.14	1	0.20	1	0.70	1	0.50	1	0.50	1	0.75	1	0.30	1	0.50	1	0.50	1	0.45
Titanium	1	-	-	1	615	2	306	388	471	117	1	342	1	859	1	722	1	974	1	379	1	269	1	748	1	888	1	587
Uranium	0.05	-	-	1	19.80	0					0		0		0		0		0		0		0		0		0	-
Vanadium	2	-	-	1	42.00	2	31.00	38.50	46.00	10.61	1	31.00	1	50.00	1	45.00	1	70.00	1	36.25	1	20.50	1	54.00	1	53.00	1	43.50
Zinc	1	123	315	1	100.90	2	90.00	129.50	*169.00*	55.86	1	*180.00*	1	*226.00*	1	*192.00*	1	94.00	1	66.75	1	32.50	1	64.00	1	76.00	1	52.00
Zirconium	0.5	-	-	1	2.50	2	0.80	1.25	1.70	0.64	1	0.90	1	1.00	1	0.90	1	0.90	1	1.36	1	0.70	1	1.30	1	1.50	1	1.20

Note:

[a]CCME SQ Guidelines: Canadian sediment quality guidelines for the protection of aquatic life, Council of Ministers of the Environment, 1999

[b]ISQG: Interim Freshwater Sediment Quality Guidelines

[c]PEL:Probable Effects Levels

Italic	Results exceed ISQG
Bold	Results exceed PEL
RDL	Reportable Detection Limit
"n"	Count - Number of years sampled
"Mean"	Mean calculated over sampling years, each year's replicates averaged prior to the calculation.
"min"	Minimum Value, minimums for sites with only one year of sampling were ommitted as they are equal to the mean
"max"	Maximum Value, maximums for sites with only one year of sampling were ommitted as they are equal to the mean
"sd"	Standard Deviation
"NS"	Not Sampled
"-"	No data available

All units mg/kg dry weight unless otherwise noted

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix C2. Sediment Quality Summary Statistics, Casino Project, 2008-2011

Parameter	RDL	CCME SQ Guidelines[a]		Klotassin River							ritannia Creek Watershe				Britannia Creek Watershed						Yukon River					
				W20		W21					W7		W3		W14		S2/W2		S1/W1		W6B		W6A		W15	
		ISQG[b]	PEL[c]	n	Mean	n	Min	Mean	Max	sd	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Aluminum	100	-	-	1	15000	2	5210	6530	7850	1867	1	6810	1	6160	1	6690	1	5940	1	6900	1	8060	1	6540	1	8083
Antimony	0.1	-	-	1	0.40	2	0.20	0.25	0.30	0.07	1	0.80	1	1.00	1	0.80	1	0.90	1	0.90	1	0.95	1	0.80	1	1.07
Arsenic	0.2-0.5	5.9	17	1	*6.40*	2	4.75	*5.98*	*7.20*	1.73	1	*13.10*	1	**18.50**	1	*12.20*	1	**18.40**	1	*15.50*	1	*9.30*	1	*7.20*	1	*9.03*
Barium	0	-	-	1	172	2	65	87	109	31	1	144	1	99	1	159	1	97	1	97	1	345	1	248	1	407
Beryllium	0.1-0.4	-	-	1	0.60	2	0.20	0.30	0.40	0.14	1	0.20	1	0.20	1	0.10	1	0.20	1	0.20	1	0.35	1	0.30	1	0.40
Bismuth	0.1	-	-	1	0.20	2	0.06	0.08	0.10	0.03	1	0.50	1	0.10	1	0.05	1	0.20	1	0.10	1	0.15	1	0.10	1	0.10
Cadmium	0.05	0.6	3.5	1	0.29	2	0.05	0.11	0.18	0.10	1	*0.68*	1	0.21	1	0.08	1	0.19	1	0.15	1	*1.21*	1	*0.70*	1	*1.31*
Calcium	100	-	-	1	6310	2	2190	2930	3670	1047	1	1200	1	1860	1	2250	1	1850	1	2300	1	9755	1	9350	1	10727
Chromium	1	37.3	90	1	*38.00*	2	13.25	16.13	19.00	4.07	1	6.00	1	15.00	1	9.00	1	12.00	1	17.00	1	26.00	1	22.00	1	21.67
Cobalt	0.3	-	-	1	11.70	2	5.03	6.16	7.30	1.61	1	8.30	1	7.30	1	6.60	1	6.90	1	8.00	1	9.25	1	7.00	1	9.07
Copper	0.5	35.7	197	1	29.90	2	6.33	10.61	14.90	6.06	1	*57.00*	1	18.00	1	6.40	1	15.80	1	20.30	1	28.00	1	18.00	1	26.63
Iron	100	-	-	1	26100	2	13800	16100	18400	3253	1	16500	1	13900	1	16700	1	13800	1	16000	1	21700	1	17200	1	20367
Lead	0.1	35	91.3	1	7.40	2	3.13	4.06	5.00	1.33	1	11.40	1	10.50	1	4.40	1	7.80	1	9.60	1	8.20	1	6.30	1	9.50
Lithium	5	-	-	1	13.00	1	8.00	8.00	8.00	0	0		0		0		0		0		1	10.00	1	9.00	0	
Magnesium	100	-	-	1	8670	2	3378	3869	4360	695	1	3560	1	4840	1	3890	1	4800	1	4890	1	7315	1	6640	1	7010
Manganese	0	-	-	1	439	2	207	281	355	105	1	450	1	343	1	355	1	354	1	336	1	451	1	359	1	488
Mercury	0.05	0.17	0.49	1	0.03	2	0.03	0.03	0.03	0.00	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.09	1	0.06	1	0.07
Moisture (%)	0.3	-	-	1	39.00	2	21.75	23.38	25.00	2.30	1	20.00	1	20.00	1	23.00	1	21.00	1	23.00	1	35.00	1	27.00	1	36.00
Molybdenum	0.1	-	-	1	0.90	2	0.55	0.63	0.70	0.11	1	5.50	1	2.50	1	0.40	1	2.70	1	2.40	1	1.20	1	1.00	1	1.30
Nickel	0.8	-	-	1	30.80	2	11.53	14.26	17.00	3.87	1	5.10	1	13.80	1	6.00	1	13.30	1	13.00	1	38.85	1	28.80	1	38.10
pH (pH units)	0.01	-	-	1	6.65	2	7.27	7.27	7.27	0.00	1	6.45	1	7.27	1	7.37	1	7.38	1	7.45	1	7.85	1	8.00	1	7.76
Phosphorus	10	-	-	1	902	2	494	550	607	80	1	337	1	374	1	431	1	428	1	405	1	926	1	868	1	846
Potassium	100	-	-	1	843	2	423	487	552	91	1	1310	1	1360	1	1280	1	1190	1	1480	1	743	1	562	1	824
Selenium	0.5	-	-	1	0.80	2	0.25	0.25	0.25	0.00	1	0.25	1	0.25	1	0.25	1	0.25	1	0.25	1	0.70	1	0.50	1	0.92
Silver	0.05	-	-	1	0.10	2	0.03	0.04	0.06	0.02	1	0.12	1	0.05	1	0.03	1	0.06	1	0.18	1	0.14	1	0.10	1	0.18
Sodium	100	-	-	1	265.00	2	149.00	172.50	196.00	33.23	1	50.00	1	50.00	1	107.00	1	50.00	1	50.00	1	139.50	1	113.00	1	124.67
Strontium	0.1	-	-	1	52.90	2	15.00	22.00	29.00	9.90	1	9.70	1	11.60	1	14.60	1	12.40	1	13.50	1	47.85	1	42.10	1	51.80
Thallium	0.05	-	-	1	0.09	2	0.03	0.04	0.06	0.02	1	0.17	1	0.12	1	0.12	1	0.12	1	0.12	1	0.11	1	0.08	1	0.12
Tin	0.1	-	-	1	0.50	2	0.30	0.30	0.30	0.00	1	0.30	1	0.20	1	0.30	1	0.20	1	0.20	1	0.40	1	0.30	1	1.00
Titanium	1	-	-	1	698	2	320	384	447	90	1	443	1	292	1	568	1	254	1	365	1	363	1	275	1	293
Uranium	0.05	-	-	1	3.20	1	1.74	1.74	1.74	0	0		0		0		0		0		1	1.34	1	1.31	0	
Vanadium	2	-	-	1	57.00	2	27.75	31.38	35.00	5.13	1	30.00	1	23.00	1	36.00	1	23.00	1	27.00	1	40.50	1	30.00	1	37.33
Zinc	1	123	315	1	84.00	2	33.50	43.25	53.00	13.79	1	65.00	1	40.00	1	34.00	1	41.00	1	43.00	1	*138.00*	1	98.00	1	*145.33*
Zirconium	0.5	-	-	1	2.70	2	1.30	1.60	1.90	0.42	1	1.10	1	0.70	1	0.60	1	0.70	1	0.80	1	1.85	1	1.60	1	1.70

Note:

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[b]ISQG: Interim Freshwater Sediment Quality Guidelines

[c]PEL:Probable Effects Levels

Italic	Results exceed ISQG
Bold	Results exceed PEL
RDL	Reportable Detection Limit
"n"	Count - Number of years sampled
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"max"	Maximum Value
"sd"	Standard Deviation
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"-"	No data available

All units mg/kg dry weight unless otherwise noted

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