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CHRISTINA LAKE REGIONAL PROJECT

FISH AND FISH HABITAT ENVIRONMENTAL SETTING REPORT

Prepared For:
MEG Energy Corp.

Prepared By:
Golder Associates Ltd.

January 2005 **04-1334-001**

EXECUTIVE SUMMARY

MEG Energy Corp. (MEG) is proposing to develop the Christina Lake Regional Project (the Project) on part of the 52 sections of oil sands leases that it holds in the area of Christina Lake, Alberta. The Project would be located within the Regional Municipality of Wood Buffalo in northeastern Alberta, approximately 15 km southeast of local Secondary Secondary Highway 881 and 20 km northeast of Conklin. MEG is proposing to develop their oil sands lease area by building and operating the Project utilizing a Steam Assisted Gravity Drainage (SAGD) oil recovery technology.

This Environmental Setting Report provides information on fish and fish habitat in selected watercourses and waterbodies within the Aquatic Resources Local Study Area (LSA) required to prepare the Environmental Impact Assessment (EIA) for the Project. The report incorporates relevant historical information obtained from the literature and the results of field investigations conducted during the winter, spring and summer of 2004.

Selected waterbodies and watercourses within the Aquatic Resources LSA include the following:

- Christina Lake;
- eleven unnamed waterbodies;
- the watersheds of two unnamed tributaries to Christina Lake; and
- two unnamed tributaries to the Christina River.

These waterbodies and watercourses were examined during the environmental setting field sampling program, as well as during the review of available information. Field surveys were conducted seasonally and included collection of the following information:

- the suitability and documented use of the available habitats for spawning, nursery, rearing, feeding, overwintering and migration by indigenous fish species;
- the presence of critical or sensitive habitats;
- the seasonal presence, relative abundance and distribution of fish;
- the presence of listed species (e.g., sensitive species or species at risk);
- the diversity of fish and fish habitat; and
- the benthic invertebrate communities present.

Two proposed watercourse crossings were also identified within the Project area associated with access/utility corridors to source and disposal wells. These crossings were assessed as part of the field sampling program.

Christina Lake

Considerable historical information was available for Christina Lake. The lake provides suitable fish habitat during both the winter and the open-water period. Due to its depth (mean and maximum depths of 17 and 33 m, respectively), the lake is dominated by pelagic habitat, with some shallow littoral habitat along the shoreline and in embayment areas. Macrophyte production and littoral spawning habitat is limited to these shoreline and embayment areas.

Eleven species of fish have been reported in Christina Lake including: Arctic grayling, walleye, northern pike, yellow perch, lake whitefish, cisco, burbot, white sucker, Iowa darter, ninespine stickleback and spottail shiner. Christina Lake was rated as providing moderate to high potential for spawning, nursery, rearing, feeding and overwintering for sport fish, suckers and forage fish. Christina Lake has historically been a high quality sport fishing destination, with walleye and pike being the primarily targeted species. Christina Lake contains habitats that would be considered critical or sensitive, including known spawning sites for walleye, and suspected spawning sites for lake whitefish, cisco, burbot and white sucker. Arctic grayling is listed as a sensitive species (ASRD 2003); and may use the lake for overwintering, nursery, rearing and feeding. The overall diversity of fish and fish habitat in Christina Lake was ranked as high.

Unnamed Waterbodies

The eleven unnamed waterbodies selected for baseline investigations ranged in size from 3.7 to 271 ha. During the open water period, all of the sampled unnamed waterbodies were shallow and characterized by littoral habitat; the majority of the waterbodies had a maximum recorded depth of less than 2 m.

Most of the waterbodies had a shallow shore slope and were surrounded by a band of grasses and forbs within a coniferous forest. Many of the surveyed waterbodies were isolated at the time of the open-water surveys, with no defined inlet or outlet streams. Macrophytyes were present in most waterbodies, including inundated shoreline vegetation during the spring survey and submergent and floating-leaved vegetation during late summer.

Winter surveys found that most of the waterbodies had shallow water depths and low dissolved oxygen levels below the ice; these waterbodies would only provide suitable overwintering habitat for forage fish species tolerant of low dissolved oxygen levels, such as brook stickleback. Four waterbodies had higher dissolved

oxygen levels and/or slightly greater under-ice water depths than the other surveyed waterbodies and may potentially provide overwintering habitat for sport fish and suckers, as well as forage fish.

Of those unnamed waterbodies where fish were encountered, northern pike and brook stickleback were the only fish species captured. In eight of the unnamed waterbodies, no fish were captured during the field surveys; some of these waterbodies may be devoid of fish. The surveyed waterbodies have the potential to provide suitable shallow water nursery, rearing and feeding habitat for sport fish (northern pike), as well as suckers and forage fish. As substrate consisted of fines, spawning habitat would be present only for fish species that spawn on vegetation or fine sediments. The eleven unnamed waterbodies do not contain any critical or sensitive habitats or listed species. The overall diversity of fish and fish habitat for the unnamed waterbodies was ranked as very low or low.

Unnamed Tributary to the North Bay of Christina Lake ("Sawbones Creek")

The unnamed tributary to the north bay of Christina Lake, locally known as "Sawbones Creek", originates from two small, unnamed headwater waterbodies and flows south into a small bay on the north shore of Christina Lake. The winter survey determined that overwintering habitat was primarily limited to the lower reach of "Sawbones Creek". The watercourse was frozen to the substrate at the sampling site located in the middle reaches, and at the farthest upstream site, the water depth was shallow and some oxygen depletion was present.

The lower reach near the confluence with Christina Lake is wide, run habitat with a well defined channel. Farther upstream, in the middle reaches of the tributary, beaver dams were present, causing braiding, impounded areas and sections of undefined channel.

Walleye were captured in the lower reach of "Sawbones Creek" upstream of the confluence with Christina Lake. Northern pike and white sucker were observed during electrofishing at this site. The lower reach of "Sawbones Creek" contains habitats that would be considered critical or sensitive, including spawning sites for walleye and northern pike. This creek, and especially the bay into which it flows (locally known as "Sawbones Bay") are known to provide spawning habitat for walleye in the spring. This lower reach also likely provides nursery, feeding and rearing habitat for these species, as well as white sucker. No listed species are present in "Sawbones Creek". The overall fish and fish habitat diversity for "Sawbones Creek" was ranked as low.

Unnamed Tributary to the East Shore of Christina Lake

The unnamed tributary is a moderately-sized, low-gradient watercourse that flows west from an unnamed waterbody to the east shore Christina Lake. Some suitable overwintering habitat may be present in beaver impoundments located in the lower reach; however, overwintering habitat appears to be limited in the middle reaches as sections of stream were partially or fully frozen to the substrate.

The lower reach near the confluence with Christina Lake consists of run habitat interspersed by large beaver impoundments. Farther upstream, in the middle and upper reaches of the tributary, the watercourse was comprised primarily of run habitat with defined banks and silt substrate. Beaver activity was present, causing ponding and sections with poorly defined banks. Beaver activity is prevalent throughout the watercourse, impeding fish migration into this tributary from Christina Lake and in the middle and upper reaches.

A white sucker was captured in the lower reach and brook stickleback were captured in the middle reaches. The unnamed tributary does not contain any critical or sensitive habitats or listed species. The overall diversity of fish and fish habitat was ranked as very low.

Unnamed Tributaries to the Christina River at the North End of the Lease

Two small, first-order tributaries to the Christina River, flowing from the north end of the lease, were assessed at the Secondary Highway 881 crossings. The watercourses were frozen to the substrate during the winter survey. Both watercourses consisted of narrow, shallow channels, with dense overhanging vegetation and organic debris. No fish were captured during the field surveys. The fish habitat use potential in these tributaries to the Christina River was considered low, with no suitable habitat for suckers and sport fish, and nil to low potential for use by forage fish.

Proposed Watercourse Crossings

At Watercourse Crossing 1 (CR-1), the watercourse consisted of a shallow swale, with terrestrial vegetation throughout; no bed, banks or fish habitat was present at the crossing location. At CR-2, the watercourse consisted of a narrow, shallow channel with limited flow within a wetland area. Brook stickleback were captured during fish sampling. The fish habitat use potential at the proposed watercourse crossing CR-2 was considered low, with no suitable habitat for suckers and sport fish and low potential for use by forage fish.

Benthic Invertebrates

Benthic invertebrates were sampled at two sites in Christina Lake, three unnamed waterbodies and two stream sites in the unnamed tributaries to Christina Lake. Mean total abundance and richness was higher in the unnamed tributaries than both Christina Lake and the unnamed waterbodies. Dominant groups found in the unnamed tributaries included seed shrimp, fingernail clams and snails. Seed shrimp and nematodes were the dominant groups in Christina Lake, while fingernail clams, scuds, bristleworms and midges were the dominant groups in the unnamed waterbodies.

ACKNOWLEDGEMENTS

This Fish and Fish Habitat Environmental Setting Report was prepared for MEG Energy Inc. by Golder Associates Ltd. as part of the Christina Lake Regional Project EIA under the direction of Al Seimens.

The field surveys were carried out by Cam Davis, Gina Hoar, Jeanette Davis and Rick Hunt. Jody Janvier of Janvier, Alberta assisted with the field work. This report was prepared by Kristine Mason, Darrell Jobson, Gina Hoar and Cam Davis, with technical advice provided by Zsolt Kovats and Scott McKenzie. The drafting and mapping was prepared by Paul St. Rose, Steve Dunsmoor and Mark Jordan. This report was reviewed by Scott McKenzie, Zsolt Kovats and Tod Collard. The report was formatted by Tammy Toby.

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1 INTRODUCTION

1.1 PROJECT DESCRIPTION

MEG Energy Corp. (MEG) is a Calgary-based, private energy company focused on the development and recovery of bitumen, shallow gas reserves and the generation of power in northeast Alberta. MEG is proposing to develop the Christina Lake Regional Project (the Project) on part of the 52 sections of oil sands leases that it holds in the area of Christina Lake, Alberta. The Project would be located within the Regional Municipality of Wood Buffalo in northeastern Alberta, approximately 15 km southeast of local Secondary Secondary Highway 881 and 20 km northeast of Conklin.

MEG is proposing to develop their oil sands lease area by building and operating the Project utilizing a Steam Assisted Gravity Drainage (SAGD) oil recovery technology. The Project would consist of a central processing facility, SAGD wells, co-generation facilities and additional infrastructure. The proposed central processing facility and the co-generation unit would be located adjacent to MEG's proposed Pilot facilities located in NE¼ 9 and SE¼ 16, Township 77, Range 5, W4M. The Project would be designed and built to produce 22,000 barrels per day of bitumen (approximately 3,500 cubic metres per day). This production, which would be in addition to the 3,000 barrels of bitumen per day from the pilot operation, would result in a total production of 25,000 barrels of bitumen per day (approximately 4,000 cubic metres per day).

This Environmental Setting Report provides information regarding the baseline conditions for fish and fish habitat in selected watercourses and waterbodies within the Aquatic Resources Local Study Area (LSA) required to prepare the Environmental Impact Assessment (EIA) for the Project. The report incorporates relevant historical information obtained from the literature and the results of field investigations conducted during the winter, spring and late summer of 2004.

1.2 STUDY OBJECTIVES

The main objectives of this study were to characterize the fish and fish habitat in waterbodies and watercourses in the Project area, and to provide the data and information necessary to assess any potential effects of the development of the Project on fish and fish habitat.

The characterization of fish and fish habitat included:

- description of the habitats of the waterbodies and watercourses in the Project area;
- discussion of the suitability of the habitats in relation to the needs of the various life stages of fish species and benthic invertebrates;
- description of the fish communities and habitat use; and
- description of the benthic invertebrate communities.

The scope of work for the fish and fish habitat environmental setting study included the compilation and review of available information for waterbodies and watercourses in the vicinity of the Project, and the survey and assessment of fish and fish habitat within the Aquatic Resources LSA.

1.3 APPROACH

The fish and fish habitat environmental setting information includes a description of the fish habitat, fish communities and benthic invertebrate communities in waterbodies and watercourses in the Project area. This information consists of available information concerning fish and fish habitat in the defined study area, including historical information and information collected during field studies conducted specifically for the Project. Field studies were conducted on representative waterbodies and watercourses within the Aquatic Resources LSA.

Historical information for the study area was reviewed. Field studies were conducted to collect current data for waterbodies and watercourses potentially affected by the Project for which historical information was not available. All of this information was summarized to provide the description of existing fish and fish habitat in the waterbodies and watercourses in the study area.

The following specific items were included in the draft Terms of Reference (AENV 2005) to provide complete environmental setting information for fish and aquatic resources:

- description of the existing baseline information;
- description of the existing fish and other aquatic resources (e.g., benthic invertebrates) in the waters found in the study area and in other fish-bearing water likely to be impacted by the Project;
- identification of species composition, distribution, relative abundance, movements and general life history parameters;

- discussion of the use of the fish resources as existing or potential Aboriginal, sport or commercial fisheries;
- description and mapping of the fish habitat of the lakes, rivers and other waters likely to be affected by the Project;
- identification of critical or sensitive areas such as spawning, rearing and over-wintering habitats; and
- discussion of seasonal habitat use including migration and spawning routes.

The evaluation of the suitability of aquatic habitats for use by fish was based on the life history needs of the different fish species and benthic invertebrate genera that are indigenous to the study area. For fish species, the habitat components shown in Table 1-1 were considered when evaluating habitat conditions and their suitability for use by different fish life stages.

Table 1-1 Fish Life Cycle Stages and Habitat Components

Life Cycle Stage	Habitat Component
spawning adult	spawning habitat
fry (young-of-the-year)	nursery habitat
juvenile	rearing habitat
adult	feeding habitat
all stages	overwintering habitat
all stages	migration routes

The evaluation of the potential suitability of the available habitats for use by fish was based on an assessment of habitat use potential, which evaluates how well the habitat can provide the physical environment indigenous fish species need to complete their life cycle. Habitat use potential is not necessarily based on whether a particular fish species or life stage uses the habitat. It is based on how well that habitat would meet the requirements of the species or life stage.

The common and scientific names of fish species and the classification of each species relative to the categories of sport fish, suckers and forage fish is provided in Appendix I.

1.4 STUDY AREA

The Aquatic Resources LSA for the Aquatic Resources Environmental Setting Report was selected based on the Project lease area, local drainage basins and the requirements of aquatics components including fish and fish habitat, surface hydrology and surface water quality. The Aquatic Resources LSA for the Project encompasses portions of the upper watershed areas of the Christina River drainage, upstream of and including Christina Lake (Figure 1-1).

The Project lease is located within the upper Christina River drainage; most of the tributaries within the lease flow towards Christina Lake. Christina Lake drains north through the Jackfish River into the Christina River. The Christina River in turn flows north to the confluence with the Clearwater River, which is a major tributary of the Athabasca River. Christina Lake and Winefred Lake are located just outside of the lease area and are among the largest waterbodies in the area.

Waterbodies and watercourses located in the Aquatic Resources LSA were identified using 1:50,000 scale topographical maps of the area. Specific waterbodies and watercourses were chosen for examination based on the potential to be affected by project development. Larger waterbodies and tributary streams within the lease area were chosen for investigation, as they would have the highest potential to provide suitable year-round fish habitat. Representative smaller waterbodies and watercourses were also examined. Selected waterbodies and watercourses include the following:

- Christina Lake;
- eleven unnamed waterbodies;
- the watersheds of two unnamed tributaries to Christina Lake; and
- two unnamed tributaries to the Christina River.

These waterbodies or watercourses were examined during the environmental setting field sampling program for the Project, as well as during the review of available information. As considerable existing information was available for Christina Lake, a reduced sampling program was implemented for this waterbody. Waterbodies and watercourse sites within the Project area were numbered (e.g., WB1, S1); the results from those waterbodies and stream sites sampled as part of the baseline field survey are provided in this report.

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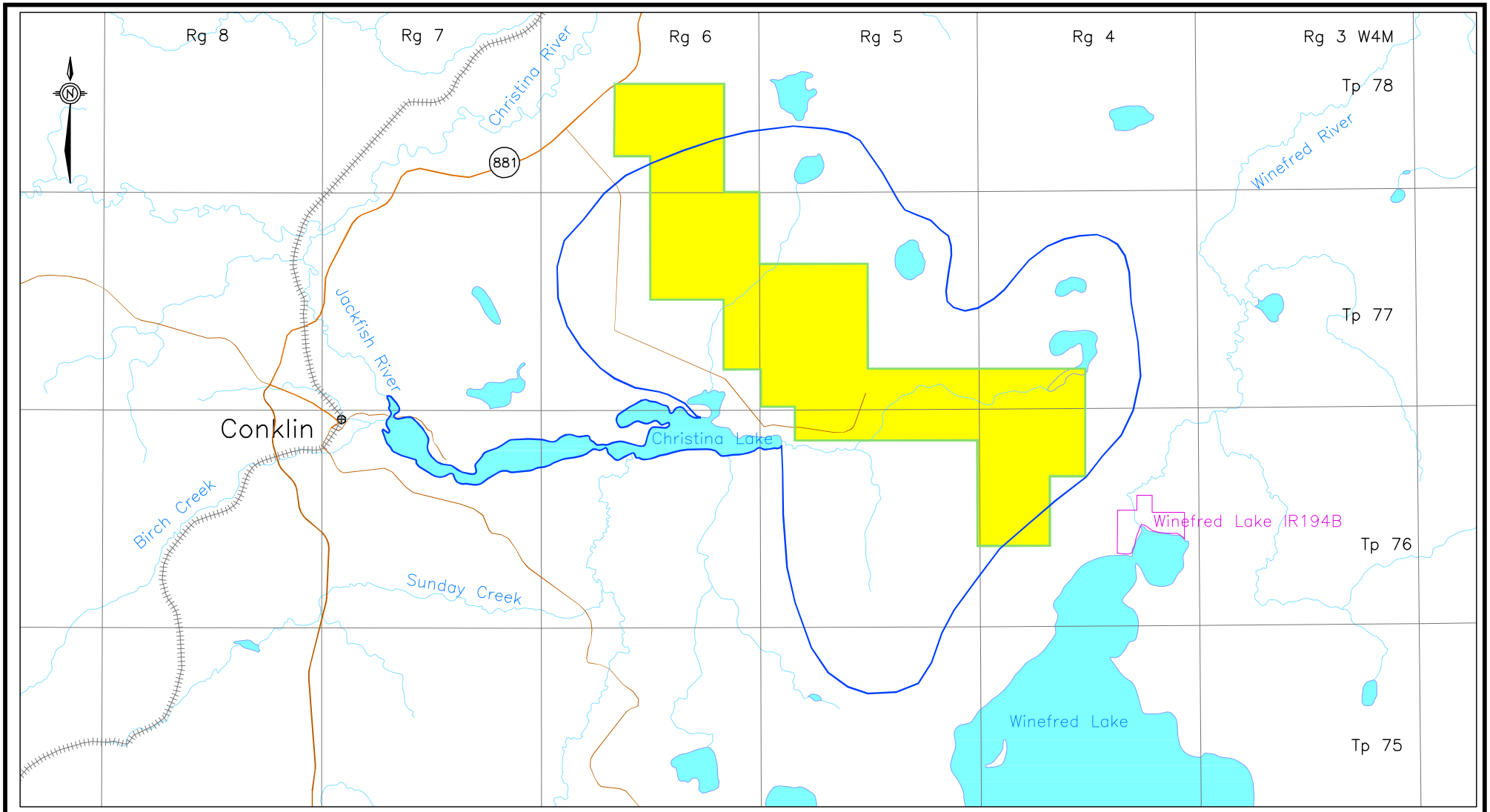


LEGEND

- MEG OIL SANDS LEASE
- LOCAL STUDY AREA

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001. SASKATCHEWAN NTDB DATA OBTAINED FROM ISC, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 13
OIL & GAS AND ENVIRONMENTAL DATA PROVIDED BY VERITAS GeoSERVICES LTD., CURRENT AS OF MAY 2001.

5 0 5
SCALE KILOMETRES

PROJECT
CHRISTINA LAKE REGIONAL PROJECT

TITLE
AQUATIC RESOURCES LOCAL STUDY AREA

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No.	Aquatic Res_LSA	
DESIGN	KM	02/12/04	SCALE	1:250000	REV. 0
CADD	PSR	18/01/05	FIGURE: 1-1		
CHECK	KM	18/01/05			
REVIEW	TC	20/01/05			

2 METHODS

The methods used for the fish and fish habitat environmental setting study included a literature review of the available information were conducted for waterbodies and watercourses in the Aquatic Resources LSA. After the initial literature review was completed, field investigations to evaluate the current baseline conditions of fish habitat, fish communities and benthic invertebrate communities in the aquatic systems that may be affected by the Project. Field data were entered in to data files and were checked through QA/QC review. Results were then analyzed and summarized.

2.1 FISH AND FISH HABITAT

2.1.1 Literature Review

Historical information for the project area was reviewed to establish and compile existing fish and fish habitat information. The following sources were used to compile the available historical fish and fish habitat data:

- government resource agencies, such as Alberta Sustainable Resource Development (ASRD) and Alberta Environment (AENV);
- environmental departments of various private industries, such as oil and gas developments in the area; and
- environmental research conducted by consultants working for industry.

The following documents were reviewed:

- Atlas of Alberta Lakes, Christina Lake (Mitchell and Prepas 1990);
- Christina Lake limnological survey phase I and II (Mills 1987);
- Preliminary survey of six lakes in northern Alberta (Bradley, n.d.);
- Sports fishing at Christina Lake: A creel census report about data collected during the summer of 1983 (Herdman 1984);
- Application for Approval of the Devon Jackfish Project Volume 2 - Environmental Impact Assessment (Devon 2003);
- A review and assessment of existing information for key wildlife and fish species in the Athabasca Oil Sands Region (Westworth 2002);
- Christina Lake Thermal Project: Application to Alberta Energy and Utilities Board and Alberta Environmental Protection: Twp. 76 Rge. 6 W4M (PanCanadian 1998);

- Christina Lake Management Plan 1991;
- Winefred Lake and Grist Lake Regional Integrated Decision (ASRD 2000);
- Sport Fish Capability, Alberta Land Inventory. Winefred Lake-73M. (AENV 1976-7);
- Preliminary fisheries survey of the lakes and rivers found in the Winefred Lake study area (Rhude 1976); and
- Kirby Project Application for Approval to Alberta Energy and Utilities Board and to Alberta Environment (Rio Alto Exploration Ltd. 2002).

2.1.2 Field Surveys

2.1.2.1 Sampling Timing and Locations

Field surveys were conducted to allow assessment of seasonal use of the waterbodies and watercourses by fish species for various life stages. Data were collected during the winter, spring and late summer in 2004 (Table 2-1) from the selected study sites within the Aquatic Resources LSA.

Table 2-1 Seasonal Surveys and Sampling Dates for Environmental Setting Field Studies

Season	Survey	Dates	Field Studies
late winter	fish habitat survey	March 04 to 10, 2004	• examined potential for waterbodies and watercourses to provide overwintering habitat for fish
spring	fish inventory, fish habitat and spawning survey	May 13 to 22, 2004	• examined fish habitat and documented fish species presence in waterbodies and watercourses, with emphasis on spring spawning fish species
late summer	fish inventory, fish habitat survey, and benthic invertebrate survey	August 23 to September 1, 2004	• examined potential for waterbodies and watercourses to support fish populations (i.e., for summer rearing and feeding) • examined benthic invertebrate communities in selected waterbodies and watercourses • assessed two proposed watercourse crossings

Christina Lake, eleven unnamed waterbodies, the watersheds of two unnamed tributaries to Christina Lake, and two unnamed tributaries to the Christina River were selected for inclusion in the baseline field study (Figure 2-1). The waterbodies that were included in the study were examined in their entirety. Watercourses were examined at selected sites considered to be representative of

conditions in each of the watercourses. The locations of the field sampling sites are presented in Figure 2-1 and in Table 2-2 shows the sampling site locations. Details and rationale for sampling site selection are provided below.

Waterbodies

Waterbodies within the lease area range from small, shallow ponds to larger sized lakes. Although Christina Lake and Winefred Lake are located just outside of the lease borders, no named waterbodies are found within the lease area.

The eleven unnamed waterbodies were selected as they were considered to have the highest probability of providing fish habitat and supporting fish communities. No historical fish and fish habitat information existed for these unnamed waterbodies. Seasonal field studies were conducted at each waterbody to provide baseline data regarding the habitat use potential and the fish communities present. Each waterbody was surveyed in its entirety during the spring and/or late summer of 2004.

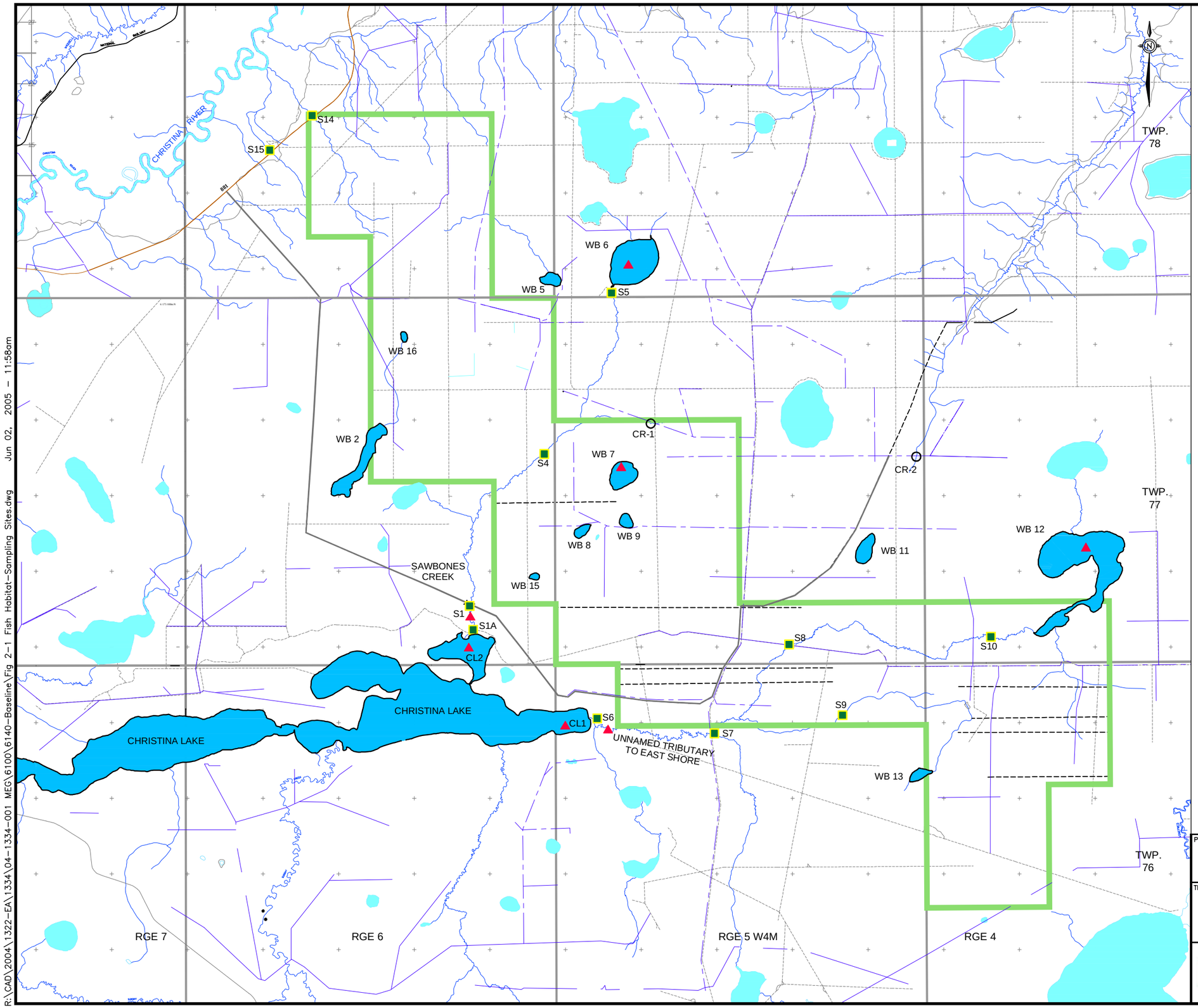
Existing fish and fish habitat information, including fisheries, bathymetric, water quality and aquatic macrophyte distribution, was available for Christina Lake. As a result, no fish sampling or habitat mapping was conducted in Christina Lake; however, benthic invertebrate and water quality sampling was conducted at selected sites.

Watercourses

Two main unnamed tributaries to Christina Lake are present within the lease:

- a tributary locally known as “Sawbones Creek”, which drains several small and medium-sized unnamed waterbodies in the middle of the lease and flows southwards to a north bay of Christina Lake (“Sawbones Bay”); and
- a tributary which drains a large wetlands complex, which includes Unnamed Waterbody 12 at the east end of the lease and flows west and enters the east end of Christina Lake.

Within the Aquatic Resources LSA, the habitat evaluation and fish sampling focused on the watersheds of these two main tributaries to Christina Lake, as well as two small unnamed tributaries to the Christina River that flow northwards from the north end of the lease. No historical fish inventory data existed for any of these watercourses.



LEGEND

- MEG LEASE
- EXISTING ACCESS ROAD
- S5 FISH AND FISH HABITAT STREAM SITE
- CR-1 CROSSING LOCATION
- BENTHIC INVERTEBRATE SAMPLE SITE
- SAMPLED LAKE

2 0 2
SCALE KILOMETRES

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

FISH AND FISH HABITAT SAMPLING SITES

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No. Fish-Fish Hab-sites	
DESIGN	CD	08/12/04	SCALE AS SHOWN	REV. 0
CADD	MJ	07/01/05	FIGURE: 2-1	
CHECK	KM	20/01/05		
REVIEW	TC	20/01/05		

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Table 2-2 Sample Site Locations for Baseline Field Studies

Waterbody or Watercourse	Sampling Location	Site ID[a]	UTM Coordinates Zone 12 (NAD 27)[b]		Length of Surveyed Stream Section (m)
			Easting	Northing	
waterbodies[c]	Christina Lake	CL1	514056	6163684	-
		CL2	511500	6165750	-
	Unnamed Waterbody 2	WB2	508603	6170889	-
	Unnamed Waterbody 5	WB5	513534	6175739	-
	Unnamed Waterbody 6	WB6	515340	6175723	-
	Unnamed Waterbody 7	WB7	515841	6170559	-
	Unnamed Waterbody 8	WB8	514643	6169002	-
	Unnamed Waterbody 9	WB9	515557	6169097	-
	Unnamed Waterbody 11	WB11	522076	6168776	-
	Unnamed Waterbody 12	WB12	527843	6168603	-
	Unnamed Waterbody 13	WB13	523415	6162401	-
	Unnamed Waterbody 15	WB15	513212	6167678	-
	Unnamed Waterbody 16	WB16	509779	6174077	-
watercourses[d]	"Sawbones Creek"	S1A	511380	6166100	700
		S1	511572	6166985	800
		S4	513330	6170804	475
		S5	515209	6175485	200
	unnamed tributary to the east shore of Christina Lake	S6	515594	6163732	400
		S7	517890	6163497	500
		S8	519972	6165854	500
		S10	524818	6166004	550
		S9 (tributary)	521096	6163943	400
	unnamed tributaries to Christina River	S14	507385	6179830	300
		S15	506350	6178800	300
proposed watercourse crossings[d]	unnamed tributary to "Sawbones Creek"	CR-1	516391	6171897	300
	unnamed tributary to Cowper Lake	CR-2	523278	6171052	400

(a) See Figure 2-1 for sample site locations.

(b) Universal Transverse Mercator (UTM) Projection Coordinates – North American Datum (1927).

(c) Waterbody surveyed in its entirety – UTM coordinates provided for centre of waterbody.

(d) UTM coordinates for approximate centre of surveyed stream section.

(e) Unnamed Tributary to the North Bay of Christina Lake, locally known as "Sawbones Creek".

Note: - = not applicable.

Baseline sampling examined representative sites in these watercourses. Sites were also selected for sampling that had potential to support fish communities including the lower reach of tributary streams near their confluence with Christina Lake. Representative locations were used to determine the typical baseline habitat conditions and fish use in the Project area. Representative

locations also provided an indication of similar conditions in watercourses that were not sampled.

Seasonal field studies were conducted at the selected sampling sites to provide baseline data concerning their habitat use potential and the fish communities present.

Watercourse Crossings

Two proposed watercourse crossings were identified within the lease area associated with access/utility corridors to source and disposal wells (Figure 2-1). These crossings were assessed during the late summer survey.

One proposed crossing (CR-1) is associated with the corridor to the disposal well site at 10-29-77-5. This crossing is located in the headwaters of a tributary to "Sawbones Creek". The other proposed crossing (CR-2) is associated with a proposed corridor from the source well site at 6-20-77-4. This crossing is in the headwaters of an unnamed tributary to Cowper Lake.

2.1.2.2 Field Sampling Methods

Various field sampling techniques were used to assess fish and fish habitat for the selected waterbodies and watercourses. It was not necessary to conduct all types of sampling activities at every sampling site. The seasonal sampling activities that were conducted at each of the selected field sampling sites are outlined in Table 2-3.

In general, the seasonal baseline field assessment of waterbody sites included the following:

- investigation of under-ice habitat and overwintering potential;
- habitat mapping of the waterbody basin and shoreline characteristics (including distribution of aquatic macrophytes);
- bathymetry transects to determine or confirm basin dimensions and depths;
- description of riparian vegetation;
- examination of inlet and outlet channels to evaluate fish passage potential;
- measurement of water quality field parameters [pH (±0.1), conductivity (±1µS/cm), temperature (±0.1°C) and dissolved oxygen (±0.1 mg/L)] along a vertical profile or series of profiles at various depths;

- fish inventory to determine the fish community present;
- spring spawning surveys (if spring spawning sport fish determined to be present);
- benthic invertebrate community survey at selected waterbodies; and
- photographs documenting available habitat types and general basin morphology.

In general, the seasonal baseline field assessments for watercourses included:

- investigation of under-ice habitat and overwintering potential;
- habitat mapping of all relevant instream and bank habitat characteristics to provide an inventory of available spawning, rearing, feeding and overwintering habitats;
- description of riparian vegetation;
- measurement of average channel dimensions;
- identification of features that may affect fish movements;
- measurement of stream discharge to help evaluate habitat use potential and fish migration potential;
- measurement of water quality field parameters [pH (±0.1), conductivity (±1µS/cm), temperature (±0.1°C) and dissolved oxygen (±0.1 mg/L)];
- fish inventory to determine the fish community present;
- spring spawning surveys to determine spawning use;
- benthic invertebrate community survey at selected sites; and
- photographs documenting available habitat types and general stream morphology.

Details of the various field sampling activities are provided below for habitat evaluation and fish sampling techniques.

Table 2-3 Summary of Baseline Field Sampling Activities

Waterbody or Watercourse	Sampling Location	Site ID[(a)]	Winter	Spring	Late Summer
waterbodies	Christina Lake[b]	CL1	-	-	△⨳
		CL2	△	-	△⨳
	Unnamed Waterbody 2	WB2	△◆	●△■□	●△■
	Unnamed Waterbody 5	WB5	◆	●△■	●△■
	Unnamed Waterbody 6	WB6	△◆■	●△■□	●△■⨳
	Unnamed Waterbody 7	WB7	△◆	●△■	●△■⨳
	Unnamed Waterbody 8	WB8	△◆	●△■	●△■
	Unnamed Waterbody 9	WB9	△◆	●△■	●△■
	Unnamed Waterbody 11	WB11	△◆■	●△■	●△■
	Unnamed Waterbody 12	WB12	△◆■	●△■	●△■⨳
	Unnamed Waterbody 13	WB13	△◆	●△■	●△■
	Unnamed Waterbody 15	WB15	△◆	-	●△■
	Unnamed Waterbody 16	WB16	△◆■	-	●△■
watercourses	"Sawbones Creek"	S1A	△◆	●△■□	●△■
		S1	△◆▲	➔●△■□▲	●△■⨳
		S4	△◆	●△■□	●△■
		S5	△◆▲	●△■□	●△■
	unnamed tributary to the east shore of Christina Lake	S6	△◆	➔●△■□	●△■⨳
		S7	△◆▲	●△■□▲	●△■
		S8	△◆	●△■□▲	●△■▲
		S10	△◆	●△■□	●△■
		S9 (tributary)	△◆	●△■□	●△■▲
	unnamed tributaries to Christina River	S14	△◆	●△■□▲	●△■
		S15	△◆	●■□▲	●△■
proposed watercourse crossings	unnamed tributary to "Sawbones Creek"	CR-1	-	-	➔●▲△■
	unnamed tributary to Cowper Lake	CR-2	-	-	➔●▲△■

(a) See Figure 2-1 for site locations.

Notes: Field Sampling Activities:
- ◆ Overwintering Assessment.
- ● Habitat Mapping and Channel Dimensions (watercourse) or Bathymetry (waterbody).
- ▲ Discharge Measurement (watercourse).
- △ Water Quality Field Parameters: Surface (watercourse) or Profile (waterbody).
- ■ Fish Inventory.
- □ Spring Spawning Survey.
- ➔ Watercourse crossing assessment.
- ⨳ Benthic Invertebrate Sampling.

Note: - = not sampled.

Habitat Evaluation

Habitat Mapping

Detailed habitat maps were generated for each sampling site except for Christina Lake. The habitat evaluation methods used for waterbodies and watercourses are detailed below.

Waterbodies

Waterbodies were mapped during the spring or late summer using the protocols outlined in the Golder 'Lake Habitat Mapping Procedure' (Golder 1997a) and 'Basic Limnology and Bathymetry Procedures' (Golder 1997b). Bathymetric transects were conducted to determine the extent of the main waterbody habitat types; shallow littoral zone and deep pelagic zone. Habitat maps were developed to show the location and extent of other habitat features such as shoreline characteristics and the distribution of aquatic vegetation.

The recorded physical characteristics of each waterbody included:

- water depths;
- identification and distribution of aquatic macrophytes (submergent, emergent and floating-leaved vegetation);
- substrate particle size (visually estimated according to the size criteria presented in Appendix II);
- shoreline slope and stability; and
- riparian vegetation.

Aquatic macrophytes were identified to the *Genus* level (see Appendix I for common and scientific names of plant species).

Waterbody habitat maps were completed for eleven unnamed waterbodies (Table 2-3). Bathymetric and aquatic vegetation maps existed for Christina Lake, and as such this large waterbody was not habitat mapped during the environmental setting field surveys.

The habitat use potential for the waterbodies was evaluated, in part, based on the characteristics of the available habitats. The proportions of the available habitat types and depths (i.e., littoral and pelagic zones), combined with substrate material, vegetation distribution and shoreline development, provides an indication of the potential suitability of the habitats for use by fish in the

waterbody relative to the habitat requirements of different fish species and life stages.

Watercourses

Watercourse sites were mapped during the spring or late summer survey using the protocols outlined in the Golder 'Stream Habitat Classification and Rating System' (Golder 1997c). The location and extent of all instream habitat types and shoreline/bank characteristics of the watercourse were mapped to provide an inventory of available habitats. The length of the watercourse at each site was divided into a continuous series of habitat types, termed channel units. A channel unit is a distinct section of the channel with specific characteristics of water depth, velocity and cover for fish. Typical channel units include riffle, pool and run habitats. Pool and run channel units were further classified as Class 1, 2 or 3 habitats, depending on their depth and available cover for fish, with Class 1 habitats being the deepest (i.e., >1.0 m), Class 2 being moderately deep (i.e., 0.75 to 1.0 m) and Class 3 being shallow (i.e., <0.75 m).

The recorded physical characteristics of each channel unit included:

- channel unit type and class;
- maximum water depth; and
- dominant substrate particle size or sizes (visually estimated according to the size criteria presented in Appendix II).

Other habitat features recorded for each sampling site included:

- aquatic vegetation;
- debris piles (small and large woody debris);
- cover for fish, including both instream (velocity shelter) and overhead (visual isolation) cover;
- beaver dams and other features that might impede fish movements;
- bank and shoreline features, including areas of unstable bank and areas of overhanging vegetation or undercut banks;
- riparian plant community composition; and
- channel dimensions, including mean channel width and wetted width.

At each sampling site, representative photographs were taken to illustrate physical characteristics such as bank conditions, bank profiles, riparian areas and channel characteristics.

Watercourse habitat maps were completed from approximately 100 m upstream to at least 300 m downstream at all watercourse sample sites (Table 2-3). Habitat maps were also prepared for the proposed watercourse crossing sites.

The habitat use potential for the sampling sites was evaluated relative to the habitat requirements of the different fish species and life stages (e.g., spawning, rearing, feeding). The types and proportions of the available channel units, combined with general water depths and substrate material.

Discharge Measurements

Stream discharges were measured (at watercourses) and proposed watercourse crossing sites during seasonal sampling activities. Discharge measurements were conducted according to the protocol in Golder 'Stream Discharge Measurement Methods' (Golder 1997d). Measurements were conducted using a calibrated tagline to determine horizontal stations and a Marsh-McBirney Flowmate 2000 velocity meter and top setting-wading rod to measure water depth and velocity. The station distance, depth and velocity data were used to calculate the total stream discharge. At many stream sites, measurement of discharge was not possible due to the lack of measurable flow or a defined channel.

Water Quality Field Parameters

Water quality field parameters (water temperature dissolved oxygen, PH and conductivity) were measured at sample sites during seasonal sampling activities. In waterbodies, water quality parameters were measured at one or more locations along vertical profiles. Profiles were measured using a HydroLab Quanta water quality meter equipped with a 30 m cable.

In watercourses, water quality parameters were measured mid-stream and approximately 0.3 m below the surface using a HydroLab Quanta water quality meter.

Overwintering Assessment

The overwintering assessment evaluated the potential for waterbodies and watercourses to provide habitat for fish throughout the winter seasaon. The assessment was conducted during the late winter period, to represent the most severe conditions for determining if fish could survive the entire winter in these habitats.

The winter field assessment of waterbody sample sites included the following:

- measurement of snow thickness, ice thickness and under-ice water depth;
- measurement of water quality field parameter profiles (water temperature, dissolved oxygen, pH and conductivity);
- fish inventory to determine fish presence; and
- underwater video documenting habitat conditions and fish presence.

The winter field assessment of watercourse sampling sites included the following:

- type and class of channel unit present at the sampling site;
- measurement of snow thickness, ice thickness and under-ice water depth;
- measurement of water depth and velocity along a transect to determine average depth and velocity;
- measurement of stream discharge at selected sites using the under-ice protocol in Golder 'Stream Discharge Measurement Methods' (Golder 1997d);
- measurement of water quality field parameters;
- fish inventory to determine fish presence; and
- underwater video documenting habitat conditions and fish presence.

The winter fish inventory was conducted using minnow trapping and under-water video (see fish inventory section below for details). Because of project timing constraints, the winter survey was conducted prior to open-water surveys when bathymetry data were collected at waterbodies and habitat mapping had been conducted at watercourses. In larger waterbodies, several holes were drilled through the ice throughout the basin to determine general under-ice water depths and to locate the area of greatest depth. For smaller waterbodies, a sampling site was located at the approximate centre of each basin. In watercourses, several holes were drilled in channel units which appeared to be pools, deep runs or impoundments to locate deep water areas.

Watercourse Crossing Assessments

At proposed watercourse crossing sites, an assessment of the physical characteristics of the crossing and the sensitivity to construction was according to the protocol in Golder 'Pipeline Crossing Habitat Evaluation Parameters -

Detailed Stream Assessment' (Golder 2002). The assessment consists of the documentation of the following parameters:

- general watercourse characteristics (e.g., stream pattern, confinement, gradient);
- photographs of the proposed crossing point;
- channel characteristics (e.g., wetted width, cross-sectional depth, velocity profile, depth of pools/riffles/runs);
- measurement of parameters (water temperature, dissolved oxygen PH conductivity) field water quality;
- fish presence and species composition in the area of the proposed crossing;
- streambed and bank material;
- erosion potential;
- other pertinent habitat features (e.g., fish habitat potential, barriers to fish movement, macrophytic growth);
- a qualitative rating of the suitability of the habitat for predator/sport fish species and forage fish species; and
- an qualitative assessment of the sensitivity of the habitats in the area to sedimentation and other disturbances from construction activities.

Fish Inventory

Fish Sampling

Fish sampling was conducted at each waterbody and watercourse sampling site to determine the fish communities present. A variety of sampling techniques were used to determine the species and life stages that use these systems.

Fish sampling techniques employed during field investigations included:

- backpack electrofishing in wadable watercourses;
- boat electrofishing in deeper watercourses;
- baited minnow traps;
- gill netting; and
- under-water video.

Fish sampling methods were employed as habitat conditions allowed. The specific sampling techniques used at each of the different sampling sites are

detailed in Table 2-4 for the winter period and in Table 2-5 and Table 2-6 for the open-water seasons.

Winter

Winter fish sampling was conducted at waterbody and watercourse sites as conditions permitted using under-water viewing and minnow trapping. Standard Gee minnow traps (baited) were set at selected sites with sufficient water depths (generally ≥0.4 m). Where visibility permitted, an under-water camera was also used at some winter sampling sites to look for the presence of fish. The video was obtained using an Aqua-Upgrader Z-120 under-water video camera equipped with infra-red lighting. A summary of winter fish sampling is provided in Table 2-4.

Table 2-4 Summary of Baseline Winter Fish Sampling

Waterbody or Watercourse[a]	Site ID[b]	Underwater Video Effort [min][c]	Minnow Trapping		
			Number of Minnow Traps	Duration of Trap Set [hr]	Effort [trap-hr]
Christina Lake (north)	CL2	17	0	-	-
Unnamed Waterbody 6	WB6	1	0	-	-
Unnamed Waterbody 11	WB11	50	1	23.3	23.3
Unnamed Waterbody 12	WB12	2	1	29.9	29.9
Unnamed Waterbody 16	WB16	15	0	-	-
"Sawbones Creek"	S1	-	1	26.6	26.6
tributary to the east shore of Christina Lake	S7	16	1	43.1	43.1

(a) Other sites not sampled due to shallow depth or complete lack of water.
(b) See Figure 2-1 for sampling locations.
(c) Effort rounded to nearest minute.
Note: - = not sampled.

Open-Water Seasons

Minnow trapping and gill netting were used during all seasonal surveys (Table 2-5). Fish were collected at most waterbody and watercourse sites using one or more baited minnow traps. Gill nets were used to sample waterbodies and several deep or impounded watercourse sites. Large multi-panel gillnets, two-panel nets and one-panel nets were used. The number and dimensions of gill nets used during sampling are provided in Table 2-5.

Table 2-5 Spring and Summer Fish Sampling Details for Waterbodies

Waterbody[a]	Season	Gill Netting						Minnow Trapping		
		Number of Gill Nets	Duration of Gill Net Set [hr]	Gill Net Dimensions			Total Gill Net Effort [panel-hr]	Number of Minnow Traps	Duration of Trap Set [hr]	Total Minnow Trap Effort [trap-hr]
				Number of Panels	Panel Size (m)	Mesh Size(s)[b] (cm)				
Unnamed Waterbody 2	spring	2	17.0	1	2.1 x 13.7	3.8	64.8	2	17.0	32.4
			15.4	1	2.1 x 13.7	5.1			15.4	
	summer	2	15.3	2	2.1 x 13.7	5.1, 5.7	46.6	4	2 x 15.3	62.6
			16.0	1	2.1 x 13.7	6.4			2 x 16.0	
Unnamed Waterbody 5	spring	2	19.9	1	2.1 x 13.7	5.1	39.7	1	19.9	19.9
			19.8	1	2.1 x 13.7	3.8				
	summer	2	13.0	5	2.4 x 61.0	6.4, 8.9, 2.5, 3.8, 1.3	78.1	4	2 x 13.0	52.2
			13.1	1	2.1 x 13.7	5.1			2 x 13.1	
Unnamed Waterbody 6	spring	1	21.9	1	2.1 x 13.7	5.1	21.9	1	21.9	21.9
	summer	2	18.8	5	2.4 x 61.0	6.4, 8.9, 2.5, 3.8, 1.3	113.5	4	2 x 18.8	76.6
			19.5	1	2.1 x 13.7	6.4			2 x 19.5	
Unnamed Waterbody 7	spring	2	25.4	2	2.1 x 13.7	5.1, 5.7	76.2	4	4 x 25.4	101.6
			25.4	1	2.1 x 13.7	3.8				
	summer	2	13.7	5	2.4 x 61.0	6.4, 8.9, 2.5, 3.8, 1.3	82.6	4	2 x 13.7	55.6
			14.1	1	2.1 x 13.7	6.4			2 x 14.1	
Unnamed Waterbody 8	spring	2	25.3	1	2.1 x 15.2	3.8	50.4	1	25.3	25.3
			25.1	1	1.5 x 13.7	12.7				
	summer	2	23.8	1	2.1 x 13.7	5.7	47.0	4	2 x 23.8	94.0
			23.2	1	2.1 x 13.7	5.1			2 x 23.2	
Unnamed Waterbody 9	spring	2	13.0	1	2.1 x 13.7	3.8	25.9	2	13.0	25.9
			12.9	1	2.1 x 13.7	3.8			12.9	
	summer	1	20.8	5	2.4 x 61.0	6.4, 8.9, 2.5, 3.8, 1.3	104.0	2	20.1	40.2
									20.1	
Unnamed Waterbody 11	spring	2	19.2	1	1 x 25	1.3	38.2	2	19.2	38.2
			19.0	1	1 x 25	5.1			19.0	
	summer	2	19.0	1	2.1 x 13.7	6.4	114.0	4	4 x 19.0	76.0
			19.0	5	2.4 x 61.0	6.4, 8.9, 2.5, 3.8, 1.3				

Table 2-5 Spring and Summer Fish Sampling Details for Waterbodies (continued)

Waterbody[a]	Season	Gill Netting						Minnow Trapping		
		Number of Gill Nets	Duration of Gill Net Set [hr]	Gill Net Dimensions			Total Gill Net Effort [panel-hr]	Number of Minnow Traps	Duration of Trap Set [hr]	Total Minnow Trap Effort [trap-hr]
				Number of Panels	Panel Size (m)	Mesh Size(s)[b] (cm)				
Unnamed Waterbody 12	spring	2	23.8	1	1.8 x 8.2	5.1	47.6	2	23.8	47.6
			23.8	1	1.8 x 8.2	5.1			23.8	
	summer	2	24.0	1	1.8 x 15.2	7.6	46.6	4	2 x 24.0	93.2
			22.6	1	1.8 x 13.7	5.1			2 x 22.6	
Unnamed Waterbody 13	spring	1	18.2	5	2.4 x 61.0	3.8, 5.1, 6.4, 7.6, 8.9	18.2	2	2 x 18.2	36.4
	summer	2	16.8	1	1.8 x 15.2	7.6	33.1	4	2 x 16.8	66.2
			16.3	1	1.8 x 13.7	5.1			2 x 16.3	
Unnamed Waterbody 15	summer	1	26.7	1	1.8 x 15.2	7.6	26.7	2	2 x 26.7	53.4
Unnamed Waterbody 16	summer	1	18.2	5	2.4 x 61.0	6.4, 8.9, 2.5, 3.8, 1.3	91.0	2	2 x 18.2	36.4

(a) See Figure 2-1 for site locations.

(b) Stretched-mesh measure.

Electrofishing was conducted for the seasonal surveys during the open-water period (Table 2-6). Backpack electrofishing was conducted at watercourse sample sites on using a Smith-Root Model 15-D backpack unit. At many watercourse sites, the water depth and soft silt substrates made backpack electrofishing impractical or unsafe. In these cases, electrofishing from shore was conducted, as well as the use of alternate sampling methods (i.e., minnow traps and gill nets).

Boat electrofishing was conducted upstream from Christina Lake in Sawbones Creek and the immediate shoreline area. Boat electrofishing was conducted using a Smith-Root Type 5.0 GPP unit powered by a 5,000 watt generator deployed in an inflatable boat (Zodiac). The boat electrofishing configuration included a double-boom anode system and double-boom cathode system, both with multiple cable dropper arrays.

All captured fish were identified and enumerated by species and life stage. Fork length (mm) and body weight (g) were measured for all large species and for a representative sub-sample of individuals for small species. If discernable from external examination, sex and state of maturity of captured fish were also recorded.

Spring Spawning Survey

A spring spawning survey was conducted for watercourse sites where potential spawning habitat for spring-spawning fish was observed. Low velocity areas with inundated vegetation were considered suitable spring spawning habitat for northern pike. Suitable habitat for other spring spawning species, such as Arctic grayling and white sucker, defined as swift flowing areas with rocky (cobble/gravel) substrate, was not observed in the study area. Spring spawning surveys for northern pike spawning were conducted in wadable areas of suitable habitat by disturbing the vegetation and using a small-mesh kick sampling net to capture incubating eggs. Samples were examined on-site for incubating eggs. The location, species of egg and number of eggs were recorded for each sample. As well, approximate egg diameter, colour and other characteristic features were recorded.

Table 2-6 Spring and Summer Fish Sampling Details for Watercourses

Watershed	Site ID[a]	Season	Electrofishing			Minnow Traps			Gill Net					
			Length of Stream (m)	Backpack Effort (sec)	Portable Boat Effort (sec)	Number of Traps Set	Set Duration [hr]	Total Minnow Trap Effort [trap-hr]	Number of Gill Nets	Number of Panels	Set Duration [hr]	Panel Size (m)	Mesh Size [b] (cm)	Total Gill net Effort [panel-hr
"Sawbones Creek"	S1A	spring	800	-	489	-	-	-	-	-	-	-	-	-
		summer	800	-	539	-	-	-	-	-	-	-	-	-
	S1	spring	250	487	-	-	-	-	-	-	-	-	-	-
		summer	300	868	-	2	3.0	6.0	-	-	-	-	-	-
	S4	spring	475	760	-	6	1.8	10.8	-	-	-	-	-	-
		summer	300	611	-	2	1.1	2.2	-	-	-	-	-	-
	S5	spring	-	-	--	2	21.9	43.8	1	1	21.9	2.1 x 15.2	3.8	21.9
		summer	-	-	-	-	-	-	1	1	18.7	2.1 x 15.2	8.9	18.7
unnamed tributary to the east shore of Christina Lake	S6	spring	-	-	-	2	22	44.0	1	1	22	2.1 x 13.7	3.8	22.0
		summer	500	-	327	-	-	-	-	-	-	-	-	-
	S7	spring	500	250	-	6	1.8	10.8	1	1	1.6	2.1 x 15.2	3.8	1.6
		summer	200	200	-	2	2.7	5.4	-	-	-	-	-	-
	S8	spring	200	500	-	6	1.7	10.2	1	1	1.7	2.1 x 15.2	3.8	1.7
		summer	260	330	-	2	1.3	7.8	-	-	-	-	-	-
	S10	spring	150	191	-	6	2.2	13.2	-	-	-	-	-	-
		summer	150	234	-	2	0.9	1.8	-	-	-	-	-	-
	S9 (tributary)	spring	-	-	-	2	3.0	6.0	1	1	3.0	2.1 x 13.7	3.8	3.0
		summer	150	254	-	2	0.9	1.8	-	-	-	-	-	-
unnamed tributaries to Christina River	S14	spring	200	150	-	-	-	-	-	-	-	-	-	-
		summer	200	200	-	-	-	-	-	-	-	-	-	-
	S15	spring	100	436	-	-	-	-	-	-	-	-	-	-
		summer	100	204	-	-	-	-	-	-	-	-	-	-
proposed watercourse crossings	CR-1	summer	100	202	-	-	-	-	-	-	-	-	-	-
	CR-2	summer	400	232	-	2	1.1	2.2	-	-	-	-	-	-

[a] See Figure 2-1 for site locations.

[b] Stretched-mesh measure.

Benthic Invertebrate Communities

Benthic invertebrates were sampled at selected sites during late summer on August 26 and August 31, 2004. Samples were collected to characterize the benthic invertebrate community in waterbodies and watercourses within the Aquatic Resources LSA. Sampling was conducted using the Golder protocol presented in 'Benthic Invertebrate Sampling' (Golder 1997e).

Benthic invertebrate samples were collected in Christina Lake and three small unnamed waterbodies (Unnamed Lakes 6, 7 and 12). Samples were collected at five randomly selected locations at each site in open-water areas, outside heavy macrophyte growth. Samples from the three unnamed waterbodies were collected from depths of approximately 1 to 2 m. The two sites in Christina Lake were approximately 3 and 15.5 m deep. Samples were collected at each location using an Ekman grab with a bottom area of 0.023 m^2. Supporting data collected in each waterbody included the following:

- exact location (GPS unit);
- field water quality measurements (pH, conductivity, dissolved oxygen and water temperature, using a field-calibrated water quality meter);
- aquatic macrophyte cover and species composition at each sample site (visual assessment); and
- water depth at each sample site.

Benthic invertebrate samples were collected at two sites in unnamed tributaries to characterize benthic communities in the Aquatic Resources LSA (Sites S1 and S6). Samples were collected from the predominant habitat type in the vicinity of each site, which was primarily depositional. Five replicate samples were collected at each site from a depth of 1 to 2 m using an Ekman grab with a bottom area of 0.023 m^2 additional supporting data collected at each watercourse site included the following:

- exact site location (GPS unit);
- field water quality measurements (pH, conductivity, dissolved oxygen and water temperature, using a field-calibrated water quality meter);
- bankfull and wetted channel widths (measuring tape);
- aquatic macrophyte cover and species composition at each sample site (visual assessment);
- current velocity at each sample site (Marsh-McBirney current velocity meter); and
- water depth at each sample site.

All Ekman samples were field sieved using a 250 µm sieve box to remove fine sediments and were preserved in 10% buffered formalin. Benthic samples were shipped to Dr. Jack Zloty of Calgary, Alberta, for sorting and taxonomic identification.

An additional sediment grab was collected from each site. This sample was double-bagged and frozen for analysis of Total Organic Carbon (TOC) and particle size. These sediment samples were submitted to Enviro-Test Laboratories, Edmonton, for analysis.

Data Analysis

All fish habitat and fish community data collected during baseline sampling were entered into data files. Data files were checked and verified against original field data to confirm the accuracy of data entry.

Catch-Per-Unit-Effort

The relative abundance of fish species at each sampling site was determined by calculating catch-per-unit-effort (CPUE) for each species and sampling technique used in the field investigations.

Benthic Invertebrates

Laboratory Analysis

Samples were sorted by separating the organic and inorganic material using a floatation method (Pask and Costa 1971). All organisms were removed from the inorganic material. The organic material was split into coarse and fine fractions using 1 mm and 250 µm mesh nested sieves. Large samples were subsampled to 1/4 (Cuffney et al. 1993) and all invertebrates were removed from a randomly chosen subsample. The fine fractions were subsampled to 1/4 using an Imhoff cone (Wrona et al. 1982). Invertebrates were removed from the organic material under a dissecting microscope.

Invertebrates were identified to the lowest level recommended by Environment Canada (1998), typically genus for most invertebrates. Exceptions included Oligochaeta, which were identified to family, and nematodes, zooplankton, ostracods and aquatic mites which were identified to major group. Identifications were made using recognized keys (Brinkhurst 1986; Stewart and Stark 1988; Pennak 1989; Clifford 1991; Merritt and Cummins 1996). Quality assurance and quality control procedures are summarized in Appendix VII.

Data Analysis

Data were screened for errors by validating benthic invertebrate abundance values. Data were also screened for outliers and errors using graphical methods. Any data entry errors that were identified were corrected. All terrestrial and non-benthic invertebrates were excluded from analysis.

The benthic invertebrate abundance data were converted from numbers per sample to numbers per square metre. Data were then summarized in terms of total abundance (number of organisms/m^2), taxonomic richness (total taxa and mean number of taxa at a site), abundance of major invertebrate groups and common invertebrates. Invertebrate groups that comprised greater than 1% of the total invertebrate abundance at a site were operationally defined as common organisms.

2.2 DIVERSITY OF FISH AND FISH HABITAT

Aquatic ecosystem diversity was addressed as part of the environmental setting study through the assessment of the diversity of the fish and fish habitat present in the Project Aquatic Resources LSA. Fish and fish habitat diversity was assessed through an examination of:

- fish species diversity;
- fish habitat diversity; and
- ecosystem diversity, as represented by trophic levels.

These three aspects of the aquatic ecosystem were selected as being suitable representatives of diversity based on Hurlbert (1971) and Pielou (1975), as described by Legendre and Legendre (1998). Fish species diversity and fish habitat diversity were examined at the waterbody or watercourse level, and at the watershed ecosystem level. Specific characteristics of fish communities and fish habitats were selected as indicators of diversity. A ranking system was developed to summarize the available information for the selected diversity indicators and to categorize the diversity of fish and fish habitat. The temporal boundary for the analysis was defined as the period of record for each watercourse or waterbody and includes all historical, current and environmental setting data.

Fish and fish habitat diversity was assessed for waterbodies and watercourses within the Aquatic Resources LSA that may be affected by the development of the Project, including Christina Lake, eleven unnamed waterbodies and the two main tributaries to Christina Lake within the lease area (Table 2-7).

Table 2-7 Waterbodies and Watercourses Assessed for Fish and Fish Habitat Diversity

Waterbodies		Watercourses
Christina Lake	Unnamed Waterbody 9	"Sawbones Creek"
Unnamed Waterbody 2	Unnamed Waterbody 11	Tributary to the East Shore of Christina Lake
Unnamed Waterbody 5	Unnamed Waterbody 12	
Unnamed Waterbody 6	Unnamed Waterbody 13	
Unnamed Waterbody 7	Unnamed Waterbody 15	
Unnamed Waterbody 8	Unnamed Waterbody 16	

2.2.1 Fish Species Diversity

Three indicators were selected to assess fish species diversity:

- species richness;
- species overlap; and
- presence or absence of listed species (i.e., species listed by federal or provincial agencies at some level of risk).

Species richness indices are essentially measures of the number of species present (Magurran 1988). Species richness was selected as an indicator because the number of species present is typically proportional to the number of available niches (Hutchinson 1957, 1965) and provides a link between species diversity and environmental diversity (Legendre and Legendre 1998). Species richness is typically greater in larger waterbodies and higher order streams and in regions where species pools are large; therefore, these factors were included in the assessment. Species richness was determined for each waterbody and watercourse by comparison of the number of species documented to occur in the waterbody or watercours to the total number of species known for the entire study area in which the waterbody or watercourse occurs. The following formula was used for each resource:

$$\text{Species Richness (\%)} = \frac{\text{Number of species}}{\text{Number of species in study area}} \times 100$$

For example, species richness in Unnamed Waterbody 2 was calculated by comparing the number of species in the waterbody to the total number of species in the Christina Lake watershed.

Species overlap refers to the proportion of species present in an ecosystem (or other defined habitat area) that are also found in other ecosystems. Species overlap thus provides a measure of the specificity of the environmental conditions (both biotic and abiotic) in that particular ecosystem. An ecosystem that contains species that are not found in other ecosystems (i.e., contains unique species), would score higher than one that contains species found in other ecosystems. Species overlap was assessed for each waterbody and watercourse by comparison of the number of unique species present in the waterbody or watercourse to the total number of species in the waterbody or watercourse, as follows:

$$\text{Species Overlap (\%)} = \frac{\text{Total number of species} - \text{number of unique species}}{\text{Number of species}} \times 100$$

For example, species overlap in Unnamed Waterbody 2 was calculated by comparing the number of species present in the waterbody that are not present elsewhere in the Christina Lake watershed (i.e., are unique) to the total number of species in the waterbody.

The presence of listed species (i.e., provincial General Status of Alberta Wild Species [ASRD 2003] or the federal Species at Risk Act [COSEWIC 2004]) has important ecological, social and regulatory implications. Certain species may be rare in the Aquatic Resources LSA due to low reproductive rates, limited dispersal capabilities, specialized habitat requirements, because they are difficult to capture or because the LSA occurs at the limit of their distribution range. These conditions may make these species more vulnerable to disturbance and emphasize their need for special consideration. Therefore, an important aspect of preserving diversity is the identification and possible maintenance of sustainable populations of rare or otherwise listed species.

A ranking system was developed to summarize the available information for the selected indicators and categorize the fish species diversity for the selected waterbodies and watercourses. A scale of one (1) to four (4) was devised for each of the three species diversity indicators. Species richness and overlap were ranked using quartiles (i.e., 25% intervals), and the presence of listed species was ranked in accordance with AENV's four main definitions of general status categories for the identification of species at risk (AENV 2001). Table 2-8 provides a summary of the indicators and the rankings used to categorize fish species diversity.

Table 2-8 Indicators and Ranking Categories for Fish Species Diversity

Indicator	Ranking Description
species richness	1 very low – less than 25% of total potential species present 2 low – 25 to 49% of total potential species present 3 moderate – 50 to 75% of total potential species present 4 high – more than 75% of total potential species present
species overlap	1 very low – more than 75% of species present are shared with one or more other resource, or no fish detected 2 low – 50 to 75% of species present are shared with one or more other resource 3 moderate – 25 to 49% of species present are shared with one or more other resource 4 high – less than 25% of species present are shared with one or more other resource
presence of listed species	1 secure – there are no “At Risk”, “May be at Risk”, or “Sensitive “ species present or the status of the species present is not determined 2 sensitive – at least one species present that is not at risk of extinction or extirpation, but may require special attention or protection to prevent it from becoming at risk 3 may be at risk – at least one species may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment 4 at risk – at least one species known to be “At Risk” after a formal detailed status assessment and designation as “Endangered” or “Threatened” in Alberta

A general ranking of species diversity was then derived by multiplying the individual ranks for each of the three indicators. The general ranking of the watercourses and waterbodies has a minimum value (score) of one, indicating low contribution to the local fish species diversity, and a maximum of 64, which denotes a high contribution. Table 2-9 summarizes the general ranking system used for categorizing the selected watercourses and waterbodies according to their diversity at the fish species level.

Table 2-9 General Ranking for Fish Species Level Indicators of Diversity

Indicator	Ranking Description
fish species diversity ranking	1 very low – total score 1 to 3 2 low – total score 4 to 8 3 moderate – total score 9 to 27 4 high – total score 28 to 64

2.2.2 Fish Habitat Diversity

Five indicators were used in the assessment of fish habitat diversity:

- waterbody habitat diversity index;
- watercourse habitat unit diversity index;
- waterbody area;
- waterbody maximum depth; and
- stream order.

Three of these indicators were applicable to the waterbodies that were included in the assessment and two were applicable to the watercourses.

The "Waterbody Habitat Diversity Index" assesses habitat diversity by examination of habitat variation and habitat composition. Habitat variation refers to the number of habitats present per area of waterbody and habitat composition refers to the number of different habitat types present in the waterbody. This assessment was based on the habitat maps prepared for the waterbodies that show the location and extent of all habitat types, as per the habitat mapping protocol (Golder 1997a). The total number of possible waterbody habitat types is 20 (examples of habitat types include littoral, pelagic, submergent vegetation and emergent vegetation). The formula used to calculate the Waterbody Habitat Diversity Index was:

$$\text{Habitat Diversity} = \frac{\text{Number of Discrete Habitats/100 m}^2 \text{ x Number of Habitat Types}}{\text{Number of Possible Habitat Types}}$$

Similarly, the "Watercourse Habitat Unit Diversity Index" also assesses habitat diversity by examination of habitat variation and habitat composition, as represented by the types and distribution of channel units. In a given length of watercourse, habitat variation refers to the number of discrete channel units present and habitat composition refers to the number of different channel unit types present. The assumption for this indicator is that a higher number of different types of habitat units can accommodate a higher number of species and a wider range of life stages, and therefore promotes species diversity. The habitat assessment for watercourses was based on the habitat maps prepared for each sampling site. At each site, the length of channel examined was divided into a series of discrete channel units and each unit was assigned a channel unit type, as per the habitat mapping protocol (Golder 1997c). There are 18 possible channel unit types defined for watercourses (principle examples of channel unit types include riffle, class 1, 2 or 3 run and class 1, 2 or 3 pool). For the diversity assessment, 17 channel unit types were considered useable by fish and were

included as the number of possible channel unit types (the waterfall channel unit type was excluded). The Watercourse Habitat Unit Diversity Index was calculated as follows:

$$\text{Habitat Unit Diversity} = \frac{\text{Number of Discrete Channel Units/100 m of stream x Number of Channel Unit Types}}{\text{Number of Possible Channel Unit Types}}$$

The remaining habitat indicators (i.e., waterbody area, waterbody depth and stream order) were selected based on the premise that, to a certain extent, larger watercourses and waterbodies are capable of supporting a higher level of diversity (Vannote et al. 1980; Post et al. 2000; Chase and Leibold 2002). Watercourse size was represented by stream order. Waterbody size was represented by a combination of waterbody area and maximum depth, where scores were calculated separately and averaged. In cases where the average was between two scores, the lower score was used to determine the ranking of the waterbodies according to their size, as any of these measures would be a limiting factor for the fish species assemblage.

All waterbodies and watercourses were evaluated on a scale of one (1) to four (4) for each relevant habitat indicator. Table 2-10 summarizes the indicators and the ranking categories used to assess the diversity of habitats in waterbodies and watercourses, and their potential to support a diversity of fish.

Table 2-10 Indicators and Ranking Categories for Habitat Diversity

Indicator	Ranking Description
waterbody habitat diversity index	1 very low – less than 0.25 2 low – 0.25 to 0.44 3 moderate – 0.45 to 1.4 4 high – more than 1.4
watercourse habitat unit diversity index	1 very low – less than 0.25 2 low – 0.25 to 0.44 3 moderate – 0.45 to 1.4 4 high – more than 1.4
waterbody size (average score)	Waterbody Area 1 very low potential – less than 1 ha 2 low potential – 1 to 10.4 ha 3 moderate potential – 10.5 to 1,000 ha 4 high potential – more than 1,000 ha Maximum Depth 1 very low potential – less than 2 m 2 low potential – 2 to 6.4 m 3 moderate potential – 6.5 to 40 m 4 high potential – more than 40 m
stream order at mouth	1 very low potential – first order 2 low potential – second order 3 moderate potential – third order 4 high potential – fourth and higher order

A general ranking of habitat diversity was then derived by multiplying the individual ranks for each of the two habitat diversity indicators relevant to a watercourse or waterbody. The general habitat diversity ranking has a minimum value (score) of one and a maximum of 16. Table 2-11 summarizes the general ranking system used for categorizing the selected waterbodies and watercourses according to their diversity at the fish habitat level.

Table 2-11 General Ranking for Fish Habitat Level Indicators of Diversity

Indicator	Ranking Description
fish habitat diversity ranking	1 very low – total score 1 to 2 2 low – total score 3 to 4 3 moderate – total score 5 to 9 4 high – total score 10 to 16

2.2.3 Ecosystem Level Indicators of Diversity

Diversity may be assessed at higher levels of system organization, such as at the ecosystem, community or guild level. A guild is described as a group of species that exploit the same class of environmental resources in the same manner (Begon et al. 1990). The ratio of predatory fish species to trophic generalists/prey species was used in this assessment as a method of assessing diversity at the community and guild level. The ratio of predatory fish species to trophic generalists/prey species is an indication of the diversity potential and the functioning of an ecosystem. To maintain a sustainable population, large-bodied top predators require a higher degree of habitat diversity, including the presence of deep-water habitat to provide large pelagic prey and refuge. Because of these stricter trophic and habitat requirements, they are usually more sensitive to changes in the ecosystem than most generalist species (Rieman and McInthyre 1993). Table 2-12 shows the ranking system devised to assess the status of predator/prey ratios.

Table 2-12 Ranking Categories for Predator to Prey Species Ratios

Indicator	Ranking Description
predator to prey/forage guild ratio	1 very low (no relationship) – no predator species, or no fish species detected 2 low – one predator species, one prey/forage guild species 3 moderate – one predator species, two or more prey/forage guild species 4 high – two or more predator species, two or more prey/forage guild species

For the purpose of this study, predators have been defined as those fish species that have a predominantly piscivorous diet at the adult stage of their life cycle. Within the Project Aquatic Resources LSA, these species include burbot, northern pike and walleye. Prey species were considered to be the forage fish guild.

3 RESULTS

3.1 FISH AND FISH HABITAT

3.1.1 Literature Review

A list of fish species potentially found in the Christina Lake watershed was compiled from historical information based on previous surveys in Christina Lake and tributaries (Table 3-1). Eight species of fish have been reported in Christina Lake including: Arctic grayling, walleye, northern pike, yellow perch, lake whitefish, cisco, burbot and white sucker (Mills 1987; Mitchell and Prepas 1990; ASRD 2004). Forage fish species, including lake chub, brook stickleback, ninespine stickleback, Iowa darter, spoonhead sculpin, spottail shiner and pearl dace, have been documented within the lake or the Christina Lake watershed (Mills 1987; Devon 2003).

Table 3-1 Fish Species of the Christina Lake Watershed

Category	Species Common Name
sport fish	Arctic grayling
	burbot
	cisco
	lake whitefish
	northern pike
	walleye
	yellow perch
suckers	white sucker
forage fish	brook stickleback
	Iowa darter
	lake chub
	ninespine stickleback
	pearl dace
	spoonhead sculpin
	spottail shiner

Source: Mitchell and Prepas (1990); Devon (2003); ASRD (2004).

Existing fish and fish habitat information is available for Christina Lake, as well as for some of its larger tributary streams. Of the six main tributaries to the lake, Sunday and Birch creeks, which flow into the southern shore of the lake, are the largest and only named tributaries. Sunday Creek flows northward, entering Christina Lake near the middle of the southern shore. Birch Creek flows into the southwest corner of the lake, near the hamlet of Conklin. Of these larger tributary streams, previous studies have only been conducted on Sunday Creek. As the information collected for Sunday Creek provides an indication of fish presence, distribution and habitat in the Christina Lake area, a brief summary of Sunday Creek is provided below.

The unnamed tributary to the north bay of Christina Lake (locally known as "Sawbones Creek") is the primary walleye spawning stream in the Christina Lake watershed (Davis, C. 2004, pers. comm.). No historical information was available for the other unnamed watercourses or any of the unnamed waterbodies within the Aquatic Resources LSA.

Christina Lake

Fish Habitat

Christina Lake drains north through the Jackfish River, which in turn drains to the Christina River. The Christina River then flows into the Clearwater River, which is a major tributary to the Athabasca River. Christina Lake is a long, narrow waterbody with three deep basins that drop off to maximum depths of 33, 26 and 24 m. The lake has a surface area of 21.3 km^2 and mean and maximum depths of 17 and 33 m, respectively (Mitchell and Prepas 1990) (Figure III-1). The lake volume is 3.4 x 10^8 m^3 and the lake has a large upstream drainage area of 1,467 km^2 (Mills 1987). The shoreline drops off quickly around the majority of the lake, except for the two shallow northern bays at the east end of the lake. Areas of sand and gravel are present along the perimeter.

Macrophyte growth in Christina Lake is limited due to the steeply sloping sides, except for the shallow bays. An aquatic vegetation map from July 1985 (Mills 1987) showed emergent vegetation including bulrushes, cattail, reeds and sedges present around the perimeter of the lake. Submergent and floating-leaved vegetation also occurred in a narrow band along the shoreline, consisting of water milfoil, pondweed, pond lily, smartweed and horse tail. The percentages of aquatic vegetation were estimated at 15% emergent, 50% submergent and 35% floating-leaved (Mills 1987). However, the presence of aquatic vegetation in Christina Lake was limited by the steep shoreline drop off around most of the lake (Mills 1987). The low hills surrounding the lake are covered with a mixed forest of birch, balsam poplar and white spruce; willows and wet muskeg areas are present around the shoreline (Mitchell and Prepas 1990).

Past studies have indicated that fish production in Christina Lake is limited by the limited littoral area and apparent lack of spawning habitat (Bradley n.d.; Mills 1987). Walleye spawning is known to occur in the small bay at the north shore of Christina Lake ("Sawbones Bay") in the spring. In the past, walleye were caught in this bay in great numbers during the spring spawning season (Herdman 1984).

Because of its depth, the lake becomes stratified during summer (Mitchell and Prepas 1990). Water quality profiles conducted in the main basin of Christina Lake during summer 1985 showed a distinct thermocline and oxygen gradient at a depth of 8 m (Figure 3-1). Temperatures ranged from close to 20ºC at the surface to less than 6ºC near the lake bottom. Oxygen levels were high in the near the surface (>11 mg/L), but decreased to less than 4 mg/L near the lake bottom (Mills 1987).

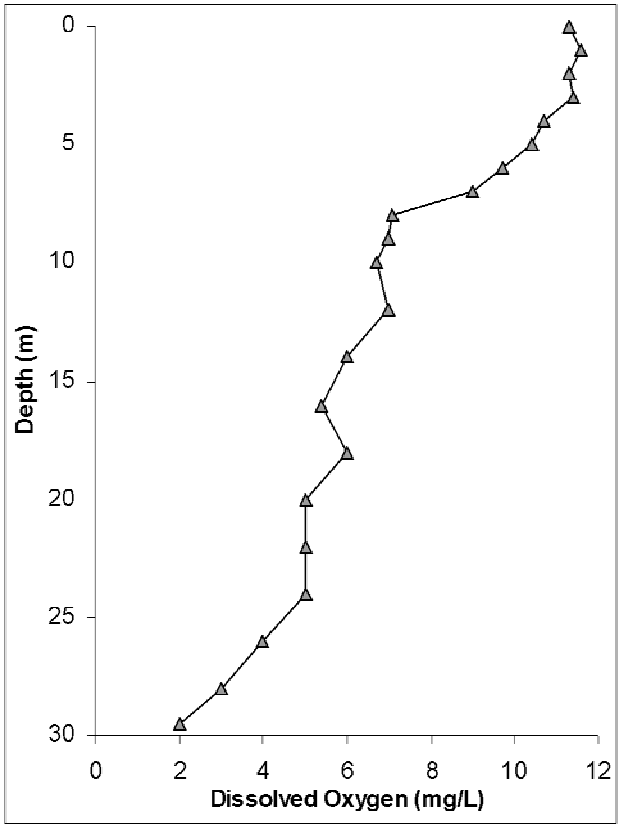
Fish Population

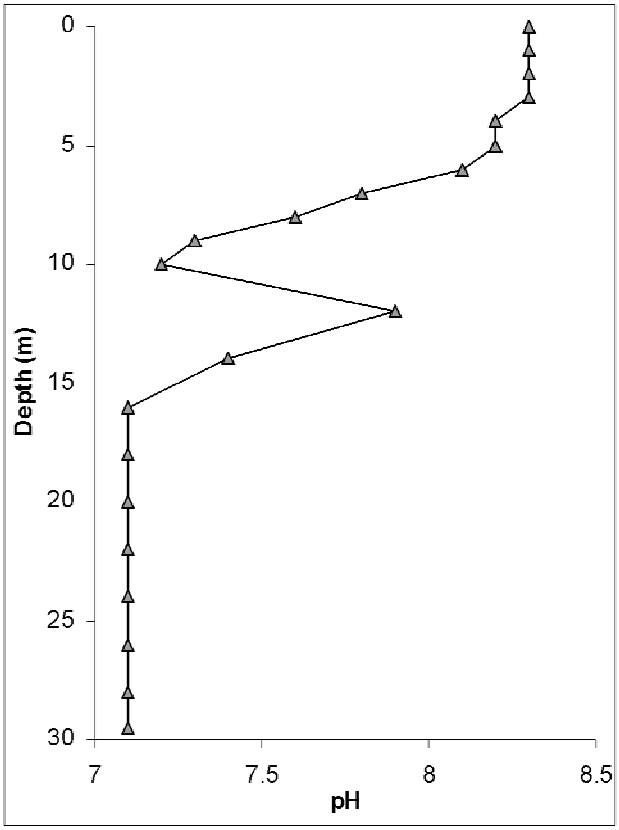
Arctic grayling, walleye, northern pike, yellow perch, lake whitefish, cisco, burbot and white sucker have been reported in Christina Lake (Mitchell and Prepas 1990; ASRD 2004). Forage fish species, including Iowa darter, ninespine stickleback and spottail shiner, have been also been documented within the lake (Mills 1987).

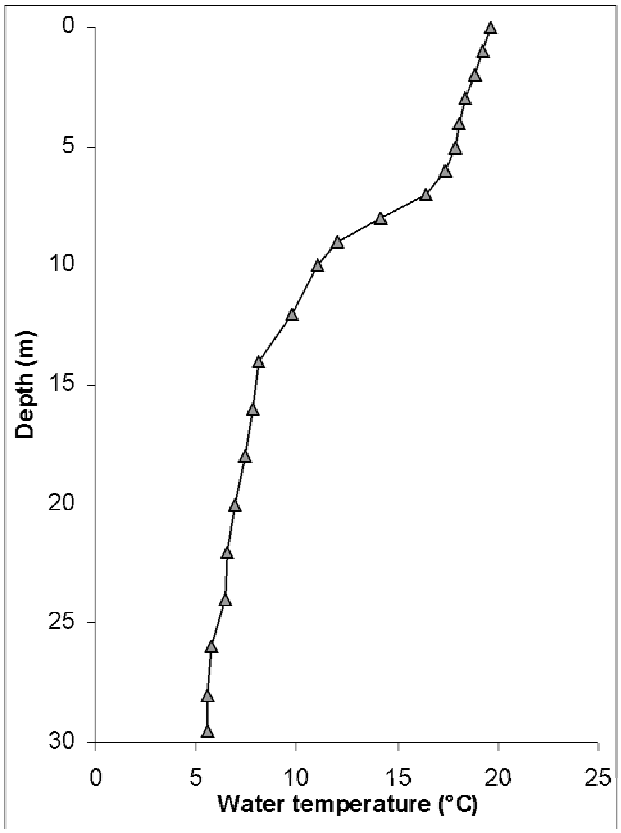
In the past, Christina Lake supported a commercial fishery that included lake whitefish, cisco, northern pike and walleye (Bradley n.d.; PanCanadian 1998; Westworth 2002). Commercial fishing records indicate that the lake was fished heavily in the 1940's to late 1960's (Bradley n.d.). Commercial fishing for whitefish occurred up to 1982, and resumed between 1987 and 1989 (Christina Lake Management Plan 1991).

Christina Lake has historically been a high quality sport fishing destination (Christina Lake Management Plan 1991). The target species for sports fishing in Christina Lake has historically been walleye and pike (Herdman 1984). A creel census in 1983 captured pike up to 21 lbs. (9.5 kg) and walleye up to 8 lbs. 7 oz. (3.8 kg). The shoreline habitat is considered important for spawning, nursery and feeding habitat for sport, suckers and forage fish (Christina Lake Management Plan 1991; PanCanadian 1998). In the 1970's, sport fish capability in the area was rated fair to good, particularly on the Christina River system; Christina Lake was identified as a Class 2 lake (few or minor limitations on sport fish production) (AENV 1976-7).

In the past, Christina Lake supported sport and sustinence fisheries for walleye, as well as a small commercial fishery. These walleye fisheries were recently deemed collapsed (Westworth 2002) and currently there is a zero catch limit for walleye in Christina Lake (i.e., catch and release only) (AENV 2004). Christina Lake still supports a large population of lake whitefish (Westworth 2002).







REFERENCE

DATA FROM MILLS, 1987.

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

WATER QUALITY PROFILES FROM THE MAIN BASIN OF CHRISTINA LAKE (JULY 23, 1985)

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No. Fig 3-1 WtrQualProf..	
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CHECK	KM	20/01/05		
REVIEW	TC	20/01/05		

FIGURE: 3-1

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Sunday Creek

Fish Habitat

Sunday Creek flows 54 km from the headwaters at Edwards Lake to the south shore of Christina Lake. Surveys were conducted in Sunday Creek by Devon (2003). Sampling sites were located approximately 8 to 10 km upstream of Christina Lake and were characterized by low to moderate quality run habitat, with some pool and impoundment habitat in the lower section formed by beaver dams (Devon 2003). Substrate was comprised primarily of silt overlaying cobble. Channel widths were approximately 10 m. Water depths ranged from 0.4 to 0.85 m in run habitat, with depths in pool habitat exceeding 1.25 m (Devon 2003). Winter field quality measurements in March 2002 indicated that Sunday Creek has low dissolved oxygen levels (4.2 mg/L) under the ice (Devon 2003). Beaver activity was prevalent, with the presence of dams creating potential impediments to fish movement. The lack of habitat diversity in Sunday Creek was considered to limit the suitability of the surveyed section of the creek as spawning, feeding and rearing habitat; the shallow depths and low winter dissolved oxygen levels was also considered to limit the suitability as overwintering habitat for most fish species (Devon 2003).

Fish Population

No fish were captured by electrofishing and seine netting in Sunday Creek during May 2002; however, Arctic grayling, northern pike, spoonhead sculpin and lake chub have been reported in the creek (Devon 2003). White sucker have also been captured in Sunday Creek (ASRD 2004) and brook stickleback were captured in an unnamed tributary to Sunday Creek (Devon 2003).

Benthic Invertebrates

The only available historical data on the benthic invertebrate community in the Aquatic Resources LSA are from a study in Christina Lake, from June 14-15, 1969 (Bradley n.d.). Single grab samples were collected with an Ekman grab at 44 sites distributed throughout the lake. Bradley (n.d.) did not report of sieve mesh size used in the study. Data were pooled and presented as mean abundances for the lake (Table 3-2).

Table 3-2 Historical Benthic Invertebrate Data from Christina Lake, June 1969

Organisms	Mean Abundance (no./m^2)	Percent of Total
chironomidae	833	51.3
ephemeroptera	5	0.3
trichoptera	8	0.5
amphipoda	691	42.6
oligochaeta	33	2.0
hirudinea	1	<0.1
pelecypoda	41	2.5
gastropoda	12	0.7
Total	**1,624**	**100**

Mean abundance of benthic invertebrates in Christina Lake in 1969 (Table 3-2) was compared to the 2004 data (Section 3.1.2.4). Dominant organisms in 1969 consisted of midges (Chironomidae) and scuds (Amphipoda) with other common taxa consisting of bristle worms (Oligochaeta) and freshwater clams (Pelecypoda). In contrast, dominant benthic invertebrates in 2004 data were seed shrimp (Ostracoda) and nematodes (Nematoda). Differences between the 1969 and 2004 data may be the result of using a larger mesh size or sampling more sites (i.e., a greater variety of habitats) in the previous study.

3.1.2 Field Surveys

Fish habitat characteristics and fish population data collected specifically for the Project are presented in the following sections for selected waterbodies and watercourses in the Aquatic Resources LSA. Results include data from the winter habitat survey, open-water seasonal habitat surveys, seasonal fish inventories and spring spawning surveys. Habitat data for two proposed watercourse crossings are also included.

The results of the seasonal field sampling program are presented below. Habitat maps and photographs for sites surveyed in 2004 are presented in Appendix III (waterbodies), Appendix IV (watercourse sites) and Appendix V (proposed watercourse crossings). Raw data for sport fish and suckers captured during baseline surveys are presented in Appendix VI.

3.1.2.1 Waterbodies

Christina Lake

Fish Habitat

Winter Habitat Survey

Winter water quality sampling was performed in the bay at the north shore of Christina Lake ("Sawbones Bay") (Site CL2). However, due to safety concerns with open water on the ice, the sampling location was fairly close to shore (maximum depth of 1.5 m). In this area, oxygen depletion was present under the ice, with dissolved oxygen levels less than 4 mg/L (Table 3-3). However, as Christina Lake is a deep lake, with mean and maximum depths of 17 and 33 m respectively (Mitchell and Prepas 1990), it is expected that the majority of overwintering habitat would be located within the main basins of the lake.

Seasonal Habitat Survey

As bathymetric (Figure III-1) and aquatic vegetation maps were available for Christina Lake, no additional mapping was performed. Water quality sampling was conducted in "Sawbones Bay" (Site CL2) and at the east end of Christina Lake (Site CL1) during the summer survey (Table 3-3). At CL2, the water temperature was warm at 15.5ºC and the dissolved oxygen level was high at 10.6 mg/L. Substrate in this area was comprised primarily of silt. Limited amounts of aquatic vegetation including pond lily and pondweed were present along the shoreline of the bay.

The water quality profile at Site CL1 showed that lake was thermally stratified, with temperate decreasing from 15.3ºC at the surface to 6.9ºC near the bottom (Table 3-3, Figure 3-2). Oxygen depletion also occurred with depth, with dissolved oxygen levels of 9.6 mg/L at the surface, decreasing to 2.3 mg/L near the lake bottom. In this area, the lake substrate was composed of silt. These results are generally similar to Mitchell and Prepas (1990).

Fish Habitat Suitability

Overall, the habitats present in Christina Lake were suitable for use as nursery, rearing and feeding habitat by most fish species. Both littoral and pelagic habitat is available. The depth of the lake and suitable year-round dissolved oxygen levels contribute to the potential for nursery, rearing, feeding and overwintering. Although the littoral area is somewhat limited, suitable spawning habitat is present for species that require gravel or rocky shoreline areas or inundated vegetation.

Table 3-3 Water Quality Profiles for Christina Lake

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profiles				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
CL2 "Sawbones Bay"	winter	1.5	surface	1.3	3.9	129	7.3
			0.5	1.8	3.3	130	7.2
			1	2.6	2.7	131	7.2
	summer	3.2	0.5	15.5	10.6	70	8.1
CL1 (east end of lake)	summer	14.6	surface	15.3	9.6	137	8.0
			1	15.3	9.0	137	7.9
			2	15.3	8.7	137	7.9
			3	15.3	8.6	137	7.9
			4	15.3	8.5	137	7.9
			5	15.3	8.2	137	7.8
			6	15.2	7.9	138	7.7
			7	14.7	5.9	139	7.3
			8	12.5	4.4	142	7.1
			9	10. 6	4.0	144	7.0
			10	9.3	4.1	145	7.0
			11	8.8	4.2	146	7.0
			12	8.3	3.9	147	7.0
			13	8.1	3.7	148	7.0
			14	7.3	3.3	150	6.9
			14.6	6.9	2.3	151	7.0

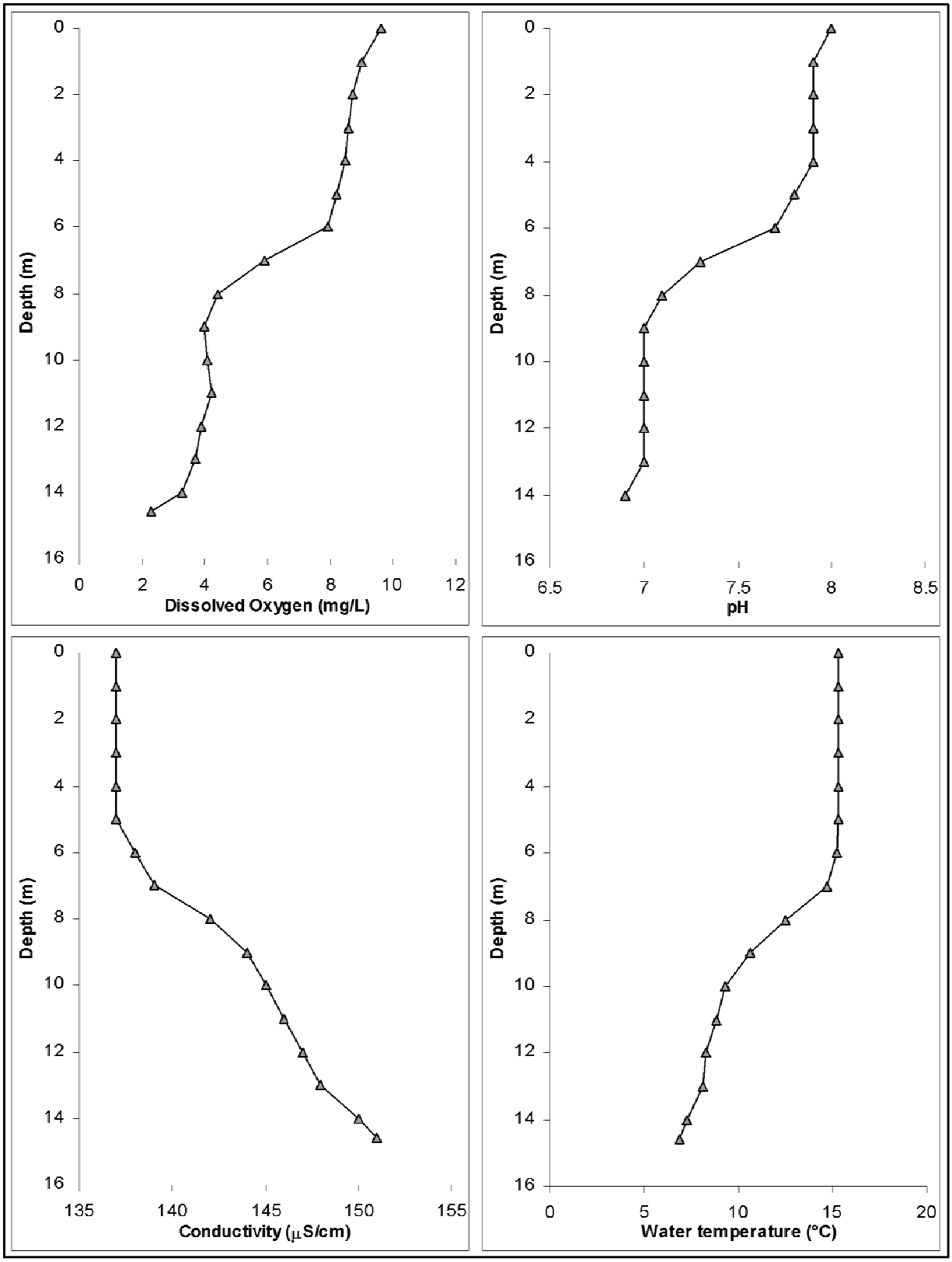
(a) See Figure 2-1 for site locations.

The habitat use potential of Christina Lake was rated as follows:

- sport fish – high for nursery, rearing and feeding, and moderate for spawning;
- suckers – high for spawning, nursery, rearing and feeding; and
- forage fish – high for all life stages.

Unnamed Waterbody 2

Unnamed Waterbody 2 is a moderately-sized, narrow waterbody located just at the western border of the lease. Unnamed Waterbody 2 is approximately 2.3 km long, 0.5 to 0.8 km wide, with a surface area of 70 ha.



PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

LATE SUMMER WATER QUALITY PROFILES FOR CHRISTINA LAKE AT CL-1

MEG ENERGY CORP.

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Fish Habitat

Winter Habitat Survey

During the winter survey at Unnamed Waterbody 2, the mean ice thickness was 0.6 m and the maximum under-ice water depth recorded was 1.5 m. The winter dissolved oxygen concentration ranged from 4.3 mg/L at the surface to 1.7 mg/L near the bottom of the waterbody (Table 3-4). Water depths and winter dissolved oxygen levels were sufficient for overwintering by forage fish. However, the low dissolved oxygen levels may limit the suitability of the waterbody for overwintering by suckers and sport fish.

Seasonal Habitat Survey

This waterbody is shallow, consisting entirely of littoral habitat (Figure III-2). The maximum depth recorded was 2.4 m during the spring survey and 3.0 m during the lake summer survey. The substrate consisted of silt, sand and organic material. No defined inlets or outlets were evident at Unnamed Waterbody 2 at the time of the survey.

The shore slope was shallow and the waterbody was surrounded by a narrow fringe of grasses and forbs, within a coniferous forest. During the late summer survey, aquatic vegetation was present, with pond lily, pondweed, coontail, cattail and bulrush.

Water quality conditions in Unnamed Waterbody 2 were suitable to support fish in the spring and summer (Table 3-4). However, in the spring, dissolved oxygen levels near the waterbody surface were somewhat low (3.8 to 4.5 mg/L). Dissolved oxygen levels were higher in the late summer, with levels near 10 mg/L near the surface, but decreasing slightly with depth. Water temperatures were greater than 10ºC in both spring and late summer seasons.

Table 3-4 Seasonal Water Quality Profiles for Unnamed Waterbody 2

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profiles				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB2	winter	1.5	surface	0.6	4.3	115	7.5
			0.5	2.1	2.3	121	7.4
			1.0	3.1	1.7	136	7.3
	spring	1.4	surface	12.0	3.8	93	7.5
			0.5	12.0	4.3	93	7.5
			1.0	11.9	4.5	93	7.5
	summer	3.0	surface	15.4	9.9	66	7.6
			1.0	15.4	9.9	66	7.6
			2.0	14.6	9.5	66	7.2
			3.0	14.4	4.1	88	6.8

(a) See Figure 2-1 for site locations.

Fish Population

Northern pike were captured in Unnamed Waterbody 2 in gill nets set in both the spring and late summer seasons. Numbers of fish recorded by species and life stage are presented in Table 3-5 and CPUE data are presented by sampling technique in Table 3-6. A total of 23 northern pike were captured, ranging in fork length from 460 to 620 mm and weight from 740 to 1600 g. No fish were captured in minnow traps set in the waterbody. These results suggest that the waterbody supports an isolated, self-sustaining population of northern pike; however, the low winter dissolved oxygen levels suggest the potential for some winterkill of northern pike.

Fish Habitat Suitability

Due to the moderate depth and suitable water quality conditions, Unnamed Waterbody 2 has suitable habitat for use by forage fish, suckers and sport fish (northern pike). However, the habitat suitability for suckers and sport fish may be limited by the shallow depth and reduced dissolved oxygen levels in winter and spring. Spawning habitat was present only for species that spawn on vegetation or fine sediments (e.g., northern pike, brook stickleback).

The habitat use potential of Unnamed Waterbody 2 was rated as follows:

- sport fish (northern pike) – low for spawning and overwintering, low to moderate for nursery, rearing and feeding;
- suckers – nil to low for all life stages; and
- forage fish – moderate for all life stages (for species that spawn on vegetation or fine sediments).

Table 3-5 Fish Species Captured at Waterbody Sampling Sites, Winter, Spring and Late Summer 2004

Waterbody	Site ID[a]	Season	Number of Fish by Species and Life Stage				Total Fish Captured
			Sport Fish			Forage Fish	
			Northern Pike			Brook Stickleback	
			F	J	A		
Unnamed Waterbody 2	WB2	spring	0	0	10	0	10
		summer	0	1	12	0	13
		species total	**23**			**0**	**23**
Unnamed Waterbody 5	WB5	spring	0	0	0	0	0
		summer	0	0	0	0	0
		species total	**0**			**0**	**0**
Unnamed Waterbody 6	WB6	spring	0	1	7	0	8
		summer	0	6	0	0	6
		species total	**14**			**0**	**14**
Unnamed Waterbody 7	WB7	spring	0	0	0	0	0
		summer	0	0	0	0	0
		species total	**0**			**0**	**0**
Unnamed Waterbody 8	WB8	spring	0	0	0	0	0
		summer	0	0	0	0	0
		species total	**0**			**0**	**0**
Unnamed Waterbody 9	WB9	spring	0	0	0	0	0
		summer	0	0	0	0	0
		species total	**0**			**0**	**0**
Unnamed Waterbody 11	WB11	winter	0	0	0	37	37
		spring	0	0	0	0	0
		summer	0	0	0	44	44
		species total	**0**			**81**	**81**
Unnamed Waterbody 12	WB12	winter	0	0	0	0	0
		spring	0	0	0	159	159
		summer	0	6	1	26	33
		species total	**7**			**185**	**192**
Unnamed Waterbody 13	WB13	spring	0	0	0	1	1
		summer	0	0	0	42	42
		species total	**0**			**43**	**43**
Unnamed Waterbody 15	WB15	summer	0	0	0	0	0
Unnamed Waterbody 16	WB16	summer	0	0	0	0	0
Total			**44**			**309**	**353**

(a) See Figure 2-1 for site locations.

(b) Life Stage: F = Fry, J = Juvenile, A = Adult.

Table 3-6 Fish Inventory and Catch-Per-Unit-Effort Results for Waterbody Sampling Sites, Winter, Spring and Late Summer 2004

Waterbody	Site ID[(a)]	Season	Gill Net		Minnow Trap	
			Sport fish - Northern Pike		Forage fish - Brook Stickleback	
			Number of Fish	Gill Net CPUE [Number/ panel-hr]	Number of Fish	Minnow Trap CPUE [Number/trap-hr]
Unnamed Waterbody 2	WB2	spring	10	0.15	0	0.00
		summer	13	0.28	0	0.00
Unnamed Waterbody 5	WB5	spring	0	0.00	0	0.00
		summer	0	0.00	0	0.00
Unnamed Waterbody 6	WB6	spring	8	0.37	0	0.00
		summer	6	0.05	0	0.00
Unnamed Waterbody 7	WB7	spring	0	0.00	0	0.00
		summer	0	0.00	0	0.00
Unnamed Waterbody 8	WB8	spring	0	0.00	0	0.00
		summer	0	0.00	0	0.00
Unnamed Waterbody 9	WB9	spring	0	0.00	0	0.00
		summer	0	0.00	0	0.00
Unnamed Waterbody 11	WB11	winter	-	-	37	1.59
		spring	0	0.00	0	0.00
		summer	0	0.00	44	0.58
Unnamed Waterbody 12	WB12	winter	-	-	0	0.00
		spring	0	0.00	159	3.34
		summer	7	0.15	26	0.28
Unnamed Waterbody 13	WB13	spring	0	0.00	1	0.03
		summer	0	0.00	42	0.63
Unnamed Waterbody 15	WB15	summer	0	0.00	0	0.00
Unnamed Waterbody 16	WB16	summer	0	0.00	0	0.00

(a) See Figure 2-1 for site locations.

Unnamed Waterbody 5

Unnamed Waterbody 5 is a small isolated waterbody located just outside the lease border. The waterbody is located within a flat muskeg area within a black spruce forest. Unnamed Waterbody 5 is approximately 0.7 km long and 0.6 km wide, with a surface area of 14.7 ha.

Fish Habitat

Winter Habitat Survey

A winter survey was not conducted at Unnamed Waterbody 5.

Seasonal Habitat Survey

This waterbody is shallow, consisting entirely of littoral habitat (Figure III-3). The majority of the waterbody was fairly flat-bottomed with depths less than 2.0 m. The maximum depth recorded was 3.9 m during the spring survey, located near the northeast shore of the waterbody.

The shore slope was shallow and the waterbody was surrounded by a grasses and shrubs, with patches of emergent macrophytes (primarily bulrush) along the shoreline. The bed substrate was comprised entirely of silt and organic material. No defined inlets or outlets to or from the waterbody were evident at the time of the survey.

In the spring, dissolved oxygen levels near the waterbody surface were low (2.4 mg/L), but had increased by late summer (11.2 mg/L) (Table 3-7). Water temperatures were greater than 10ºC in both spring and late summer seasons.

Table 3-7 Seasonal Water Quality Profiles for Unnamed Waterbody 5

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profiles				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB5	spring	1.0	surface	12.8	2.4	50	7.0
			0.5	12.8	2.8	50	7.0
	summer	1.5	surface	15.2	11.2	38	7.3
			0.5	15.1	10.6	39	6.9

(a) See Figure 2-1 for site locations.

Fish Population

No fish were captured in gill nets or minnow traps set in Unnamed Waterbody 5 during baseline fish sampling in spring and late summer (Table 3-5).

Fish Habitat Suitability

The habitat suitability of Unnamed Waterbody 5 was considered poor due to shallow depth and low spring dissolved oxygen levels. The lack of pelagic habitat contributed to spring oxygen depletion, reducing the suitability of the waterbody for nursery, rearing, feeding, particularly by species more sensitive to lower oxygen levels. The waterbody does provide some habitat for nursery, rearing and feeding by shallow water species and spawning habitat for species that spawn on vegetation (e.g., northern pike, brook stickleback).

The habitat use potential of Unnamed Waterbody 5 was rated as follows:

- sport fish (northern pike) – nil to low for spawning, nursery, rearing and feeding;
- suckers – nil to low for spawning, nursery, rearing and feeding; and
- forage fish – low to moderate for spawning, nursery, rearing and feeding (species that spawn on vegetation or fine sediments).

The overwintering habitat suitability at Unnamed Waterbody 5 was not examined. Due to its shallow depth (< 2 m), and depleted dissolved oxygen levels in the spring, it is expected that this waterbody would not retain sufficient dissolved oxygen levels through the winter to support suckers or sport fish. The waterbody would only provide suitable overwintering habitat for species, such as brook stickleback, that are tolerant of low dissolved oxygen concentrations.

Unnamed Waterbody 6

Unnamed Waterbody 6 is a moderately-sized waterbody located at the headwaters of the main tributary which flows into the north bay of Christina Lake. It is located outside of the lease border. Unnamed Waterbody 6 is rounded in shape, approximately 1.5 km long and 1.2 km wide, with a surface area of 125 ha.

Fish Habitat

Winter Habitat Survey

The winter survey determined that overwintering habitat in Unnamed Waterbody 6 was limited. The mean ice thickness was 0.7 m and the maximum under-ice water depth was 0.4 m. The winter dissolved oxygen concentration was low at 2.0 mg/L (Table 3-8). The waterbody would only provide suitable overwintering habitat for species, such as brook stickleback, that are tolerant of low dissolved oxygen concentrations. The shallow depths and near anoxic conditions would not make it suitable as overwintering habitat for suckers and sport fish.

Seasonal Habitat Survey

This waterbody is shallow, consisting entirely of littoral habitat (Figure III-4). The majority of the waterbody was fairly flat-bottomed, with a maximum recorded depth of 1.9 m during the spring survey.

The shore slope was shallow and the waterbody was surrounded by a narrow fringe of grasses and forbs, within a coniferous forest. The bed substrate was comprised entirely of silt and sand. Emergent and submergent aquatic vegetation

was present around the perimeter of the lake, including cattails, bulrushes and pondweed. An inlet stream flows into the north end of the waterbody. This stream consists of a poorly defined channel within the muskeg. The outlet stream flows south from Unnamed Waterbody 6 towards Christina Lake. In this area, the stream is fairly wide and deep, allowing fish to move from the waterbody into this stream (see Site S5 for a description of the stream habitat).

Data from the open-water seasons show that water quality conditions in Unnamed Waterbody 6 are suitable to support fish during the spring and late summer, with dissolved oxygen levels > 6 mg/L in both seasons (Table 3-8).

Table 3-8 Seasonal Water Quality Profiles for Unnamed Waterbody 6

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profiles				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB6	winter	0.4	surface	1.8	2.0	113	7.3
	spring	1.5	0.5	12.1	6.3	57	7.5
			1.0	10.2	6.2	57	7.5
			1.5	9.3	6.2	58	7.4
	summer	1.1	surface	13.1	8.3	43	7.0
			0.5	13.1	8.3	43	6.9
			1.0	13.1	6.0	44	6.7

(a) See Figure 2-1 for site locations.

Fish Population

During baseline fisheries inventory, northern pike were captured in gill nets set in both the spring and late summer seasons. Numbers of fish recorded by species and life stage are presented in Table 3-5 and CPUE data are presented by sampling technique in Table 3-6. A total of 14 northern pike were captured, ranging in fork length from 213 to 700 mm and weight from 110 to 1,750 g. No fish were captured in minnow traps set in the waterbody or observed during winter under-ice video.

Fish Habitat Suitability

Due to the shallow depth of the waterbody and low dissolved oxygen levels below the ice, Unnamed Waterbody 6 likely has limited overwintering habitat for suckers and sport fish (northern pike). However, the waterbody provides suitable shallow water habitat for nursery, rearing and feeding for forage fish, suckers and sport fish (northern pike). Northern pike spawning habitat was present in nearby

stream habitat, as well as potentially around vegetation along the shoreline of the waterbody.

The habitat use potential of Unnamed Waterbody 6 was rated as follows:

- sport fish (northern pike) – low for overwintering, low to moderate for spawning, nursery, rearing and feeding;
- suckers – nil to low for all life stages; and
- forage fish – low for overwintering (species tolerant of low dissolved oxygen concentration), low to moderate for spawning, nursery, rearing and feeding (species that spawn on vegetation or fine sediments).

Unnamed Waterbody 7

Unnamed Waterbody 7 is a small isolated waterbody in the centre of the Project area. Unnamed Waterbody 7 is somewhat rounded in shape, approximately 0.75 km long and 0.6 km wide, with a surface area of 40 ha.

Fish Habitat

Winter Habitat Survey

The winter survey determined that overwintering habitat in Unnamed Waterbody 7 was limited. The ice thickness was 0.6 m and the maximum under-ice water depth was 0.6 m. The winter dissolved oxygen concentration was low at 1.9 mg/L (Table 3-9). The waterbody would only provide suitable overwintering habitat for species, such as brook stickleback, that are tolerant of low dissolved oxygen concentrations. The shallow depths and near anoxic conditions make it not suitable as overwintering habitat for sport fish.

Seasonal Habitat Survey

This waterbody is shallow, consisting entirely of littoral habitat (Figure III-5). The majority of the waterbody was fairly flat-bottomed, with a maximum recorded depth of 1.2 m during the spring survey.

The shore slope was shallow and the waterbody was surrounded by a floating mat of grasses/forbs. The bed substrate was comprised entirely of silt. Submergent and floating-leaved vegetation were present, including pond lily, water milfoil and pondweed. A beaver lodge was present on the north shore of the waterbody. No inlet or outlet streams were evident at the time of the survey.

Data from the open-water seasons show that water quality conditions in Unnamed Waterbody 7 are suitable to support fish during the spring and late summer (Table 3-9), with dissolved oxygen levels > 6 mg/L in both seasons.

Table 3-9 Seasonal Water Quality Profiles for Unnamed Waterbody 7

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profiles				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB7	winter	0.3	surface	0.6	1.9	172	6.9
	spring	1.1	0.5	13.6	6.3	69	7.3
			1.0	13.3	6.3	69	7.2
			1.1	13.3	6.3	69	7.2
	summer	1.1	surface	13.6	7.8	52	6.8
			0.5	13.6	7.3	53	6.7

(a) See Figure 2-1 for site locations.

Fish Population

No fish were captured in gill nets or minnow traps set in Unnamed Waterbody 7 during baseline fish sampling in spring and late summer (Table 3-5).

Fish Habitat Suitability

Although no fish were captured during baseline sampling, Unnamed Waterbody 7 was considered to have suitable habitat for use by forage fish species. However, due the small size, shallow depth (<1.2 m) and lack of inlet or outlet streams, the habitat potential for use by suckers and sport fish species, such as northern pike, was considered nil to low. Although the waterbody may provide suitable shallow water nursery, rearing and feeding habitat during open-water seasons, the waterbody did not have suitable conditions for suckers and sport fish overwintering.

The habitat use potential of Unnamed Waterbody 7 was rated as follows:

- sport fish (northern pike) – nil for overwintering, low for spawning, nursery, rearing and feeding;
- suckers – nil to low for all life stages; and
- forage fish – low for overwintering, low to moderate for spawning, nursery, rearing and feeding (species that spawn on vegetation or fine sediments).

Unnamed Waterbody 8

Unnamed Waterbody 8 is a very small isolated waterbody in the centre of the Project area. Unnamed Waterbody 8 is approximately 0.5 km long and 0.25 km wide, with a surface area of 9.9 ha.

Fish Habitat

Winter Habitat Survey

The winter survey determined that overwintering habitat in Unnamed Waterbody 8 was limited. The ice thickness was 0.6 m and the maximum under-ice water depth was 0.6 m. The winter dissolved oxygen concentration was low at 1.8 mg/L (Table 3-10). The waterbody would only provide suitable overwintering habitat for species, such as brook stickleback, that are tolerant of low dissolved oxygen concentrations. The shallow depths and near anoxic conditions would not make it suitable as overwintering habitat for suckers and sport fish (northern pike).

Seasonal Habitat Survey

This waterbody is shallow, consisting entirely of littoral habitat, with a maximum recorded depth of 1.5 m during the spring survey and 1.2 m during the late summer survey (Figure III-6).

The shore slope was shallow and the waterbody was surrounded by a floating mat of grasses and forbs, within a coniferous forest. The bed substrate was comprised entirely of silt. During the summer survey, submergent and floating-leaved vegetation were abundant, consisting primarily of pond lily. A beaver lodge was present on the southeast shore of the waterbody. No inlet or outlet streams were evident at the time of the survey.

Data from the open-water seasons show that water quality conditions in Unnamed Waterbody 8 are suitable to support fish during the spring and late summer (Table 3-10). Dissolved oxygen levels were > 6.5 mg/L in spring and > 9 mg/L in the late summer.

Fish Population

No fish were captured in gill nets or minnow traps set in Unnamed Waterbody 8 during baseline fish sampling in spring and late summer (Table 3-5).

Table 3-10 Seasonal Water Quality Profiles for Unnamed Waterbody 8

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profiles				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB8	winter	0.6	surface	2.1	1.8	336	7.1
	spring	1.5	0.5	14.0	6.6	108	7.6
			1.0	14.0	6.6	109	7.6
			1.4	13.9	6.7	113	7.6
	summer	1.2	surface	14.9	9.1	99	7.3
			0.5	14.2	9.1	100	7.2
			1.0	13.9	9.6	100	7.2

(a) See Figure 2-1 for site locations.

Fish Habitat Suitability

Although no fish were captured during baseline sampling, Unnamed Waterbody 8 was considered to have suitable habitat for use by forage fish species. However, due the small size, shallow depth (<1.5 m) and lack of inlet or outlet streams, the habitat potential for use by suckers and sport fish species, such as northern pike, was considered nil to low. Although the waterbody may provide suitable shallow water nursery, rearing and feeding habitat during open-water seasons, the waterbody did not have suitable conditions for suckers or sport fish overwintering.

The habitat use potential of Unnamed Waterbody 8 was rated as follows:

- sport fish (northern pike) – nil for overwintering, low for spawning, low to moderate for nursery, rearing and feeding;
- suckers – nil to low for all life stages; and
- forage fish – low for overwintering (species tolerant of low dissolved oxygen concentration), low to moderate for spawning, nursery, rearing and feeding (species that spawn on vegetation or fine sediments).

Unnamed Waterbody 9

Unnamed Waterbody 9 is a very small isolated waterbody in the centre of the Project area, just east of Unnamed Waterbody 8 and south of Unnamed Waterbody 7. Unnamed Waterbody 9 is rounded in shape, approximately 0.4 km long and 0.3 km wide, with a surface area of 10.3 ha.

Fish Habitat

Winter Habitat Survey

The winter survey determined that overwintering habitat in Unnamed Waterbody 9 was very limited. The ice thickness was 0.7 m and the under-ice water depth was 0.3 m. The winter dissolved oxygen concentration was low at 2.1 mg/L (Table 3-11). The waterbody would only provide suitable overwintering habitat for species, such as brook stickleback, that are tolerant of low dissolved oxygen concentrations. The shallow depths and near anoxic conditions would not make it suitable as overwintering habitat for suckers or sport fish (northern pike).

Seasonal Habitat Survey

This waterbody is very shallow, with a maximum recorded depth of 1.0 m during the spring survey and 2.0 m during the lake summer survey (Figure III-7).

The shore slope was shallow and the waterbody was surrounded by a band of grasses and shrubs within a coniferous forest. The bed substrate was comprised entirely of silt. Submergment vegetation were present during the summer survey consisting of pondweed and water weed. A beaver lodge was present on the north shore of the waterbody. No inlet or outlet streams were evident at the time of the survey.

Data from the open-water seasons show that water quality conditions in Unnamed Waterbody 9 are suitable to support fish during the spring and late summer, with dissolved oxygen levels > 6 mg/L in both seasons (Table 3-11).

Table 3-11 Seasonal Water Quality Profiles for Unnamed Waterbody 9

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profile				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB9	winter	0.3	surface	0.4	2.1	319	7.1
	spring	1.0	0.5	14.2	6.3	127	7.4
	summer	0.65	1.0	14.1	6.3	127	7.4
			surface	15.5	7.7	91	6.9
			0.5	15.1	7.9	91	6.8

(a) See Figure 2-1 for sampling locations.

Fish Population

No fish were captured in gill nets or minnow traps set in Unnamed Waterbody 9 during baseline fish sampling in spring and late summer (Table 3-5).

Fish Habitat Suitability

Although no fish were captured during baseline sampling, Unnamed Waterbody 9 was considered to have suitable habitat for use by forage fish species. However, due the small size, shallow depth (<1.0 m) and lack of inlet or outlet streams, the habitat potential for use by suckers and sport fish species, such as northern pike, was considered nil to low. Although the waterbody may provide suitable rearing and feeding habitat during open-water seasons, the waterbody did not have suitable conditions for suckers or sport fish (northern pike) overwintering.

The habitat use potential of Unnamed Waterbody 9 was rated as follows:

- sport fish (northern pike) – nil for overwintering, low for spawning, low to moderate for nursery, rearing and feeding;
- suckers – nil to low for all life stages; and
- forage fish – low for overwintering, low to moderate for spawning, nursery, rearing and feeding (species that spawn on vegetation or fine sediments).

Unnamed Waterbody 11

Unnamed Waterbody 11 is a very small isolated waterbody located north of the lease boundary on the east side of the Altagas road. Unnamed Waterbody 11 was approximately 0.8 km long, 0.2 to 0.4 km wide, with a surface area of 26 ha.

Fish Habitat

Winter Habitat Survey

During the winter survey of Unnamed Waterbody 11, the ice thickness was 0.7 m, with and the under-ice water depth was 0.4 m. The winter dissolved oxygen concentration was high at 8.1 mg/L (Table 3-12), which would be sufficient for overwintering by sport fish, suckers and forage fish. However, the shallow water depths may limit the suitability of the waterbody for overwintering by suckers and sport fish.

Seasonal Habitat Survey

This waterbody is quite shallow and consists entirely of littoral habitat (Figure III-8). The maximum depth recorded was 1.9 m during the spring survey and 2.0 m during the late summer survey.

The shore slope was shallow and the waterbody was surrounded by a narrow band of grasses and forbs within a coniferous forest. The bed substrate was comprised entirely of silt. No inlet or outlet streams were evident at the time of the survey.

Data from the open-water seasons show that water quality conditions in Unnamed Waterbody 11 are suitable to support fish during the spring and late summer (Table 3-12). However, some oxygen depletion was measured in the spring at the surface (3.8 mg/L) and near the bottom in the late summer (2.7 mg/L).

Table 3-12 Seasonal Water Quality Profiles for Unnamed Waterbody 11

Site ID[(a)]	Season	Average Water Depth of Profile (m)	Water Quality Profiles				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB11	winter	0.4	surface	2.1	8.1	215	6.8
	spring	1.1	surface	15.0	3.8	95	8.0
			0.5	14.6	4.7	96	8.0
			1.0	14.6	5.1	92	8.0
	summer	2.0	surface	15.0	10.8	78	8.1
			0.5	14.9	11.0	78	8.1
			1.0	14.9	10.8	78	8.1
			2.0	14.8	2.7	165	6.5

[(a)] See Figure 2-1 for sampling locations.

Fish Population

A total of 44 brook stickleback was captured in minnow traps during baseline sampling in Unnamed Waterbody 11 (Table 3-5). CPUE data are presented in Table 3-6. No fish were captured in gill nets set in the waterbody.

Fish Habitat Suitability

Unnamed Waterbody 11 was considered to have suitable habitat for forage fish, providing rearing, feeding, spawning and overwintering habitat. The waterbody was considered to have limited potential for use by suckers and sport fish species, such as northern pike. Although some suckers and sport fish (northern pike) overwintering may be possible in the waterbody due to the high winter dissolved oxygen levels, potential spawning habitat was limited.

The habitat use potential of Unnamed Waterbody 11 was rated as follows:

- sport fish (northern pike) – nil to low for spawning and overwintering, low to moderate for nursery, rearing and feeding;
- suckers – nil to low for all life stages; and
- forage fish – moderate for all life stages (species that spawn on vegetation or fine sediments).

Unnamed Waterbody 12

Unnamed Waterbody 12 is one of the larger waterbodies in the area. It is located at the headwaters of the unnamed tributary to the east shore of Christina Lake. The waterbody is partially located within the lease boundary. Unnamed Waterbody 12 is kidney-shaped, approximately 4.8 km along its axis, with widths ranging from 0.2 to 1.0 km, and a surface area of 271 ha.

Fish Habitat

Winter Habitat Survey

During the winter survey of Unnamed Waterbody 12, the ice thickness was 0.7 m and the under-ice water depth was 0.4 m. The winter dissolved oxygen concentration was high at 8.5 mg/L (Table 3-13), which would be sufficient for overwintering by sport fish, suckers and forage fish. However, the shallow water depths may limit the suitability of the waterbody for overwintering by suckers and sport fish.

Seasonal Habitat Survey

This waterbody is quite shallow, consisting entirely of littoral habitat (Figure III-9). The maximum depth recorded was 1.2 m during the spring and late summer surveys.

The shore slope was shallow and the waterbody was surrounded by a wide band of grasses and forbs within a coniferous forest. The bed substrate was comprised entirely of silt. Submergent and emergent vegetation were abundant during the late summer survey, consisting of bulrushes, cattails, pond lily, water weed, water milfoil and pondweed. Four beaver lodges were located along the shoreline of the waterbody during the spring survey. An inlet stream flows into the north shore of the waterbody. This stream consists of a poorly defined channel within the muskeg. The outlet stream flows west from Unnamed Waterbody 12 towards the east shore of Christina Lake. In this area, the stream is fairly wide and deep, allowing fish to move from the waterbody into this stream (see stream site S10 for a description of the stream habitat).

Data from the open-water seasons show that water quality conditions in Unnamed Waterbody 12 are suitable to support fish during the spring and late summer (Table 3-13), with dissolved oxygen levels greater than 6 mg/L in both seasons.

Table 3-13 Seasonal Water Quality Profiles for Unnamed Waterbody 12

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profiles				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB12	winter	0.4	surface	1.3	8.5	165	6.8
			0.4	1.6	8.3	216	6.7
	spring	1.2	surface	11.8	6.4	64	7.5
			0.5	11.5	6.2	69	7.5
			1.0	10.5	6.2	67	7.4
	summer	1.2	surface	13.1	7.4	66	6.9
			0.5	13.1	7.4	66	6.9
			1.0	13.2	6.9	66	7.4
			1.2	13.2	7.2	147	6.6

(a) See Figure 2-1 for site locations.

Fish Population

Baseline fisheries inventory sampling in Unnamed Waterbody 12 captured seven northern pike in gill nets and 185 brook stickleback in minnow traps.

Numbers of fish recorded by species and life stage are presented in Table 3-5 and CPUE data are presented by sampling technique in Table 3-6. The northern pike ranged in fork length from 355 to 474 mm and weight from 390 to 1,030 g. Brook stickleback were also captured in the inlet stream, close to the confluence with Unnamed Waterbody 12. No fish were observed during winter under-ice video.

Fish Habitat Suitability

Although the waterbody had shallow water depths below the ice, dissolved oxygen levels were high, indicating that the waterbody may provide suitable overwintering habitat for forage fish, suckers and sport fish. The waterbody provides suitable shallow water habitat for nursery, rearing and feeding for forage fish, suckers and sport fish species, such as northern pike. Northern pike spawning habitat was present in nearby stream habitat, as well as potentially in shoreline vegetation.

The habitat use potential of Unnamed Waterbody 12 was rated as follows:

- sport fish (northern pike) – low to moderate for all life stages;
- suckers – nil to low for all life stages; and
- forage fish – moderate to high for all life stages (species that spawn on vegetation or fine sediments).

Unnamed Waterbody 13

Unnamed Waterbody 13 is a very small, shallow waterbody located in the headwaters of a tributary which flows into the unnamed tributary to the east shore of Christina Lake. The waterbody is partially located within the lease boundary. Unnamed Waterbody 13 was approximately 0.3 km long and 0.2 km wide, with a surface area of 12.1 ha.

Fish Habitat

Winter Habitat Survey

During the winter survey of Unnamed Waterbody 13, the ice thickness was 0.5 m, with a mean under under-ice water depth of 0.2 m (Table 3-14). No winter water quality measurements could be taken due to the shallow under-ice depth. Due to the extremely shallow water depths below the ice and the low dissolved oxygen levels measured in the spring, it is probable that winter oxygen depletion occurs in this waterbody. Therefore, it is likely that the waterbody would only provide suitable overwintering habitat for species, such as brook stickleback, that are tolerant of low oxygen levels. The shallow depths and

potential for anoxic conditions would not make it suitable as overwintering habitat for suckers or sport fish.

Seasonal Habitat Survey

This waterbody is very shallow, with a maximum recorded depth of 0.8 m during the spring survey and 1.0m during the lake summer survey and 1.0 m during the late summer survey (Figure III-10).

The waterbody was located in muskeg, with a wide band of sedges within a coniferous forest. The bed substrate was comprised entirely of silt. Emergent vegetation is also present near the northwest shore and by the outlet stream, primarily consisting of bulrushes and cattails. Both the inlet stream and the outlet stream are fairly wide streams flowing within the muskeg, with extensive beaver activity (dams and debris piles), causing ponding and potential impediments to fish migration.

Data from the open-water seasons show that water quality conditions in Unnamed Waterbody 13 are suitable to support fish during the spring and late summer (Table 3-14). Dissolved oxygen levels were fairly low in the spring (4.2 mg/L), but higher in the late summer (> 11 mg/L).

Table 3-14 Seasonal Water Quality Profiles for Unnamed Waterbody 13

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profile				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB13	winter	0.2	surface	-	-	-	-
	spring	0.8	0.7	15.5	4.2	159	7.9
	summer	1.0	surface	15.7	11.3	140	9.0
			0.5	15.6	11.6	139	9.1
			1.0	15.1	*14.5*	136	9.4

(a) See Figure 2-1 for site locations.
Note - = Not measured.
Italics indicate questionable data.

Fish Population

A total of 43 brook stickleback was captured in minnow traps during baseline spring and late summer sampling in Unnamed Waterbody 13 (Table 3-5). CPUE data are presented in Table 3-6. No fish were captured in gill nets set in the waterbody.

Fish Habitat Suitability

Unnamed Waterbody 13 was considered to have suitable habitat for forage fish, providing rearing, feeding and spawning habitat. The waterbody was considered to have nil to low potential for use by suckers and sport fish species, such as northern pike. Although the waterbody may provide suitable rearing habitat in the open-water seasons, the waterbody was extremely shallow (<0.8 m) with the potential for winter oxygen depletion, which would limit the overwintering potential for suckers and sport fish (northern pike).

The habitat use potential of Unnamed Waterbody 13 was rated as follows:

- sport fish (northern pike) – nil for overwintering, low for spawning, nursery, rearing and feeding;
- suckers – nil to low for all life stages; and
- forage fish – low for overwintering, low to moderate for spawning, nursery, rearing and feeding (species that spawn on vegetation or fine sediments).

Unnamed Waterbody 15

Unnamed Waterbody 15 is a very small isolated waterbody located to the southwest of Unnamed Waterbody 8. Unnamed Waterbody 15 was approximately 0.3 km long and 0.2 km wide, with a surface area of 3.7 ha.

Fish Habitat

Winter Habitat Survey

The winter survey determined that overwintering habitat in Unnamed Waterbody 15 was limited. The ice thickness was 0.65 m and the under-ice water depth was 0.4 m. The winter dissolved oxygen concentration was low at 1.8 mg/L (Table 3-15). The waterbody would only provide suitable overwintering habitat for species, such as brook stickleback, that are tolerant of low dissolved oxygen concentrations. The shallow depths and near anoxic conditions would not make it suitable as overwintering habitat for suckers and sport fish.

Seasonal Habitat Survey

This waterbody is shallow with a recorded maximum depth of 1.4 m during the late summer survey (Figure III-11).

The shore slope was shallow and the waterbody was surrounded by a narrow band of grasses and shrubs within a black spruce forest. The bed substrate was comprised entirely of silt. Submergent and floating-leaved vegetation, including

pond lily, pondweed and water weed, were abundant during the summer survey. No inlet or outlet streams were evident at the time of the survey.

Water quality data show that conditions in Unnamed Waterbody 15 are suitable to support fish during late summer (Table 3-15), with dissolved oxygen levels > 9 mg/L.

Table 3-15 Seasonal Water Quality Profiles for Unnamed Waterbody 15

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profiles				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB15	winter	0.4	surface	1.1	1.8	275	7.3
	summer	1.4	surface	14.8	9.6	108	7.6
			0.5	14.6	9.4	108	7.6
			1.3	14.0	9.5	108	7.4

(a) See Figure 2-1 for site locations.

Fish Population

No fish were captured in gill nets or minnow traps set in Unnamed Waterbody 15 during baseline fish sampling in late summer (Table 3-5).

Fish Habitat Suitability

Although no fish were captured during baseline sampling, Unnamed Waterbody 15 was considered to have suitable habitat for forage fish. However, due the small size, shallow depth (<1.5 m) and lack of inlet or outlet streams, the waterbody likely does not provide suitable habitat for suckers and sport fish, such as northern pike. Although the waterbody may provide suitable shallow water rearing and feeding habitat during open-water seasons, the waterbody did not have suitable conditions for suckers or sport fish overwintering.

The habitat use potential of Unnamed Waterbody 15 was rated as follows:

- sport fish (northern pike) – nil for overwintering, nil to low for spawning, low to moderate for nursery, rearing and feeding;
- suckers – nil to low for all life stages; and
- forage fish – low for overwintering, low to moderate for spawning, nursery, rearing and feeding (species that spawn on vegetation or fine sediments).

Unnamed Waterbody 16

Unnamed Waterbody 16 is a very small isolated waterbody towards the north end of the lease. It is one of the deepest waterbodies in the Project area, with a maximum recorded depth of 3.8 m during the summer survey (Figure III-12). Unnamed Waterbody 16 was approximately 0.3 km long and 0.2 km wide, with a surface area of 3.8 ha.

Fish Habitat

Winter Habitat Survey

During the winter survey at Unnamed Waterbody 16, the ice thickness was 0.6 m and the under-ice water depth was 3.2 m. The winter dissolved oxygen concentration ranged from 11.0 mg/L at the surface to 5.5 mg/L near the bottom of the waterbody (Table 3-16). Water depths and winter dissolved oxygen levels were sufficient for overwintering by sport fish, suckers and forage fish.

Seasonal Habitat Survey

The shore slope was shallow and the waterbody was surrounded by a wide band of sedges and grasses within a coniferous forest. The bed substrate was comprised entirely of silt. Emergent vegetation consisting of bulrushes and cattails was present along the shoreline. No defined inlet or outlet streams were evident at the time of the survey.

Water quality data show that water quality conditions in Unnamed Waterbody 16 were suitable to support fish during late summer (Table 3-16). Dissolved oxygen levels were greater than 8 mg/L at the surface, with oxygen depletion near the bottom (1.0 mg/L). Temperatures ranged from 9.1 mg/L near the bottom to >14 mg/L at the surface.

Fish Population

No fish were captured in Unnamed Waterbody 16 during baseline fish sampling in late summer (Table 3-5). No fish were observed during winter under-ice video.

Table 3-16 Seasonal Water Quality Profiles for Unnamed Waterbody 16

Site ID[(a)]	Season	Water Depth of Profile (m)	Water Quality Profiles				
			Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
WB16	winter	3.2	0.5	0.5	11.0	79	6.8
			1.0	0.3	9.5	81	6.7
			1.5	2.5	6.2	87	6.6
			2.0	2.9	5.7	94	6.7
			2.5	3.3	5.6	102	6.7
			3.0	3.5	5.5	115	6.8
	summer	3.8	surface	14.4	8.6	52	6.7
			0.5	14.4	8.5	51	6.6
			1.0	13.7	8.0	51	6.5
			1.5	13.5	7.8	52	6.4
			2.0	13.3	7.4	52	6.4
			3.0	9.7	1.6	91	6.3
			3.5	9.1	1.0	101	6.3

(a) See Figure 2-1 for site locations.

Fish Habitat Suitability

Although no fish were captured during baseline sampling, Unnamed Waterbody 16 was considered to have suitable habitat for sport fish (northern pike), suckers and forage fish, providing rearing, feeding and overwintering habitat. Potential sucker and sport fish overwintering habitat may be present in the waterbody due to the depth and high winter dissolved oxygen levels. Sport fish (northern pike) spawning habitat would be limited to inundated shoreline vegetation, as there is no stream habitat present.

The habitat use potential of Unnamed Waterbody 16 was rated as follows:

- sport fish (northern pike) – low for spawning and overwintering, moderate for nursery, rearing and feeding;
- suckers – nil to low for all life stages; and
- forage fish – moderate for all life stages (species that spawn on vegetation or fine sediments).

3.1.2.2 Watercourses

Tributary to the North Bay of Christina Lake ("Sawbones Creek")

"Sawbones Creek" is a moderately-sized, low-gradient watercourse located in a boreal forest setting.

Fish Habitat

Winter Habitat Survey

"Sawbones Creek" was surveyed at three sites (S1, S4 and S5) to assess winter fish habitat suitability. The winter field survey determined that overwintering habitat within the creek was primarily limited to the lower reach. The most downstream site (S1A) was not sampled in the winter due to safety concerns.

Site S1 was located approximately 1.2 km upstream from Christina Lake, at an existing road crossing. The discharge of the creek at Site S1 at the time of the survey was approximately 0.04 m^3/s (Table 3-17) and the mean ice thickness ranged from 0.2 to 0.5 m. The habitat at the survey site was comprised of run, with a wetted width of 6.4 m. The maximum under-ice water depth was 0.8 m located towards the middle of the channel. Mean velocities in the run habitat were less than 0.07 m/s. Water quality sampling indicated that dissolved oxygen levels were fairly high at 8.3 mg/L (Table 3-17). The stream was full of slush ice.

Farther upstream at Site S4, located in the middle reaches of the tributary, the watercourse was frozen to the substrate across the transect, providing no potentially suitable overwintering habitat. The wetted width of the creek was 7.5 m, with ice thickness ranging from 0.3 to 0.5 m.

Site S5 was located just downstream of Unnamed Waterbody 6. At this survey site, the watercourse was 6.8 m in wetted width and comprised of flat habitat. Ice thickness ranged from 0.2 to 0.4 m, with a maximum under-ice water depth of 0.4 m. Water was present at this site but there was no measurable discharge, with mean flow velocities less than 0.02 m/s. At this site, oxygen depletion was present, with dissolved oxygen levels of 2.2 mg/L (Table 3-17). At these dissolved oxygen levels and shallow water depths, overwintering at this site would likely be limited to those forage fish species tolerant of low dissolved oxygen levels.

Table 3-17 Discharge and Seasonal Water Quality for Sample Sites in the Tributary to the North Bay of Christina Lake ("Sawbones Creek")

Location in Tributary	Site ID[(a)]	Season	Discharge (m^3/s)	Water Quality Field Parameters			
				Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
lower reaches	S1A	summer	-	15.5	10.6	70	8.1
	S1	winter	0.041	-0.2	8.3	197	7.1
		spring	0.749	5.2	9.3	103	7.3
		summer	NDF	13.8	10.2	93	7.2
middle reaches	S4	winter	n/a	n/a	n/a	n/a	n/a
		spring	-	3.8	7.5	53	6.6
		summer	-	13.7	8.9	87	6.7
upper reach	S5	winter	-0.007	0.1	2.2	109	7.3
		spring	-	13.5	3.6	55	7.0
		summer	NDF	12.5	3.7	55	6.1

[(a)] See Figure 2-1 for site locations.
n/a = not applicable, watercourse frozen to substrate.
"-" = Not sampled, conditions not appropriate.
NDF = No detectable flow.

Seasonal Habitat Survey

The lower reach near the confluence with Christina Lake is wide, run habitat with a well defined channel. This lower reach was surveyed for approximately 1 km, upstream from Christina Lake to near Site S1 at the existing road crossing. Farther upstream, in the middle reaches of the tributary, beaver dams were present, causing braiding, impounded areas and sections of undefined channel. Data from the open-water seasons show that water quality conditions in "Sawbones Creek" are suitable to support fish during the spring and late summer at all sites (Table 3-17). However, some oxygen depletion was present at Site S5, located in the upper reach, during both seasons, with dissolved oxygen levels of 3.6 mg/L in spring and 3.7 mg/L in summer.

Spring spawning surveys were conducted at the watercourse sampling sites in "Sawbones Creek". Sampling of aquatic vegetation was conducted where areas of suitable northern pike spawning habitat occurred (i.e., low velocity areas with inundated vegetation). No eggs were observed or collected and no spawning activity was recorded during the surveys. No suitable habitat was observed at the sampling sites in "Sawbones Creek" for spring spawning fish species that spawn on gravel substrate (i.e., Arctic grayling, white sucker).

Site S1A

Upstream of the confluence with Christina Lake, "Sawbones Creek" is comprised of wide, deep run habitat. Flows and water levels in the lower portion of Site S1A are influenced by seasonal backflooding in Christina Lake. Bankfull widths ranged from 15 to 25 m just upstream of Christina Lake, with depths ranging from 0.6 m to approximately 2 m in depth. Substrate was comprised entirely of silt. Cover was provided by overhanging grasses and shrubs, instream vegetation and large organic debris. Beaver activity was present, consisting of a beaver lodge, beaver dams and debris piles. In the spring, inundated grasses and sedges were abundant along the stream margins. Riparian vegetation consisted of grasses and forbs, within a coniferous forest.

Site S1

Site S1 was located approximately 1.2 m upstream of Christina Lake at an existing road crossing. At this site, the tributary had a bankfull width of approximately 8.2 m, with a wetted width of 5.6 m. Channel morphology consisted of fairly deep run. During the late summer survey, the average water depth was 1.2 m, with a maximum depth of 2.0 m. Velocities were less than 0.3 m/s in the spring, with a discharge of approximately 0.75 m^3/s, and no detectable flow in summer (Table 3-17). Bed and bank materials were comprised entirely of silt. Cover was provided mainly by overhanging and instream vegetation and large organic debris (large and small woody debris, debris piles and root wads). In the spring, inundated grasses and sedges were abundant in the stream and along the margins. During the late summer survey, submergent aquatic vegetation was present, including water weed and water milfoil. Riparian vegetation consisted of grasses and forbs, within a coniferous forest.

Site S4

Site S4 was located in the middle reaches of "Sawbones Creek". At Site S4, channel morphology was primarily composed of shallow slow-moving run, with some shallow pool habitat present behind breached beaver dams. Due to abundant beaver activity, multiple braided channels were present flowing through the muskeg. In a section of defined channel, the bankfull width was approximately 4.6 m, with a wetted width of 2.7 m in late summer. During the summer survey, the average water depth was 0.4 m, with a maximum depth of 1.0 m measured in impoundments. Flows were low, with velocities ranging from 0 to 0.09 m/s in summer. Bed and bank substrate was comprised entirely of silt. Cover was limited, and provided primarily from debris piles, instream vegetation and overhanging shrubs and grass. The riparian vegetation consisted of grasses and shrubs, within a black spruce forest. Beaver activity was abundant, with the presence of dams and debris piles causing numerous impediments to fish migration throughout the surveyed section.

Site S5

Site S5 was located in the upper reach of "Sawbones Creek", within 1 km of Unnamed Waterbody 6. Channel morphology at Site S5 was primarily composed of flat (i.e., low velocity and near laminar flow). Flows were low and not measurable. In the spring, the bankfull and wetted widths ranged from approximately 1.3 to 5.2 m, with maximum water depths of approximately 0.85 m. Bed and bank substrate were comprised entirely of silt. Cover was provided mainly by overhanging grasses and emergent vegetation (cattails). Riparian vegetation consisted of grasses and shrubs, within a black spruce forest. Access to this site was available from Unnamed Waterbody 6 located just upstream at the headwaters of "Sawbones Creek".

Fish Population

Walleye was the only fish species captured in "Sawbones Creek" for all sites combined. Numbers of fish recorded by species and life stage are presented in Table 3-18 and CPUE data are presented by sampling technique in Table 3-19. Two adult walleye were captured in Site S1A upstream of Christina Lake during portable boat electrofishing in spring. The walleye were 434 mm and 381 mm in fork length. Northern pike, white sucker, and additional walleye were observed but not captured during sampling at this site.

No fish were captured at any of the upstream sites in "Sawbones Creek" during spring and summer baseline surveys. However, in the spring, five adult northern pike were observed stacked up below a 1 m beaver dam in an unnamed tributary which flows into "Sawbones Creek" between sites S1 and S4. Juvenile fish (believed to be northern pike juveniles) were observed in a shallow pool during the late summer survey at Site S4, but were not captured.

Due to barriers to fish passage and sections of undefined channel in the middle and upper reaches, the use of this watercourse by northern pike and walleye from Christina Lake would be limited to the lower reaches. Northern pike were also captured in Unnamed Waterbody 6 located at the headwaters of this watercourse. Northern pike from Unnamed Waterbody 6 likely use the upper reach of this watercourse seasonally (i.e., in the area of Site S5). Once again, the numerous barriers in the middle reaches of the tributary would impede fish movement throughout the tributary.

Fish Habitat Suitability

The habitat use potential in "Sawbones Creek" varied by reach. The lower reach, upstream from Christina Lake had a wide, well defined channel and was accessible to fish from Christina Lake. Habitat limitations were present in the middle and upper reaches, including poor habitat diversity, limited fish passage due to beaver dams and sections of undefined channel, and poor water quality.

Emergent and submergent vegetation was present at all sites surveyed in the watercourse, which may provide northern pike spawning and juvenile rearing habitat. The presence of beaver dams may prevent pike from accessing potential habitat in the upper watershed.

The habitat use potential for "Sawbones Creek" was rated as follows:

- sport fish (northern pike):
  - lower reaches (Sites S1A and S1): low for overwintering, moderate for spawning, nursery, feeding and rearing;
  - middle reaches (Site S4): nil for overwintering, nil to low for spawning, nursery, feeding and rearing; and
  - upper reach (Site S5): nil to low for overwintering, low to moderate for spawning, nursery, feeding and rearing.
- sport fish (walleye):
  - lower reaches (Site S1A and S1): low for overwintering and spawning, low to moderate for nursery, feeding and rearing;
  - middle reaches (Site S4): nil for overwintering, nil to low for spawning, nursery, feeding and rearing; and
  - upper reach (Site S5): nil to low for spawning and overwintering, low for nursery, feeding and rearing.
- suckers:
  - lower reaches (Sites S1A and S1): low for overwintering, nil to low for spawning, moderate for nursery, feeding and rearing;
  - middle reaches (Site S4): nil for overwintering, nil to low for spawning, nursery, feeding and rearing; and
  - upper reach (Site S5): nil to low for overwintering and spawning, low to moderate for nursery, feeding and rearing.
- forage fish: moderate to high for spawning, nursery, feeding and rearing and low to moderate for overwintering in all reaches (species that spawn on vegetation or fine sediments).

Table 3-18 Fish Species Captured at Watercourse Sample Sites

Tributary Watershed	Site ID[a]	Season	Number of Fish by Species and Life Stage[b]							Total Fish Captured
			Sport Fish			Suckers			Forage Fish	
			Walleye			White Sucker			Brook Stickleback	
			F	J	A	F	J	A		
"Sawbones Creek"	S1A	spring[c]	0	0	2	0	0	0	0	2
		summer[d]	0	0	0	0	0	0	0	0
		species total	**2**			**0**			**0**	**2**
	S1	winter	0	0	0	0	0	0	0	0
		spring	0	0	0	0	0	0	0	0
		summer	0	0	0	0	0	0	0	0
		species total	**0**			**0**			**0**	**0**
	S4	spring	0	0	0	0	0	0	0	0
		summer	0	0	0	0	0	0	0	0
		species total	**0**			**0**			**0**	**0**
	S5	spring	0	0	0	0	0	0	0	0
		summer	0	0	0	0	0	0	0	0
		species total	**0**			**0**			**0**	**0**
unnamed tributary to the east shore of Christina Lake	S6	spring	0	0	0	0	0	0	0	1
		summer	0	0	0	0	0	1	0	0
		species total	**0**			**1**			**0**	**2**
	S7	winter	0	0	0	0	0	0	0	0
		spring	0	0	0	0	0	0	0	0
		summer	0	0	0	0	0	0	0	0
		species total	**0**			**0**			**0**	**0**
	S8	spring	0	0	0	0	0	0	1	1
		summer	0	0	0	0	0	0	0	0
		species total	**0**			**0**			**1**	**1**
	S10	spring	0	0	0	0	0	0	2	0
		summer	0	0	0	0	0	0	1	0
		species total	**0**			**0**			**3**	**0**
	S9 (tributary)	spring	0	0	0	0	0	0	0	**0**
		summer	0	0	0	0	0	0	0	0
		species total	**0**			**0**			**0**	**0**
unnamed tributaries to Christina River	S14	spring	0	0	0	0	0	0	0	0
		summer	0	0	0	0	0	0	0	0
		species total	**0**			**0**			**0**	**0**
	S15	spring	0	0	0	0	0	0	0	**0**
		summer	0	0	0	0	0	0	0	0
		species total	**0**			**0**			**0**	**0**
proposed watercourse crossings	CR-1	summer	0	0	0	0	0	0	**0**	**0**
	CR-2	summer	0	0	0	0	0	0	**6**	**0**
total			**2**			**1**			**10**	**7**

(a) See Figure 2-1 for site locations.
(b) Life Stage: F = Fry, J = Juvenile, A = Adult.
(c) Two walleye and 4 northern pike observed but not captured during electrofishing.
(d) White sucker and northern pike observed but not captured during electrofishing.

Table 3-19 Catch-Per-Unit-Effort for Watercourse Sample Sites (Winter, Spring and Summer 2004)

Watercourse	Season	Sport Fish	Suckers	Forage Fish	Total
		Walleye	White Sucker	Brook Stickleback	
Boat Electrofishing [Number/100 s]					
"Sawbones Creek"[a]	spring	0.41	o	0	0.41
	summer	0	0	0	0.00
Unnamed Tributary to the East Shore of Christina Lake[b]	summer	0	0.31	0	0.31
Backpack Electrofishing [Number/100 s]					
"Sawbones Creek"[c]	spring	0	0	0	0.00
	summer	0	0	0	0.00
Unnamed Tributary to the East Shore of Christina Lake[d]	spring	0	0	0.32	0.32
	summer	0	0	0.10	0.10
Unnamed Tributary to Christina River (Site S14)	spring	0	0	0	0.00
	summer	0	0	0	0.00
Unnamed Tributary to Christina River (Site S15)	spring	0	0	0	0.00
	summer	0	0	0	0.00
Proposed Watercourse Crossing (CR-1)	summer	0	0	0	0.00
Proposed Watercourse Crossing (CR-2)	summer	0	0	2.59	2.59
Gill Net [Number/panel-hr]					
"Sawbones Creek"[e]	spring	0	0	0	0.00
	summer	0	0	0	0.00
Unnamed Tributary to the East Shore of Christina Lake[f]	spring	0	0	0	0.00
Minnow Trap [Number/trap-hr]					
"Sawbones Creek"[c]	winter (S1)	0	0	0	0.00
	spring	0	0	0	0.00
	summer	0	0	0	0.00
Unnamed Tributary to the East Shore of Christina Lake[d]	winter (S7)	0	0	0	0.00
	spring	0	0	0	0.00
	summer	0	0	0	0.00
Proposed Watercourse Crossing (CR-2)	summer	0	0	0	0.00

[a] Site S1A only.
[b] Site S6 only.
[c] Sites S1, S4 and S5.
[d] Sites S7, S8, S10 and S9.
[e] Site S5 only.
[f] Sites S6, S7, S8.

Tributary to the East Shore of Christina Lake

The unnamed tributary to the east shore of Christina Lake is a moderately-sized, low-gradient watercourse located in a boreal forest setting.

Fish Habitat

Winter Habitat Survey

The unnamed watercourse which flows into the east shore of Christina Lake was surveyed at two sites (S7 and S8) to assess winter fish habitat suitability, as well as a tributary site S9. The lower reach of the watercourse, near the confluence with Christina Lake (Site S6) was not surveyed in the winter due to safety concerns, because of the presence of open water on Christina Lake. However, some suitable over-wintering habitat may be present in the beaver impoundments in this reach.

At Site S7, located in the middle reaches of the unnamed watercourse, the discharge at the time of the survey was approximately 0.195 m^3/s and the mean ice thickness ranged from 0.3 to 0.6 m. The habitat at the survey site was comprised of run, with a wetted width of 7.2 m. The maximum under-ice water depth was 0.7 m; however, the watercourse was partially frozen to the substrate along the transect. Mean velocities in the run habitat were less than 0.15 m/s. Dissolved oxygen levels were high at 11.2 mg/L (Table 3-20).

Farther upstream at Site S8, the watercourse was frozen to the substrate at several locations, with layers of shelf ice present. At a site used for water withdrawal at the bridge crossing, the dissolved oxygen level was 9.0 mg/L (Table 3-20). Limited overwintering habitat appears to be available at this location. Site S10 was not surveyed during the winter.

Site S9 was located on an unnamed tributary. Water was present at this site but there was no measurable discharge. Ice thickness ranged from 0.2 to 0.6 m, with a maximum under-ice water depth of 0.2 m. The watercourse was partially frozen to the substrate along the transect. Some oxygen depletion was measured, with dissolved oxygen levels at 4.6 mg/L (Table 3-20). Due to the shallow water depths and low dissolved oxygen levels, over-wintering at this site would be limited to forage fish.

Table 3-20 Discharge Measurements and Seasonal Water Quality for Sample Sites in the Tributary to the East Shore of Christina Lake

Location in Tributary	Site ID[(a)]	Season	Discharge (m^3/s)	Water Quality Field Parameters			
				Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
Lower Reach	S6	spring	-	8.2	9.1	184	7.6
		summer	NDF	12.4	7.9	242	7.5
Middle Reaches	S7	winter	0.195	-0.2	11.2	204	6.4
		spring	0.298	7.4	6.5	153	7.7
		summer	NDF	11.0	10.7	273	7.6
	S8	winter	-	-0.2	9.0	212	7.1
		spring	0.087	5.4	7.1	103	7.0
		summer	0.005	12.2	10.2	240	7.1
Upper Reach	S10	spring	NDF	6.1	9.6	99	6.9
		summer	NDF	13.2	4.9	103	6.6
Tributary to Middle Reaches	S9	winter	-	-0.1	4.6	533	6.8
		spring	-	9.1	5.1	144	7.4
		summer	0.003	9.3	9.0	224	7.2

[(a)] See Figure 2-1 for site locations.
n/a = not applicable, watercourse frozen to substrate.
"-" = Not sampled, conditions not appropriate.
NDF = No detectable flow.

Seasonal Habitat Survey

The lower reach of the unnamed tributary near the confluence with Christina Lake (Site S6) consists of run habitat interspersed by large beaver impoundments. Beaver activity is abundant and multiple beaver dams impede fish migration into this tributary from Christina Lake. Farther upstream, in the middle (Sites S7 and S8) and upper reaches of the tributary (Site S10), the watercourse was comprised primarily of run habitat with defined banks and silt substrate. Beaver activity continued to be present, causing some sections with poorly defined banks. Although beaver activity is less abundant in the middle and upper reaches, potential impediments to migration were present in all reaches of the tributary.

Data from the open-water seasons show that water quality conditions in the unnamed tributary to the east shore of Christina Lake are suitable to support fish during the spring and late summer at all sites (Table 3-20). However, some oxygen depletion was present at S10 during the late summer with dissolved oxygen levels of 4.6 mg/L, and at the tributary site (S9) in the spring (5.1 mg/L).

Spring spawning surveys were conducted at the sampling sites in the unnamed tributary; sampling of aquatic vegetation was conducted where areas of suitable northern pike spawning habitat occurred. No eggs were observed or collected and no spawning activity was recorded during the surveys. No suitable habitat was observed at the survey sites for spring spawning fish species that spawn on gravel substrate (i.e., Arctic grayling, white sucker).

Site S6

Site S6 was located in the lower reach of the unnamed tributary, upstream from Christina Lake. Channel morphology at this site consists of run habitat interspersed by large beaver impoundments. Substrate consisted entirely of silt in both channelized (run habitat) and poorly defined or undefined sections (beaver impounded areas). Flows were very low, with no detectable flow in summer (Table 3-20). Wetted widths ranged from approximately 6 m in channelized sections to greater than 14 m in impounded sections. Maximum depths in the impounded areas were greater than 1.5 m. Cover was provided primarily by overhanging grass and shrubs, instream vegetation and depths in the impoundments. Aquatic vegetation present during the late summer survey included water weed and water milfoil.

Site S7

Site S7 was located in the middle reaches of the unnamed watercourse, approximately 3.5 km upstream of Christina Lake. At this site, channel morphology primarily consisted of run habitat, with some beaver impounded areas present. Bankfull and wetted widths were approximately 5.3 and 3.5 m during the late summer survey. Mean water depth in summer was 0.8 m, with maximum depths greater than 1.5 m. In spring, velocities ranged from 0.03 to 0.34 m/s, with a discharge of 0.298 m^3/s; in late summer, stream flow was low, with velocities less than 0.01 m/s (Table 3-20). Bed and bank materials were comprised entirely of silt. Cover was limited and provided mainly by overhanging grasses and shrubs, with some undercut bank, and large organic debris present. Riparian vegetation consisted of grasses and willows, within a black spruce forest.

Site S8

Site S8 was also located in the middle reaches of the unnamed tributary, approximately 3.5 km upstream of Site S7. At Site S8, the watercourse consisted of an unconfined meandering stream flowing through a black spruce muskeg area. Channel morphology consisted of run habitat, with mean and maximum water depths of 0.75 m and 1.5 m, respectively during the spring survey. Flows were low, with an approximate discharge of 0.087 m^3/s in spring and 0.005 m^3/s in summer (Table 3-20). Bankfull widths ranged from 5.2 to 6.4 m, with wetted widths ranging from 2.1 to 5.7 m. Bed and bank materials were comprised

entirely of silt, with average bank heights of 0.75 m. Cover was limited and provided mainly by large organic debris and overhanging shrubs, with some undercut bank and inundated vegetation present. Riparian vegetation consisted of grasses and willows, within a black spruce forest.

Site S10

Site S10 was located in the upper reach, approximately 1 km downstream of Unnamed Waterbody 12. In this area, the stream had an irregular meandering pattern flowing through a muskeg area. Channel morphology consisted of moderate quality run and flat habitats, with a maximum water depth of 1.0 m during the spring survey. Bankfull and wetted widths ranged from 5.2 to 7.9 m. Flows were low, with no measurable velocity. Bed and bank materials were comprised entirely of silt, with a mean bank height of 0.65 m. Instream cover was provided mainly by aquatic macrophytes and limited amounts of large organic debris. Inundated sedge vegetation was present along the edges of the stream. A series of old beaver dams was present in the surveyed section. Riparian vegetation consisted of willows and grasses, within a black spruce forest.

Site S9 (tributary)

Site S9 was located on an unnamed tributary flowing into the middle reaches of the tributary to the east shore of Christina Lake, between Sites S7 and S8. Channel morphology at Site S9 was composed of poor quality run and beaver impoundments. Sections of undefined channel were present as a result of the heavy beaver activity. Substrate was comprised entirely of silt. Cover for fish was provided mainly by overhanging vegetation and woody debris. Riparian vegetation consisted of grasses and shrubs within the muskeg, surrounded by coniferous forest.

Fish Population

Two fish species were captured in the unnamed tributary to the east shore of Christina Lake for all sites combined, and included white sucker and brook stickleback. Numbers of fish recorded by species and life stage are presented in Table 3-18 and CPUE data are presented by sampling technique in Table 3-19.

One white sucker (310 mm fork length, 410 g) was captured by portable boat electrofishing at Site S6.

No fish were captured farther upstream at Site S7 during spring or summer sampling, and no fish were observed during winter under-ice video at Site S7. However, a dead adult northern pike was observed partially submerged in the

substrate at Site S7 during spring, indicating that this species is present in the watercourse.

Brook stickleback was the only species captured in the upper watershed (Sites S8 and S10) (Table 3-18, Table 3-19). However, northern pike were captured in Unnamed Waterbody 12 located at the headwaters of this tributary (i.e., upstream of Site S10).

Fish Habitat Suitability

The habitat use potential in the unnamed tributary to the east shore of Christina Lake varied by reach. Impediments to fish migration were present throughout the watershed, with multiple beaver dams present impeding fish migration from Christina Lake.

The habitat use potential for the unnamed tributary to the east shore of Christina Lake was rated as follows:

- sport fish (northern pike):
  - lower reach (Site S6): low for overwintering, low to moderate for spawning, nursery, feeding and rearing;
  - middle reaches (Site S7): low for overwintering, moderate for spawning, nursery, feeding and rearing;
  - middle reaches (Site S8): nil to low for overwintering, low to moderate for spawning, nursery, feeding and rearing; and
  - upper reach (Site S10): low for overwintering, moderate for spawning, nursery, feeding and rearing.
- suckers:
  - lower reach (Site S6): low for overwintering, nil to low for spawning, low to moderate for nursery, feeding and rearing;
  - middle reaches (Site S7): low for overwintering, nil to low for spawning, moderate for nursery, feeding and rearing;
  - middle reaches (Site S8): nil to low for overwintering and spawning, low to moderate for nursery, feeding and rearing; and
  - upper reach (Site S10): low for overwintering, nil to low for spawning, moderate for nursery, feeding and rearing.
- forage fish: moderate to high for spawning, nursery, feeding and rearing and low to moderate for overwintering in all reaches (species that spawn on vegetation or fine sediments).

Tributaries to Christina River

Fish Habitat

Winter Habitat Survey

Surveys were conducted on two small, first-order unnamed tributaries to the Christina River that flow northwards from the north end of the lease. The survey location for both of these unnamed tributaries was near the Secondary Highway 881 crossing.

During the winter habitat survey, both watercourses were frozen to the substrate at the survey locations. The wetted widths at Site S14 ranged from 3.1 to 3.9 m. Ice thicknesses ranged from 0.4 to 0.9 m (downstream of the culvert at Secondary Highway 881). At Site S15, the wetted width was 2.2 m and the ice thickness was 0.3 m. As both watercourses were frozen to the substrate, no overwintering habitat was present at these survey sites.

Seasonal Habitat Survey

Site S14

The unnamed tributary to the Christina River at Site S14 was surveyed at the Secondary Highway 881 crossing. At Site S14, the watercourse consisted of a narrow (<1.5 m), shallow well defined channel. Downstream of the culvert at Secondary Highway 881, the channel width was approximately 4 m, with the width decreasing to less than 1.5 m farther downstream. Channel morphology was composed of shallow low quality run and riffle. Mean and maximum depths were 0.15 and 0.4 m, respectively. Flows were low, with an approximate discharge of 0.02 m^3/s in spring (Table 3-21); in summer, discharge was not measurable, with velocities less than 0.01 m/s. Substrate was predominantly silt, with some cobbles present. Overhanging vegetation was abundant. Cover was provided by overhanging shrubs, large organic debris (debris piles, root wads and large woody debris) and some undercut banks. Riparian vegetation consisted of grasses and shrubs, within a coniferous forest. During the spring survey, the stream was frozen to the substrate approximately 75 m upstream and 175 m downstream of the culvert at Secondary Highway 881. Multiple log jams were present causing potential barriers to fish migration.

Water quality data from the open-water seasons show that conditions at Site S14 are suitable to support fish during both seasons, with dissolved oxygen levels of 7.2 mg/L in spring and 8.8 mg/L in late summer (Table 3-21).

Table 3-21 Discharge and Seasonal Water Quality for Sample Sites in Tributaries to the Christina River

Site ID[(a)]	Season	Discharge (m^3/s)	Water Quality Field Parameters			
			Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
S14	winter	n/a	n/a	n/a	n/a	n/a
	spring	0.02	7.8	7.2	191	6.9
	summer	NDF	10.0	8.8	284	7.4
S15	winter	n/a	n/a	n/a	n/a	n/a
	spring	0.025	-	-	-	-
	summer	NDF	7.9	9.0	366	7.9

[(a)] See Figure 2-1 for site locations.
n/a = not applicable, watercourse frozen to substrate.
"-" = Not sampled.
NDF = No detectable flow.

Site S15

The unnamed tributary to the Christina River at Site S15 was surveyed at the Secondary Highway 881 crossing. At Site S15, the watercourse consisted of a narrow (<1.2 m), shallow (< 0.25 m) channel. Channel morphology was primarily composed of shallow riffle, with mean and maximum depths of 0.13 m and 0.25 m, respectively. Flows were low, with an approximate discharge of 0.025 m^3/s in spring (Table 3-20); in summer, discharge was not measurable, with velocities less than 0.03 m/s. Substrate was primarily silt, with some cobbles present downstream of the culvert at Secondary Highway 881. Cover for fish was provided mainly by overhanging shrubs, and large organic debris (debris piles and large and small woody debris). Riparian vegetation consisted of grasses and shrubs, within a coniferous forest. During the spring survey, the stream was frozen to the substrate approximately 75 m upstream and 300 m downstream of the culvert at Secondary Highway 881.

Water quality data show that conditions at Site S15 are suitable to support fish during the summer, with a dissolved oxygen concentration of 9.0 mg/L (Table 3-21).

Fish Population

No fish were captured in either of the tributaries to the Christina River at Sites S14 or S15 during fish sampling in spring and summer (Table 3-18).

Fish Habitat Suitability

At Sites S14 and S15, both of these tributaries to the Christina River were considered to have limited habitat for use by forage fish species. Due to the narrow channels and very shallow water depths, these tributaries would not provide suitable habitat for suckers or sport fish at the surveyed locations. There is no access to the survey sites from the Christina River due to sections of subsurface flow.

The habitat use potential for the tributaries to the Christina River (Sites S14 and S15) was rated as follows:

- sport fish – nil for all life stages;
- suckers – nil for all life stages; and
- forage fish – nil to low for all life stages.

Proposed Watercourse Crossings

Fish Habitat

Watercourse Crossing CR-1

The proposed watercourse crossing CR-1 is located on an unnamed tributary to "Sawbones Creek" in the Christina Lake drainage. At the proposed crossing location, the tributary is not mapped on the 1:50,000 NTS map (73 M/10), but is instead shown as a large wetlands.

This watercourse consists of a shallow swale, with terrestrial vegetation (grasses and shrubs) throughout. A shallow wetted area was present, with wetted widths ranging from 1.2 to 3.6 m and water depths ranging to 0.2 m. However, no defined bed or banks were present and no flow was present at the time of the survey.

Watercourse Crossing CR-2

The proposed watercourse crossing CR-2 is located on the upper headwaters of an unnamed tributary, which flows approximately 30 km northeast to Cowper Lake. From Cowper Lake, the Cowper River flows into Winefred River, which is a tributary to the Christina River.

The watercourse consisted of a narrow, fairly shallow channel within a wide bog wetland area. The mean bankfull and wetted width at the crossing site was approximately 1.4 m. The flow was very low and discharge was not measurable. During the late summer survey, the average water depth was 0.3 m, with a maximum depth of 0.48 m. The channel morphology was entirely flat type

habitat (i.e., low velocity and near laminar flow). Bed and bank material consisted entirely of silt. The channel area was inundated with submerged macrophytes and grasses. Riparian vegetation consisted of grasses and forbs, bordered by black spruce and tamarack. Downstream of the all terrain vehicle (ATV) bridge at the existing rights-of-way (ROW), braiding and multiple channels were present within a wide bog area.

Water quality data showed that conditions at CR-2 are suitable to support fish during late summer, with a dissolved oxygen concentration of 7.1 mg/L (Table 3-22).

Table 3-22 Summer Discharge and Water Quality for Proposed Watercourse Crossings

Watercourse	Site ID[(a)]	Discharge (m^3/s)	Water Quality Field Parameters			
			Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH
Unnamed Tributary to "Sawbones Creek"	CR-1	n/a	8.5	6.8	145	6.8
Unnamed Tributary to Cowper Lake	CR-2	NDF	9.5	7.1	160	6.7

[(a)] See Figure 2-1 for site locations.

"-" = Not sampled, conditions not appropriate.

NDF = No detectable flow.

n/a = not applicable.

Fish Population

No fish were captured during electrofishing in the wetted area at CR-1. Six brook stickleback were captured during fish sampling at CR-2 (Table 31, Table 3-19).

Fish Habitat Suitability

Due to the lack of defined bed and banks and the presence of terrestrial vegetation, the habitat use potential at the proposed watercourse crossing CR-1 was rated as follows:

- sport fish – nil for all life stages;
- suckers – nil for all life stages; and
- forage fish – nil for all life stages.

Due to the narrow, shallow channel and limited flow, the fish habitat use potential at the proposed watercourse crossing CR-2 was limited, and was rated as follows:

- sport fish – nil for all life stages;
- suckers – nil for all life stages; and
- forage fish – low for all life stages (species that spawn on vegetation or fine sediments).

Alberta Sustainable Resource Development (ASRD) has developed timing constraints for the ten Fish Management Zones in Alberta (AENV 2000). The two proposed watercourse crossing sites (CR-1 and CR-2) are located within the Fort McMurray Management Area and classified as Class C with a Restricted Activity Period of April 1 to July 15. Restricted activity periods are designed to protect spawning and incubation times, and are times when works that disrupt the bed or banks of a waterbody should be avoided.

3.1.2.3 Species At Risk

No fish species in the Christina Lake watershed or in the oil sands region are on the Canadian Species at Risk list (COSEWIC 2004). This includes the lists of *threatened species*, *endangered species* and *species of special concern*. However, one species listed as *sensitive* (to human activities or natural events) by ASRD (ASRD 2003), Arctic grayling, does occur in the Christina Lake watershed. Arctic grayling are widespread in northern Alberta, but are not abundant, and population declines have been noted over the past 20 to 30 years (ASRD 2003). Increased angler access to remote streams has put pressure on this species; however, legislation introduced in 1998 was designed to protect large fish, which are considered the most vulnerable (ASRD 2003).

Arctic grayling are found in Christina Lake and the Jackfish River (outlet of Christina Lake). They do not occur in any of the unnamed waterbodies, and due to their habitat preferences are unlikely to occur in the tributaries, except near the mouths (i.e., at the confluence with Christina Lake).

3.1.2.4 Benthic Invertebrate Communities

Habitat

Variability in habitat among Christina Lake and small waterbody sites in the Aquatic Resources LSA (Figure 2-1) was moderate (Table 3-23). Conductance and pH were highest in Christina Lake where samples were taken from greater

depths. Light penetration in Christina Lake was too low to determine how much of the substrate was covered in macrophyte growth; however, in the smaller waterbodies, macrophyte coverage was 100 percent.

In most of the waterbodies sampled, silt made up a considerable proportion of the sediment. Sand comprised the greatest proportion of sediment in Christina Lake at Site CL1 and sediment from Site WB6 (unnamed tributary to the east shore of Christina Lake) had proportionally more clay. Carbon content in sediments from the smaller waterbodies was considerably greater than in Christina Lake.

Habitat was similar in the two unnamed streams "Sawbones Creek" (Site S1) and the unnamed tributary to east shore (Site S6) in the Aquatic Resources LSA (Figure 2-1). Stream flow was negligible at each site, depths were reasonably similar, and macrophyte cover was similar in both. Field water quality parameters were comparable, but conductance was higher at Site S6.

Sediment at the stream sites was dominated by sand. The amount of carbon in stream sediments was similar at both sites, with a difference of less than six percent.

Table 3-23 Habitat Characteristics of the Sampling Sites in Waterbodies and Watercourses in the Aquatic Resources Local Study Area

Waterbody/Watercourse	Units	Christina Lake (Site CL1)	Christina Lake (Site CL2)	Unnamed Waterbody 6 (Site WB6)	Unnamed Waterbody 7 (Site WB7)	Unnamed Waterbody 12 (Site WB12)	"Sawbones Creek" (Site S1)	Unnamed Tributary to the East Shore (Site S6)
UTM Locations (NAD 27) and Sampling Date								
easting	-	513900	511500	515340	515450	526595	511511	514816
northing	-	6163800	6165750	6175723	6170023	6168265	6166898	6163877
sampling date	-	26-Aug-04	26-Aug-04	31-Aug-04	31-Aug-04	31-Aug-04	31-Aug-04	31-Aug-04
Field Water Quality Parameters								
dissolved oxygen	mg/L	9.6	10.6	8.3	7.3	7.4	10.2	7.9
conductance	µS/cm	137	70	43	53	66	93	242
pH	-	8.0	8.1	6.9	6.7	6.9	7.2	7.5
water temperature	°C	15.3	15.5	13.1	13.6	13.1	13.8	12.4
mean depth	m	14.6	3.1	1.1	1.0	1.6	2.0	1.5
water velocity	m/s	-	-	-	-	-	n/m	n/m
macrophyte cover	%	n/a[(a)]	na[(b)]	100	100	100	90	80
Sediment Particle Size								
sand	%	29	51	5	13	20	54	42
silt	%	56	38	35	51	64	24	28
clay	%	16	11	61	36	16	22	30
Sediment Carbon Content								
total carbon	%	14.3	14.8	37.8	46.8	43.8	9.2	14.7
total organic carbon	%	14.3	14.5	37.7	46.8	43.8	9.0	14.6
inorganic carbon	%	0.05	0.31	0.06	0.03	0.05	0.12	0.06

[(a)] Water was too deep to determine macrophyte cover.

[(b)] Visibility in water was extremely low.

n/a = not assessed.

n/m = Stream flows were non-measurable.

Community Structure

Attributes of the benthic invertebrate community in 2004 reflect waterbody type, suggesting habitat difference plays a role in community structure. Mean abundance in the smaller waterbodies ranged between 3,100 and 4,600 organisms/m^2, while mean abundance in Christina Lake at sites CL1 and CL2, was above and below this range, respectively (Table 3-24). Total richness was lower in Christina Lake than in the smaller waterbodies. Mean abundance was considerably higher at the stream sites, ranging between 12,300 and 21,700 organisms/m^2. Stream sites S1 and S6 had 24 and 28 taxa, respectively.

Mean abundance of the most dominant taxon was greatest in Christina Lake. Seed shrimp at Site CL1 and nematodes at Site CL2 both made up greater than 56 percent of their respective communities. The group defined as "other" at Site CL1 consisted mainly of copepods (Harpacticoida) (Appendix VI, Table VI-2). A large part of the remaining community at Site CL2 consisted largely of bristle worms (Oligochaeta), midges in the group Orthocladiinae and biting midges (Ceratopogonidae).

In the smaller waterbodies and tributary streams, no group contributed greater than 35 percent (Tables 3-24 and 3-25) of overall mean abundance. Large dominant groups included fingernail clams (Sphaeriidae), scuds, bristle worms and various midge (Chironomidae) taxa. Stream communities consisted mostly of seed shrimp, fingernail clams, snails (Gastropoda), nematodes and various midges (Appendix VII, Table VII-2).

Midge groups contributed proportionally more to community composition at Site WB6 than any other site. Six genera represented the subfamily Chironominae, three represented the tribe Tanytarsini and there was one genus from the subfamily Tanypodinae. There were fewer midge genera at Site WB7; however, the same subfamilies and tribe were represented as at Site WB6, with the addition of the subfamily Orthocladiinae. Three midge groups were represented at Site WB12 (Chironominae, Tanypodinae and Tanytarsini). The subfamily Tanypodinae and tribe Tanytarsini were represented at both stream sites; however, an additional four genera from the subfamily Chironominae were present at Site S6 (unnamed tributary to the east shore of Christina Lake).

Table 3-24 Benthic Invertebrate Community Structure in Waterbodies in the Aquatic Resources Local Study Area, August 2004

Biological Variables	Christina Lake (Site CL1)	Christina Lake (Site CL2)	Unnamed Waterbody 6 (Site WB6)	Unnamed Waterbody 7 (Site WB7)	Unnamed Waterbody 12 (Site WB12)
mean total abundance	5,475	946	3,904	4,618	3,191
standard error	1,206	741	709	1,344	165
total richness	10	9	21	17	16
Percent Composition of Major Groups[a]					
ostracoda	56.5	0	9.3	5.6	0
nematoda	0.5	56.1	0	0	2.7
pelecypoda	5.5	1.5	0	24.2	25.3
amphipoda	0.5	1.5	11.7	4.7	34.8
oligochaeta	1.6	19.7	25.6	5.6	0
gastropoda	0	0	0.2	2.2	12.9
ceratopogoninae	0	6.1	0	0	3.5
EPT[b]	0	0	0.2	3.7	0
hirudinea	0	0	0.4	0.2	1.1
chironomidae	-	-	-	-	-
chironominae	3.9	1.5	33.5	24.2	1.3
tanypodinae	3.1	0	5.9	17.9	10.2
tanytarsini	1.8	0	13.2	9.3	2.7
orthocladiinae	0	13.6	0	1.9	0
other	26.4	0	0	0.6	5.4

(a) Percent composition of major groups is shown as percent contribution to mean total abundance.

(b) EPT = Ephemeroptera, Plecoptera and Trichoptera combined.

Table 3-25 Benthic Invertebrate Community Structure in Watercourses in the Aquatic Resources Local Study Area, August 2004

Biological Variables	Tributary to the North Bay of Christina Lake ("Sawbones Creek") (Site S1)	Tributary to the East Shore of Christina Lake (Site S6)
mean total abundance	21,758	12,375
standard error	6,309	3,880
total richness	24	28
Percent Composition of Major Groups [a]		
ostracoda	34.8	21.2
pelecypoda	20.4	12.3
gastropoda	5.4	27.2
nematoda	2.8	10.4
ceratopogoninae	3.0	0.3
oligochaeta	1.0	0.7
EPT [b]	0.1	0.8
hirudinea	0.1	0.8
chironomidae	-	-
tanytarsini	18.2	2.1
tanypodinae	12.4	4.2
chironominae	0.7	10.8
orthocladiinae	0.8	0
other	0.4	9.2

[a] Percent composition of major groups is shown as percent contribution to mean total abundance.

[b] EPT = Ephemeroptera, Plecoptera and Trichoptera combined.

3.2 DIVERSITY OF FISH AND FISH HABITAT

The following sections provide the results of the assessment of fish and fish habitat diversity in the study area. The assessment was based on selected indicators of fish species diversity, habitat diversity and ecosystem diversity.

3.2.1 Fish Species Diversity

The results of the fish species diversity assessment for the watercourses or waterbodies potentially affected by the Project are presented in Table 3-26 for the three species diversity indicators; species richness, species overlap and listed species. A numerical rank (from 1 to 4) was determined for each of these three indicators and a general rank for each watercourse or waterbody was assigned based on the value obtained by multiplying the three individual ranks.

Table 3-26 Ranking of Watercourses and Waterbodies According to Fish Species Level Indicators of Diversity

Watercourse or Waterbody	Fish Species Richness		Fish Species Overlap		Listed Fish Species		Fish Species Diversity Ranking
	Number of Species and % of Potential Species	Ranking	Number of Unique Species and % of Overlapping Species	Ranking	Listed Species	Ranking (highest risk status)	
Waterbodies							
Christina Lake	11 of 15 potential species – 73%	3-moderate	9 unique species, 40% overlap	3-moderate	sensitive - Arctic grayling	2-sensitive	3-moderate (score=18)
Unnamed Waterbody 2	1 of 15 potential species – 7%	1-very low	no unique species, 100% overlap	1-very low	none	1-secure	1-very low (score=1)
Unnamed Waterbody 5	0 of 15 potential species – 0%	1-very low	no fish detected	1-very low	no fish detected	1-secure	1-very low (score=1)
Unnamed Waterbody 6	1 of 15 potential species – 7%	1-very low	no unique species, 100% overlap	1-very low	none	1-secure	1-very low (score=1)
Unnamed Waterbody 7	0 of 15 potential species – 0%	1-very low	no fish detected	1-very low	no fish detected	1-secure	1-very low (score=1)
Unnamed Waterbody 8	0 of 15 potential species – 0%	1-very low	no fish detected	1-very low	no fish detected	1-secure	1-very low (score=1)
Unnamed Waterbody 9	0 of 15 potential species – 0%	1-very low	no fish detected	1-very low	no fish detected	1-secure	1-very low (score=1)
Unnamed Waterbody 11	1 of 15 potential species – 7%	1-very low	no unique species, 100% overlap	1-very low	none	1-secure	1-very low (score=1)
Unnamed Waterbody 12	2 of 15 potential species – 13%	1-very low	no unique species, 100% overlap	1-very low	none	1-secure	1-very low (score=1)
Unnamed Waterbody 13	1 of 15 potential species – 7%	1-very low	no unique species, 100% overlap	1-very low	none	1-secure	1-very low (score=1)
Unnamed Waterbody 15	0 of 15 potential species – 0%	1-very low	no fish detected	1-very low	no fish detected	1-secure	1-very low (score=1)
Unnamed Waterbody 16	0 of 15 potential species – 0%	1-very low	no fish detected	1-very low	no fish detected	1-secure	1-very low (score=1)
Watercourses							
“Sawbones Creek”	3 of 15 potential species – 20%	1-very low	no unique species, 100% overlap	1-very low	none	1-secure	1-very low (score=1)
tributary to the east Shore of Christina Lake	2 of 15 potential species – 13%	1-very low	no unique species, 100% overlap	1-very low	none	1-secure	1-very low (score=1)

Fish species diversity was moderate in Christina Lake due to moderate rankings for species richness and uniqueness, combined with the presence of a species that is listed as sensitive (Arctic grayling) (ASRD 2003). Species diversity was ranked as very low in all other waterbodies and watercourses (Table 3-26).

3.2.2 Fish Habitat Diversity

The results of the habitat diversity assessment for the watercourses or waterbodies potentially affected by the Project are presented in Table 3-27. Results are presented for the assessment of the selected fish habitat diversity indicators. A numerical rank (from 1 to 4) was determined for each of these indicators and used to calculate an average rank for each watercourse or waterbody.

Overall, habitat diversity was ranked as high for Christina Lake. Seven unnamed waterbodies were ranked as having moderate habitat diversity, with the four remaining unnamed waterbodies having low diversity.

The tributary watercourses to Christina Lake had low or very low habitat diversity rankings. Habitat diversity in "Sawbones Creek" was very low overall. Although very low habitat diversity also was present in individual sites in "Sawbones Creek", somewhat higher diversity was present in the middle reaches (Sites S1 and S4) due to the greater number of discrete channel units.

Although the unnamed tributary to the east shore of Christina Lake exhibited low average conditions, higher habitat diversity was present at Site S7, which had a Habitat Unit Diversity Index of 0.42 (i.e., moderate) compared to values <0.25 (i.e., very low) at Sites S6, S8 and S10. Site S7 had a high index value due to the large number of discrete channel units present.

Table 3-27 Ranking of Waterbodies and Watercourses According to Indicators of Fish Habitat Diversity

Watercourse or Waterbody	Watercourse Habitat Unit Diversity Index		Stream Order at Mouth		Waterbody Habitat Diversity Index		Waterbody Size			Fish Habitat Diversity Ranking
	Habitat Unit Diversity	Ranking	Stream Order	Ranking	Habitat Diversity	Ranking	Area [ha]	Maximum Depth [m]	Ranking	
Waterbodies										
Christina Lake	-	-	-	-	2.0	4-high	2,130	33	3-moderate	4-high (score=12)
Unnamed Waterbody 2	-	-	-	-	0.7	3-moderate	70.2	2.4	2-low	3-moderate (score=6)
Unnamed Waterbody 5	-	-	-	-	0.6	3-moderate	14.7	3.9	2-low	3-moderate (score=6)
Unnamed Waterbody 6	-	-	-	-	0.7	3-moderate	125	1.9	2-low	3-moderate (score=6)
Unnamed Waterbody 7	-	-	-	-	0.8	3-moderate	40	1.2	2-low	3-moderate (score=6)
Unnamed Waterbody 8	-	-	-	-	0.6	3-moderate	9.9	1.5	1-very low	2-low (score=3)
Unnamed Waterbody 9	-	-	-	-	0.6	3-moderate	10.3	1.0	1-very low	2-low (score=3)
Unnamed Waterbody 11	-	-	-	-	0.4	2-low	26	1.9	2-low	2-low (score=4)
Unnamed Waterbody 12	-	-	-	-	1.1	3-moderate	271	1.2	2-low	3-moderate (score=6)
Unnamed Waterbody 13	-	-	-	-	0.7	3-moderate	12.1	0.8	2-low	3-moderate (score=6)
Unnamed Waterbody 15	-	-	-	-	0.8	3-moderate	3.7	1.4	1-very low	2-low (score=3)
Unnamed Waterbody 16	-	-	-	-	0.6	3-moderate	3.8	3.8	2-low	3-moderate (score=6)
Watercourses										
"Sawbones Creek"[(a)]	0.11	1-very low	2nd	2-low	-	-	-	-	-	1-very low (score=2)
Tributary to the East Shore of Christina Lake[(b)]	0.36	2- low	2nd	2-low	-	-	-	-	-	2-low (score=4)

Note: - = not applicable.

(a) Sites S1A, S1, S4 and S5.

(b) Sites S6, S7, S8 and S10.

3.2.3 Ecosystem Level Indicators of Diversity

Ecosystem diversity was assessed for each of the selected watercourses and waterbodies based on the ratio of predator species to prey species. Table 3-28 presents the number of predator (piscivorous) species and prey (forage fish) species in each of the watercourses and waterbodies and the ecosystem diversity ranking.

The ecosystem diversity was rated as high for Christina Lake and "Sawbones Creek". Burbot, walleye and northern pike are present in Christina Lake and walleye and northern pike in "Sawbones Creek". Northern pike were captured in three unnamed waterbodies (Sites WB2, WB6 and WB12), and these waterbodies were rated as having low ecosystem diversity. The remaining waterbodies and watercourses all lack predator species and were rated as having very low ecosystem diversity.

Table 3-28 Ranking of Waterbodies and Watercourses for Predator to Prey Species Ratios

Watercourse or Waterbody	Predator to Prey/Forage Guild Ratio	
	Number of Predator/Prey Species	Ranking
Waterbodies		
Christina Lake	3 predator / 2 prey	4-high
Unnamed Waterbody 2	1 predator / 0 prey	2-low
Unnamed Waterbody 5	no fish detected	1-very low
Unnamed Waterbody 6	1 predator / 0 prey	2-low
Unnamed Waterbody 7	no fish detected	1-very low
Unnamed Waterbody 8	no fish detected	1-very low
Unnamed Waterbody 9	no fish detected	1-very low
Unnamed Waterbody 11	0 predator / 1 prey	1-very low
Unnamed Waterbody 12	1 predator / 1 prey	2-low
Unnamed Waterbody 13	0 predator / 1 prey	1-very low
Unnamed Waterbody 15	no fish detected	1-very low
Unnamed Waterbody 16	no fish detected	1-very low
Watercourses		
"Sawbones Creek"	2 predator / 1 prey	4-high
tributary to the east shore of Christina Lake	0 predator / 1 prey	1-very low

3.2.4 Summary

The overall fish and fish habitat diversity of each of the selected waterbodies and watercourses was assessed by combining the general rankings for species, habitat and ecosystem level diversity indicators (Table 3-29). The contribution of each waterbody or watercourse to fish and fish habitat diversity was categorized as Very Low, Low, Moderate, or High based on the ranking they received in the evaluation of each of the species, habitat and ecosystem indicators. Based on the ranking system used for this assessment, Christina Lake provides the highest contribution to fish and fish habitat diversity in the Aquatic Resources LSA. Christina Lake was ranked moderate or high for all three diversity indicators and is the only resource that was ranked above very low or low for overall fish and fish habitat diversity.

Table 3-29 Summary of Diversity Rankings for Watercourses and Waterbodies

Watercourse or Waterbody	Ranking			
	Species Diversity	Habitat Diversity	Ecosystem Diversity	Overall Diversity
Waterbodies				
Christina Lake	moderate	high	high	high
Unnamed Waterbody 2	very low	moderate	low	low
Unnamed Waterbody 5	very low	moderate	very low	very low
Unnamed Waterbody 6	very low	moderate	low	low
Unnamed Waterbody 7	very low	moderate	very low	very low
Unnamed Waterbody 8	very low	low	very low	very low
Unnamed Waterbody 9	very low	low	very low	very low
Unnamed Waterbody 11	very low	low	very low	very low
Unnamed Waterbody 12	very low	moderate	low	low
Unnamed Waterbody 13	very low	moderate	very low	very low
Unnamed Waterbody 15	very low	low	very low	very low
Unnamed Waterbody 16	very low	moderate	very low	very low
Watercourses				
“Sawbones Creek”	very low	very low	high	low
tributary to the east shore of Christina Lake	very low	low	very low	very low

4 SUMMARY

Information regarding fish and fish habitat in the waterbodies and watercourses potentially affected by the Project were synthesized from historical information and current environmental setting data. Available information was compiled for the Aquatic Resources LSA for the following:

- the suitability and documented use of the available habitats for spawning, nursery, rearing, feeding, overwintering and migration by indigenous fish species;
- the presence of critical or sensitive habitats;
- the seasonal presence, relative abundance and distribution of fish;
- the presence of listed species (e.g., sensitive species or species at risk);
- the diversity of fish and fish habitat; and
- the benthic invertebrate communities present.

Christina Lake

Christina Lake provides suitable habitat for sport fish, suckers and forage fish during both the winter and the open-water period. Due to the deep nature of the lake (mean and maximum depths of 17 and 33 m respectively), the lake is dominated by pelagic habitat, but some shallow littoral habitat is present along the shoreline and in embayment areas. Macrophyte production and littoral spawning habitat is limited to these shoreline and embayment areas.

Due to its depth, Christina Lake provides suitable winter habitat for fish. Although the lake becomes stratified during summer, water quality conditions are suitable for nursery, rearing and feeding for sport fish, suckers and forage fish species. Christina Lake was rated as providing moderate to high potential for spawning, nursery, rearing, feeding and overwintering for sport fish, suckers and forage fish.

Eleven species of fish have been reported in Christina Lake including: Arctic grayling, walleye, northern pike, yellow perch, lake whitefish, cisco, burbot, white sucker, Iowa darter, ninespine stickleback and spottail shiner. In the past, Christina Lake supported a commercial fishery that included lake whitefish, cisco, northern pike and walleye. Christina Lake has historically been a high quality sport fishing destination, with walleye and pike being the primarily targeted species. The walleye fishery has recently been deemed collapsed (Westworth 2002) and currently there is a zero catch limit for walleye in Christina Lake (AENV 2004).

Christina Lake contains habitats that would be considered critical or sensitive, including known spawning sites for walleye, and suspected spawning sites for lake whitefish, cisco, burbot and white sucker. Arctic grayling is listed as a sensitive species (ASRD 2003); and may use the lake for overwintering, nursery, rearing and feeding. The overall diversity of fish and fish habitat in Christina Lake was ranked as high, based on a moderate ranking for species diversity, high ranking for habitat diversity, and a high ranking for ecosystem (trophic level) diversity.

Unnamed Waterbodies

Eleven unnamed waterbodies were assessed in the Aquatic Resources LSA. No historical information was available for any of these unnamed waterbodies. The eleven unnamed waterbodies selected for baseline investigations ranged in size from 3.7 ha (WB15) to 271 ha (WB12). All of the unnamed waterbodies were shallow and characterized by entirely littoral habitat. The majority of the waterbodies had maximum recorded depths less than 2 m. Three waterbodies had maximum depths greater than 2 m (WB2 [2.4 m], WB5 [3.9 m] and WB16 [3.8 m]).

The waterbodies were located in an area with undulating to level topography. Most of the waterbodies had a shallow shore slope and were surrounded by a band of grasses and forbs, within black spruce and tamarack coniferous forest. Many of the waterbodies were isolated at the time of the open-water surveys with no inlet or outlet streams; exceptions include WB6, WB12 and WB13. All unnamed waterbodies had silt substrate. Macrophytyes were present in most waterbodies, including inundated shoreline vegetation during the spring survey and submergent and floating-leaved vegetation during late summer.

Winter surveys found that most of the waterbodies had shallow water depths and low dissolved oxygen levels below the ice; waterbodies with these conditions would only provide suitable overwintering habitat for forage fish species tolerant of low dissolved oxygen levels, such as brook stickleback. The exceptions include WB2, WB11, WB12 and WB16, which had higher dissolved oxygen levels, with WB2 and WB16 also having greater under-ice water depths compared with the other waterbodies. These four waterbodies may potentially provide overwintering habitat for sport fish and suckers, as well as forage fish.

Water quality data from spring and late summer surveys indicated that most waterbodies had suitable conditions for fish during the open water seasons; however, some waterbodies showed some level of dissolved oxygen depletion in spring or summer (WB2, WB5, WB11 and WB13).

All waterbodies have the potential to provide suitable shallow water nursery, rearing and feeding habitat for sport (northern pike), as well as suckers and forage fish. As waterbody substrate consisted of fines, spawning habitat would be present only for fish species that spawn on vegetation or fine sediments. In most waterbodies, northern pike spawning habitat was present in inundated shoreline vegetation in spring. Although present, potential northern pike spawning and/or rearing and feeding habitat was considered low in WB5, WB7, WB8, WB11, WB13, WB15 and WB16.

Northern pike and brook stickleback were the only fish species captured during environmental setting field surveys in the unnamed waterbodies. Northern pike were captured in three waterbodies: WB2, WB6 and WB12. Brook stickleback were captured in three waterbodies: WB11, WB12 and WB13. No fish were captured in the remaining six waterbodies.

The eleven unnamed waterbodies surveyed in the Aquatic Resources LSA do not contain any critical or sensitive habitats or listed species. Unnamed waterbodies in the Project area providing overwintering habitat were few; critical habitat such as high quality spawning and overwintering sites, were not present. The overall diversity of fish and fish habitat for three unnamed waterbodies (WB2, WB6 and WB12) was ranked as low, based on a very low ranking for species diversity, moderate ranking for habitat diversity, and a low ranking for ecosystem (trophic level) diversity. The remaining eight waterbodies were ranked as very low for fish and fish habitat diversity, based on a very low ranking for species diversity, low or moderate ranking for habitat diversity, and a very low ranking for ecosystem (trophic level) diversity.

Unnamed Tributaries to Christina Lake

Unnamed Tributary to the North Bay of Christina Lake ("Sawbones Creek")

The unnamed tributary to the north bay of Christina Lake, locally known as "Sawbones Creek", originates from two small, unnamed headwater waterbodies and flows south into a small bay on the north shore of Christina Lake. The unnamed tributary is a moderately-sized, low-gradient watercourse located in a boreal forest setting.

The winter field survey determined that overwintering habitat within the creek was primarily limited to the lower reach. Although the most downstream site (S1A) was not sampled in the winter, some overwintering habitat was present at Site S1, with depths up to 0.8 m and adequate dissolved oxygen levels (8.3 mg/L). However, in the middle reaches (Site S4), the watercourse was frozen to the substrate at the sampling site, providing no potentially suitable overwintering habitat. At the farthest upstream site (Site S5), the water was

shallow (maximum depth of 0.4 m), with some oxygen depletion present (2.2 mg/L).

The lower reach near the confluence with Christina Lake is wide, run habitat with a well defined channel. Farther upstream, in the middle reaches of the tributary, beaver dams were present, causing braiding, impounded areas and sections of undefined channel. Data from the open-water seasons show that water quality conditions in "Sawbones Creek" are suitable to support fish during the spring and late summer at all sites.

Walleye was the only fish species captured in "Sawbones Creek". The walleye were captured in the lower reach just upstream of the confluence with Christina Lake (Site S1A), with northern pike and white sucker also being observed during electrofishing at this site. No eggs were observed or collected and no spawning activity was recorded during the spring spawning surveys.

The lower reach of "Sawbones Creek" contains habitats that would be considered critical or sensitive, including spawning sites for walleye and northern pike. This creek, and especially the bay into which it flows ("Sawbones Bay") are known to provide spawning habitat for walleye in the spring. This lower reach also likely provides nursery, feeding and rearing habitat for these species, as well as white sucker. No listed species are present in "Sawbones Creek".

The overall diversity of fish and fish habitat was ranked as low, based on very low rankings for species and habitat diversity and high for ecosystem (trophic level) diversity. The ecosystem diversity was high due to the presence of two large-bodied top predators (walleye and northern pike).

Unnamed Tributary to the East Shore of Christina Lake

This main tributary to Christina Lake flows west from a moderately-sized unnamed waterbody (WB12) into the east shore of the lake. The watercourse is a moderately-sized, low-gradient watercourse located in a boreal forest setting.

Based on the winter survey, some areas with suitable overwintering habitat are present in the unnamed watercourse. Although the most downstream site (Site S6) was not surveyed due to safety concerns, some suitable overwintering habitat may be present in beaver impoundments located in this reach. In the middle reaches (Sites S7 and S8), overwintering habitat appears to be limited. Some sections of stream had run habitat with depths and under-ice dissolved oxygen levels suitable for overwintering. However, other sections of the stream were partially or fully frozen to the substrate.

The lower reach near the confluence with Christina Lake at Site S6 consists of run habitat interspersed by large beaver impoundments. Beaver activity is prevalent and multiple beaver dams would impede fish migration into this tributary from Christina Lake. Farther upstream, in the middle and upper reaches of the tributary (Sites S7, S8, S10), the watercourse was comprised primarily of run habitat with defined banks and silt substrate. Beaver activity was present, causing ponding and sections with poorly defined banks. Although beaver activity is less abundant in the middle and upper reaches, potential impediments to migration were present in all reaches of the tributary.

Data from the open-water seasons show that water quality conditions in the unnamed tributary to the east shore of Christina Lake are suitable to support fish during the spring and late summer at all sites.

White sucker and brook stickleback were captured in the unnamed tributary to the east shore of Christina Lake. The single white sucker was captured in the lower reach (Site S6), with the brook stickleback being captured in the middle reaches at Site S8. No eggs were observed or collected and no spawning activity was recorded during the spring spawning surveys.

The unnamed tributary to the east shore of Christina Lake does not contain any critical or sensitive habitats or listed species. Critical habitat such as high quality spawning and overwintering sites, were not present. The overall diversity of fish and fish habitat was ranked as very low, based on very low rankings for species diversity and ecosystem (trophic level) diversity. The watercourse had a low ranking for habitat diversity due to the habitats present at Site S7. However, the habitat diversity in the majority of the tributary was ranked very low.

Unnamed Tributaries to Christina River

Two small, first-order tributaries to the Christina River flowing from the north end of the lease were assessed at the Secondary Highway 881 crossings (Sites S14 and S15). No historical information was available for these unnamed watercourses.

During the winter survey, both watercourses were frozen to the substrate. Both watercourses consisted of narrow (< 1.5 m), shallow channels, with dense overhanging vegetation and organic debris. No fish were captured at sites in either tributary during spring and late summer fish sampling. There is no fish access to the surveyed section from the Christina River due to sections of subsurface flow and other barriers, such as debris piles and log jams. Due to the narrow, shallow channel and limited flow, the fish habitat use potential in these tributaries to the Christina River was considered low (Sites S14 and S15), with

no suitable habitat for suckers and sport fish and nil to low potential for use by forage fish.

The unnamed tributaries to the Christina River do not contain any critical or sensitive habitats or listed species. Critical habitat such as high quality spawning and overwintering sites, were not present.

Proposed Watercourse Crossings

Two proposed watercourse crossings were assessed during the late summer survey. Both of these watercourses are classified as Class C with a Restricted Activity Period of April 1 to July 15 (AENV 2000). At CR-1 the unnamed watercourse consists of a shallow swale, with terrestrial vegetation throughout. No bed, banks or fish habitat was present at the proposed crossing location.

At CR-2, the unnamed watercourse consisted of a narrow, shallow channel within a bog wetland area. Brook stickleback were captured during fish sampling. Due to the narrow, shallow channel and limited flow, the fish habitat use potential at the proposed watercourse crossing CR-2 was considered low, with no suitable habitat for suckers and sport fish and low potential for use by forage fish.

Benthic Invertebrates

Benthic invertebrates were sampled at two sites in Christina Lake, three unnamed waterbodies (WB6, WB7 and WB12) and two watercourse sites in the unnamed tributaries to Christina Lake (Sites S1 and S6). Mean total abundance and richness was higher in the unnamed tributaries than both Christina Lake and the unnamed waterbodies. Dominant groups found in the unnamed tributaries included seed shrimp, fingernail clams and snails. Seed shrimp and nematodes were the dominant groups in Christina Lake, while fingernail clams, scuds, bristleworms and midges were the dominant groups in the unnamed waterbodies.

5 CLOSURE

We trust the above meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

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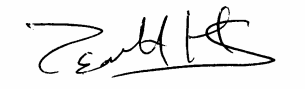

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6 GLOSSARY OF TERMS AND LIST OF ABBREVIATIONS/ACRONYMS

6.1 GLOSSARY OF TERMS

Aquatic vegetation	Plants that live in the water or along the shorelines of waterbodies and watercourses.
Bank	The rising slope or face of ground bordering a waterbody or watercourse, usually comprising unconsolidated material.
Bankfull width	The width of a watercourse when it completely fills its channel and the elevation of the water surface reaches the upper margins of the bank.
Baseline	A surveyed or predicted condition that serves as a reference point on which later surveys are coordinated or correlated.
Bathymetry	The measure of water depth at various places in a body of water.
Benthic Invertebrates	A type of organism that lacks backbone structure and inhabits the bottom sediments of rivers, lakes and streams. It is typically an aquatic insect species that spends at least part of its lifestages dwelling on bottom sediments in the river.
Catch-per-unit-effort (CPUE)	A measure of the effort (over time or distance) expended to capture fish. This permits quantification (number of fish per hour or per unit distance) of abundance.
Channel	The bed of a stream or river.
Community	Pertaining to plant or animal species living in close association or interacting as a unit.
Conductivity	A measure of a waterbody's capacity to conduct an electrical current, which provides an estimate of the total concentration of dissolved ionic matter in the water.
Critical habitat	A term for a habitat that is considered vital to the completion of the life cycle of one or more fish species.
Depositional habitat	An aquatic environment where the bottom material consists of fine sediments. It refers to portions of watercourses or water bodies where water movement is very slow allowing fine sediments that may be in suspension to settle out and become deposited on the bottom.
Discharge	The volume of water in a stream or river, that flows past a given point in a unit of time, i.e., m^3/s.

Dissolved oxygen (DO)	The amount of oxygen present in the water. Dissolved oxygen provides the oxygen needed for fish and some benthic invertebrates to breathe. The amount of oxygen present in solution is measured in milligrams of oxygen per litre of water (mg/L).
Diversity	The variety, distribution and abundance of different plant and animal communities and species within an area.
Electrofishing	A method of fishing in which a field of electricity is passed through water to kill, stun, disable or force fish toward a net.
Emergent vegetation	Aquatic plants which root in shallow water but grow primarily above the water, e.g., cattails and bulrushes.
Environmental Impact Assessment	A review of the effects that a proposed development will have on the local and regional environment.
Feeding habitat	The term used for habitats used by adult fish outside migration and spawning periods. It usually refers to habitats used in the late spring, summer and early fall for general activities associated with obtaining food.
Fines	Silt and clay particles.
Fish inventory	Method for using a variety of fish capture techniques within a sampling area to determine the fish species and life stages present in an area. Several sampling techniques are used because different techniques are better for catching different types or sizes of fish.
First order stream	A stream originating in a seepage zone or spring, with no entering tributaries. The most originating channels, or headwaters, in a drainage network.
Flat	Area characterized by low velocity and near laminar flow.
Floating-leaved vegetation	Aquatic plants which root and grow under the water but have large leaves that float at the surface, e.g., pond lily.
Forage fish	A type of small fish, e.g., brook stickleback or fathead minnow, that provide food for larger fish.
Forb	Broad-leaved herb, as distinguished from grasses.
Fry	The early stage of development for the fish from hatching until it is one year old.
Generalist	Organism which can survive under a wide variety of conditions, and does not specialize to live under any particular set of circumstances.
Gill net	A net that captures fish by entangling their gill covers.

Habitat	The part of the physical environment where an animal or plant naturally or normally lives and grows, e.g., stream habitat or forest habitat.
Impoundment	The formation of a pond within a stream, caused by an interruption of the normal flow by an obstruction such as a beaver dam.
Indigenous	Term applied to a species or genus that occurs naturally in an area.
Inundation	Flooding.
Juvenile	The development of the fish from one year old until sexually maturity.
Kick-net	A net that gently disturbs animals living in or on the bottom of a watercourse and allows the current to sweep them into the net.
Littoral zone	The area in a lake that is closest to the shore. It includes the part of the lake bottom, and its overlying water, between the highest water level and the depth where there is enough light (about one percent of the surface light) for rooted aquatic plants and algae to colonize bottom sediments.
Macrophyte	See aquatic vegetation.
Migration route	The term for a pathway a fish follows to move from one area to another. Migration routes typically occur between areas that provide different habitat types or provide seasonal habitat needs for the fish. An example of a migration route is the route a fish uses to move from overwintering habitat to spring spawning habitat.
Minnow trap	A passive trap for capturing small fish, such as minnows, usually comprising a baited container with funnel-shaped openings.
Nursery habitat	Areas that provide the types of habitat required by fish fry for rearing and feeding after hatching. Typical characteristics of nursery habitat include small food items, cover from predators and velocity shelter.
Oil Sands	A sand deposit containing a heavy hydrocarbon (bitumen) in the intergranular pore space of sands and fine grained particles. Typical oil sands comprise approximately 10 wt% bitumen, 85 wt% coarse sand (>44 μm) and a fines (<44 μm) fraction, consisting of silts and clays.
Overwintering habitat	The particular environment or place an organism or species uses during the winter for feeding and as a refuge.
Pelagic zone	A term for the deep portion of a waterbody where light cannot penetrate to the bottom sediments.
pH	The measure of a substance's acidity or alkalinity.

Reach	A length of a stream or river, having relatively uniform physical characteristics such as gradient, water velocity and substrate.
Rearing habitat	Area used by young fish for feeding and as a refuge from predators.
Riffle-Run-Pool	A mixture of flows and depth and providing a variety of habitats. Pools are deep with slow water. Riffles are shallow with fast, turbulent water running over rocks. Runs are deep with fast water and little or no turbulence.
Riparian vegetation	A vegetation area influenced by groundwater, subirrigation (areas where a high water table reaches or saturates the root zone) or surface water and that provides important habitat for fish and a majority of wildlife species. This vegetation is often a transition zone between aquatic and terrestrial habitat.
Run	See Riffle-Run-Pool.
Second order stream	The junction of two first-order streams.
Spawning	The reproductive stage of adult fish which includes fertilization and deposition of eggs.
Spawning habitat	A particular type of area where a fish species chooses to reproduce. Preferred habitat (substrate, water flow, temperature) varies from species to species.
Species	A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups; a taxonomic grouping of genetically and morphologically similar individuals; the category below genus.
Species Composition	A term that refers to the presence, absence and abundance of species found in the sampling area.
Species Richness	The number of different species occupying a given area.
Sport fish	A type of large fish, e.g., northern pike or walleye, caught for sport.
Submergent vegetation	Aquatic plants which root and grow primarily under the water, e.g., coontail and water milfoil.
Substrate	The material that occurs on the bottom of a watercourse or waterbody, e.g., fines (silt and sand), gravel, cobble, boulder and bedrock. Substrate size is an important aspect of fish habitat because it may dictate habitat suitability for things such as food, i.e., benthic invertebrate, production, cover for fish and spawning suitability.
Sucker	A specific type of large-bodied fish and the main type of large-bodied fish not included in the sport fish category. Suckers have a characteristic mouth that is located under the head, and large thick lips.

Tributary	A stream that feeds or flows into a larger watercourse or waterbody.
Trophic	Pertaining to part of a food chain, for example, the primary producers are a trophic level just as tertiary consumers are another trophic level.
Waterbody	A standing body of water such as a lake or pond.
Watercourse	A flowing body of water such as a river, stream or creek.
Wetted width	The term for the width of the portion of the channel that was wet at the time of a survey and changes as water level changes.
Winterkill	The term for the death of fish in a watercourse or waterbody, usually due to low levels of dissolved oxygen, that occur when ice cover prevents oxygen replenishment.
Young-of-the-Year (YOY)	Fish at age 0, within the first year after hatching.

6.2 LIST OF ABBREVIATIONS/ACRONYMS

%	Percent
<	Less than
>	More than
µm	Micrometre
AENV	Alberta Environment
ASRD	Alberta Sustainable Resource Development
ATV	All terrain vehicle
the Project	Christina Lake Regional Project
e.g.	For example
EIA	Environmental impact assessment
EPT	Ephemeroptera, Plecoptera and Trichoptera
GIS	Geographic Information System
Golder	Golder Associates Ltd.
GPS	Global positioning system
ha	Hectare
i.e.	That is
km	Kilometre
LSA	Local Study Area
m	Metre
m^3/s	Cubic metres/second
MEG	MEG Energy Corp.
mg/L	Milligrams per litre
mm	Millimetre
n/a	Not applicable
NAD	North American Datum
NTS	National Topographic System

organisms/m^2	Organisms per square metre
QA/QC	Quality assurance/quality control
ROW	Rights-of-way
SAGD	Steam Assisted Gravity Drainage
TOC	Total Organic Carbon
UTM	Universal Transverse Mercator
W4M	West of the Fourth Meridian

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7.2 PERSONAL COMMUNICATIONS

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APPENDIX I

COMMON AND SCIENTIFIC NAMES OF FAUNA AND FLORA

Table I-1 Fish Common and Scientific Names

Taxonomic Family	Species	
	Common Name	**Scientific Name**
Pikes – Esocidae	northern pike	*Esox lucius*
Cods – Gadidae	burbot	*Lota lota*
Perches – Percidae	walleye	*Sander vitreus*
	yellow perch	*Perca flavescens*
Trouts – Salmonidae	Arctic grayling	*Thymallus arcticus*
	cisco	*Coregonus artedi*
	lake whitefish	*Coregonus clupeaformis*
Suckers – Catostomidae	white sucker	*Catostomus commersoni*
Sculpins – Cottidae	spoonhead sculpin	*Cottus ricei*
Minnows – Cyprinidae	lake chub	*Couesius plumbeus*
	pearl dace	*Semotilus margarita*
	spottail shiner	*Notropis hudsonius*
Perches – Percidae	Iowa darter	*Etheostoma exile*
Sticklebacks – Gasterosteidae	brook stickleback	*Culaea inconstans*
	ninespine stickleback	*Pungitius pungitius*

Table I-2 Common and Scientific Names of Plants

Common Name	Scientific Name (*Genus*)
Submergent Aquatic Macrophytes	
coontail	*Ceratophyllum*
horse tail	*Equisetum*
pond lily	*Nuphor*
pondweed	*Potamogeton*
smartweed	*Polygonum*
water milfoil	*Myriophyllum*
water weed	*Elodea*
Emergent Aquatic Macrophytes	
bulrush	*Scirpus*
cattail	*Typha*
Riparian Terrestrial Vegetation	
sedge grasses	*Carex*
reeds	*Phragmites*
willow	*Salix*
spruce	*Picea*
poplar	*Populus*
tamarack	*Larix*
birch	*Betula*

APPENDIX II

SUBSTRATE PARTICLE SIZE CATEGORIES

Table II-1 Substrate Particle Size Ranges

Class Name	Size Range	
	mm	Inches
clay/silt	<0.06	<0.0024
sand	0.06-2.0	0.0024-0.08
small gravel	2-8	0.08-0.3
medium gravel	8-32	0.3-1.3
large gravel	32-64	1.3-2.5
small cobble	64-128	2.5-5
large cobble	128-256	5-10
small boulder	256-762	10-30
large boulder	>762	>30
bedrock	-	-

APPENDIX III

HABITAT MAPS AND PHOTOGRAPHS FOR WATERBODY SAMPLE SITES

Photo 1 - Aerial view of east end of Christina Lake near CL1 (May 2004).

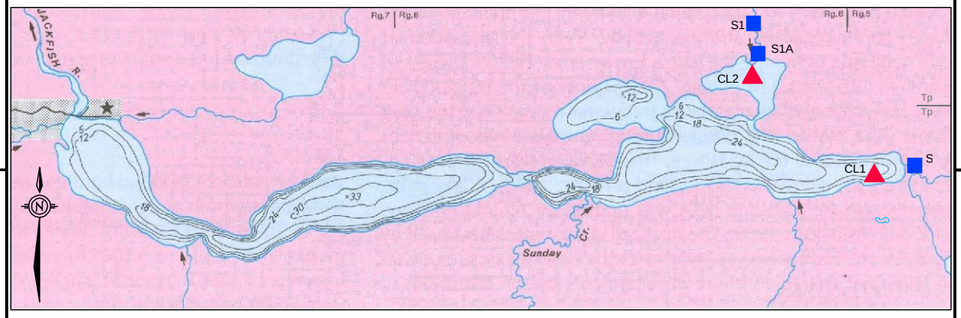


Photo 4 - Aerial view of "Sawbones Bay" near CL2 and stream Site S1A (May 2004).

Photo 2 - Representative shoreline habitat near CL2 (August 2004).

Photo 3 - Representative lake habitat near CL1 (August 2004).

REFERENCE

SCAN MAP ADAPTED FROM THE ATLAS OF ALBERTA LAKES.
EDITED BY MITCHELL AND PREPAS.

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

CHRISTINA LAKE

MEG ENERGY CORP.

PROJECT 04-1334-001.6140			FILE No.	CHRISTINA LAKE
DESIGN	CD	17/12/04	SCALE AS SHOWN	REV. 0
CADD	PSR	12/01/05		
CHECK	CD	12/01/05		
REVIEW	TC	18/01/05		

FIGURE: III-1

R:\CAD\2004\1322-EA\1334\04-1334-001 MEG\6100\6140-Baseline\Fig III-1 CHRISTINA LAKE.dwg Jun 02, 2005 - 12:28pm

Photo 1 - Aerial view of Unnamed Waterbody 2 from the south end looking north (May 2004).

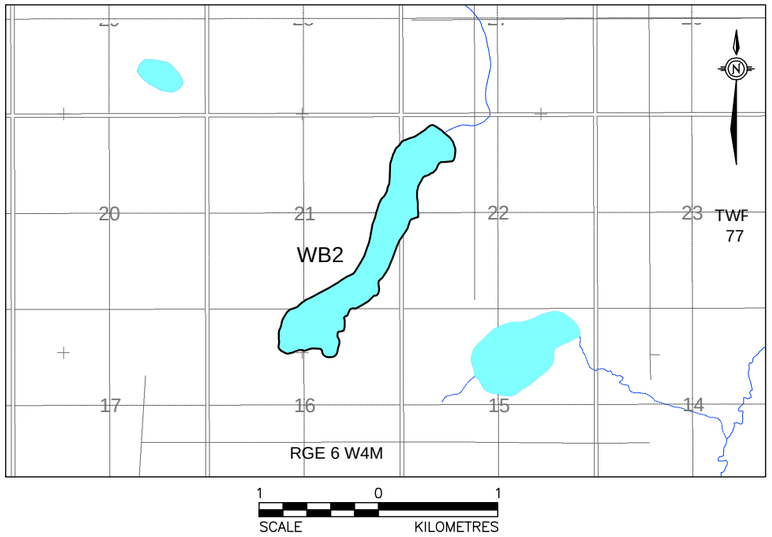


Photo 4 - Typical shoreline habitat of Unnamed Waterbody 2 (August 2004).

Photo 2 - Aerial view of the north end of Unnamed Waterbody 2 (May 2004).

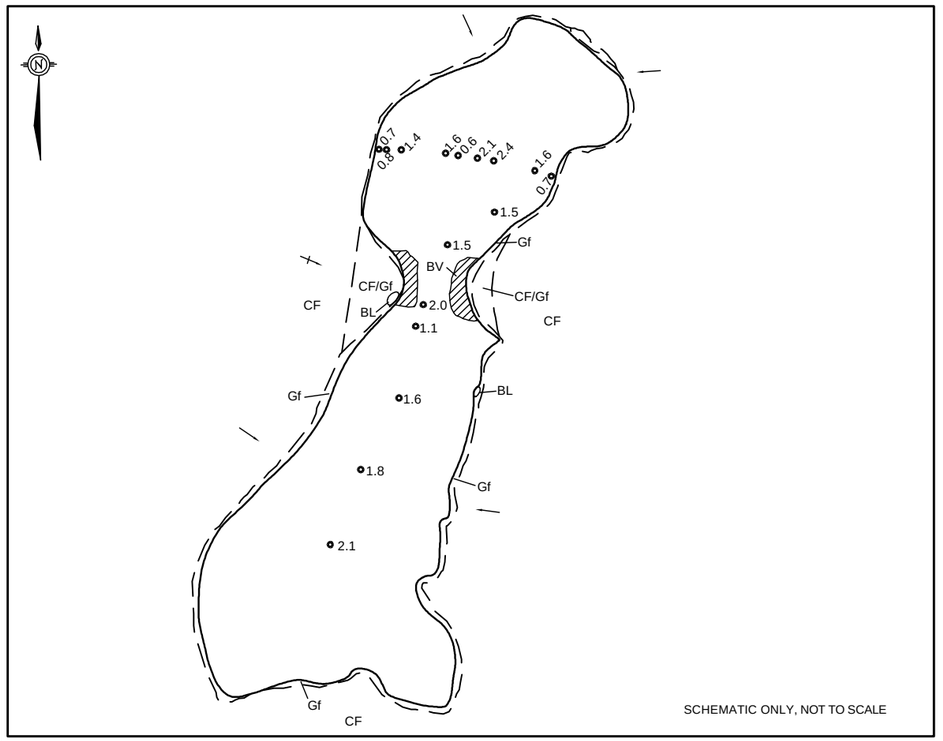


Photo 3 - Aerial view of south end of Unnamed Waterbody 2 (May 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.8 — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Si	Silt (<0.06 mm)
Sa	Sand (0.06–2 mm)
Gr	Gravel (2–64 mm)
Co	Cobble (64–256 mm)
Bo	Boulder (>256 mm)
Bd	Bedrock
Or	Organic Material

Vegetation Type:

MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Gf	Grass/Forbes
Sh	Shrubs

Aquatic Macrophytes

- Emergent Vegetation (EV)
- Submergent or Floating–Leaved Vegetation (SV)
- Terrestrial Vegetation (TV)

Submergent

C	Ceratophyllum
Ch	Chara
E	Elodea
L	Lemna
M	Myriophyllum
N	Nuphar
P	Potamogeton

Emergent

Sc	Scirpus
Sp	Sparganium
T	Typha

Terrestrial Vegetation

Ca	Carex
La	Larix
Pi	Picea
Pp	Populus
Sx	Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 2 HABITAT MAP

MEG ENERGY CORP.

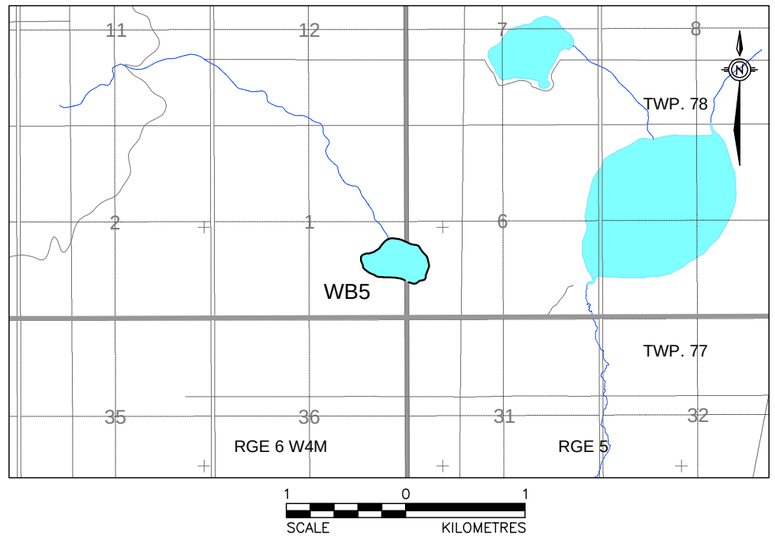
PROJECT 04–1334–001.6140			FILE No.		Lake 2
DESIGN	CD	08/12/04	SCALE	AS SHOWN	REV. 0
CADD	MJ	07/01/05			
CHECK	CM	20/01/05			
REVIEW	TC	20/01/05			

FIGURE: III-2

R:\CAD\2004\1322–EA\1334\04–1334–001 MEG\6100\6140–Baseline\Lake 2.dwg Jun 02, 2005 – 1:00pm

Photo 1 - Representative shoreline view of Unnamed Waterbody 5 (August 2004).

Photo 2 - View of black spruce riparian vegetation along the southeast shoreline of Unnamed Waterbody 5 (August 2004).



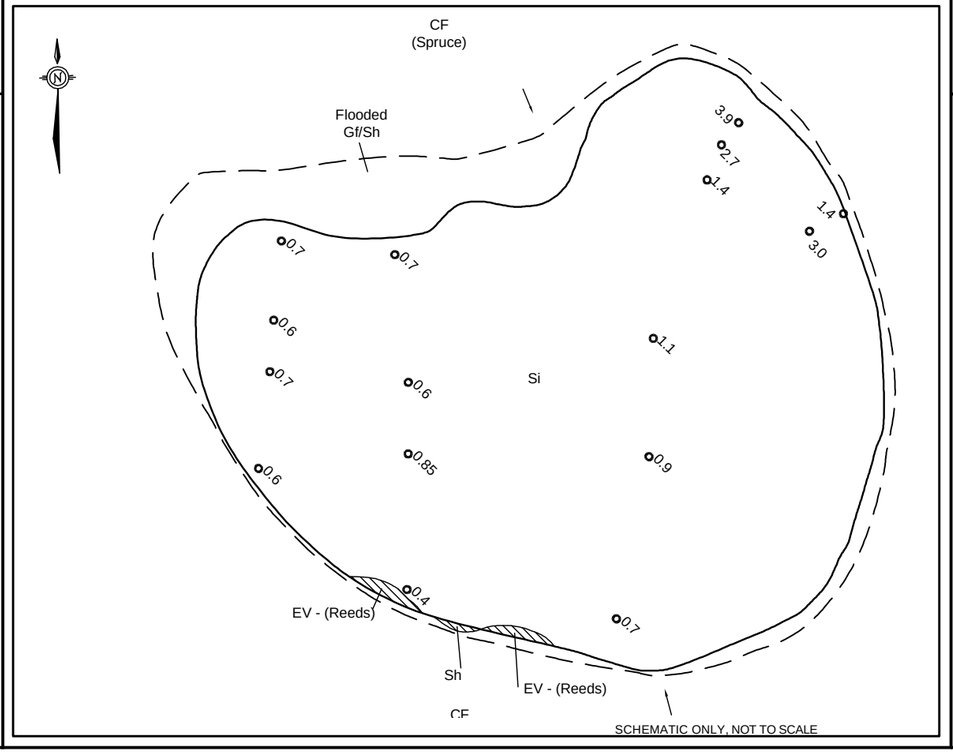


Photo 4 - Aerial view of Unnamed Waterbody 5 (August 2004).

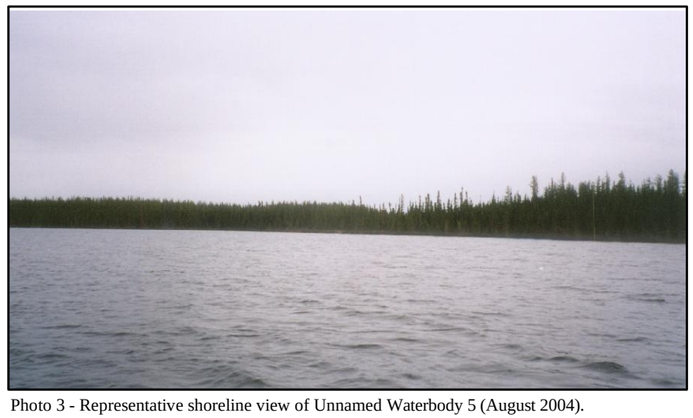


Photo 3 - Representative shoreline view of Unnamed Waterbody 5 (August 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.61 m — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Si	Silt (<0.06 mm)
Sa	Sand (0.06–2 mm)
Gr	Gravel (2–64 mm)
Co	Cobble (64–256 mm)
Bo	Boulder (>256 mm)
Bd	Bedrock
Or	Organic Material

Vegetation Type:

MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Gf	Grass/Forbes
Sh	Shrubs

Aquatic Macrophytes

- Emergent Vegetation (EV)
- Submergent or Floating–Leaved Vegetation (SV)
- Terrestrial Vegetation (TV)

Submergent

C	Ceratophyllum
Ch	Chara
E	Elodea
L	Lemna
M	Myriophyllum
N	Nuphar
P	Potamogeton

Emergent

Sc	Scirpus
Sp	Sparganium
T	Typha

Terrestrial Vegetation

Ca	Carex
La	Larix
Pi	Picea
Pp	Populus
Sx	Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 5 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.	Lake 5
DESIGN	CD	08/12/04	SCALE AS SHOWN	REV. 0
CADD	MJ	07/01/05		
CHECK	CM	20/01/05		
REVIEW	TC	20/01/05		

FIGURE: III-3

R:\CAD\2004\1322–EA\1334\04–1334–001 MEG\6100\6140–Baseline\Fig III–3 Lake 5.dwg Jun 02, 2005 – 12:29pm

Photo 1 - Aerial view of Unnamed Waterbody 6 (May 2004).

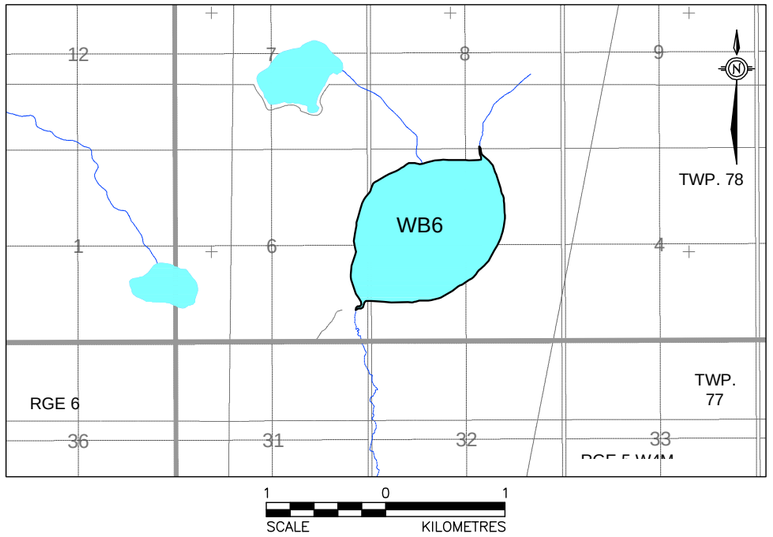


Photo 4 - Typical shoreline habitat at Unnamed Waterbody 6 (August 2004).

Photo 2 - View of emergent and shoreline vegetation at Unnamed Waterbody 6 (August 2004).

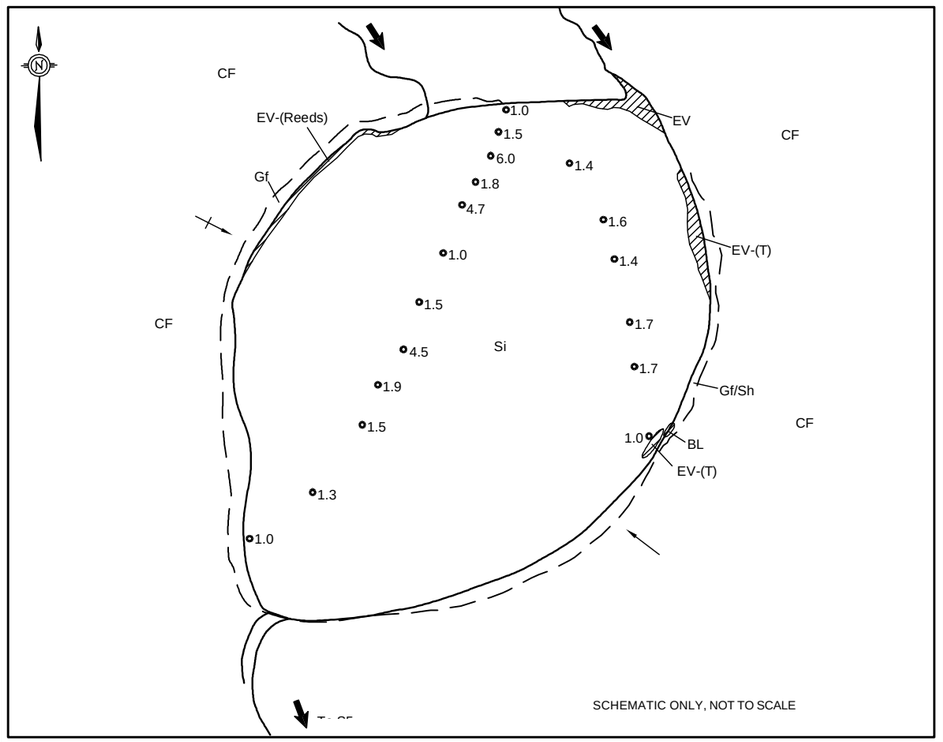


Photo 3 - Representative view of Unnamed Waterbody 6 (August 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.61 m — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

- Si — Silt (<0.06 mm)
- Sa — Sand (0.06–2 mm)
- Gr — Gravel (2–64 mm)
- Co — Cobble (64–256 mm)
- Bo — Boulder (>256 mm)
- Bd — Bedrock
- Or — Organic Material

Vegetation Type:

- MF — Mixed Forest
- CF — Coniferous Forest
- DF — Deciduous Forest
- Gf — Grass/Forbes
- Sh — Shrubs

Aquatic Macrophytes

- Emergent Vegetation (EV)
- Submergent or Floating-Leaved Vegetation (SV)
- Terrestrial Vegetation (TV)

Submergent

- C — Ceratophyllum
- Ch — Chara
- E — Elodea
- L — Lemna
- M — Myriophyllum
- N — Nuphar
- P — Potamogeton

Emergent

- Sc — Scirpus
- Sp — Sparganium
- T — Typha

Terrestrial Vegetation

- Ca — Carex
- La — Larix
- Pi — Picea
- Pp — Populus
- Sx — Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 6 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04-1334-001.6140			FILE No.		Lake 6
DESIGN	CD	08/12/04	SCALE	AS SHOWN	REV. 0
CADD	SWD	13/01/05			
CHECK	CD	13/01/05			
REVIEW	TC	18/01/05			

FIGURE: III-4

R:\CAD\2004\1322-EA\1334\04-1334-001 MEG\6100\6140-Baseline\Fig III-4 Lake 6.dwg Jun 02, 2005 - 12:31pm

Photo 1 - Aerial view of Unnamed Waterbody 7 (May 2004).

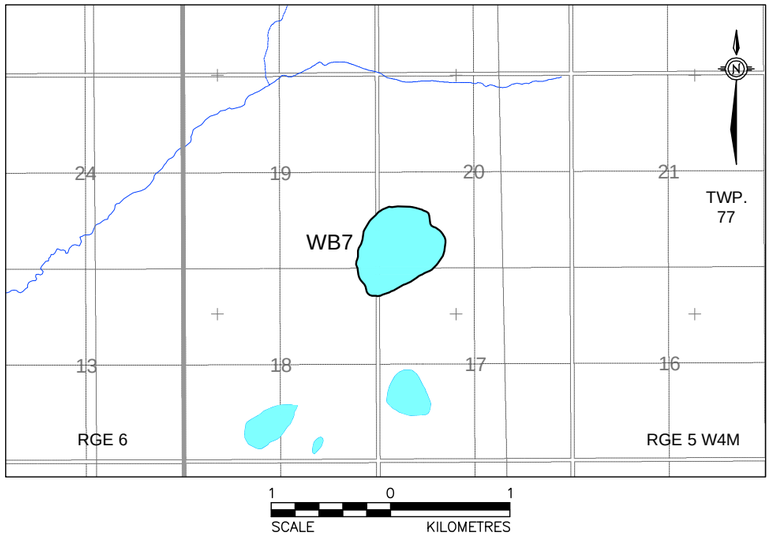


Photo 4 - Typical shoreline habitat at Unnamed Waterbody 7 (August 2004).

Photo 2 - Typical shoreline habitat at Unnamed Waterbody 7 (August 2004).

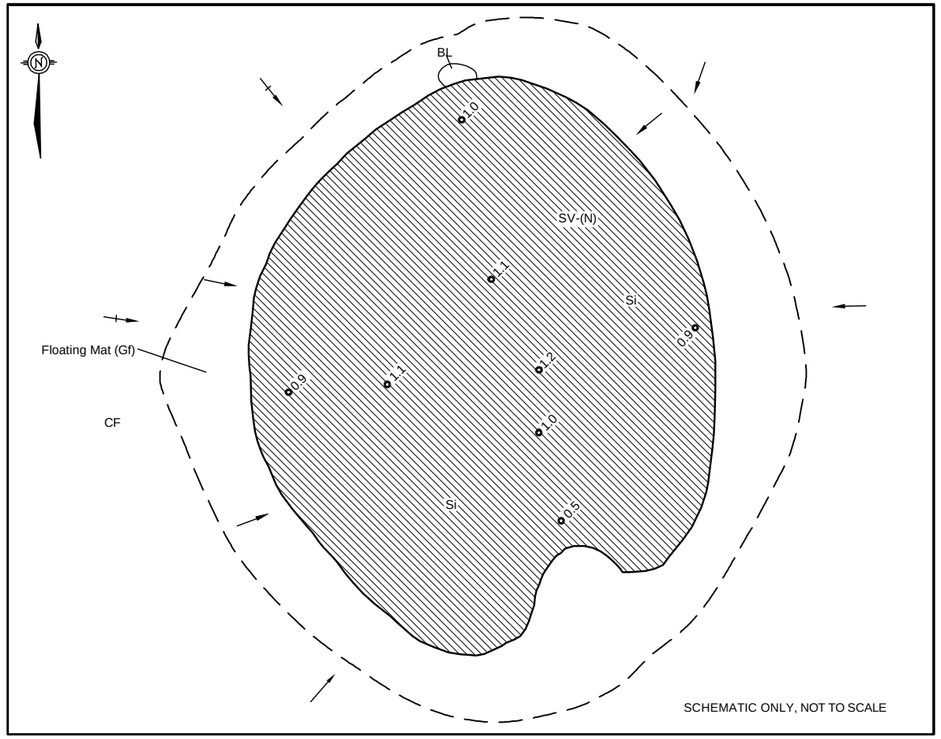


Photo 3 - View of riparian vegetation along the west shoreline of Unnamed Waterbody 7 (August 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.61 m — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Si	Silt (<0.06 mm)
Sa	Sand (0.06–2 mm)
Gr	Gravel (2–64 mm)
Co	Cobble (64–256 mm)
Bo	Boulder (>256 mm)
Bd	Bedrock
Or	Organic Material

Vegetation Type:

MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Gf	Grass/Forbes
Sh	Shrubs

Aquatic Macrophytes

- Emergent Vegetation (EV)
- Submergent or Floating–Leaved Vegetation (SV)
- Terrestrial Vegetation (TV)

Submergent

C	Ceratophyllum
Ch	Chara
E	Elodea
L	Lemna
M	Myriophyllum
N	Nuphar
P	Potamogeton

Emergent

Sc	Scirpus
Sp	Sparganium
T	Typha

Terrestrial Vegetation

Ca	Carex
La	Larix
Pi	Picea
Pp	Populus
Sx	Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 7 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.		Lake 7
DESIGN	CD	08/12/04	SCALE	AS SHOWN	REV. 0
CADD	MJ	07/01/05			
CHECK	CM	20/01/05			
REVIEW	TC	20/01/05			

FIGURE: III-5

R:\CAD\2004\1322–EA\1334\04–1334–001 MEG\6100\6140–Baseline\Lake 7.dwg Jun 02, 2005 – 1:01pm

Photo 1 - Aerial view of unnamed Waterbody 8 showing abundant aquatic vegetation (August 2004).

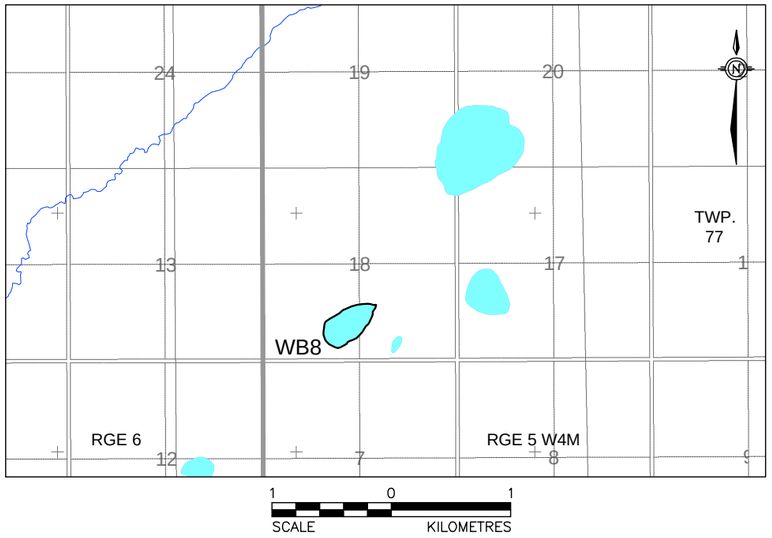


Photo 4 - Typical shoreline habitat of Unnamed Waterbody 8 (August 2004).

Photo 2 - Typical shoreline habitat at Unnamed Waterbody 8 (August 2004).

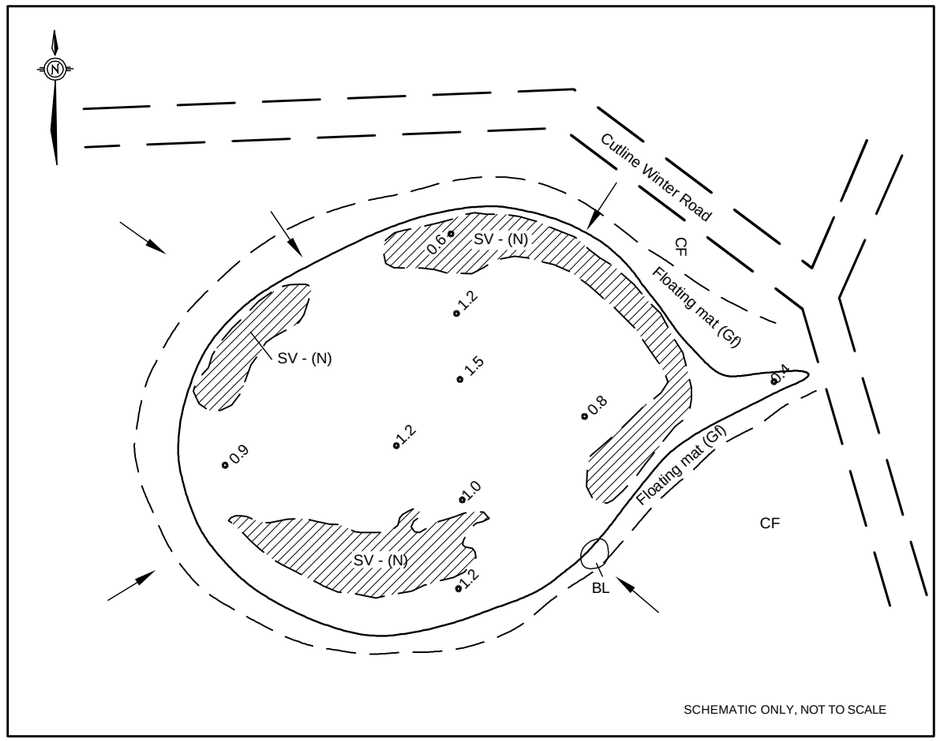


Photo 3 - Typical shoreline habitat at Unnamed Waterbody 8 (August 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.61 m — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Si	Silt (<0.06 mm)
Sa	Sand (0.06–2 mm)
Gr	Gravel (2–64 mm)
Co	Cobble (64–256 mm)
Bo	Boulder (>256 mm)
Bd	Bedrock
Or	Organic Material

Vegetation Type:

MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Gf	Grass/Forbes
Sh	Shrubs

Aquatic Macrophytes

- Emergent Vegetation (EV)
- Submergent or Floating–Leaved Vegetation (SV)
- Terrestrial Vegetation (TV)

Submergent

C	Ceratophyllum
Ch	Chara
E	Elodea
L	Lemna
M	Myriophyllum
N	Nuphar
P	Potamogeton

Emergent

Sc	Scirpus
Sp	Sparganium
T	Typha

Terrestrial Vegetation

Ca	Carex
La	Larix
Pi	Picea
Pp	Populus
Sx	Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 8 HABITAT MAP

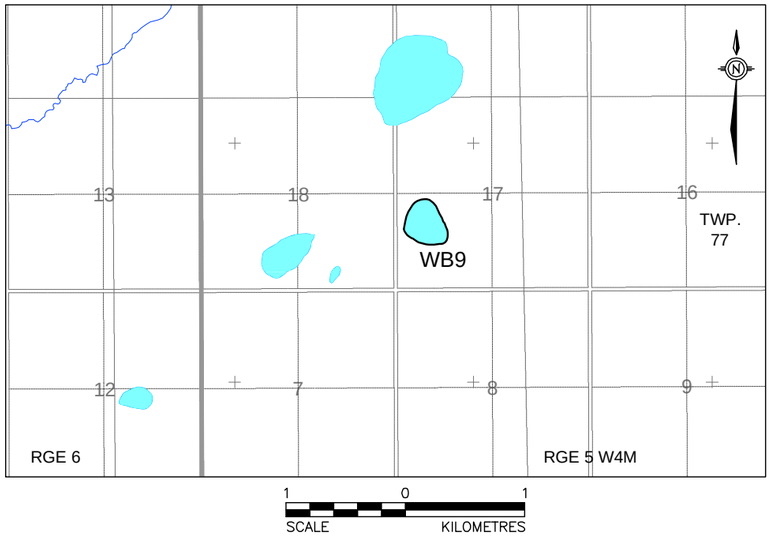
MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.		Lake 8
DESIGN	CD	08/12/04	SCALE	AS SHOWN	REV. 0
CADD	MJ	07/01/05			
CHECK	CM	20/01/05			
REVIEW	TC	20/01/05			

FIGURE: III-6

R:\CAD\2004\1322–EA\1334\04–1334–001 MEG\6100\6140–Baseline\Lake 8.dwg Jun 02, 2005 – 1:03pm

Photo 1 - Aerial view of Unnamed Waterbody 9 (August 2004).



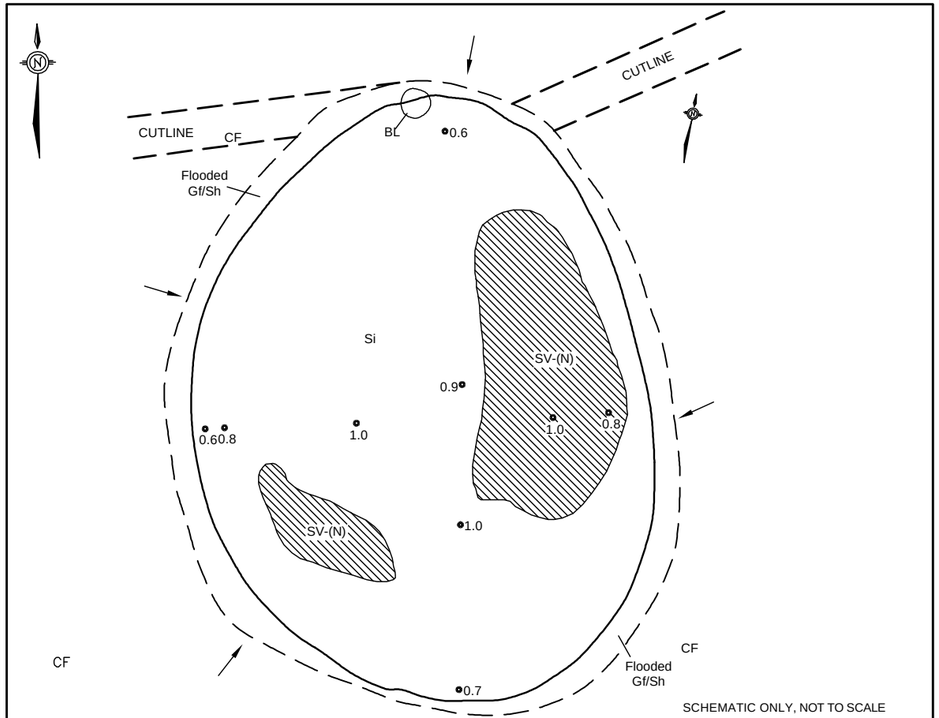


Photo 2 - Emergent and submergent vegetation located in Unnamed Waterbody 9 (August 2004).

Photo 3 - Typical shoreline habitat at Unnamed Waterbody 9 (August 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.61 m — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Si	Silt (<0.06 mm)
Sa	Sand (0.06–2 mm)
Gr	Gravel (2–64 mm)
Co	Cobble (64–256 mm)
Bo	Boulder (>256 mm)
Bd	Bedrock
Or	Organic Material

Vegetation Type:

MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Gf	Grass/Forbes
Sh	Shrubs

Aquatic Macrophytes

Emergent Vegetation	(EV)
Submergent or Floating–Leaved Vegetation	(SV)
Terrestrial Vegetation	(TV)

Submergent

C	Ceratophyllum
Ch	Chara
E	Elodea
L	Lemna
M	Myriophyllum
N	Nuphar
P	Potamogeton

Emergent

Sc	Scirpus
Sp	Sparganium
T	Typha

Terrestrial Vegetation

Ca	Carex
La	Larix
Pi	Picea
Pp	Populus
Sx	Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 9 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.	Lake 9
DESIGN	CD	08/12/04	SCALE AS SHOWN	REV. 0
CADD	MJ	07/01/05		
CHECK	CM	20/01/05		
REVIEW	TC	20/01/05		

FIGURE: III-7

R:\CAD\2004\1322-EA\1334\04-1334-001 MEG\6100\6140-Baseline\Lake 9.dwg Jun 02, 2005 - 1:05pm

Photo 1 - Aerial view of Unnamed Waterbody 11 (May 2004).

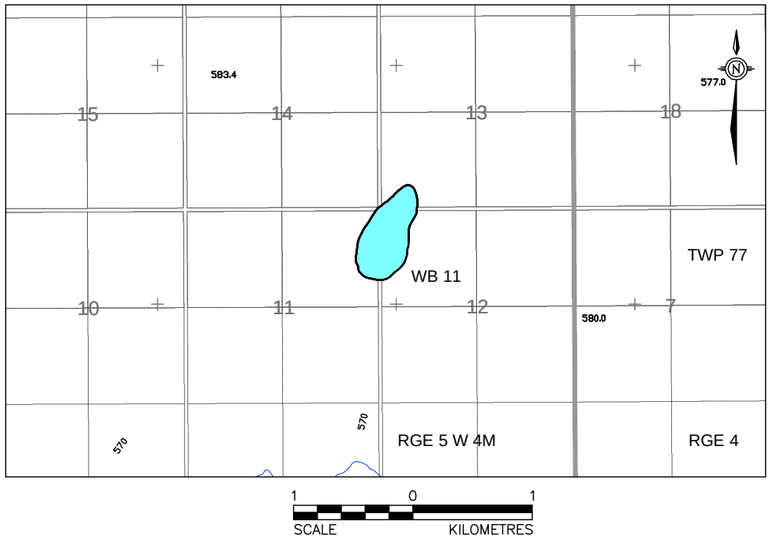


Photo 4 - Typical shoreline habitat at Unnamed Waterbody 11 (August 2004).

Photo 2 - Brook stickleback captured at Unnamed Waterbody 11 (March 2004).

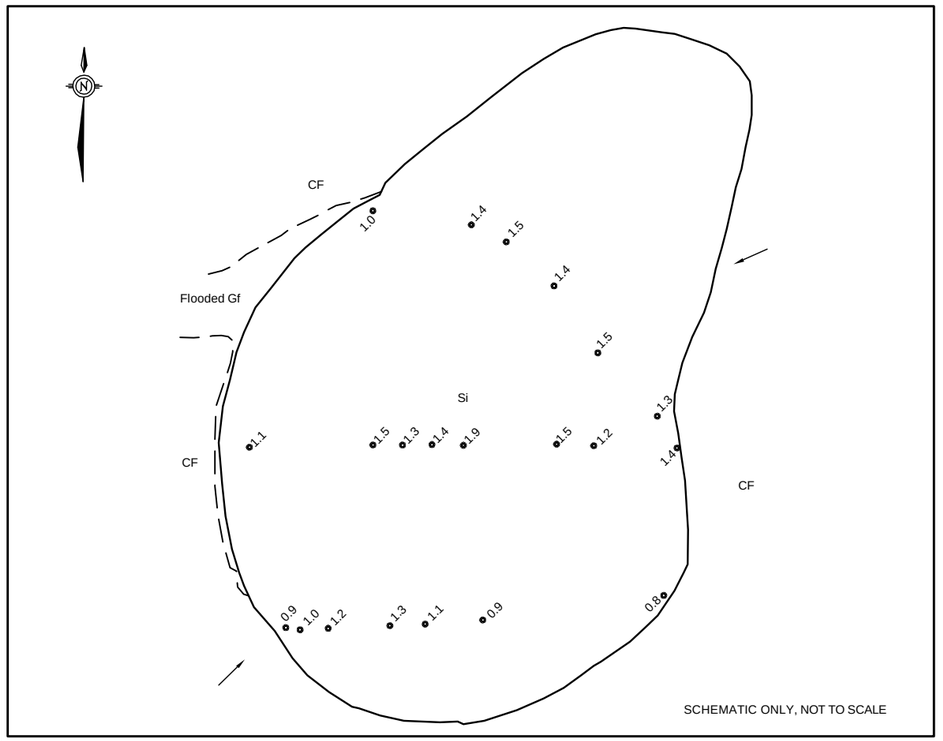


Photo 3 - Representative view at Unnamed Waterbody 11 (August 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.61 m — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Si	Silt (<0.06 mm)
Sa	Sand (0.06–2 mm)
Gr	Gravel (2–64 mm)
Co	Cobble (64–256 mm)
Bo	Boulder (>256 mm)
Bd	Bedrock
Or	Organic Material

Vegetation Type:

MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Gf	Grass/Forbes
Sh	Shrubs

Aquatic Macrophytes

- Emergent Vegetation (EV)
- Submergent or Floating-Leaved Vegetation (SV)
- Terrestrial Vegetation (TV)

Submergent

C	Ceratophyllum
Ch	Chara
E	Elodea
L	Lemna
M	Myriophyllum
N	Nuphar
P	Potamogeton

Emergent

Sc	Scirpus
Sp	Sparganium
T	Typha

Terrestrial Vegetation

Ca	Carex
La	Larix
Pi	Picea
Pp	Populus
Sx	Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 11 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04-1334-001.6140			FILE No.	Lake 11
DESIGN	CD	08/12/04	SCALE AS SHOWN	REV. 0
CADD	MJ	07/01/05		
CHECK	CM	20/01/05		
REVIEW	TC	20/01/05		

FIGURE: III-8

R:\CAD\2004\1322-EA\1334\04-1334-001 MEG\6100\6140-Baseline\Lake 11.dwg Jun 02, 2005 - 12:48pm

Photo 1 - Aerial view of the north end of Unnamed Waterbody 12 (August 2004).

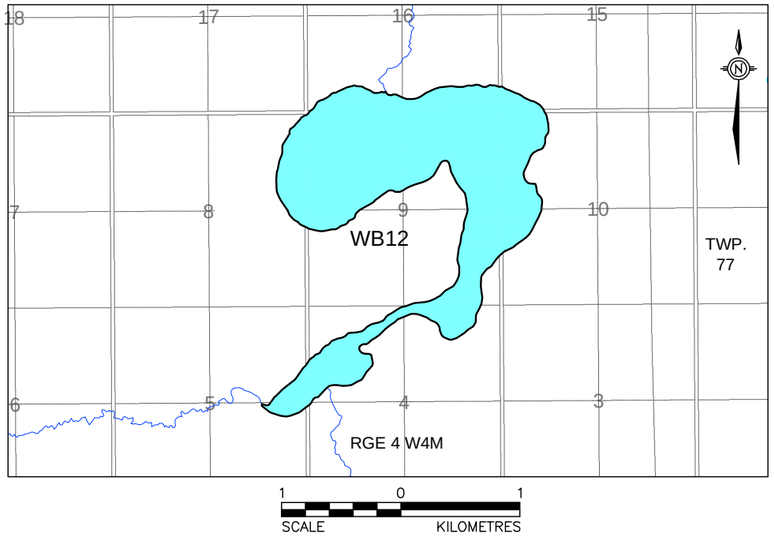


Photo 4 - Typical shoreline vegetation of Unnamed Waterbody 12 (August 2004) .

Photo 2 - Aerial view of the south end of Unnamed Waterbody 12 (August 2004).

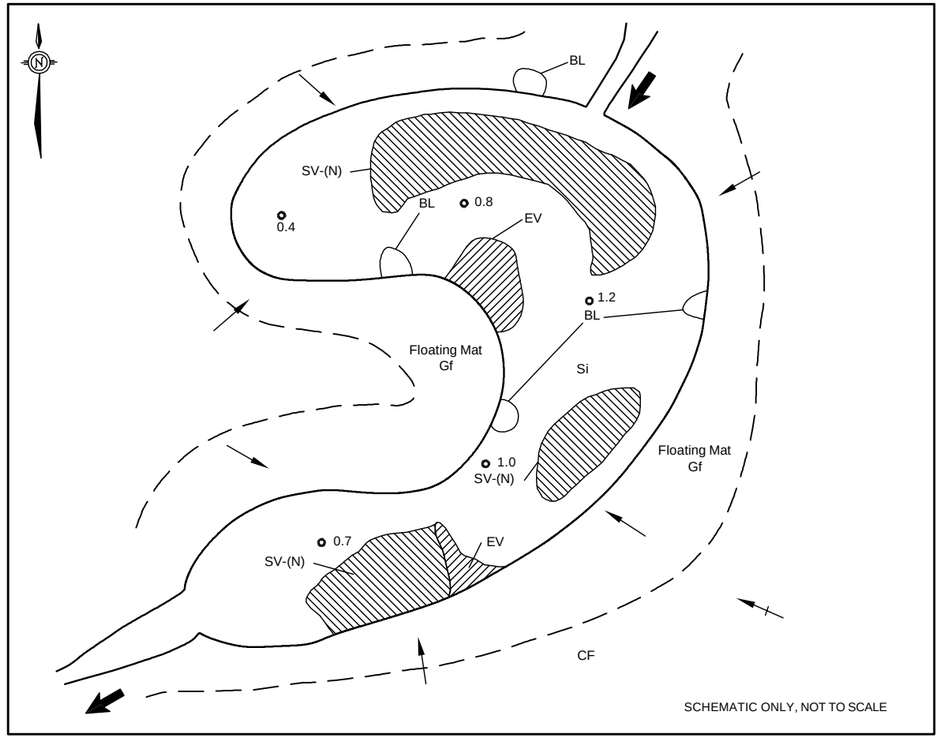


Photo 3 - Aerial view of Unnamed Waterbody 12 (May 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.61 m — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Si	Silt (<0.06 mm)
Sa	Sand (0.06–2 mm)
Gr	Gravel (2–64 mm)
Co	Cobble (64–256 mm)
Bo	Boulder (>256 mm)
Bd	Bedrock
Or	Organic Material

Vegetation Type:

MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Gf	Grass/Forbes
Sh	Shrubs

Aquatic Macrophytes

- Emergent Vegetation (EV)
- Submergent or Floating–Leaved Vegetation (SV)
- Terrestrial Vegetation (TV)

Submergent

C	Ceratophyllum
Ch	Chara
E	Elodea
L	Lemna
M	Myriophyllum
N	Nuphar
P	Potamogeton

Emergent

Sc	Scirpus
Sp	Sparganium
T	Typha

Terrestrial Vegetation

Ca	Carex
La	Larix
Pi	Picea
Pp	Populus
Sx	Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 12 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.		Lake 12
DESIGN	CD	08/12/04	SCALE	AS SHOWN	REV. 0
CADD	MJ	07/01/05			
CHECK	CM	20/01/05			
REVIEW	TC	20/01/05			

FIGURE: III-9

R:\CAD\2004\1322–EA\1334\04–1334–001 MEG\6100\6140–Baseline\Fig III–9 Lake 12.dwg Jun 02, 2005 – 12:32pm

Photo 1 - Aerial view of Unnamed Waterbody 13 (May 2004).

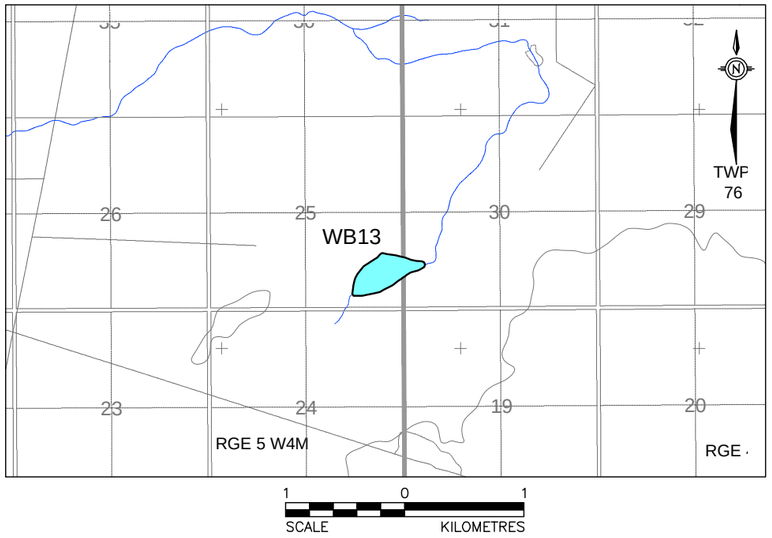


Photo 4 - Typical shoreline vegetation of Unnamed Waterbody 13 (August 2004).

Photo 2 - Representative view at Unnamed Waterbody 13 (August 2004).

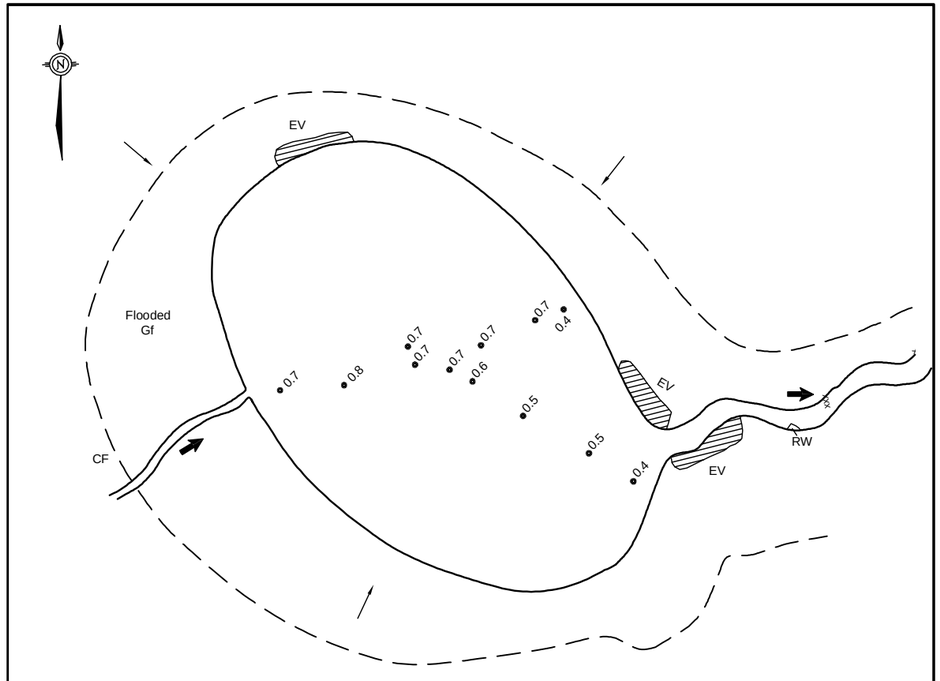


Photo 3 - Emergent vegetation in Unnamed Waterbody 13 (August 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.61 m — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope
- xxxx — Beaver Dam
- RW — Root Wad

Substrate Particle Size:

- Si — Silt (<0.06 mm)
- Sa — Sand (0.06–2 mm)
- Gr — Gravel (2–64 mm)
- Co — Cobble (64–256 mm)
- Bo — Boulder (>256 mm)
- Bd — Bedrock
- Or — Organic Material

Vegetation Type:

- MF — Mixed Forest
- CF — Coniferous Forest
- DF — Deciduous Forest
- Gf — Grass/Forbes
- Sh — Shrubs

Aquatic Macrophytes

- Emergent Vegetation (EV)
- Submergent or Floating-Leaved Vegetation (SV)
- Terrestrial Vegetation (TV)

Submergent

- C — Ceratophyllum
- Ch — Chara
- E — Elodea
- L — Lemna
- M — Myriophyllum
- N — Nuphar
- P — Potamogeton

Emergent

- Sc — Scirpus
- Sp — Sparganium
- T — Typha

Terrestrial Vegetation

- Ca — Carex
- La — Larix
- Pi — Picea
- Pp — Populus
- Sx — Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 13 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04-1334-001.6140			FILE No.		Lake 13
DESIGN	CD	08/12/04	SCALE	AS SHOWN	REV. 0
CADD	MJ	07/01/05	FIGURE: III-10		
CHECK	CM	20/01/05			
REVIEW	TC	20/01/05			

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Photo 1 - Aerial view of Unnamed Waterbody 15 (August 2004).

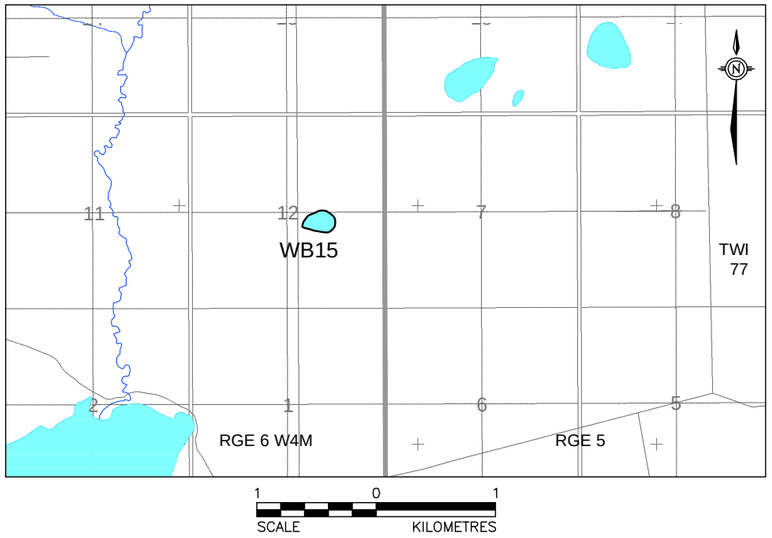
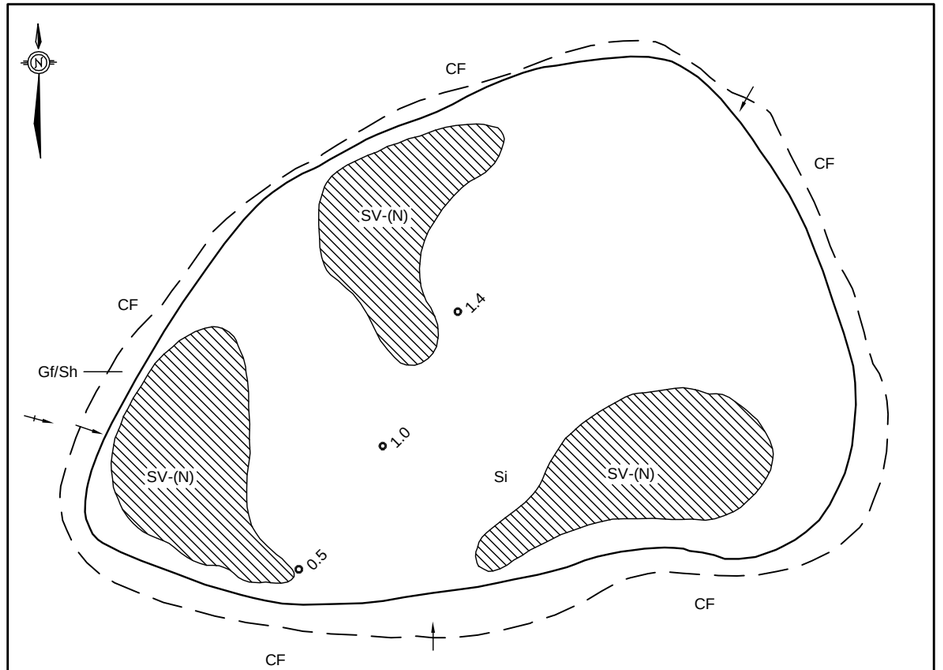


Photo 4 - Typical shoreline and aquatic vegetation at Unnamed Waterbody 15 (August 2004).

Photo 2 - Floating leaved vegetation located at Unnamed Waterbody 15 (pond lily) (August 2004).



SCHEMATIC ONLY, NOT TO SCALE

Photo 3 - Typical shoreline habitat at Unnamed Waterbody 15 (August 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.61 m — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Si	Silt (<0.06 mm)
Sa	Sand (0.06–2 mm)
Gr	Gravel (2–64 mm)
Co	Cobble (64–256 mm)
Bo	Boulder (>256 mm)
Bd	Bedrock
Or	Organic Material

Vegetation Type:

MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Gf	Grass/Forbes
Sh	Shrubs

Aquatic Macrophytes

- Emergent Vegetation (EV)
- Submergent or Floating-Leaved Vegetation (SV)
- Terrestrial Vegetation (TV)

Submergent

C	Ceratophyllum
Ch	Chara
E	Elodea
L	Lemna
M	Myriophyllum
N	Nuphar
P	Potamogeton

Emergent

Sc	Scirpus
Sp	Sparganium
T	Typha

Terrestrial Vegetation

Ca	Carex
La	Larix
Pi	Picea
Pp	Populus
Sx	Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 15 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04-1334-001.6140			FILE No.	Lake 15
DESIGN	CD	08/12/04	SCALE AS SHOWN	REV. 0
CADD	SWD	12/01/05	**FIGURE: III-11**	
CHECK	CD	12/01/05		
REVIEW	TC	18/01/05		

R:\CAD\2004\1322-EA\1334\04-1334-001 MEG\6100\6140-Baseline\Lake 15.dwg Jun 02, 2005 - 12:55pm

Photo 1 - Aerial view of Unnamed Waterbody 16 (May 2004).

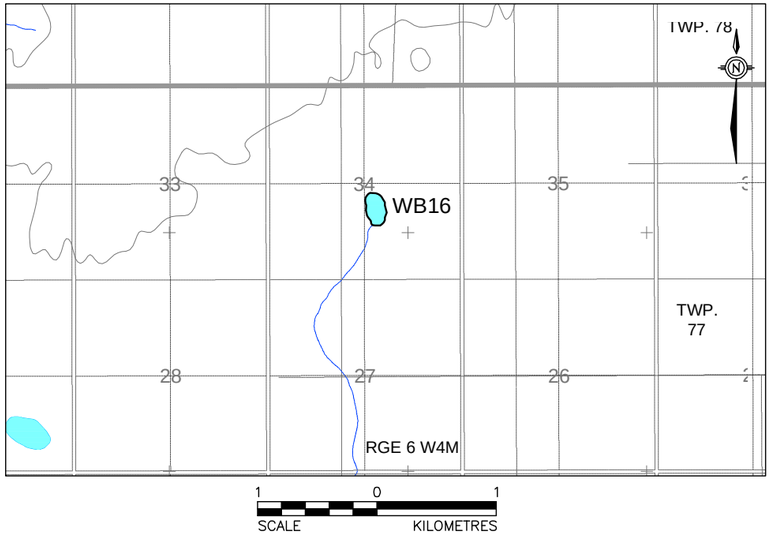


Photo 4 - Typical shoreline vegetation of Unnamed Waterbody 16 (August 2004).

Photo 2 - Aquatic and terrestial vegetation located at Unnamed Waterbody 16 (August 2004).

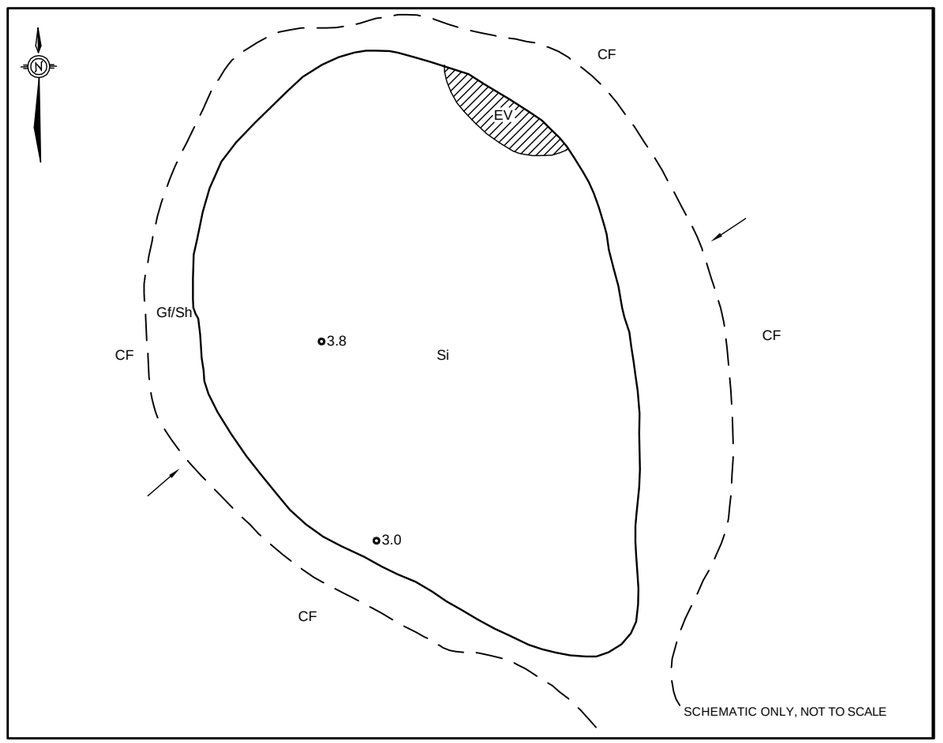


Photo 3 - Aquatic vegetation in Unnamed Waterbody 16 (August 2004).

LEGEND - LAKE HABITAT MAPPING SYSTEM

- 0.61 m — Indicates Depth
- Direction of Flow
- BL — Beaverlodge
- DP — Debris Pile
- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Si	Silt (<0.06 mm)
Sa	Sand (0.06–2 mm)
Gr	Gravel (2–64 mm)
Co	Cobble (64–256 mm)
Bo	Boulder (>256 mm)
Bd	Bedrock
Or	Organic Material

Vegetation Type:

MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Gf	Grass/Forbes
Sh	Shrubs

Aquatic Macrophytes

- Emergent Vegetation (EV)
- Submergent or Floating–Leaved Vegetation (SV)
- Terrestrial Vegetation (TV)

Submergent

C	Ceratophyllum
Ch	Chara
E	Elodea
L	Lemna
M	Myriophyllum
N	Nuphar
P	Potamogeton

Emergent

Sc	Scirpus
Sp	Sparganium
T	Typha

Terrestrial Vegetation

Ca	Carex
La	Larix
Pi	Picea
Pp	Populus
Sx	Salix

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

UNNAMED WATERBODY 16 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.	Lake 16
DESIGN	CD	08/12/04	SCALE AS SHOWN	REV. 0
CADD	MJ	07/01/05		
CHECK	CM	20/01/05		
REVIEW	TC	20/01/05		

FIGURE: III-12

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APPENDIX IV

HABITAT MAPS AND PHOTOGRAPHS FOR WATERCOURSE SAMPLE SITES

Photo 1 - Downstream view of site S1A looking towards Christina Lake (May 2004).

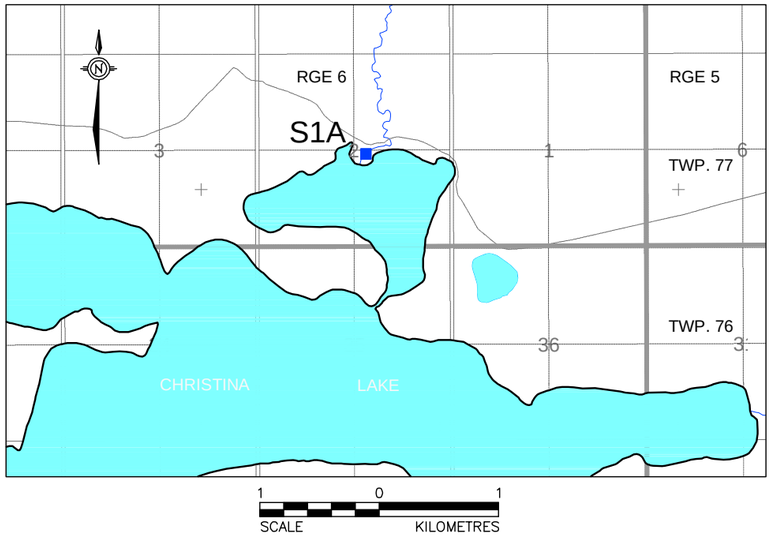


Photo 4 - Upstream view of run habitat at site S1A (May 2004).

Photo 2 - Left downstream bank at site S1A showing vegetated riparian area (May 2004).

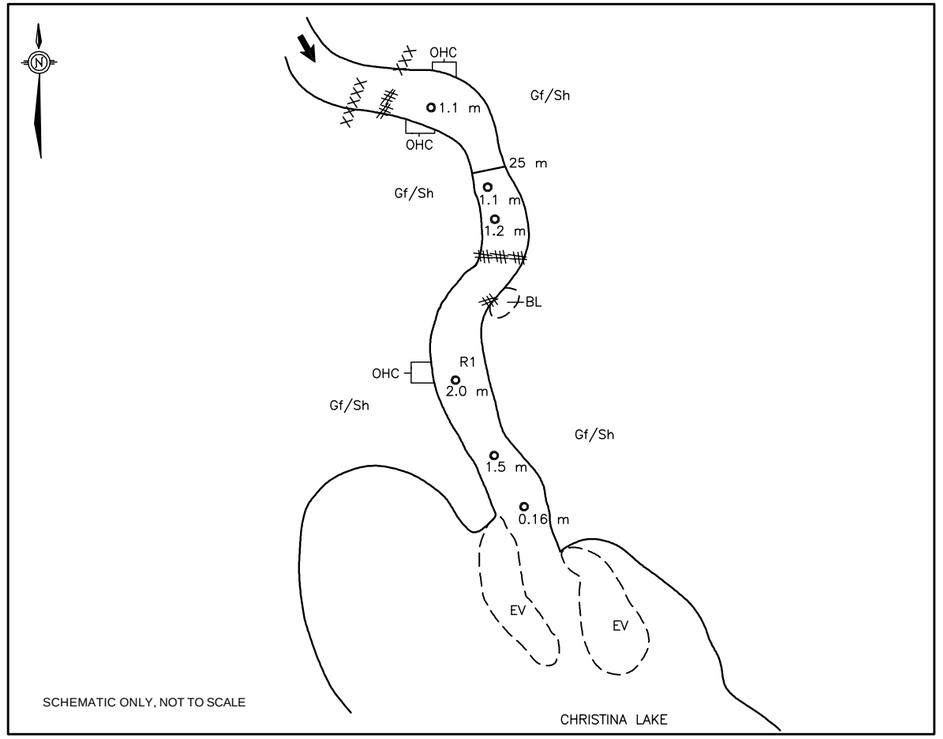


Photo 3 - Walleye captured at site S1A during spring sampling (May 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

FA	Falls; Very Swift, Vertical Drop; Impassable to Fish
CA	Cascade; Very Swift, Turbulent; Passable to Fish
CH	Chute; Channel Restricted, Swift, Moderate Depth
RA	Rapids; Very Swift, Deep, With Cover
RF	Riffle; Swift, Shallow, Turbulent
R1	Class 1 Run; Moderately Swift, Deep With Cover
R2	Class 2 Run; Moderately Swift, Moderate Depth and Cover
R3	Class 3 Run; Moderately Swift, Shallow, Limited Cover
FL	Flat; Slow, Laminar Flow, Depositional
P1	Class 1 Scour Pool; Slow, Deep
P2	Class 2 Scour Pool; Slow, Moderate Depth
P3	Class 3 Scour Pool; Slow, Shallow
IP1	Class 1 Impoundment Pool; Deep
IP2	Class 2 Impoundment Pool; Moderate Depth
IP3	Class 3 Impoundment Pool; Shallow
BW	Backwater; Slow, Reverse Flow
BG	Boulder Garden
SN	Snye; Isolated Area of Zero Velocity
1.5 m	Indicates Channel Unit Depth
|	Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Or	Organic Material
Si	Silt (<0.06mm)
Sa	Sand (0.06–2mm)
Gr	Gravel (2–64mm)
Co	Cobble (64–256mm)
Bo	Boulder (>256mm)
Bd	Bedrock

Vegetation Type:

Gf	Grass/Forbes
Se	Sedges
Sh	Shrubs
CF	Coniferous Forest
MF	Mixed Forest

Habitat Feature:

- Sand/Mud Bar
- Gravel Bar
- Island
- Woody Debris Pile (DP)
- UCB Undercut Bank (fish cover)
- USB Unstable Bank (slumping or eroding)

- OHC High Quality Overhead Cover
- ISC High Quality Instream Cover
- LE Ledge; Bedrock Intrusion, Vertical Drop
- Overhanging Vegetation
- Inundated Vegetation
- SV Submergent Vegetation
- EV Emergent Vegetation
- TV Terrestrial Vegetation
- XX Beaver Dam
- Direction of Flow

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S1A HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.		S1A
DESIGN	CD	16/12/04	SCALE	AS SHOWN	REV. 0
CADD	SWD	06/01/05			
CHECK	CD	06/01/05			**FIGURE: IV-1**
REVIEW	TC	20/01/05			

Jun 02, 2005 – 12:33pm

R:\CAD\2004\1322–EA\1334\04–1334–001 MEG\6100\6140–Baseline\Fig IV–1 Stream Channel S1A.dwg

Photo 1 - Downstream view at Site S1 showing typical run habitat (August 2004).

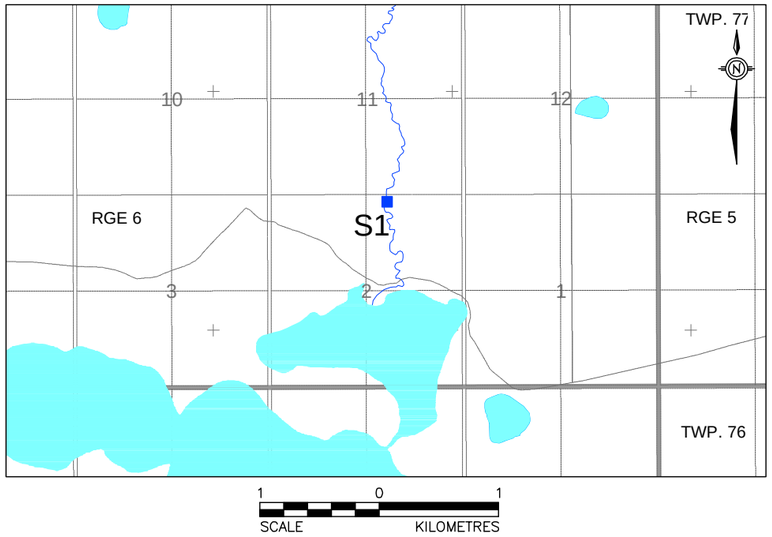
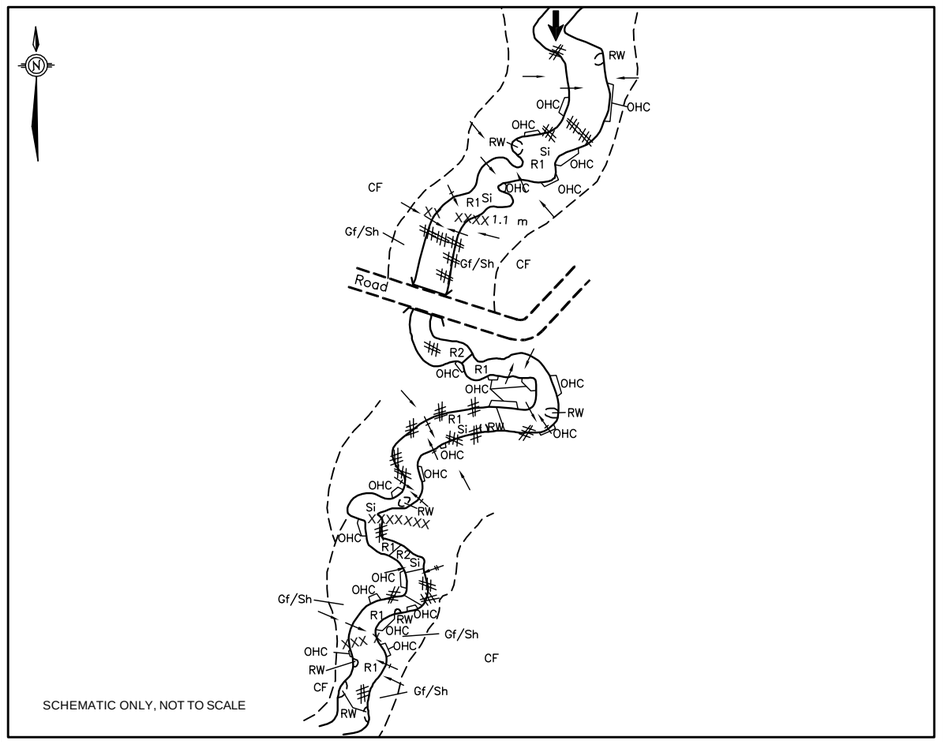


Photo 4 - Upstream view at Site S1 showing instream vegetation (August 2004).

Photo 2 - Left downstream bank at Site S1 showing silt banks and overhanging vegetation (August 2004).



SCHEMATIC ONLY, NOT TO SCALE

Photo 3 - Right downstream bank at Site S1 showing riparian vegetation (August 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

- FA Falls; Very Swift, Vertical Drop; Impassable to Fish
- CA Cascade; Very Swift, Turbulent; Passable to Fish
- CH Chute; Channel Restricted, Swift, Moderate Depth
- RA Rapids; Very Swift, Deep, With Cover
- RF Riffle; Swift, Shallow, Turbulent
- R1 Class 1 Run; Moderately Swift, Deep With Cover
- R2 Class 2 Run; Moderately Swift, Moderate Depth and Cover
- R3 Class 3 Run; Moderately Swift, Shallow, Limited Cover
- FL Flat; Slow, Laminar Flow, Depositional
- P1 Class 1 Scour Pool; Slow, Deep
- P2 Class 2 Scour Pool; Slow, Moderate Depth
- P3 Class 3 Scour Pool; Slow, Shallow
- IP1 Class 1 Impoundment Pool; Deep
- IP2 Class 2 Impoundment Pool; Moderate Depth
- IP3 Class 3 Impoundment Pool; Shallow
- BW Backwater; Slow, Reverse Flow
- BG Boulder Garden
- SN Snye; Isolated Area of Zero Velocity
- O1.5 m Indicates Channel Unit Depth
- | Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

- Or Organic Material
- Si Silt (<0.06mm)
- Sa Sand (0.06–2mm)
- Gr Gravel (2–64mm)
- Co Cobble (64–256mm)
- Bo Boulder (>256mm)
- Bd Bedrock

Vegetation Type:

- Gf Grass/Forbes
- Se Sedges
- Sh Shrubs
- CF Coniferous Forest
- MF Mixed Forest

Habitat Feature:

- Sand/Mud Bar
- Gravel Bar
- Island
- Woody Debris Pile (DP)
- UCB Undercut Bank (fish cover)
- USB Unstable Bank (slumping or eroding)
- OHC High Quality Overhead Cover
- ISC High Quality Instream Cover
- LE Ledge; Bedrock Intrusion, Vertical Drop
- Overhanging Vegetation
- Inundated Vegetation
- SV Submergent Vegetation
- EV Emergent Vegetation
- TV Terrestrial Vegetation
- XX Beaver Dam
- Direction of Flow
- RW Root Wad

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S1 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.	S1
DESIGN	CD	13/12/04	SCALE AS SHOWN	REV. 0
CADD	SWD	12/01/05		
CHECK	CD	12/01/05	**FIGURE: IV-2**	
REVIEW	TC	18/01/05		

R:\CAD\2004\1322–EA\1334\04–1334–001 MEG\6100\6140–Baseline\Fig IV–2 Stream Channel S1.dwg Jun 02, 2005 – 12:36pm

Photo 1 - View of left downstream bank at Site S4 showing grass/shrub riparian vegetation (May 2004).

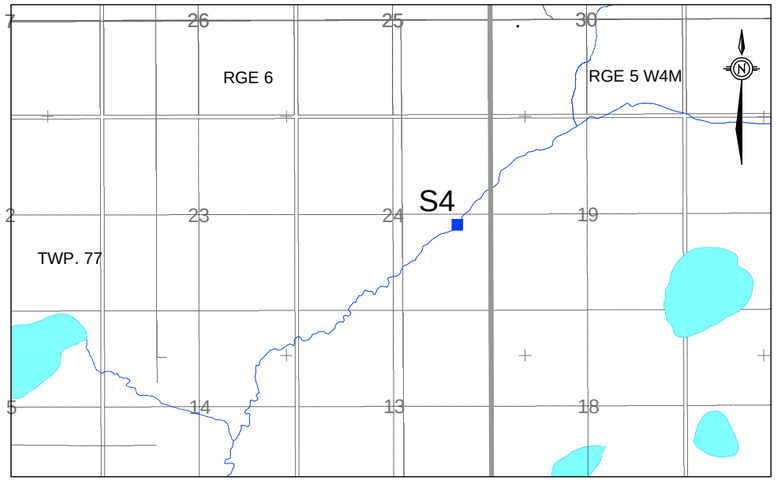


Photo 4 - Aerial view of Site S4 (August 2004).

Photo 2 -View of right downstream bank at Site S4 showing riparian vegetation (August 2004).

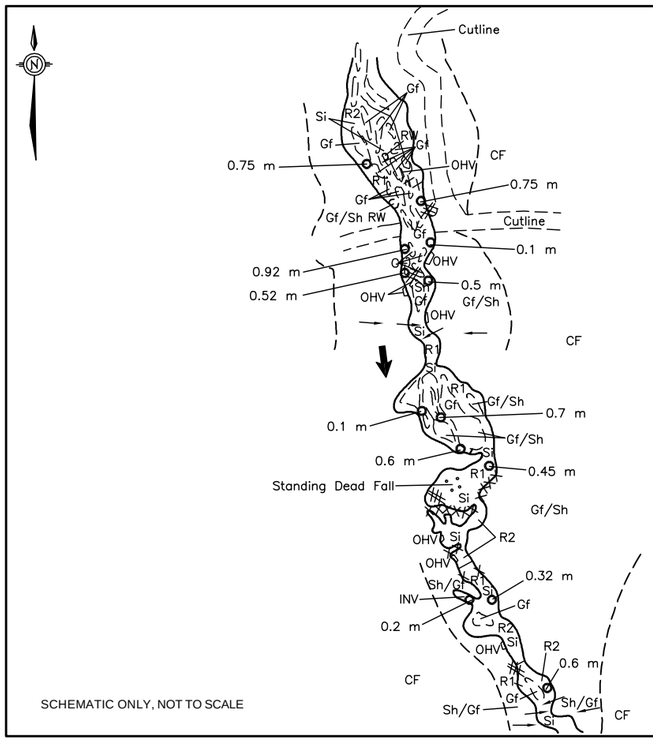


Photo 3 - Upstream view at Site S4 showing shallow run habitat (August 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

- FA Falls; Very Swift, Vertical Drop; Impassable to Fish
- CA Cascade; Very Swift, Turbulent; Passable to Fish
- CH Chute; Channel Restricted, Swift, Moderate Depth
- RA Rapids; Very Swift, Deep, With Cover
- RF Riffle; Swift, Shallow, Turbulent
- R1 Class 1 Run; Moderately Swift, Deep With Cover
- R2 Class 2 Run; Moderately Swift, Moderate Depth and Cover
- R3 Class 3 Run; Moderately Swift, Shallow, Limited Cover
- FL Flat; Slow, Laminar Flow, Depositional
- P1 Class 1 Scour Pool; Slow, Deep
- P2 Class 2 Scour Pool; Slow, Moderate Depth
- P3 Class 3 Scour Pool; Slow, Shallow

- IP1 Class 1 Impoundment Pool; Deep
- IP2 Class 2 Impoundment Pool; Moderate Depth
- IP3 Class 3 Impoundment Pool; Shallow
- BW Backwater; Slow, Reverse Flow
- BG Boulder Garden
- SN Snye; Isolated Area of Zero Velocity
- 1.5 m Indicates Channel Unit Depth
- | Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

- Or Organic Material
- Si Silt (<0.06mm)
- Sa Sand (0.06–2mm)
- Gr Gravel (2–64mm)
- Co Cobble (64–256mm)
- Bo Boulder (>256mm)
- Bd Bedrock

Vegetation Type:

- Gf Grass/Forbes
- Se Sedges
- Sh Shrubs
- CF Coniferous Forest
- MF Mixed Forest

Habitat Feature:

- Sand/Mud Bar
- Gravel Bar
- Island
- Woody Debris Pile (DP)
- UCB Undercut Bank (fish cover)
- USB Unstable Bank (slumping or eroding)

- OHC High Quality Overhead Cover
- ISC High Quality Instream Cover
- LE Ledge; Bedrock Intrusion, Vertical Drop
- Overhanging Vegetation
- Inundated Vegetation
- SV Submergent Vegetation
- EV Emergent Vegetation
- TV Terrestrial Vegetation
- XX Beaver Dam
- Direction of Flow
- RW Root Wad

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S4 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.	S4
DESIGN	CD	06/01/05	SCALE AS SHOWN	REV. 0
CADD	SWD	07/01/05		
CHECK	CD	07/01/05		
REVIEW	TC	20/01/05		

FIGURE: IV-3

R:\CAD\2004\1322–EA\1334\04–1334–001 MEG\6100\6140–Baseline\Fig IV–3 Stream Channel S4.dwg Jun 02, 2005 – 12:37pm

Photo 1 - Downstream view of Site S5 showing flat habitat (May 2004).

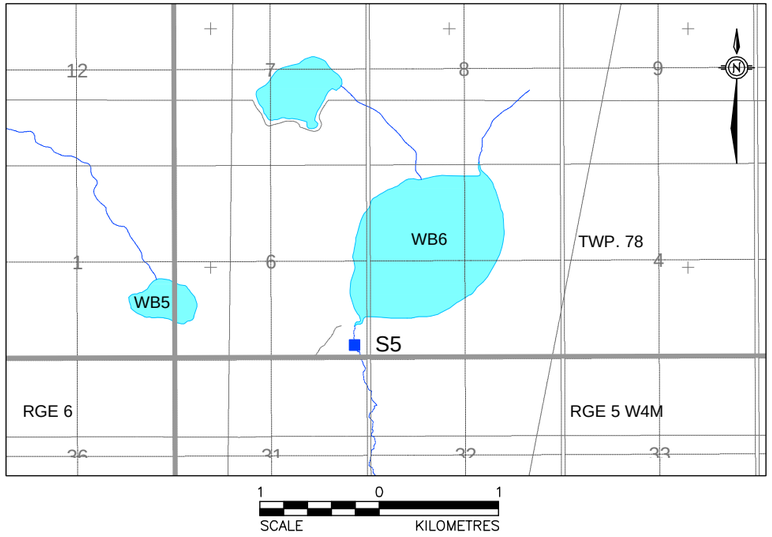


Photo 4 - Upstream view of Site S5 showing placement of gill net in stream channel (August 2004).

Photo 2 - Left downstream bank at Site S5 showing inundated grass vegetation (August 2004).

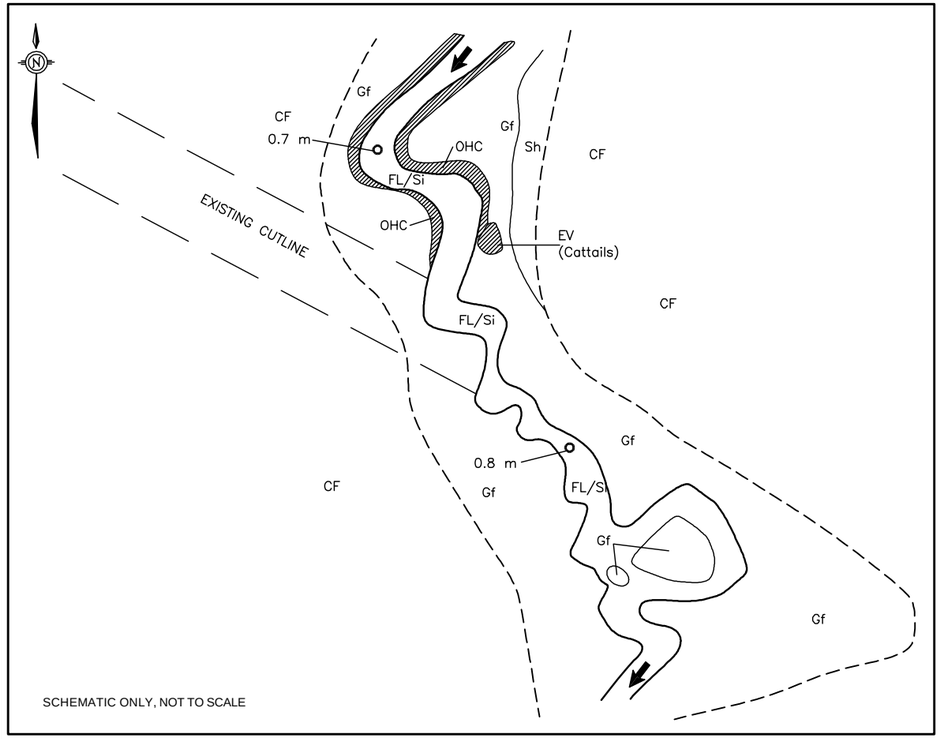


Photo 3 - Right downstream bank at Site S5 showing inundated grass vegetation (August 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

FA	Falls; Very Swift, Vertical Drop; Impassable to Fish
CA	Cascade; Very Swift, Turbulent; Passable to Fish
CH	Chute; Channel Restricted, Swift, Moderate Depth
RA	Rapids; Very Swift, Deep, With Cover
RF	Riffle; Swift, Shallow, Turbulent
R1	Class 1 Run; Moderately Swift, Deep With Cover
R2	Class 2 Run; Moderately Swift, Moderate Depth and Cover
R3	Class 3 Run; Moderately Swift, Shallow, Limited Cover
FL	Flat; Slow, Laminar Flow, Depositional
P1	Class 1 Scour Pool; Slow, Deep
P2	Class 2 Scour Pool; Slow, Moderate Depth
P3	Class 3 Scour Pool; Slow, Shallow
IP1	Class 1 Impoundment Pool; Deep
IP2	Class 2 Impoundment Pool; Moderate Depth
IP3	Class 3 Impoundment Pool; Shallow
BW	Backwater; Slow, Reverse Flow
BG	Boulder Garden
SN	Snye; Isolated Area of Zero Velocity
O1.5	m Indicates Channel Unit Depth
|	Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Or	Organic Material
Si	Silt (<0.06mm)
Sa	Sand (0.06–2mm)
Gr	Gravel (2–64mm)
Co	Cobble (64–256mm)
Bo	Boulder (>256mm)
Bd	Bedrock

Vegetatation Type:

Gf	Grass/Forbes
Se	Sedges
Sh	Shrubs
CF	Coniferous Forest
MF	Mixed Forest

Habitat Feature:

- Sand/Mud Bar
- Gravel Bar
- Island
- Woody Debris Pile (DP)
- UCB Undercut Bank (fish cover)
- USB Unstable Bank (slumping or eroding)
- OHC High Quality Overhead Cover
- ISC High Quality Instream Cover
- LE Ledge; Bedrock Intrusion, Vertical Drop
- Overhanging Vegetation
- Inundated Vegetation
- SV Submergent Vegetation
- EV Emergent Vegetation
- TV Terrestrial Vegetation
- XX Beaver Dam
- Direction of Flow

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S5
HABITAT MAP

MEG ENERGY CORP.

PROJECT 04-1334-001.6140			FILE No.		S5
DESIGN	CD	13/12/04	SCALE	AS SHOWN	REV. 0
CADD	SWD	12/01/05			
CHECK	CD	12/01/05			
REVIEW	TC	18/01/05			

FIGURE: IV-4

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Photo 1 - Downstream view of Site S6 (August 2004).

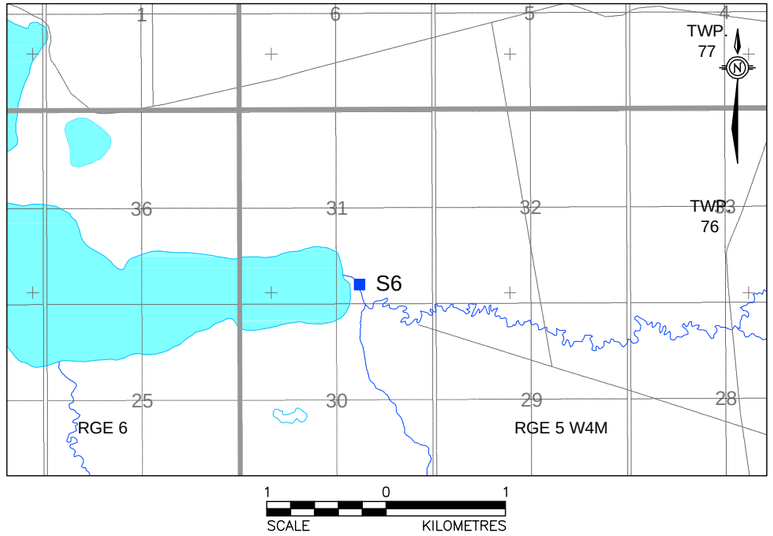
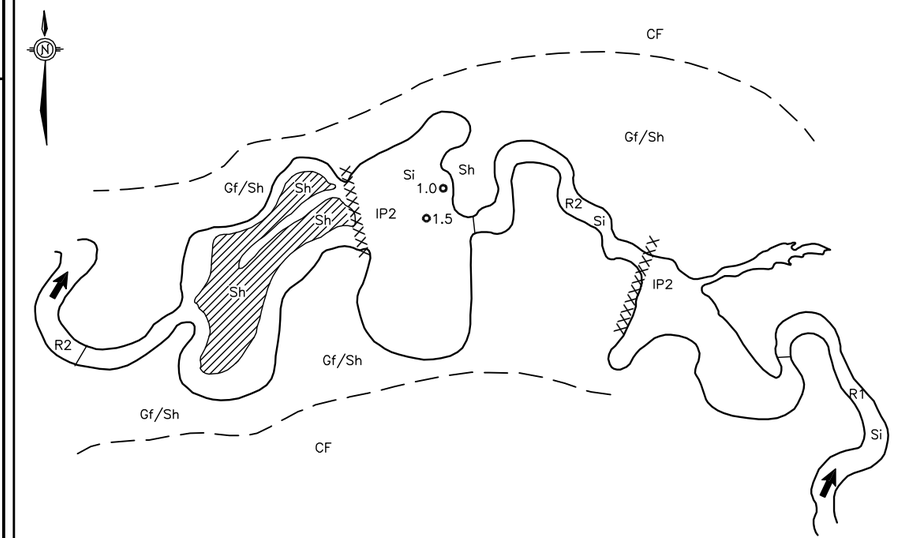


Photo 4 - Upstream view of Site S6 (August 2004).

Photo 2 - Left downstream bank at Site S6 showing shrub/grass riparian vegetation (August 2004).



SCHEMATIC ONLY, NOT TO SCALE

Photo 3 - Right downstream bank at Site S6 showing riparian vegetation (August 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

FA	Falls; Very Swift, Vertical Drop; Impassable to Fish
CA	Cascade; Very Swift, Turbulent; Passable to Fish
CH	Chute; Channel Restricted, Swift, Moderate Depth
RA	Rapids; Very Swift, Deep, With Cover
RF	Riffle; Swift, Shallow, Turbulent
R1	Class 1 Run; Moderately Swift, Deep With Cover
R2	Class 2 Run; Moderately Swift, Moderate Depth and Cover
R3	Class 3 Run; Moderately Swift, Shallow, Limited Cover
FL	Flat; Slow, Laminar Flow, Depositional
P1	Class 1 Scour Pool; Slow, Deep
P2	Class 2 Scour Pool; Slow, Moderate Depth
P3	Class 3 Scour Pool; Slow, Shallow
IP1	Class 1 Impoundment Pool; Deep
IP2	Class 2 Impoundment Pool; Moderate Depth
IP3	Class 3 Impoundment Pool; Shallow
BW	Backwater; Slow, Reverse Flow
BG	Boulder Garden
SN	Snye; Isolated Area of Zero Velocity
1.5	m Indicates Channel Unit Depth
|	Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Or	Organic Material
Si	Silt (<0.06mm)
Sa	Sand (0.06–2mm)
Gr	Gravel (2–64mm)
Co	Cobble (64–256mm)
Bo	Boulder (>256mm)
Bd	Bedrock

Vegetatation Type:

Gf	Grass/Forbes
Se	Sedges
Sh	Shrubs
CF	Coniferous Forest
MF	Mixed Forest

Habitat Feature:

- Sand/Mud Bar
- Gravel Bar
- Island
- Woody Debris Pile (DP)

UCB	Undercut Bank (fish cover)
USB	Unstable Bank (slumping or eroding)
OHC	High Quality Overhead Cover
ISC	High Quality Instream Cover
LE	Ledge; Bedrock Intrusion, Vertical Drop

- Overhanging Vegetation
- Inundated Vegetation

SV	Submergent Vegetation
EV	Emergent Vegetation
TV	Terrestrial Vegetation
XX	Beaver Dam

- Direction of Flow

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S6 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04-1334-001.6140			FILE No.		S6
DESIGN	CD	06/01/05	SCALE	AS SHOWN	REV. 0
CADD	SWD	07/01/05			
CHECK	CD	07/01/05			
REVIEW	TC	18/01/05			

FIGURE: IV-5

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Photo 1 - Downstream view of Site S7 (August 2004).

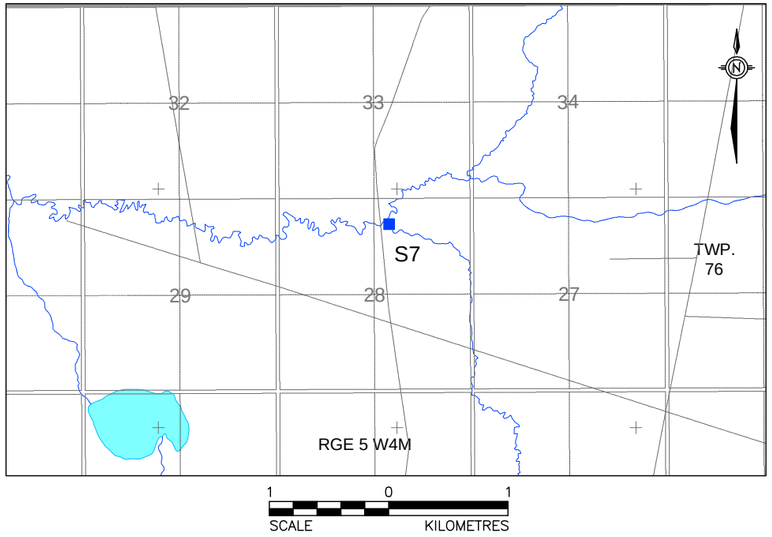
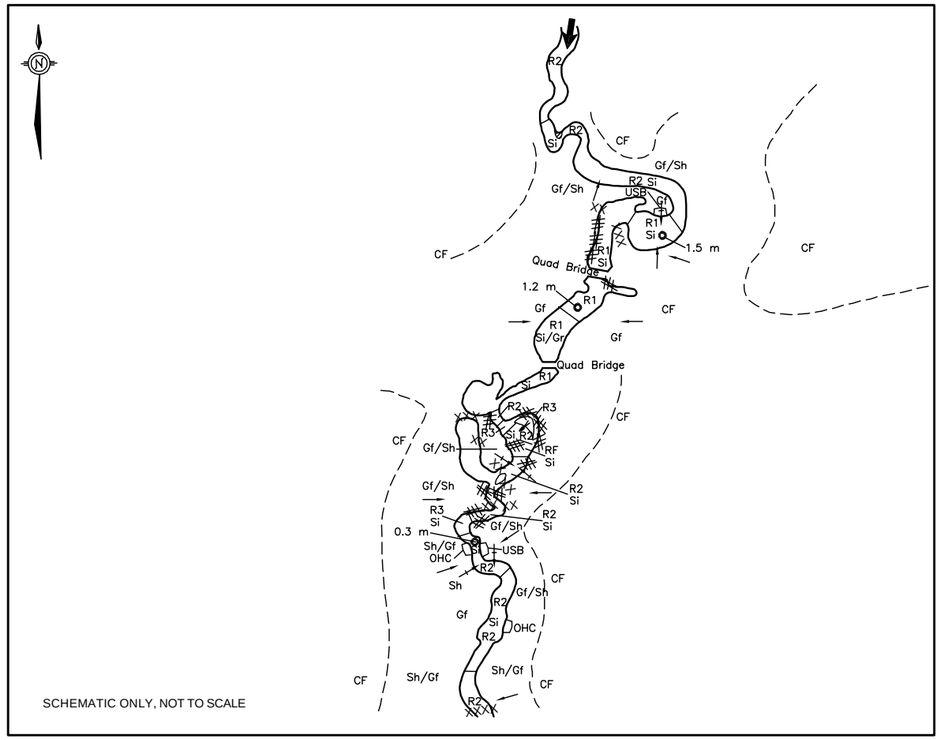


Photo 4 - Upstream view of Site S7 (August 2004).

Photo 2 - Left downstream bank at Site S7 showing grass/shrub riparian vegetation (August 2004).



SCHEMATIC ONLY, NOT TO SCALE

Photo 3 - Right downstream bank at Site S7 showing well vegetated banks (August 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

FA	Falls; Very Swift, Vertical Drop; Impassable to Fish
CA	Cascade; Very Swift, Turbulent; Passable to Fish
CH	Chute; Channel Restricted, Swift, Moderate Depth
RA	Rapids; Very Swift, Deep, With Cover
RF	Riffle; Swift, Shallow, Turbulent
R1	Class 1 Run; Moderately Swift, Deep With Cover
R2	Class 2 Run; Moderately Swift, Moderate Depth and Cover
R3	Class 3 Run; Moderately Swift, Shallow, Limited Cover
FL	Flat; Slow, Laminar Flow, Depositional
P1	Class 1 Scour Pool; Slow, Deep
P2	Class 2 Scour Pool; Slow, Moderate Depth
P3	Class 3 Scour Pool; Slow, Shallow
IP1	Class 1 Impoundment Pool; Deep
IP2	Class 2 Impoundment Pool; Moderate Depth
IP3	Class 3 Impoundment Pool; Shallow
BW	Backwater; Slow, Reverse Flow
BG	Boulder Garden
SN	Snye; Isolated Area of Zero Velocity
1.5	m Indicates Channel Unit Depth
|	Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Or	Organic Material
Si	Silt (<0.06mm)
Sa	Sand (0.06–2mm)
Gr	Gravel (2–64mm)
Co	Cobble (64–256mm)
Bo	Boulder (>256mm)
Bd	Bedrock

Vegetation Type:

Gf	Grass/Forbes
Se	Sedges
Sh	Shrubs
CF	Coniferous Forest
MF	Mixed Forest

Habitat Feature:

	Sand/Mud Bar
GRAVEL	Gravel Bar
	Island
	Woody Debris Pile (DP)
UCB	Undercut Bank (fish cover)
USB	Unstable Bank (slumping or eroding)
OHC	High Quality Overhead Cover
ISC	High Quality Instream Cover
LE	Ledge; Bedrock Intrusion, Vertical Drop
	Overhanging Vegetation
	Inundated Vegetation
SV	Submergent Vegetation
EV	Emergent Vegetation
TV	Terrestrial Vegetation
XX	Beaver Dam
	Direction of Flow

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S7 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.		S7
DESIGN	CD	13/12/04	SCALE	AS SHOWN	REV. 0
CADD	SWD	13/01/05	FIGURE: IV-6		
CHECK	KM	12/01/05			
REVIEW	TC	18/01/05			

R:\CAD\2004\1322–EA\1334\04–1334–001 MEG\6100\6140–Baseline\Fig IV–6 Stream Channel S7.dwg Jun 02, 2005 – 12:42pm

Photo 1 - Downstream view of Site S8 showing shallow run habitat (August 2004).

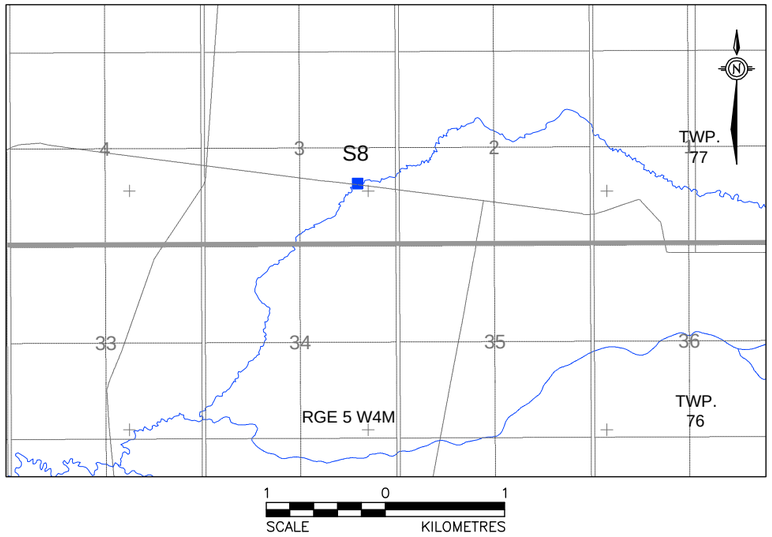
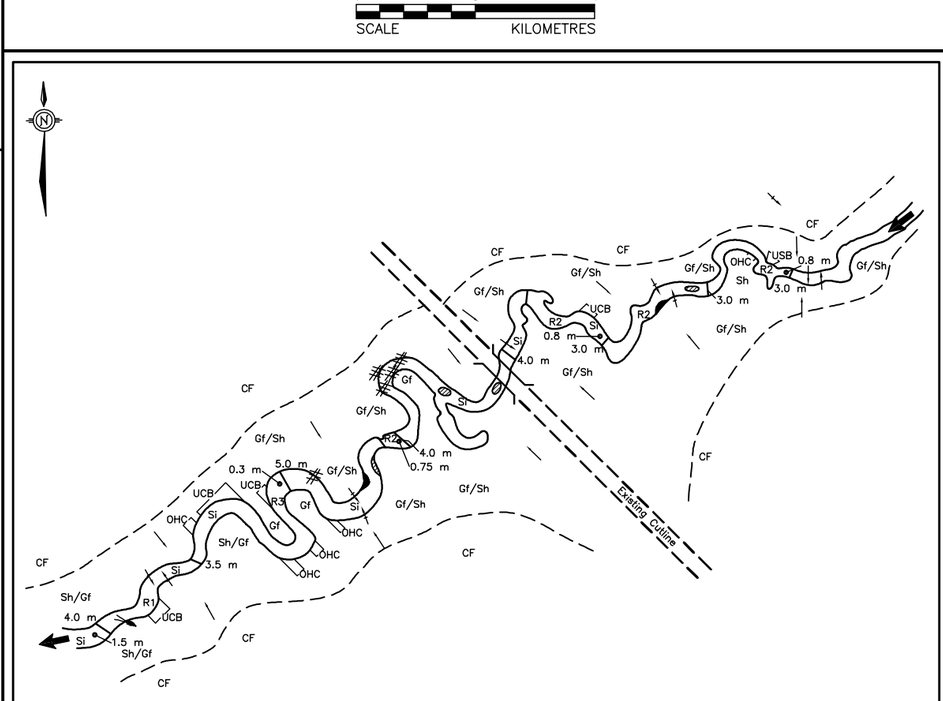


Photo 4 - Right downstream bank at Site S8 showing riparian vegetation (August 2004)

Photo 2 - Left downstream bank at Site S8 showing silt substate and vegetated banks (August 2004).



SCHEMATIC ONLY, NOT TO SCALE

Photo 3 - Upstream view at Site S8 showing instream vegetation (August 2004)

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

FA	Falls; Very Swift, Vertical Drop; Impassable to Fish
CA	Cascade; Very Swift, Turbulent; Passable to Fish
CH	Chute; Channel Restricted, Swift, Moderate Depth
RA	Rapids; Very Swift, Deep, With Cover
RF	Riffle; Swift, Shallow, Turbulent
R1	Class 1 Run; Moderately Swift, Deep With Cover
R2	Class 2 Run; Moderately Swift, Moderate Depth and Cover
R3	Class 3 Run; Moderately Swift, Shallow, Limited Cover
FL	Flat; Slow, Laminar Flow, Depositional
P1	Class 1 Scour Pool; Slow, Deep
P2	Class 2 Scour Pool; Slow, Moderate Depth
P3	Class 3 Scour Pool; Slow, Shallow
IP1	Class 1 Impoundment Pool; Deep
IP2	Class 2 Impoundment Pool; Moderate Depth
IP3	Class 3 Impoundment Pool; Shallow
BW	Backwater; Slow, Reverse Flow
BG	Boulder Garden
SN	Snye; Isolated Area of Zero Velocity
1.5 m	Indicates Channel Unit Depth
|	Channel Unit Divider

Shore/Bottom Slope

	Shallow Slope
	Moderate Slope
	Moderately Steep Slope
	Steep Slope

Substrate Particle Size:

Or	Organic Material
Si	Silt (<0.06mm)
Sa	Sand (0.06–2mm)
Gr	Gravel (2–64mm)
Co	Cobble (64–256mm)
Bo	Boulder (>256mm)
Bd	Bedrock

Vegetatation Type:

Gf	Grass/Forbes
Se	Sedges
Sh	Shrubs
CF	Coniferous Forest
MF	Mixed Forest

Habitat Feature:

	Sand/Mud Bar
	Gravel Bar
	Island
	Woody Debris Pile (DP)
UCB	Undercut Bank (fish cover)
USB	Unstable Bank (slumping or eroding)
OHC	High Quality Overhead Cover
ISC	High Quality Instream Cover
LE	Ledge; Bedrock Intrusion, Vertical Drop
	Overhanging Vegetation
	Inundated Vegetation
SV	Submergent Vegetation
EV	Emergent Vegetation
TV	Terrestrial Vegetation
XX	Beaver Dam
	Direction of Flow

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S8 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.		S8
DESIGN	CD	13/12/04	SCALE	AS SHOWN	REV. 0
CADD	SWD	07/01/05			
CHECK	KM	23/12/04			
REVIEW	TC	18/01/05			

FIGURE: IV-7

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Photo 1 - Aerial view of Site 9 showing shallow run habitat (August 2004).

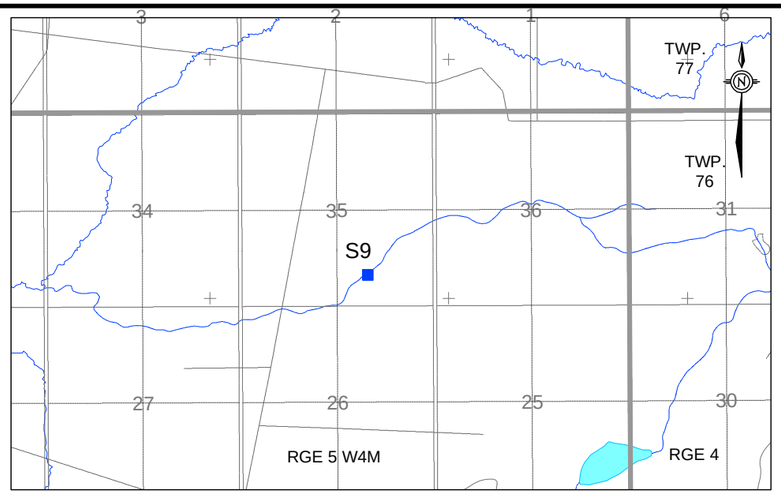


Photo 4 - Right downstream bank at Site S9 showing narrow channel with abundant vegetation (August 2004).

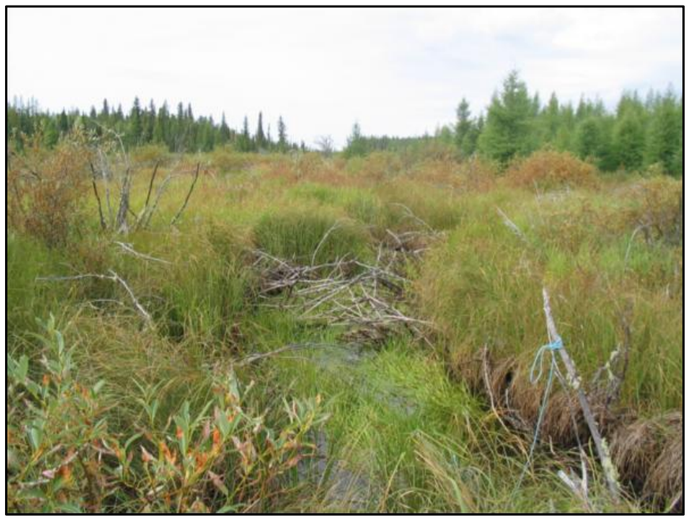
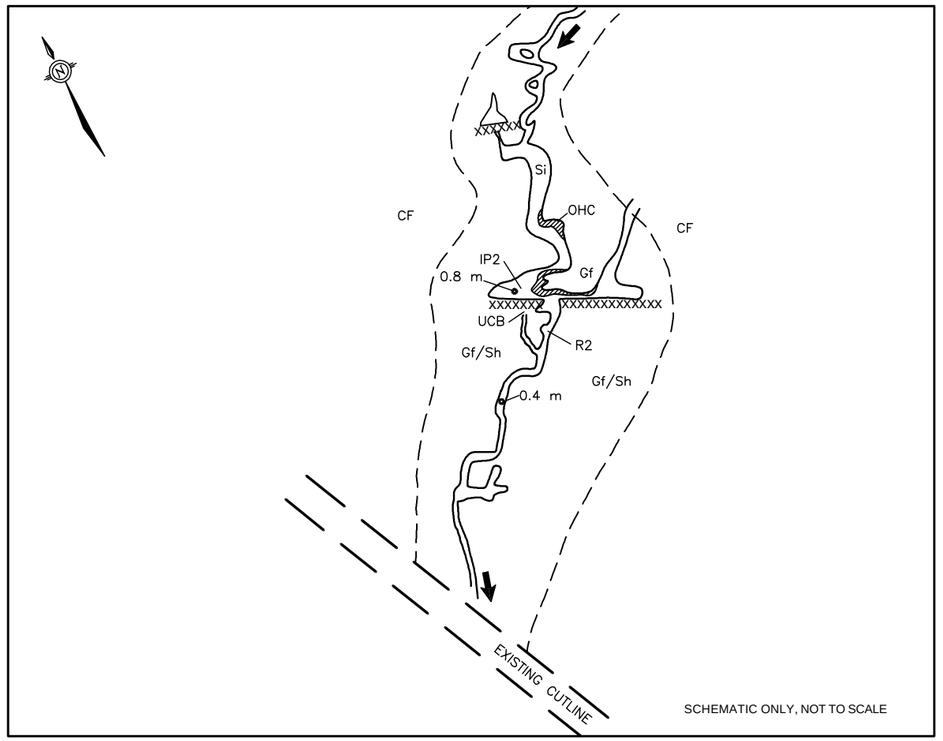


Photo 2 - Downstream view of impounded area at Site S9 (August 2004).



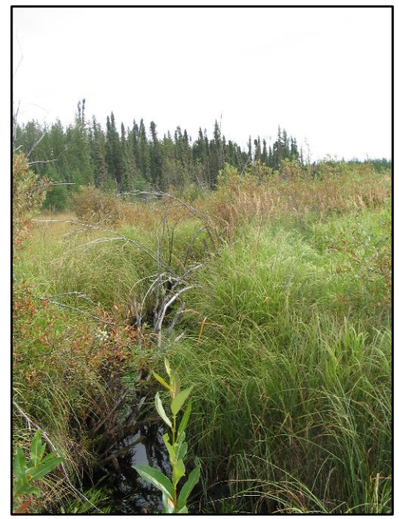


Photo 3 - Upstream view at Site S9 (August 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

FA	Falls; Very Swift, Vertical Drop; Impassable to Fish
CA	Cascade; Very Swift, Turbulent; Passable to Fish
CH	Chute; Channel Restricted, Swift, Moderate Depth
RA	Rapids; Very Swift, Deep, With Cover
RF	Riffle; Swift, Shallow, Turbulent
R1	Class 1 Run; Moderately Swift, Deep With Cover
R2	Class 2 Run; Moderately Swift, Moderate Depth and Cover
R3	Class 3 Run; Moderately Swift, Shallow, Limited Cover
FL	Flat; Slow, Laminar Flow, Depositional
P1	Class 1 Scour Pool; Slow, Deep
P2	Class 2 Scour Pool; Slow, Moderate Depth
P3	Class 3 Scour Pool; Slow, Shallow
IP1	Class 1 Impoundment Pool; Deep
IP2	Class 2 Impoundment Pool; Moderate Depth
IP3	Class 3 Impoundment Pool; Shallow
BW	Backwater; Slow, Reverse Flow
BG	Boulder Garden
SN	Snye; Isolated Area of Zero Velocity
O1.5	m Indicates Channel Unit Depth
|	Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Or	Organic Material
Si	Silt (<0.06mm)
Sa	Sand (0.06–2mm)
Gr	Gravel (2–64mm)
Co	Cobble (64–256mm)
Bo	Boulder (>256mm)
Bd	Bedrock

Vegetatation Type:

Gf	Grass/Forbes
Se	Sedges
Sh	Shrubs
CF	Coniferous Forest
MF	Mixed Forest

Habitat Feature:

- Sand/Mud Bar
- Gravel Bar
- Island
- Woody Debris Pile (DP)
- UCB Undercut Bank (fish cover)
- USB Unstable Bank (slumping or eroding)

OHC	High Quality Overhead Cover
ISC	High Quality Instream Cover
LE	Ledge; Bedrock Intrusion, Vertical Drop
	Overhanging Vegetation
	Inundated Vegetation
SV	Submergent Vegetation
EV	Emergent Vegetation
TV	Terrestrial Vegetation
XX	Beaver Dam
	Direction of Flow

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S9
HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.	S9
DESIGN	CD	06/01/05	SCALE AS SHOWN	REV. 0
CADD	SWD	07/01/05		
CHECK	CD	07/01/05	**FIGURE: IV-8**	
REVIEW	TC	18/01/05		

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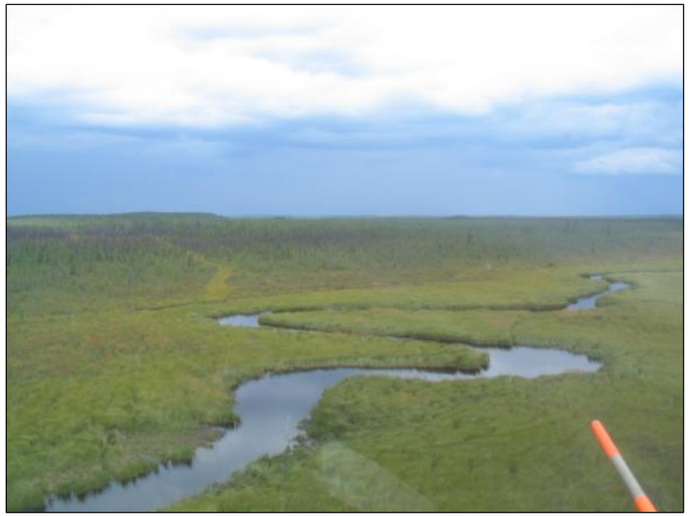

Photo 1 - Aerial upstream view of Site S10 (August 2004).

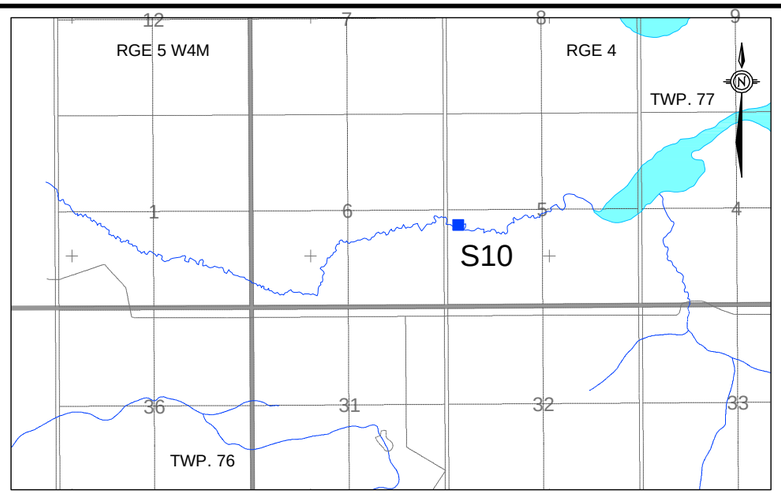

Photo 4 - Upstream view of Site S10 showing typical run habitat (August 2004).

Photo 2 - Downstream view of Site S10 showing inundated vegetation (August 2004).

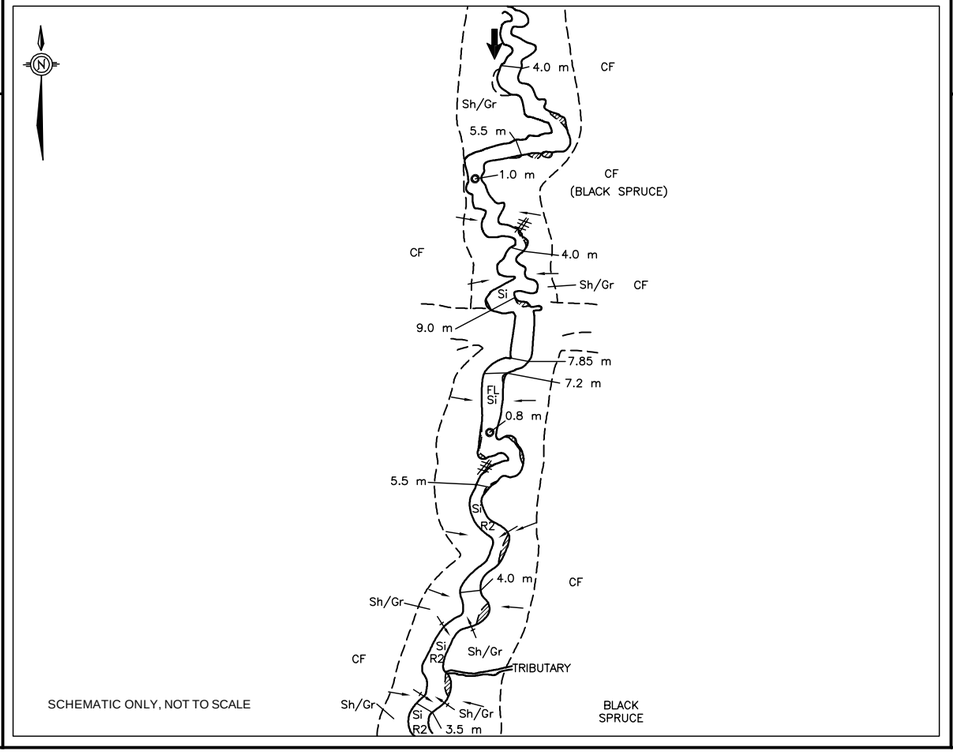

Photo 3 - Left downstream bank at Site S10 showing grass/forb riparian vegetation (August 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

- FA Falls; Very Swift, Vertical Drop; Impassable to Fish
- CA Cascade; Very Swift, Turbulent; Passable to Fish
- CH Chute; Channel Restricted, Swift, Moderate Depth
- RA Rapids; Very Swift, Deep, With Cover
- RF Riffle; Swift, Shallow, Turbulent
- R1 Class 1 Run; Moderately Swift, Deep With Cover
- R2 Class 2 Run; Moderately Swift, Moderate Depth and Cover
- R3 Class 3 Run; Moderately Swift, Shallow, Limited Cover
- FL Flat; Slow, Laminar Flow, Depositional
- P1 Class 1 Scour Pool; Slow, Deep
- P2 Class 2 Scour Pool; Slow, Moderate Depth
- P3 Class 3 Scour Pool; Slow, Shallow
- IP1 Class 1 Impoundment Pool; Deep
- IP2 Class 2 Impoundment Pool; Moderate Depth
- IP3 Class 3 Impoundment Pool; Shallow
- BW Backwater; Slow, Reverse Flow
- BG Boulder Garden
- SN Snye; Isolated Area of Zero Velocity
- 1.5 m Indicates Channel Unit Depth
- | Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

- Or Organic Material
- Si Silt (<0.06mm)
- Sa Sand (0.06–2mm)
- Gr Gravel (2–64mm)
- Co Cobble (64–256mm)
- Bo Boulder (>256mm)
- Bd Bedrock

Vegetation Type:

- Gf Grass/Forbes
- Se Sedges
- Sh Shrubs
- CF Coniferous Forest
- MF Mixed Forest

Habitat Feature:

- Sand/Mud Bar
- Gravel Bar
- Island
- Woody Debris Pile (DP)
- UCB Undercut Bank (fish cover)
- USB Unstable Bank (slumping or eroding)
- OHC High Quality Overhead Cover
- ISC High Quality Instream Cover
- LE Ledge; Bedrock Intrusion, Vertical Drop
- Overhanging Vegetation
- Inundated Vegetation
- SV Submergent Vegetation
- EV Emergent Vegetation
- TV Terrestrial Vegetation
- XX Beaver Dam
- Direction of Flow

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S10 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.		S10
DESIGN	CD	07/01/05	SCALE	AS SHOWN	REV. 0
CADD	SWD	07/01/05			
CHECK	CD	07/01/05			
REVIEW	TC	18/01/05			

FIGURE: IV-9

R:\CAD\2004\1322–EA\1334\04–1334–001 MEG\6100\6140–Baseline\Fig IV–9 Stream Channel S10.dwg Jun 02, 2005 – 12:45pm

Photo 1 - Downstream view at Site S14 showing narrow channel with overhanging vegetation (August 2004).

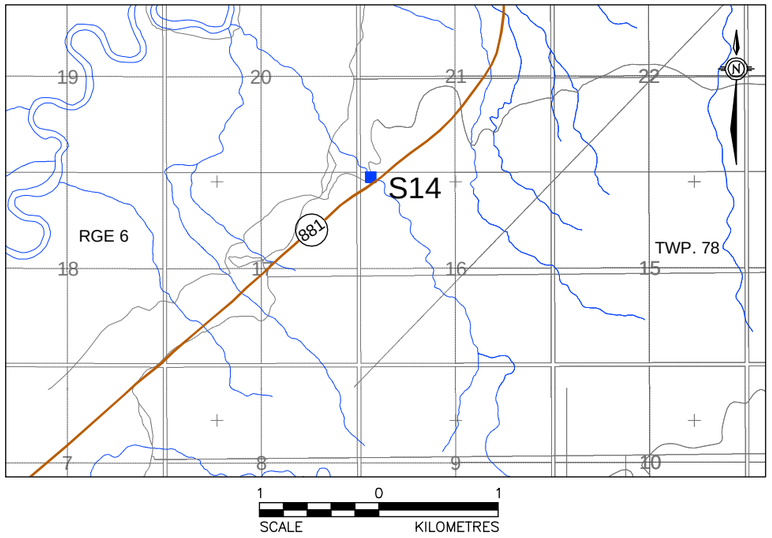

Photo 4 - Upstream view at Site S14 showing dense overhanging vegetation (August 2004).

Photo 2 - View of typical riparian habitat at Site S14 (August 2004).

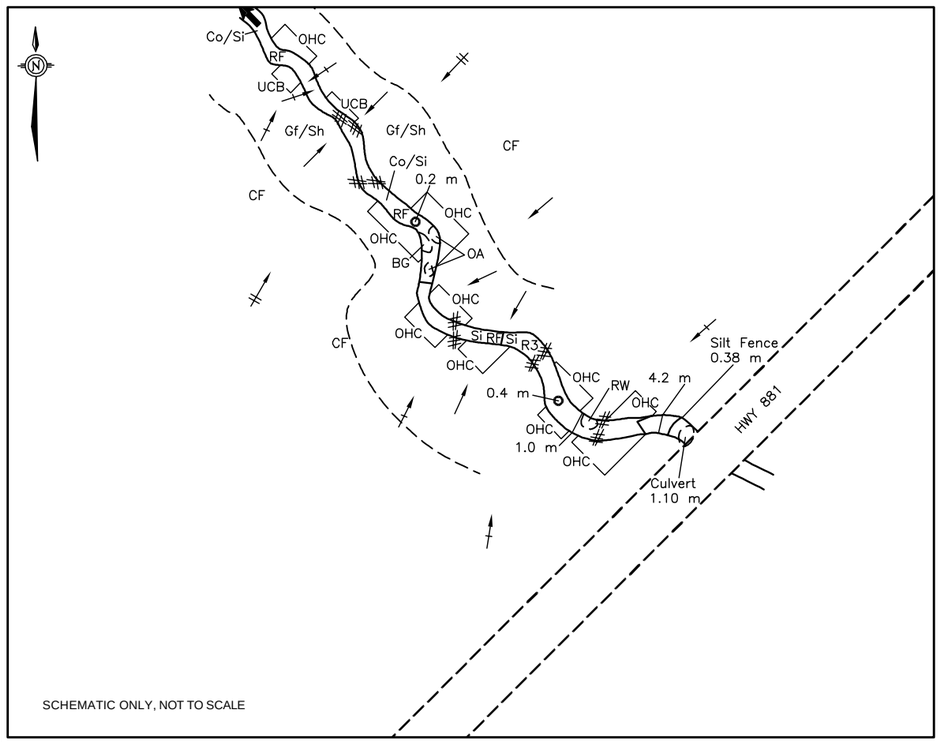

Photo 3 - View of typical shallow depths and cobble/silt substrate at Site S14 (August 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

FA	Falls; Very Swift, Vertical Drop; Impassable to Fish
CA	Cascade; Very Swift, Turbulent; Passable to Fish
CH	Chute; Channel Restricted, Swift, Moderate Depth
RA	Rapids; Very Swift, Deep, With Cover
RF	Riffle; Swift, Shallow, Turbulent
R1	Class 1 Run; Moderately Swift, Deep With Cover
R2	Class 2 Run; Moderately Swift, Moderate Depth and Cover
R3	Class 3 Run; Moderately Swift, Shallow, Limited Cover
FL	Flat; Slow, Laminar Flow, Depositional
P1	Class 1 Scour Pool; Slow, Deep
P2	Class 2 Scour Pool; Slow, Moderate Depth
P3	Class 3 Scour Pool; Slow, Shallow
IP1	Class 1 Impoundment Pool; Deep
IP2	Class 2 Impoundment Pool; Moderate Depth
IP3	Class 3 Impoundment Pool; Shallow
BW	Backwater; Slow, Reverse Flow
BG	Boulder Garden
SN	Snye; Isolated Area of Zero Velocity
1.5 m	Indicates Channel Unit Depth
|	Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Or	Organic Material
Si	Silt (<0.06mm)
Sa	Sand (0.06–2mm)
Gr	Gravel (2–64mm)
Co	Cobble (64–256mm)
Bo	Boulder (>256mm)
Bd	Bedrock

Vegetation Type:

Gf	Grass/Forbes
Se	Sedges
Sh	Shrubs
CF	Coniferous Forest
MF	Mixed Forest

Habitat Feature:

- Sand/Mud Bar
- Gravel Bar
- Island
- Woody Debris Pile (DP)

UCB	Undercut Bank (fish cover)
USB	Unstable Bank (slumping or eroding)
OHC	High Quality Overhead Cover
ISC	High Quality Instream Cover
LE	Ledge; Bedrock Intrusion, Vertical Drop

- Overhanging Vegetation
- Inundated Vegetation

SV	Submergent Vegetation
EV	Emergent Vegetation
TV	Terrestrial Vegetation
XX	Beaver Dam

- Direction of Flow

RW	Root Wad

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S14
HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.		S14
DESIGN	CD	13/12/04	SCALE	AS SHOWN	REV. 0
CADD	SWD	12/01/05	**FIGURE: IV-10**		
CHECK	CD	12/01/05			
REVIEW	TC	18/01/05			

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Photo 1 - Downstream view at Site S15 (August 2004).

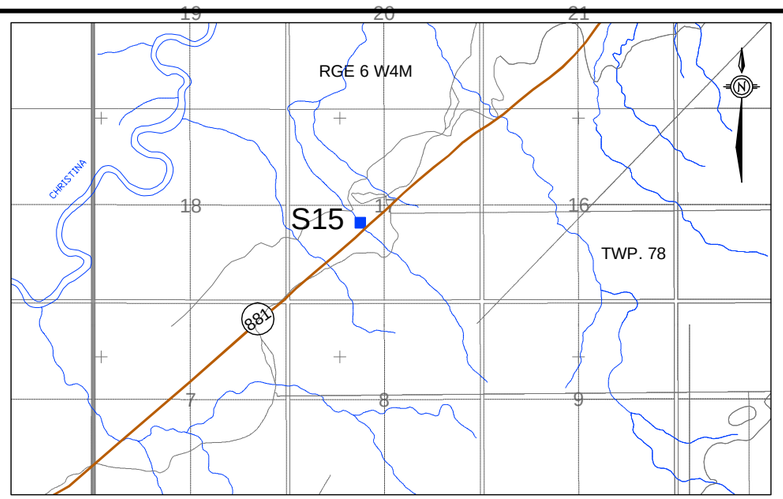
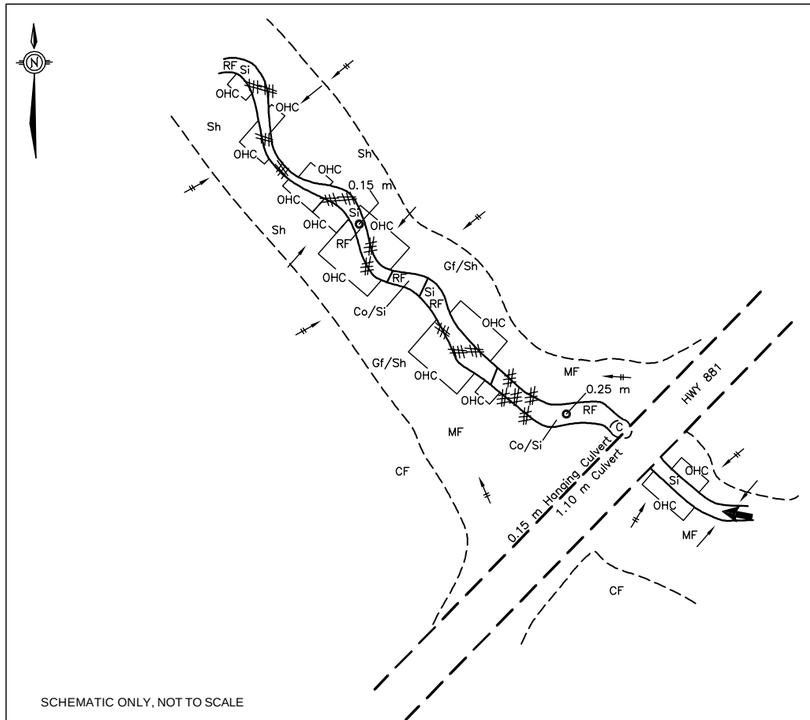


Photo 4 - View of typical habitat at Site S15, showing narrow channel and shallow water depths (August 2004).

Photo 2 - View of narrow channel and typical riparian vegetation at Site S15 (August 2004).



SCHEMATIC ONLY, NOT TO SCALE

Photo 3 - Upstream view at Site S15 (August 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

FA	Falls; Very Swift, Vertical Drop; Impassable to Fish
CA	Cascade; Very Swift, Turbulent; Passable to Fish
CH	Chute; Channel Restricted, Swift, Moderate Depth
RA	Rapids; Very Swift, Deep, With Cover
RF	Riffle; Swift, Shallow, Turbulent
R1	Class 1 Run; Moderately Swift, Deep With Cover
R2	Class 2 Run; Moderately Swift, Moderate Depth and Cover
R3	Class 3 Run; Moderately Swift, Shallow, Limited Cover
FL	Flat; Slow, Laminar Flow, Depositional
P1	Class 1 Scour Pool; Slow, Deep
P2	Class 2 Scour Pool; Slow, Moderate Depth
P3	Class 3 Scour Pool; Slow, Shallow
IP1	Class 1 Impoundment Pool; Deep
IP2	Class 2 Impoundment Pool; Moderate Depth
IP3	Class 3 Impoundment Pool; Shallow
BW	Backwater; Slow, Reverse Flow
BG	Boulder Garden
SN	Snye; Isolated Area of Zero Velocity
1.5	m Indicates Channel Unit Depth
|	Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Or	Organic Material
Si	Silt (<0.06mm)
Sa	Sand (0.06–2mm)
Gr	Gravel (2–64mm)
Co	Cobble (64–256mm)
Bo	Boulder (>256mm)
Bd	Bedrock

Vegetatation Type:

Gf	Grass/Forbes
Se	Sedges
Sh	Shrubs
CF	Coniferous Forest
MF	Mixed Forest

Habitat Feature:

	Sand/Mud Bar
SAND	Gravel Bar
	Island
	Woody Debris Pile (DP)
UCB	Undercut Bank (fish cover)
USB	Unstable Bank (slumping or eroding)

OHC	High Quality Overhead Cover
ISC	High Quality Instream Cover
LE	Ledge; Bedrock Intrusion, Vertical Drop
	Overhanging Vegetation
	Inundated Vegetation
SV	Submergent Vegetation
EV	Emergent Vegetation
TV	Terrestrial Vegetation
XX	Beaver Dam
	Direction of Flow

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

STREAM SITE S15 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.		S15
DESIGN	CD	13/12/04	SCALE	AS SHOWN	REV. 0
CADD	SWD	12/01/05	FIGURE: IV-11		
CHECK	CD	12/01/05			
REVIEW	TC	18/01/05			

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APPENDIX V

HABITAT MAPS AND PHOTOGRAPHS FOR PROPOSED WATERCOURSE CROSSINGS

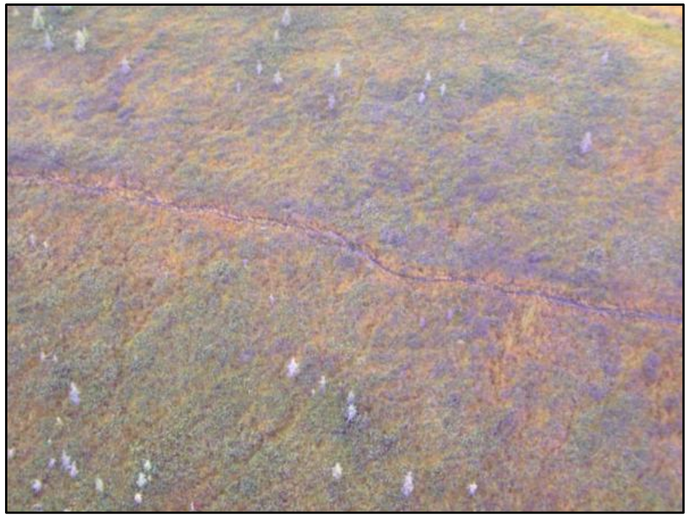

Photo 1 - Aerial view of unnamed tributary at proposed watercourse crossing CR-1 showing terrestrial vegetation throughout (August 2004).

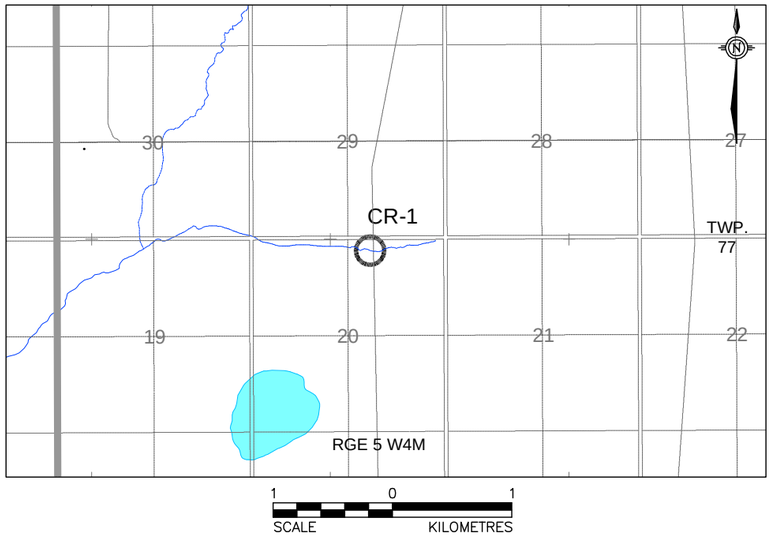

Photo 2 - View of shallow swale at CR-1 (August 2004).

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

PROPOSED WATERCOURSE CROSSING CR-1

MEG ENERGY CORP.

PROJECT 04-1334-001.6140			FILE No.		CR-1
DESIGN	XXX	01/01/02	SCALE	AS SHOWN	REV. 0
CADD	SWD	06/01/05	**FIGURE: V-1**		
CHECK	CD	06/01/05			
REVIEW	TC	18/01/05			

R:\CAD\2004\1322-EA\1334\04-1334-001 MEG\6100\6140-Baseline\Fig V-1 Unnamed Creek CR-1.dwg Jun 02, 2005 - 12:46pm

Photo 1 - Aerial view of unnamed tributary at proposed watercourse crossing CR-2 (August 2004).

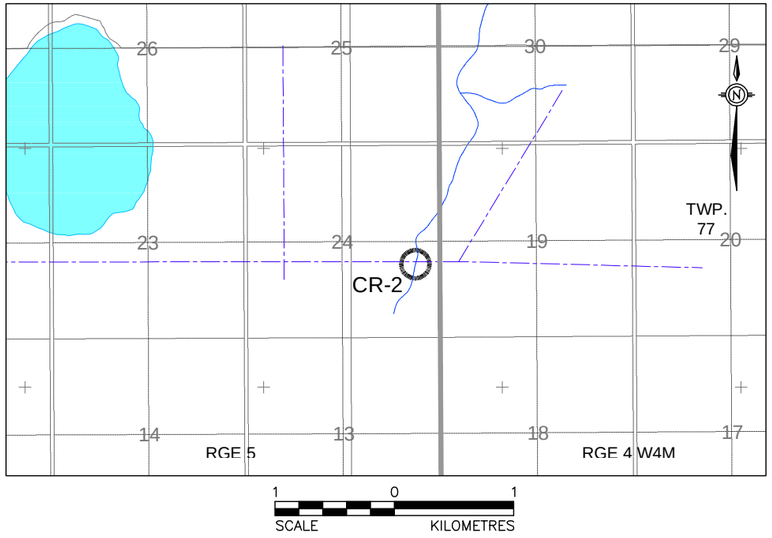

Photo 4 - View of typical shallow, flat habitat at CR-2 (August 2004).

Photo 2 - Downstream view of the unnamed tributary at CR-2 showing ATV bridge (August 2004).

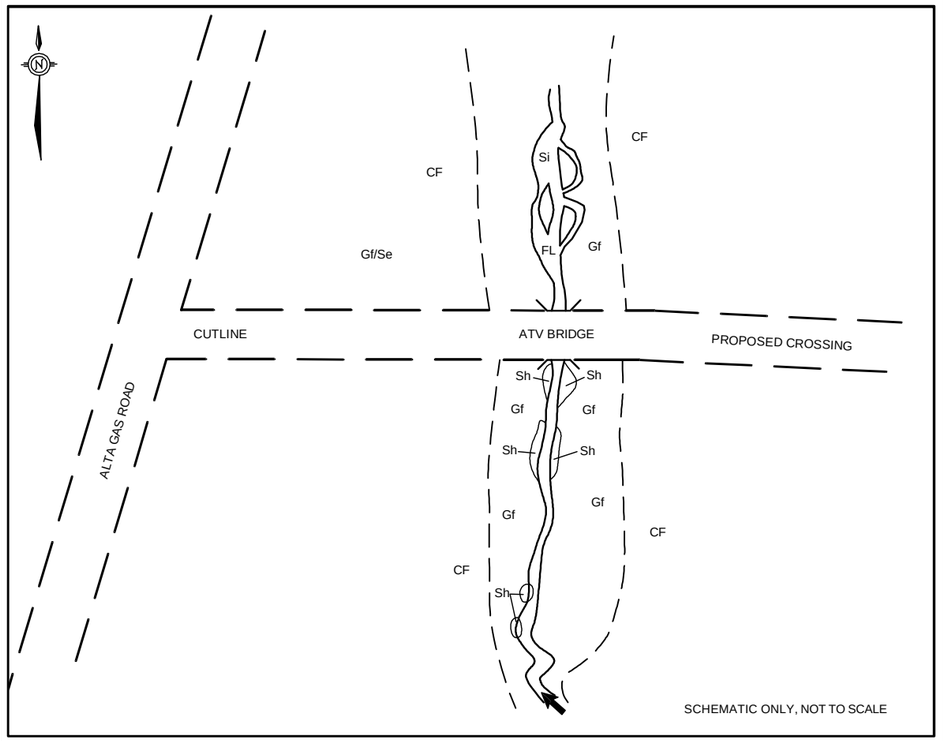

Photo 3 - Upstream view at CR-2 showing flat habitat (August 2004).

LEGEND - STREAM HABITAT MAPPING SYSTEM

Channel Unit/Habitat Type:

FA	Falls; Very Swift, Vertical Drop; Impassable to Fish
CA	Cascade; Very Swift, Turbulent; Passable to Fish
CH	Chute; Channel Restricted, Swift, Moderate Depth
RA	Rapids; Very Swift, Deep, With Cover
RF	Riffle; Swift, Shallow, Turbulent
R1	Class 1 Run; Moderately Swift, Deep With Cover
R2	Class 2 Run; Moderately Swift, Moderate Depth and Cover
R3	Class 3 Run; Moderately Swift, Shallow, Limited Cover
FL	Flat; Slow, Laminar Flow, Depositional
P1	Class 1 Scour Pool; Slow, Deep
P2	Class 2 Scour Pool; Slow, Moderate Depth
P3	Class 3 Scour Pool; Slow, Shallow
IP1	Class 1 Impoundment Pool; Deep
IP2	Class 2 Impoundment Pool; Moderate Depth
IP3	Class 3 Impoundment Pool; Shallow
BW	Backwater; Slow, Reverse Flow
BG	Boulder Garden
SN	Snye; Isolated Area of Zero Velocity
1.5	m Indicates Channel Unit Depth
|	Channel Unit Divider

Shore/Bottom Slope

- Shallow Slope
- Moderate Slope
- Moderately Steep Slope
- Steep Slope

Substrate Particle Size:

Or	Organic Material
Si	Silt (<0.06mm)
Sa	Sand (0.06–2mm)
Gr	Gravel (2–64mm)
Co	Cobble (64–256mm)
Bo	Boulder (>256mm)
Bd	Bedrock

Vegetation Type:

Gf	Grass/Forbes
Se	Sedges
Sh	Shrubs
CF	Coniferous Forest
MF	Mixed Forest

Habitat Feature:

- Sand/Mud Bar
- Gravel Bar
- Island
- Woody Debris Pile (DP)
- UCB Undercut Bank (fish cover)
- USB Unstable Bank (slumping or eroding)
- OHC High Quality Overhead Cover
- ISC High Quality Instream Cover
- LE Ledge; Bedrock Intrusion, Vertical Drop
- Overhanging Vegetation
- Inundated Vegetation
- SV Submergent Vegetation
- EV Emergent Vegetation
- TV Terrestrial Vegetation
- XX Beaver Dam
- Direction of Flow

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

PROPOSED WATERCOURSE CROSSING CR-2 HABITAT MAP

MEG ENERGY CORP.

PROJECT 04–1334–001.6140			FILE No.		CR–2
DESIGN	CD	17/12/02	SCALE	AS SHOWN	REV. 0
CADD	SWD	12/01/05			
CHECK	CD	12/01/05			
REVIEW	TC	18/01/05			

FIGURE: V-2

R:\CAD\2004\1322-EA\1334\04-1334-001 MEG\6100\6140-Baseline\Fig V-2 Unnamed Creek CR-2.dwg Jun 02, 2005 - 12:47pm

APPENDIX VI

RAW LENGTH AND WEIGHT DATA FOR SUCKERS AND SPORT FISH CAPTURED DURING 2004 BASELINE SURVEYS

Table VI-1 Raw Length and Weight Data for Suckers and Sport Fish Captured During 2004 Baseline Field Surveys

Waterbody or Watercourse	Site ID	Capture Date	Capture Method	Species	Fork Length (mm)	Weight (g)	Life Stage
Unnamed Waterbody 2	WB2	21-May-04	gill net	Northern pike	880	1300	adult
Unnamed Waterbody 2	WB2	21-May-04	gill net	Northern pike	480	900	adult
Unnamed Waterbody 2	WB2	21-May-04	gill net	Northern pike	540	1120	adult
Unnamed Waterbody 2	WB2	21-May-04	gill net	Northern pike	540	1110	adult
Unnamed Waterbody 2	WB2	21-May-04	gill net	Northern pike	520	1150	adult
Unnamed Waterbody 2	WB2	21-May-04	gill net	Northern pike	530	1160	adult
Unnamed Waterbody 2	WB2	21-May-04	gill net	Northern pike	620	1510	adult
Unnamed Waterbody 2	WB2	21-May-04	gill net	Northern pike	530	1100	adult
Unnamed Waterbody 2	WB2	21-May-04	gill net	Northern pike	495	880	adult
Unnamed Waterbody 2	WB2	21-May-04	gill net	Northern pike	481	750	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	580	1600	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	526	1170	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	487	810	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	520	1150	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	543	1070	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	540	1180	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	460	820	juvenile
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	568	1530	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	525	1060	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	529	1145	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	503	990	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	495	740	adult
Unnamed Waterbody 2	WB2	29-Aug-04	gill net	Northern pike	535	1180	adult
Unnamed Waterbody 6	WB6	21-May-04	gill net	Northern pike	600	1500	adult
Unnamed Waterbody 6	WB6	21-May-04	gill net	Northern pike	700	1750	adult
Unnamed Waterbody 6	WB6	21-May-04	gill net	Northern pike	481	950	juvenile
Unnamed Waterbody 6	WB6	21-May-04	gill net	Northern pike	458	750	adult
Unnamed Waterbody 6	WB6	21-May-04	gill net	Northern pike	562	1330	adult
Unnamed Waterbody 6	WB6	21-May-04	gill net	Northern pike	650	1340	adult
Unnamed Waterbody 6	WB6	21-May-04	gill net	Northern pike	560	1445	adult
Unnamed Waterbody 6	WB6	21-May-04	gill net	Northern pike	520	1235	adult
Unnamed Waterbody 6	WB6	31-Aug-04	gill net	Northern pike	213	180	juvenile
Unnamed Waterbody 6	WB6	31-Aug-04	gill net	Northern pike	390	760	juvenile
Unnamed Waterbody 6	WB6	31-Aug-04	gill net	Northern pike	230	160	juvenile
Unnamed Waterbody 6	WB6	31-Aug-04	gill net	Northern pike	229	130	juvenile

Table VI-1 Raw Length and Weight Data for Suckers and Sport Fish Captured During 2004 Baseline Field Surveys (continued)

Waterbody or Watercourse	Site ID	Capture Date	Capture Method	Species	Fork Length (mm)	Weight (g)	Life Stage
Unnamed Waterbody 6	WB6	31-Aug-04	gill net	Northern pike	220	110	juvenile
Unnamed Waterbody 6	WB6	31-Aug-04	gill net	Northern pike	225	120	juvenile
Unnamed Waterbody 12	WB12	31-Aug-04	gill net	Northern pike	469	840	juvenile
Unnamed Waterbody 12	WB12	31-Aug-04	gill net	Northern pike	450	800	juvenile
Unnamed Waterbody 12	WB12	31-Aug-04	gill net	Northern pike	327	610	juvenile
Unnamed Waterbody 12	WB12	31-Aug-04	gill net	Northern pike	355	390	juvenile
Unnamed Waterbody 12	WB12	31-Aug-04	gill net	Northern pike	424	1030	adult
Unnamed Waterbody 12	WB12	31-Aug-04	gill net	Northern pike	355	490	juvenile
Unnamed Waterbody 12	WB12	31-Aug-04	gill net	Northern pike	415	960	juvenile
"Sawbones Creek"	S1A	16-May-04	boat electrofishing	Walleye	381	260	adult
unnamed tributary to the north bay of Christina Lake ("Sawbones Creek")	S1A	16-May-04	boat electrofishing	Walleye	434	450	adult
unnamed tributary to the east shore of Christina Lake	S6	31-Aug-04	boat electrofishing	White sucker	310	410	adult

APPENDIX VII
BENTHIC INVERTEBRATE DATA

Table VII-1 Abundances of Invertebrates in Ekman Grab Samples (0.023 m^2) Collected in the Project Aquatics Local Study Area, August 26 and August 31, 2004

-1 Abundances of Invertebrates in Ekman Grab Samples (0.02322m^2) Collected in the Christina Lake Regional Project Local Study Area, August 26 and August 31, 2004																																
Major Group	Family(Subfamily/ Tribe)	Genus/Species	Christina Lake						"Sawbones Creek" (Site S1)					Unnamed Tributary to East Shore (Site S6)					Unnamed Waterbody 6					Unnamed Waterbody 7					Unnamed Waterbody 12				
			CL1 -A	CL1 -B	CL1 -C	CL2- A	CL2 -B	CL2 -C	S1 -A	S1 -B	S1 -C	S1 -D	S1 -E	S6 -A	S6 -B	S6 -C	S6 -D	S6 -E	WB6 -A	WB6 -B	WB6 -C	WB6 -D	WB6 -E	WB7 -A	WB7 -B	WB7 -C	WB7 -D	WB7 -E	WB12 -A	WB12 -B	WB12 -C	WB12 -D	WB12 -E
Oligochaeta	Naididae	-	0	0	0	6	0	0	0	10	0	10	0	0	5	0	0	0	0	10	10	10	20	0	0	0	0	0	0	0	0	0	0
	Enchytraeidae	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	10	0	0	0	0	0	0	0	0	0	0
	Lumbriculidae	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	12	0	0	10	0	0	0	0	0	0	0
	Tubificidae	-	2	4	0	6	0	1	0	0	5	0	0	0	0	5	0	0	30	0	0	0	0	0	10	10	0	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	*Glossiphonia complanata*	0	0	0	0	0	0	0	0	0	0	1	0	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		Theromyzon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
		Helobdella stagnalis	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0
	Erpobdellidae	*Erpobdella punctata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
		Nephelopsis obscura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Nematoda	-	-	2	0	0	30	0	7	10	30	10	20	0	10	5	65	60	10	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0
Gastropoda	Physidae	*Physa*	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Planorbidae	*Gyraulus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	10	0	0
		Helisoma	0	0	0	0	0	0	0	40	0	10	0	170	31	5	120	30	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
	Valvatidae	*Valvata sincera*	0	0	0	0	0	0	33	15	4	12	20	4	0	0	3	13	0	0	0	0	0	0	0	0	0	0	4	4	2	20	8
		Valvata tricarinata	0	0	0	0	0	0	0	0	0	0	0	4	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pelecypoda	Sphaeriidae	-	9	8	4	1	0	0	104	266	35	71	41	8	13	1	117	38	0	0	0	0	0	90	10	0	10	20	31	11	30	2	20
Hydracarina	-	-	0	0	0	0	0	0	0	0	0	10	0	10	10	15	80	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ostracoda	-	-	72	96	48	0	0	0	140	310	130	160	140	90	15	10	120	70	10	11	0	10	11	10	0	0	10	10	0	0	0	0	0
Cladocera	Chydoridae	-	0	0	0	0	0	0	0	20	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	30	70	10	60	30
	Daphnidae	*Daphnia*	0	0	0	14	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Macrothricidae	-	1	0	0	0	0	0	10	20	5	0	0	10	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copepoda - Calanoida	-	-	0	0	0	0	16	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copepoda - Cyclopoida	-	-	87	120	32	102	36	62	10	30	20	10	10	0	0	5	0	0	80	60	10	20	110	10	20	0	0	0	180	220	60	260	40
Copepoda - Harpacticoida	-	-	69	28	4	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0	0	0
Amphipoda	Gammaridae	*Gammarus*	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	14	1	0	2	1	0	0	0	1	0	0	0	0	0	0
	Hyalellidae	*Hyalella azteca*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	4	25	10	1	3	1	9	21	13	31	22	42
Ephemeroptera	Caenidae	*Caenis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	10	10	0	0	0	0	0	0	0	0
Odonata - Anisoptera	Corduliidae	*Cordulia*	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Coleoptera	Chrysomelidae	*Donacia*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Leptoceridae	*Triaenodes*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Limnephilidae	*Nemotaulius*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Phryganeidae	*Agrypnia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chaoboridae	*Chaoborus*	0	0	0	4	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	12	0
	Ceratopogonidae	-	0	0	0	4	0	0	11	40	5	0	20	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	1	1
	Tabanidae	*Chrysops*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
	Chironomidae - pupa	-	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0
	Chironomidae	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(Diamesinae)	*Potthastia longimana* gr.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(Chironominae)	-	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table VII-1 Abundances of Invertebrates in Ekman Grab Samples (0.023 m^2) Collected in the Project Aquatics Local Study Area, August 26 and August 31, 2004 (continued)

-1 Abundances of Invertebrates in Ekman Grab Samples (0.02322m^2) Collected in the Christina Lake Regional Project Local Study Area, August 26 and August 31, 2004																																
Major Group	Family(Subfamily/ Tribe)	Genus/Species	Christina Lake						"Sawbones Creek" (Site S1)					Unnamed Tributary to East Shore (Site S6)					Unnamed Waterbody 6					Unnamed Waterbody 7					Unnamed Waterbody 12				
			CL1 -A	CL1 -B	CL1 -C	CL2- A	CL2 -B	CL2 -C	S1 -A	S1 -B	S1 -C	S1 -D	S1 -E	S6 -A	S6 -B	S6 -C	S6 -D	S6 -E	WB6 -A	WB6 -B	WB6 -C	WB6 -D	WB6 -E	WB7 -A	WB7 -B	WB7 -C	WB7 -D	WB7 -E	WB12 -A	WB12 -B	WB12 -C	WB12 -D	WB12 -E
		Chironomus	0	0	0	1	0	0	0	0	0	0	0	0	15	0	0	10	11	2	2	3	3	0	0	0	0	0	0	0	0	1	1
		Cladopelma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Cryptochironomus	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0
		Dicrotendipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	10	12	0	0	0	0	0	0	0	0	0	0
		Endochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Glyptotendipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	12	1	1	18	4	0	0	0	0	0	0	0	0	0	0
		Microtendipes	0	0	0	0	0	0	0	0	0	0	0	0	0	10	20	0	1	2	0	10	0	0	0	0	0	0	0	1	0	0	0
		Pagastiella	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	60	40	0	20	10	0	0	0	0	0
		Parachironomus	0	0	0	0	0	0	0	0	0	0	0	0	5	0	20	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Paralauterborniella	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Polypedilum	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	11	0	20	3	2	0	0	0	0	0	0	0	0	0	0
		Sergentia	2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(Tanytarsini)	*Cladotanytarsus*	0	0	0	0	0	0	10	20	5	0	30	0	0	0	0	0	0	0	20	0	0	10	0	0	10	20	0	0	0	0	0
		Micropsectra	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Paratanytarsus	0	0	0	0	0	0	0	0	0	0	0	0	5	0	20	0	10	10	0	0	10	0	0	0	0	0	0	0	0	0	0
		Stempellinella	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Tanytarsus	0	0	6	0	0	0	90	161	55	50	30	0	5	0	0	0	0	0	0	10	0	10	0	0	0	0	10	0	0	0	0
	(Orthocladiinae)	*Cricotopus*	0	0	0	4	0	2	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Psectrocladius	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
		Tvetenia	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(Tanypodinae)	-	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Clinotanypus	0	0	0	0	0	0	10	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Procladius	6	4	2	0	0	0	50	153	40	40	20	0	0	0	40	10	14	1	0	1	11	10	51	0	20	15	2	21	0	13	2
Terrestrial	-	-	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total			253	271	104	176	60	100	489	1149	320	395	322	307	129	148	625	250	216	114	69	103	232	222	152	24	104	85	290	373	145	392	145

Table VII-2 Abundances of Common Invertebrates in the Christina Lake Regional Project Local Study Area, August 26 and August 31, 2004

Christina Lake (Site CL1)						
Major Taxon	**Family**	**Subfamily/ Tribe**	**Genus/ Species**	**Mean (no./m^2)**	**SE**	**% of total**
Ostracoda	-	-	-	3,096	596	56.5
Copepoda - Harpacticoida	-	-	-	1,448	816	26.4
Pelecypoda	Sphaeriidae	-	-	301	66	5.5
Diptera	Chironomidae	Chironominae	*Sergentia*	215	66	3.9
Diptera	Chironomidae	Tanypodinae	*Procladius*	172	50	3.1
Oligochaeta	Tubificidae	-	-	86	50	1.6
Diptera	Chironomidae	Tanytarsini	*Tanytarsus*	86	86	1.6
Mean Abundance				**5,475**	**1,206**	**98.7**
Total Richness				**10**	-	-
Christina Lake (Site CL2)						
Major Taxon	**Family**	**Subfamily/ Tribe**	**Genus/ Species**	**Mean (no./m^2)**	**SE**	**% of total**
Nematoda	-	-	-	530	390	56.1
Oligochaeta	Tubificidae	-	-	100	80	10.6
Oligochaeta	Naididae	-	-	86	86	9.1
Diptera	Chironomidae	Orthocladiinae	*Cricotopus*	86	50	9.1
Diptera	Ceratopogonidae	-	-	57	57	6.1
Diptera	Chironomidae	Orthocladiinae	*Tvetenia*	43	43	4.5
Pelecypoda	Sphaeriidae	-	-	14	14	1.5
Amphipoda	Hyalellidae	-	*Hyalella azteca*	14	14	1.5
Diptera	Chironomidae	Chironominae	*Chironomus*	14	14	1.5
Mean Abundance				**946**	**741**	**100.0**
Total Richness				**9**	-	-

Table VII-2 Abundances of Common Invertebrates in the Christina Lake Regional Project Local Study Area, August 26 and August 31, 2004 (continued)

Unnamed Waterbody 6 (Site WB6)						
Major Taxon	**Family**	**Subfamily/ Tribe**	**Genus/ Species**	**Mean (no./m^2)**	**SE**	**% of total**
Oligochaeta	Naididae	-	-	430	136	11.0
Ostracoda	-	-	-	361	91	9.3
Diptera	Chironomidae	Chironominae	*Glyptotendipes*	310	145	7.9
Diptera	Chironomidae	Chironominae	*Polypedilum*	310	159	7.9
Amphipoda	Hyalellidae	-	*Hyalella azteca*	301	196	7.7
Diptera	Chironomidae	Chironominae	*Dicrotendipes*	284	117	7.3
Oligochaeta	Tubificidae	-	-	258	258	6.6
Diptera	Chironomidae	Tanytarsini	*Paratanytarsus*	258	105	6.6
Diptera	Chironomidae	Tanypodinae	*Procladius*	232	127	5.9
Diptera	Chironomidae	Chironominae	*Chironomus*	181	74	4.6
Oligochaeta	Enchytraeidae	-	-	172	105	4.4
Diptera	Chironomidae	Tanytarsini	*Cladotanytarsus*	172	172	4.4
Amphipoda	Gammaridae		*Gammarus*	155	113	4.0
Oligochaeta	Lumbriculidae	-	-	138	97	3.5
Diptera	Chironomidae	Chironominae	*Microtendipes*	112	81	2.9
Diptera	Chironomidae	Chironominae	-	86	86	2.2
Diptera	Chironomidae	Tanytarsini	*Tanytarsus*	86	86	2.2
Mean Abundance				**3,904**	**709**	**98.5**
Total Richness				**21**	-	-
Unnamed Waterbody 7 (Site WB7)						
Major Taxon	**Family**	**Subfamily/ Tribe**	**Genus/ Species**	**Mean (no./m^2)**	**SE**	**% of total**
Pelecypoda	Sphaeriidae	-	-	1,118	701	24.2
Diptera	Chironomidae	Chironominae	*Pagastiella*	1,118	463	24.2
Diptera	Chironomidae	Tanypodinae	*Procladius*	826	370	17.9
Diptera	Chironomidae	Tanytarsini	*Cladotanytarsus*	344	161	7.4
Ostracoda	-	-	-	258	105	5.6
Amphipoda	Hyalellidae	-	*Hyalella azteca*	206	84	4.5
Oligochaeta	Tubificidae	-	-	172	105	3.7
Ephemeroptera	Caenidae		*Caenis*	172	105	3.7
Oligochaeta	Lumbriculidae	-	-	86	86	1.9
Gastropoda	Planorbidae		*Gyraulus*	86	86	1.9
Diptera	Chironomidae	Tanytarsini	*Tanytarsus*	86	86	1.9
Diptera	Chironomidae	Orthocladiinae	*Psectrocladius*	86	86	1.9
Mean Abundance				**4,618**	**1,344**	**98.7**
Total Richness				**17**	-	-

Table VII-2 Abundances of Common Invertebrates in the Christina Lake Regional Project Local Study Area, August 26 and August 31, 2004 (continued)

Unnamed Waterbody 12 (Site WB12)						
Major Taxon	**Family**	**Subfamily/ Tribe**	**Genus/ Species**	**Mean (no./m^2)**	**SE**	**% of total**
Amphipoda	Hyalellidae	-	*Hyalella azteca*	1,109	213	34.8
Pelecypoda	Sphaeriidae	-	-	808	239	25.3
Gastropoda	Valvatidae	-	*Valvata sincera*	327	140	10.2
Diptera	Chironomidae	Tanypodinae	*Procladius*	327	174	10.2
Copepoda - Harpacticoida	-	-	-	172	105	5.4
Diptera	Ceratopogonidae	-	-	112	91	3.5
Nematoda	-	-	-	86	86	2.7
Gastropoda	Planorbidae	-	*Gyraulus*	86	86	2.7
Diptera	Chironomidae	Tanytarsini	*Tanytarsus*	86	86	2.7
Mean Abundance				**3,191**	**165**	**97.6**
Total Richness				**16**	-	-
Tributary to the North Bay of Christina Lake ("Sawbones Creek") (Site S1)						
Major Taxon	**Family**	**Subfamily/ Tribe**	**Genus/ Species**	**Mean (no./m^2)**	**SE**	**% of total**
Ostracoda	-	-	-	7,568	1,456	34.8
Pelecypoda	Sphaeriidae	-	-	4,446	1,826	20.4
Diptera	Chironomidae	Tanytarsini	*Tanytarsus*	3,320	992	15.3
Diptera	Chironomidae	Tanypodinae	*Procladius*	2,606	1,015	12.0
Gastropoda	Valvatidae	-	*Valvata sincera*	722	207	3.3
Diptera	Ceratopogonidae	-	-	654	303	3.0
Nematoda	-	-	-	602	219	2.8
Diptera	Chironomidae	Tanytarsini	*Cladotanytarsus*	559	232	2.6
Gastropoda	Planorbidae	-	*Helisoma*	430	333	2.0
Mean Abundance				**21,758**	**6,309**	**96.1**
Total Richness				**24**	-	-

Table VII-2 Abundances of Common Invertebrates in the Christina Lake Regional Project Local Study Area, August 26 and August 31, 2004 (continued)

Tributary to the East Shore of Christina Lake (Site S6)						
Major Taxon	**Family**	**Subfamily/ Tribe**	**Genus/ Species**	**Mean (no./m^2)**	**SE**	**% of total**
Gastropoda	Planorbidae	-	*Helisoma*	3,062	1,354	24.7
Ostracoda	-	-	-	2,623	918	21.2
Pelecypoda	Sphaeriidae	-	-	1,522	917	12.3
Nematoda	-	-	-	1,290	573	10.4
Hydracarina	-	-	-	1,075	593	8.7
Diptera	Chironomidae	Chironominae	*Parachironomus*	473	258	3.8
Diptera	Chironomidae	Tanypodinae	*Procladius*	430	333	3.5
Diptera	Chironomidae	Chironominae	*Microtendipes*	258	172	2.1
Diptera	Chironomidae	Chironominae	*Chironomus*	215	136	1.7
Diptera	Chironomidae	Tanytarsini	*Paratanytarsus*	215	167	1.7
Gastropoda	Valvatidae	-	*Valvata sincera*	172	103	1.4
Diptera	Chironomidae	Chironominae	*Cladopelma*	172	172	1.4
Mean Abundance				**12,375**	**3,880**	**93.0**
Total Richness				**28**	-	-

APPENDIX VIII

QUALITY ASSURANCE AND QUALITY CONTROL FOR BENTHIC INVERTEBRATE MONITORING

Background Information

Practices used in a biological study will determine the quality of the samples collected, data compiled and analyzed, and the final report. A quality assurance and quality control (QA/QC) program will assist in maintaining the integrity of the study and help identify uncertainties associated with assessments made from the data.

Management and technical practices used to ensure that data are consistent and of high quality fall under quality assurance. Specific aspects of quality assurance that encompass techniques used to assess data quality and the remedial measures to be taken when the data quality objectives are not met, are considered quality control.

The QA/QC program for this survey consisted of quality management, the use of standardized field and laboratory procedures, the development of data quality objectives, and specific quality control procedures to determine whether data quality objectives were met.

Quality Management

The Quality Assurance Manager for the benthic invertebrate component of the Project was Z. Kovats, M.Sc. who performed the required QA/QC functions. This included ensuring field work and laboratory work were conducted according to standard procedures, and were consistent with generally accepted practices (AENV 1990; Gibbons et al. 1993; Environment Canada 2002) and scientific literature. Other activities included identifying data quality objectives, and carrying out QC protocols related to benthic invertebrate sample processing, field and laboratory reporting and data analysis.

Data Quality Objective for Laboratory Work

The data quality objective for benthic invertebrate sample sorting requires a minimum sorting efficiency of 90% removal of the organisms from each sample (Environment Canada 2002). In the event that this level of sorting efficiency is not achieved, all samples must be re-sorted until such a level is attained.

Benthic Invertebrate Sample Processing - QC Procedures and Results

Three samples were resorted to verify sorting efficiency of benthic invertebrate sample processing. Quality control results are shown in Table VII-1. Invertebrate removal efficiency ranged from 96.3 to 98.9%. These results indicate that the data quality objective of >90% sorting efficiency was met.

Table VIII-1 Quality Control Results for Re-Sorted Samples

	Sample CL2-A	Sample S1-C	Sample S6-B
total missed	2	5	5
total in sample	176	320	129
percent missed	1.1	1.6	3.9
sorting efficiency (%)[(a)]	98.9	98.5	96.3

(a) % sorting efficiency = [1-(# missed / (# sorted originally + # missed)]* 100.

Data Management and Analysis

Taxonomic lists used for data analysis were checked against tally sheets by the person entering the data. Backup files were generated during data analysis to prevent loss of data. The accuracy of calculations was verified during and after data analysis. Backups of data and results of analysis in printed and electronic format are stored with appropriate documentation to ensure the analysis may be reproduced, if necessary.